ARGOSystems AS210
Time & Frequency Standard

The ARGOSystems AS210 consists of either a 6-slot rack mount mainframe or a 5-slot portable mainframe and several plug-in modules. The mainframe is a Tektronix TM-506 or a TM-515 which has been electrically and mechanically modified to accommodate an Efratom FRK Rubidium Frequency Standard in the power supply section behind the main motherboard.

The AS210-01A Module Controller is a double wide plug-in containing a microprocessor that controls the remaining three (or four) plug-in modules that are placed in the mainframe.

The complete list of available modules is shown below. Service manuals are available for each mainframe and plug-in (but a few have proven hard to find).

AS210	**Brief List of System Errors**
AS210A-PM	**Portable Mainframe**
AS210-RM, -LM	**Mainframe (manual not found yet)**
AS210-01A	**Module Controller**
AS210-02	**Frequency Comparator**
AS210-03	**Frequency Generator**
AS210-04	**Digital Delay Generator**
AS210-05	**Standby Battery**
AS210-06	**Microwave Frequency Generator**
AS210-08	**Distribution Amplifier (manual not found yet)**
AS210-20	**Time Clock (manual not found yet)**
Efratom FRK	**Low Noise Rubidium Frequency Standard**

ARGOSystems AS210
Electronic Counter and Frequency Standard Calibration System errors

AS210-01A MODULE CONTROLLER	
1-01	Display RAM cannot be cleared
1-02	Display RAM cannot be written to
1-03	Keyboard interface malfunction
1-04	EPROM checksum error
1-05	RAM read/write error
1-06	Parallel I/O malfunction
1-07	No 10 pps to CPU interrupt 7.5
1-08	Power fail timer not advancing
1-09	Power fail timer advancing faster than once every 10 Seconds
1-10	Interval timer malfunction
1-11	IEEE-488 interface malfunction
1-12	RAM battery back-up is completely discharged
1-13	No modules plugged in to satisfy remote learn command

AS210-02 FREQUENCY COMPARATOR	
2-01	Output decade registers cannot be cleared
2-02	Input selector circuit is not working properly
2-03	Measurement complete but flip flops will not reset
2-04	No measurement time base
2-05	Self test measurement not within ±1 part in 10^8
2-11 to 2-16	No signal present at indicated input or signal output is not one of the allowed standard frequencies
2-20	Data points selected for drift rate calculation are separated by less than 1 minute
2-21	Data points separated by discontinuous time (power failure without battery backup of frequency standard)
2-22	Initial data point in drift rate calculation overflowed
2-23	Final data point overflowed
2-30	Channel number specified has no data associated with it
2-40	Data point specified is empty
2-50	Remote continue command with module in standby mode

AS210-03 FREQUENCY GENERATOR	
3-03	1 MHz malfunction, no leveling loop indication
3-04	10 MHz malfunction, no leveling loop indication
3-X1	Frequency X did not phase lock where X is 0 thru 5, and 0 = 50 MHz, 1 = 100 MHz, 2 = 200 MHz, 3 = 300 MHz, 4 = 400 MHz, 5 = 500 MHz
3-X2	Frequency X had no leveling loop indication where X is 0 thru 5

AS210-04 DIGITAL DELAY GENERATOR	
4-00	On 10 KHz setting delay ≥99 µSeconds or on 1 KHz setting delay ≥999 µSeconds
4-10	Self test, PRR ≠ 1 pps
4-11	Self test, PRR ≠ 10 pps
4-12	Self test, PRR ≠ 100 pps
4-20	Self test delay error: 1 Hz
4-21	Self test delay error: 10 Hz
4-22	Self test delay error: 100 Hz
4-30	Self test delayed pulse not occurring

AS210-05 STANDBY BATTERY	
	No information available

AS210-06 MICROWAVE GENERATOR	
6-00	Frequency not available
6-0X	No leveling loop indication at frequency X where X is 1 thru 9, and 1 = 1 GHz, 2 = 2 GHz, 3 = 3 GHz, … 9 = 9 GHz
6-1X	No leveling loop indication at frequency X where X is 0 thru 8, and 0 = 10 GHz, 1 = 11 GHz, 2 = 12 GHz, 3 = 13 GHz, … 8 = 18 GHz
6-30	1 GHz source not locked
6-40	Calibration in progress
6-50	Unable to level, and level chosen is greater than guaranteed by performance specifications

AS210-08 DISTRIBUTION AMPLIFIER	
	No information available

AS210-20 TIME CLOCK	
	No information available

M83-0004

AS210A-PM

PORTABLE MAINFRAME

Revised 8/84

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PREFACE

This manual contains the operation and maintenance instructions for the AS210A-PM Portable Mainframe. The data contained herein is arranged as follows:

Reference Publications

AS210-01A Module Controller Operation and Maintenance Manual
AS210-02 Frequency Comparator Operation and Maintenance Manual
AS210-03 Frequency Generator Operation and Maintenance Manual
AS210-04 Digital Delay Generator Operation and Maintenance Manual
AS210-05 Standby Battery Operation and Maintenance Manual
AS210-06 Microwave Generator Operation and Maintenance Manual
AS210-08 Distribution Amplifier Operation and Maintenance Manual
AS210-20 Time Clock Operation and Maintenance Manual

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

The heart of the AS210 Electronic Counter and Frequency Standard Calibration System is the AS210A-PM Mainframe shown in Figure 1.1. The AS210A-PM Portable Mainframe can support the double width AS210-01A Module Controller and three single width AS210-type plug-ins. The highly accurate Rubidium frequency standard that provides the time base for the system's frequency measurement circuits is housed within the mainframe. The mainframe and all plug-in modules are completely programmable through an IEEE-488 interface. The AS210-01A and other plug-in modules of the AS210 series are described in separate manuals available from ARGOSystems.

1-2 AS210A-PM PHYSICAL AND ELECTRICAL DESCRIPTION

The AS210A-PM Portable Mainframe consists of two main pieces: a rugged chassis with covers and a power module assembly. The power module slides into the rear of the chassis and is secured by two captured mounting screws. AS210-type modules are inserted into the front of the chassis to mate with the power module. The AS210A-PM Portable Mainframe will slide easily under an airline seat while traveling.

The portable mainframe chassis includes a module locking bar which prevents the modules from sliding out, front and rear covers to protect the instrument during travel, and a convenient heavy-duty carrying handle. The power module contains the highly accurate rubidium frequency standard, power supply, internal/external time base selector circuitry, and the motherboard. The internal/external time base selector assembly permits the AS210 system to be phase-locked to an external frequency standard.

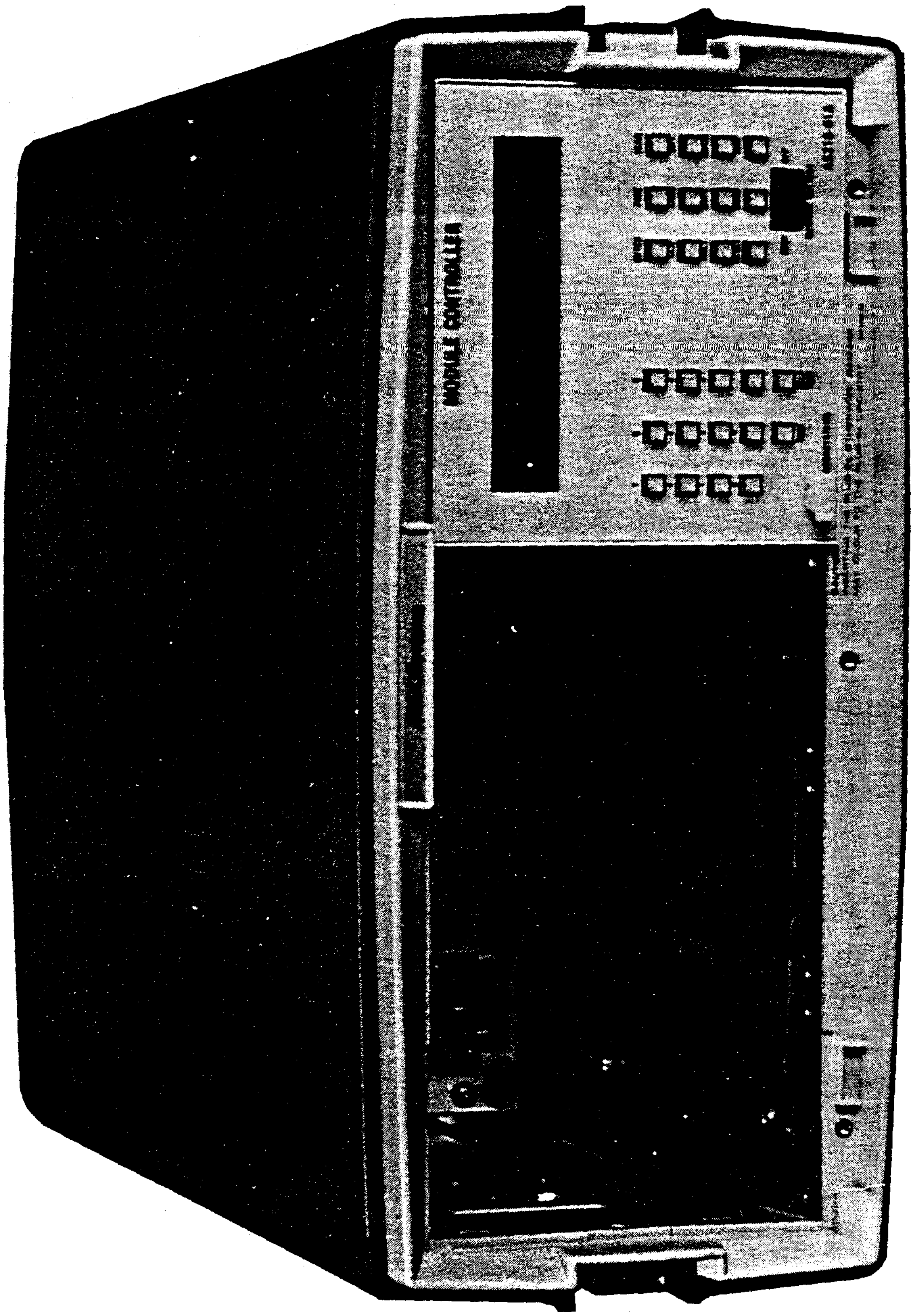


Figure 1.1 Portable Mainframe with AS210-01A Module Controller Installed

The blower fan and power transformer are located on the rear panel. Connectors and controls located on the rear panel are a 10 MHz reference frequency output, internal/external frequency select switch, IEEE-488 interface connector, power switch, external frequency reference input, and internal frequency adjustment. The power module may be removed from the chassis and modules installed for maintenance purposes. Table 1-1 is an electrical/mechanical specification for the mainframe in the AS210 Electronic Counter and Frequency Standard Calibration system.

Table 1-1

AS210 MAINFRAME SPECIFICATIONS

	SPECIFICATION	TYPICAL
INTERNAL RUBIDIUM FREQUENCY STANDARD FREQUENCY RETRACE (AFTER TURN-ON)	$\pm 3 \times 10^{-11}$	$\pm 1 \times 10^{-11}$
STABILITY VERSUS		
TIME	$\pm 2 \times 10^{-11}$ per month	$\pm 1 \times 10^{-11}$ per month
TEMPERATURE (0 to 40°C)	$\pm 1 \times 10^{-10}$	$\pm 5 \times 10^{-11}$
VIBRATION, SHOCK, PULSE, TRANSIT, DROP, AND BENCH HANDLING (PER MIL-T-28800B)	$+1 \times 10^{-10}$	$+5 \times 10^{-11}$
$\pm$10 PERCENT LINE VOLTAGE VARIATION	$\pm 1 \times 10^{-10}$	$\pm 5 \times 10^{-11}$
LINE FREQUENCY VARIATION (50-400 Hz)	$\pm 1 \times 10^{-10}$	$\pm 5 \times 10^{-11}$
WARM-UP CHARACTERISTICS	Less than 1×10^{-10} in 20 minutes maximum Less than 1×10^{-10} in 10 minutes typical	
OUTPUT FREQUENCY	10 MHz	
OUTPUT LEVEL	1 volt peak-to-peak	
INTERNAL RUBIDIUM FREQUENCY ADJUSTMENT		
RANGE	$\pm 5 \times 10^{-10}$	
RESOLUTION	3×10^{-11}	

TABLE 1-1 (Continued)

	SPECIFICATION	TYPICAL
EXTERNAL REFERENCE FREQUENCY INPUT		
FREQUENCY	1, 5, or 10 MHz	
LEVEL	1 VRMS	
REMOTE PROGRAMMING	IEEE-488	
OPERATING ENVIRONMENT		
TEMPERATURE	0-40°C	
ALTITUDE	To 15,000 ft	
HUMIDITY	0-85% relative humidity	
NON-OPERATING ENVIRONMENT		
TEMPERATURE	-55 to +75°C	
ALTITUDE	To 40,000 ft	
HUMIDITY	To 95% relative humidity	
PHYSICAL CHARACTERISTICS		
POWER (AS210A-PM)	115V or 230V ac, 2 amps 50-400 Hz	
SIZE (AS210A-PM)	Depth 20.35" Width 15.25" Height 6.81"	
WEIGHT (AS210A-PM)	30.5 lbs without plug-ins	

CHAPTER 2
INSTALLATION

2-1 INTRODUCTION

The AS210A-PM Portable Mainframe supports modules of the AS210 series. Power and signal interface is provided to the modules automatically when they are plugged in. The mainframe has a self-contained power supply and requires a source of 115 Vac prime power. The rear panel has a BNC connector for an external reference frequency standard. When an external standard is used, the rear panel INT/EXT switch is set to the EXT position. The AS210-05 Standby Battery Module may be installed on-line to supply power to the rubidium frequency standard and the AS210-20 Time Clock Module for a minimum of three hours during ac power interruptions.

CAUTION

Do not attempt installation of Tektronix plug-in modules in the AS210 Mainframe. Severe damage to plug-in and mainframe will result.

2-2 AS210A-PM LOCKING BAR REMOVAL AND INSTALLATION PROCEDURE

The AS210A-PM Portable Mainframe locking bar is useful during transit to secure the modules of the AS210 system in the mainframe. To remove the locking bar, simply loosen the three retaining screws across the face of the locking bar and remove. To install the locking bar, reverse the above procedure.

CHAPTER 3
OPERATION

3-1 INTRODUCTION

WARNING

Be sure that there is at least three inches clearance between the fan of the mainframe and any obstruction, before operating the instrument.

The AS210A-PM Portable Mainframe performs no functions by itself. Details of operation for the various plug-in modules are contained in a separate publication (see Preface). The only operator interface with the mainframe is the internal/external reference switch which is used to select the frequency reference. Figure 3.1 is the illustration of the AS210A-PM Portable Mainframe rear view. Table 3-1 describes the controls and connectors of the AS210A-PM and is keyed to Figure 3.1.

3-2 AC OPERATING VOLTAGE SELECTION

On the AS210A-PM rear panel, the fuse and voltage selector is located to the right of the fan. See Figure 3.1 and Table 3-1.

To select the ac operating voltage, slide the plastic cover open on the voltage selector and rotate the fuse-pull down. Remove the fuse and voltage select board. Position the voltage select board so that the desired printed voltage is on the top left side of the board. Push the board firmly into the module slot. Rotate the fuse-pull back into normal position and install the proper value fuse. The AS210A-PM Mainframe is now ready for operation.

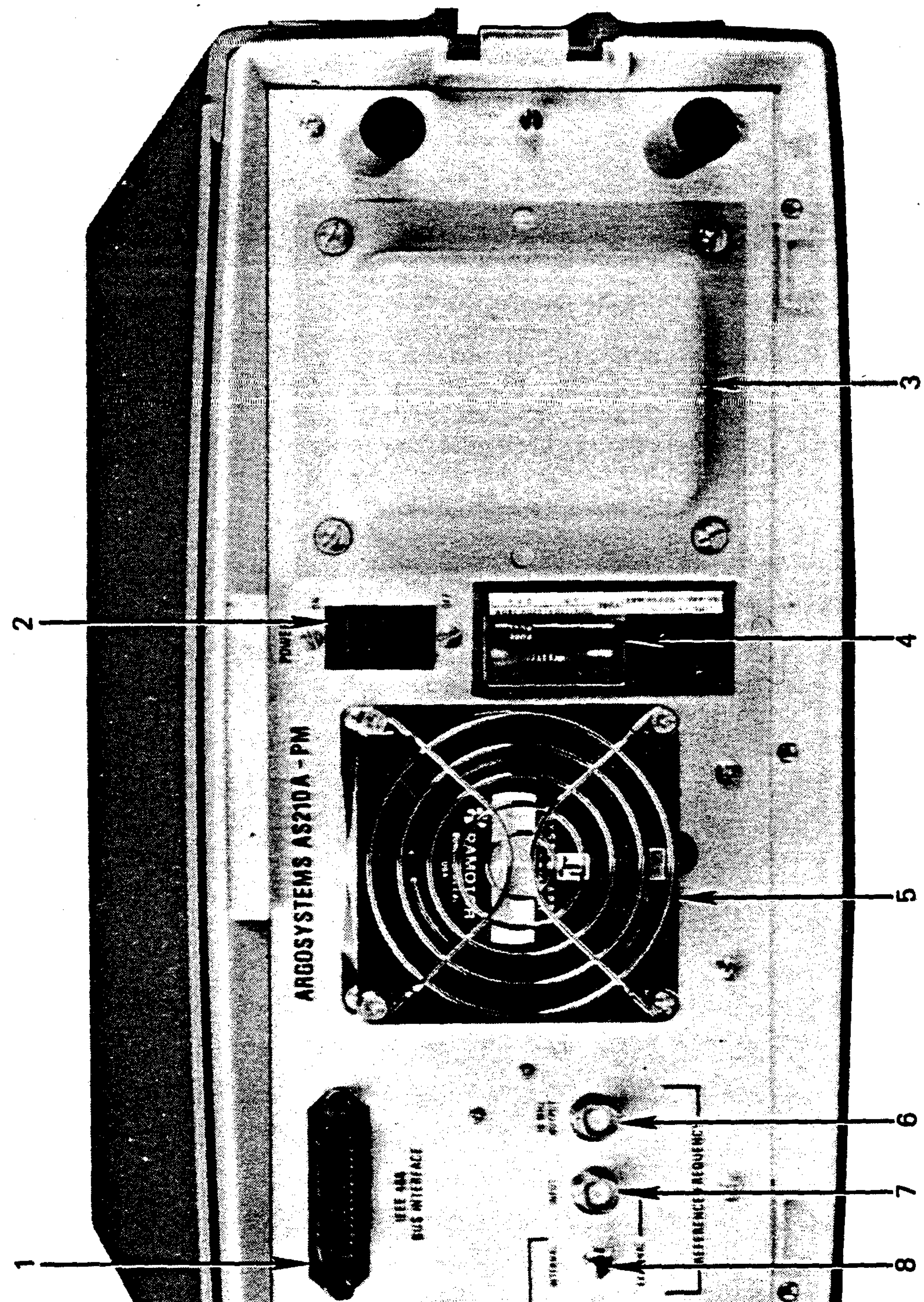


Figure 3.1 Portable Mainframe Rear Panel Controls and Connectors

Table 3-1

AS210A-PM PORTABLE MAINFRAME CONTROLS AND CONNECTORS

INDEX NUMBER FIGURE 3.1	PANEL MARKING	FUNCTION
1	IEEE-488-1975 BUS INTERFACE	Connector for remote control of the AS210 system
2	POWER	Main power switch
3		Power transformer
4		Fuse and power connector
5		Fan
	REFERENCE FREQUENCY	
6	10 MHz OUTPUT	Output connector for 10 MHz from selected frequency standard
7	INPUT	Input connection for an external frequency reference
8	INTERNAL/EXTERNAL	Switch for selecting internal or external frequency reference
9	ADJUST	Standard frequency adjustment

CHAPTER 4
THEORY OF OPERATION

4-1 INTRODUCTION

This chapter provides a functional description of the AS210A-PM Portable Mainframe. The mainframe contains dc voltage supplies, a backplane interconnect assembly, and the rubidium frequency standard. The description is keyed to the block diagram in Figure 4.1 and the schematic diagrams in Chapter 5. Details of common types of circuits are not included in this description.

4-2 DC VOLTAGE SUPPLIES

Prime ac power is applied to a power line filter/voltage selector located on the rear panel of the AS210A-PM. The voltage selector allows 115 Vac or 230 Vac be used with the system. The AS210A-PM power transformer T1 provides four ac voltages to the portable mainframe: 9.9 Vac for the +11 Vdc unregulated and +5 volt regulated supplies; 24.5 Vac for the +31 Vdc unregulated supply; 20.5 Vac for the +26 Vdc unregulated supply; and 39.5 Vac for the ±18 Vdc regulated supplies.

A bridge rectifier (CR3), filter capacitor (C4), and two +5 Vdc regulators (U3-U4), provide a +5 Vdc supply voltage for the module controller and a +5 Vdc suppy for the remaining modules in the AS210 system. Three bridge rectifiers (CR1, CR2, CR4) and four filter capacitors (C1, C2, C3, C5) provide the +31 Vdc, +26 Vdc, and ±18 Vdc unregulated supplies. The ±18 Vdc regulated voltage supplies for the AS210 system are provided by adjustable voltage regulators (U1 and U2). The ±18 volt regulators are set by factory selected resistors. If replacement becomes necessary, please contact the factory.

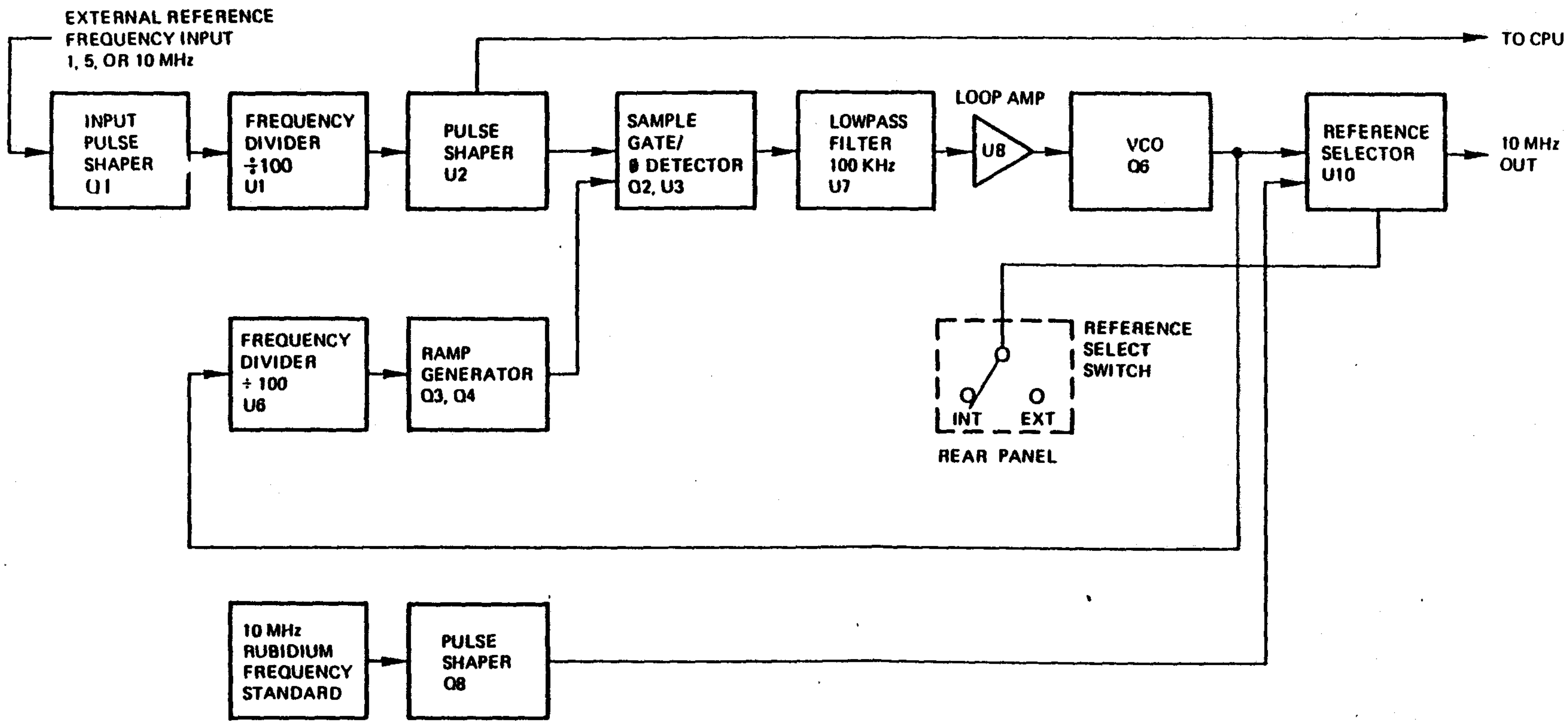


Figure 4.1 AS210A-PM Functional Block Diagram

4-3 EXTERNAL REFERENCE SELECTOR CIRCUIT, A2

The AS210 system can be used with the 10 MHz internal rubidium frequency standard or an external frequency standard of 1, 5, or 10 MHz. The external reference frequency input is located on the rear panel of the mainframe. The external reference signal is accepted automatically by the time base circuitry when the reference frequency select switch is in the EXT position. The external reference signal is divided by 100 in frequency divider U1 and shaped into a 250 nanosecond pulsewidth signal by one-shot U2 for application to phase detector U3. The phase detector compares the input standard signal with a ramp signal produced by the VCO so that the VCO is locked to the standard. The 10 MHz VCO output is divided by 100 in dual decade divider U6. The output of U6 (100 kHz) drives ramp generators Q3, Q4. The VCO output is applied to a reference selector gate which is controlled by the rear panel INT/EXT reference switch. The signal from the pulse shaper is also available to the microprocessor. If the reference frequency select switch is in the EXT position, and no signal is applied to the external frequency reference input, an error message is generated. When the reference frequency select switch is in the INT position, control transistors Q1 and Q5 turn the power off to the external reference frequency circuitry. In the external position, the +26 Vdc voltage supply for the rubidium frequency standard is disconnected so that interference does not occur to the VCO output.

CHAPTER 5
MAINTENANCE AND CALIBRATION

5-1 INTRODUCTION

The purpose of this chapter is to provide maintenance and calibration data for the AS210A-PM Portable Mainframe. Section I covers routine preventive maintenance procedures. Section II outlines performance tests for the mainframe. Section III contains the calibration/alignment procedures, and Section IV describes troubleshooting data. Figures 5.5 and 5.6 are the schematic diagrams for the AS210A-PM. Please contact the factory for any assistance required in the maintenance or servicing of the mainframes.

SECTION I

5-2 PREVENTIVE MAINTENANCE

Table 5-1 lists preventive maintenance checks and services which should be performed regularly.

Table 5-1
PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURE
CABLES	Visually inspect cables for strained, cut, frayed, or otherwise damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfaces as follows: A. Remove the dust and loose dirt with a clean soft cloth. B. Remove dust or dirt from plugs and jacks with a brush. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle.
CORROSION	Make sure exterior surfaces of unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: A. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. B. Brush two coats of paint on base metal to protect it from further corrosion.

SECTION II

5-3 PERFORMANCE TESTING

This section describes the procedure to test the AS210A-PM Portable Mainframe to assure proper performance of the instrument. The mainframe must be used in conjunction with the AS210 Module Controller since the CPU in the AS210-01A monitors the circuits of the mainframe. If the mainframe fails any of these performance tests, please see Section III, Calibration/Alignment Procedures, and/or Section IV, Troubleshooting Procedures in this chapter.

5-4 INTERNAL FREQUENCY STANDARD ACCURACY TEST

The following is a procedure for quickly determining if the frequency standard located in the AS210A Mainframe is working. See Sections 5-11 and 5-12 for calibration. The output signal is accessible at the BNC output connector labeled 10 MHz, located on the rear panel of the mainframe. Table 5-2 contains the required equipment to perform this test.

Table 5-2
REQUIRED TEST EQUIPMENT FOR THE INTERNAL FREQUENCY STANDARD ACCURACY TEST

ITEM	RECOMMENDED TEST EQUIPMENT
ELECTRONIC COUNTER	HP-5345A
FREQUENCY STANDARD	HP-5061A or 5062C OPT 010
COAXIAL CABLE (2 Required)	3-foot long, 50 ohm, BNC

5-5 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Connect the equipment as indicated in Figure 5.1 and apply power to the AS210. The rubidium frequency standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. Monitor the display of the electronic counter. The reading should be 10,000,000 $\pm$0.1 Hz. If the reading is not within the specification, see Section III, Calibration/Alignment Procedures, and/or Section IV, Troubleshooting Procedures.

D. Disconnect the frequency counter from the AS210 Mainframe.

5-6 INTERNAL FREQUENCY STANDARD DRIFT TEST

The following is a procedure for testing the drift of the internal frequency standard located in the AS210 Mainframe. The output signal is accessible at the BNC output connector labeled 10 MHz located on the rear panel of the mainframe. Table 5-3 contains the required equipment to perform this test.

Table 5-3

REQUIRED TEST EQUIPMENT FOR THE INTERNAL FREQUENCY STANDARD DRIFT TEST

ITEM	RECOMMENDED TEST EQUIPMENT
ELECTRONIC COUNTER	HP-5345A
FREQUENCY STANDARD	HP-5061A or 5062C OPT 010
COAXIAL CABLE	3-foot long, 50 ohm, BNC

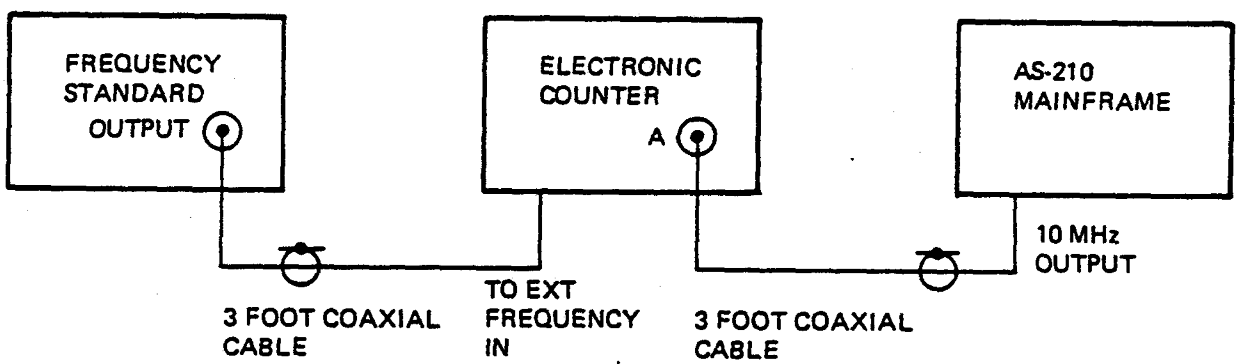


Figure 5.1 AS210 Internal Frequency Standard Test Configuration

5-7 TEST PROCEDURE WHEN USING AS210-01 MODULE CONTROLLER

A. Ensure that power is disconnected from the AS210 system before beginning.

B. Connect the equipment as indicated in Figure 5.2 and apply power to the AS210 system. The Rubidium frequency standard in the AS210 Mainframe will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. Set the AS210-02 Frequency Comparator RATE switch to 1 PER HOUR.

D. Press RESET. The display should indicate "SEL?"

E. Press CONT. The display should indicate "CH 1-6".

F. Press 1, press ENTER. The display should indicate "SEL 10-".

G. Set the AS210-02 Frequency Comparator RANGE switch to 10^{-11}. Press CONT.

H. Allow the AS210 system to operate in this mode for 24 hours and 10 minutes.

I. Press HALT. The display should indicate "24 OFF".

J. Press DSPL. The display should indicate "SEL CH". Press 1, press ENTER.

K. Press CONT. Record the AS210-01 Module Controller's displayed measurement.

L. Repeat Step K until all 24 measurements are recorded.

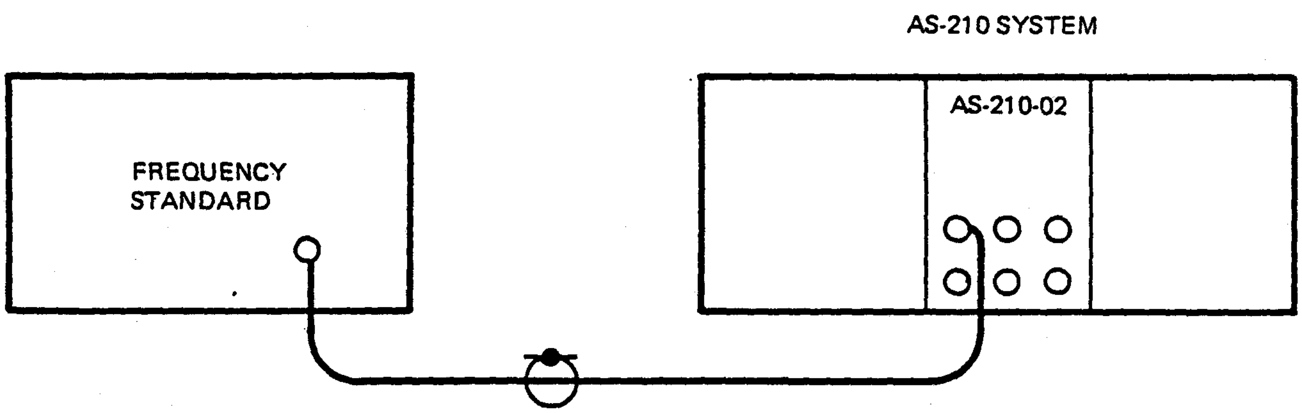


Figure 5.2 AS210 Internal Frequency Standard Drift Test Configuration

M. Compute the 24-hour AS210 internal frequency standard drift rate using the following equation and the results recorded from steps K and L.

$$\frac{\sum X_i \, Y_i - 276\,\bar{Y}}{50} = \text{Drift rate per day}$$

with $X_i = 0, 1, 2, \ldots, 23$

$i = 1, 2, 3 \ldots, 24$

Y_i = AS210 measurement at the i^{th} hour

$$\bar{Y} = \frac{\sum Y_i}{24}$$

5-8 TEST PROCEDURE WHEN USING AS210-01A MODULE CONTROLLER

A. Repeat steps A through I of paragraph 5-7.

B. Press CALC. The display will be blank.

C. Press "YEAR".

D. The display will indicate "SEL CH".

E. Press "CONT".

F. "DP 1" will appear in display.

G. Press "2", "DP 2" will appear in display.

H. Press "CONT", last data point will automatically be selected.

I. Drift rate is displayed in display.

SECTION III

5-9 CALIBRATION/ALIGNMENT PROCEDURES

WARNING

The following calibration/alignment procedures (Chapter 5, Section III) and Troubleshooting Procedures (Chapter 5, Section IV) are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that of routine maintenance (Chapter 5, Section I) and performance testing (Chapter 5, Section II) unless you are qualified to do so.

Figure 5.3 is a flow diagram of the calibration/alignment procedure for the AS210A-PM Portable Mainframe. Use this flow diagram with the theory of operation in Chapter 4, the text in this chapter, and the illustrated parts lists in Chapter 6. Please note it is not necessary to disassemble the AS210 system to determine if calibration/alignment is needed. For any assistance needed in performing this calibration/alignment procedure, please contact the factory.

5-10 AS210A-PM PORTABLE MAINFRAME DISASSEMBLY PROCEDURE FOR POWER MODULE REMOVAL AND INSTALLATION

WARNING

Dangerous voltages exist at several points throughout the power module. When the power module must be operated with the chassis removed, do not touch exposed connections or components. Disconnect power before cleaning the system or replacing parts.

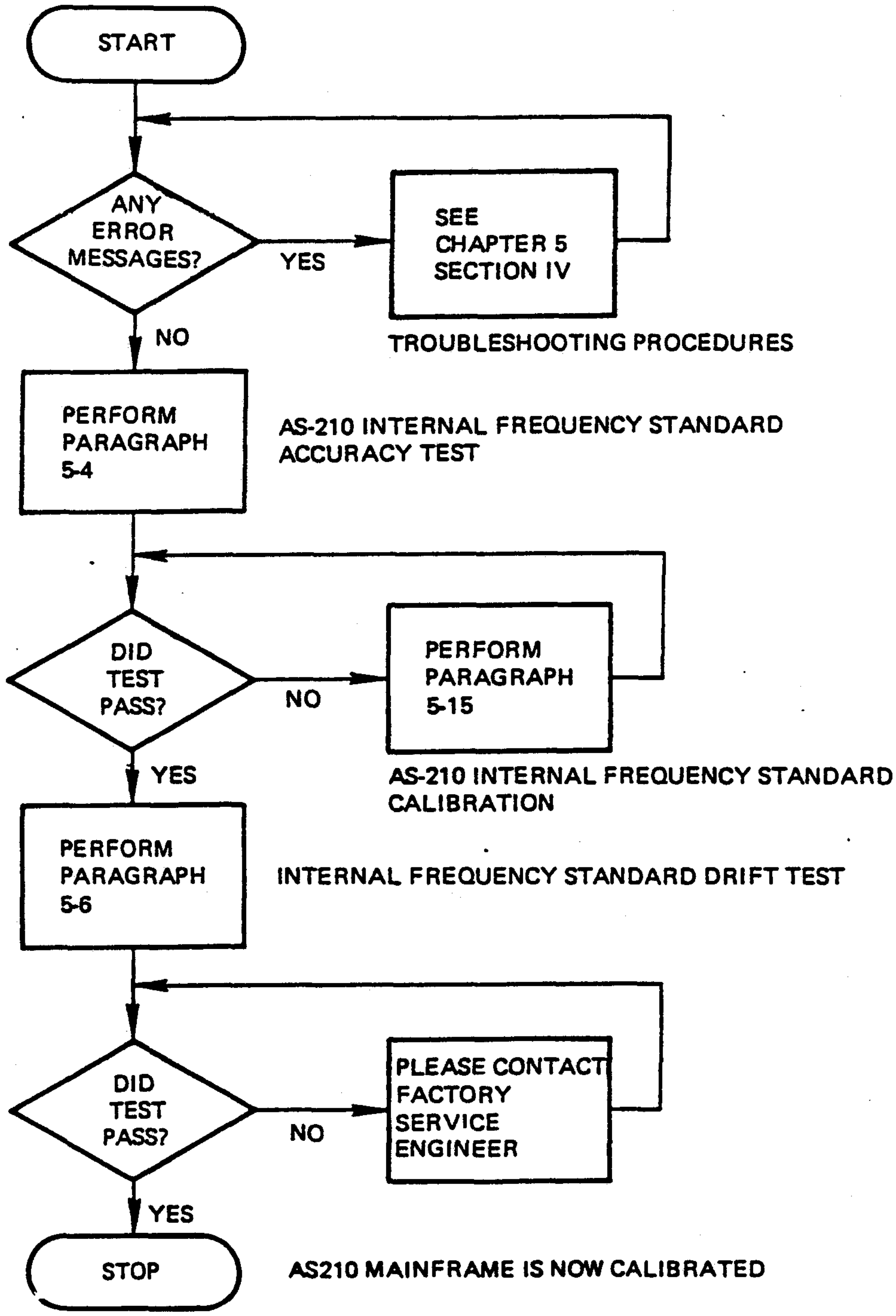
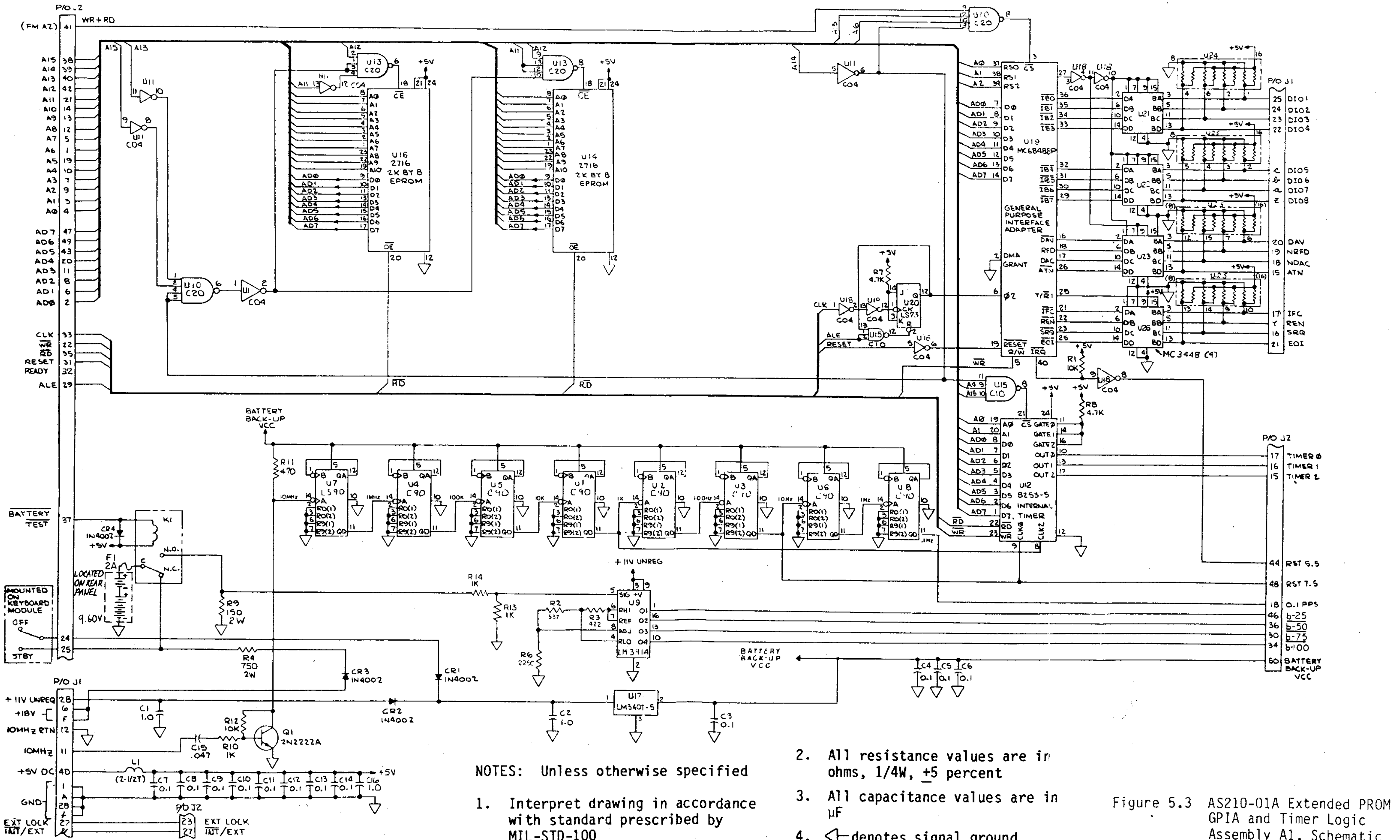


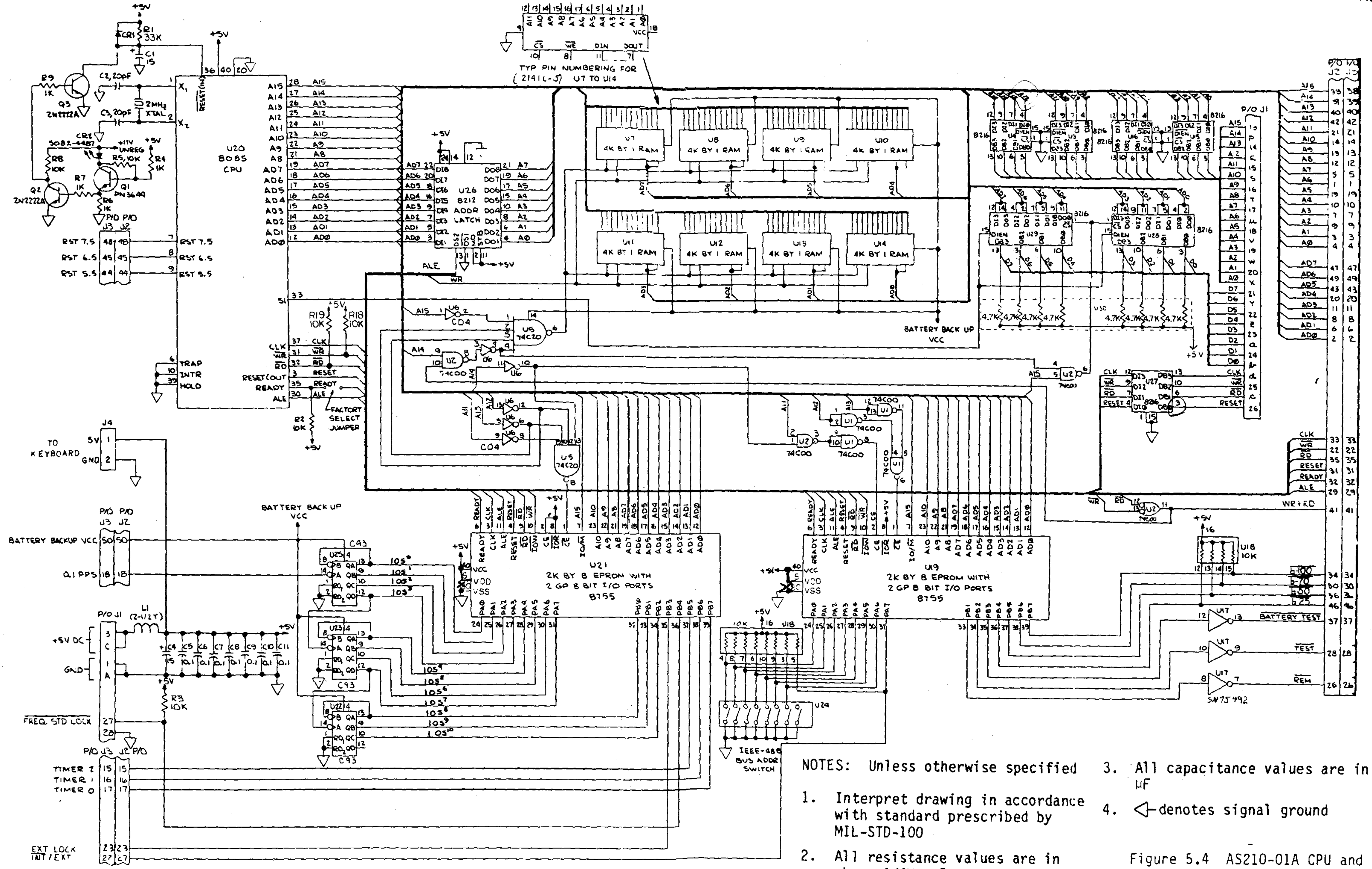
Figure 5.3 Flow Diagram of the Calibration/Alignment Procedure for the AS210 System Mainframe



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100
2. All resistance values are in ohms, 1/4W, ±5 percent
3. All capacitance values are in µF
4. ◁ denotes signal ground

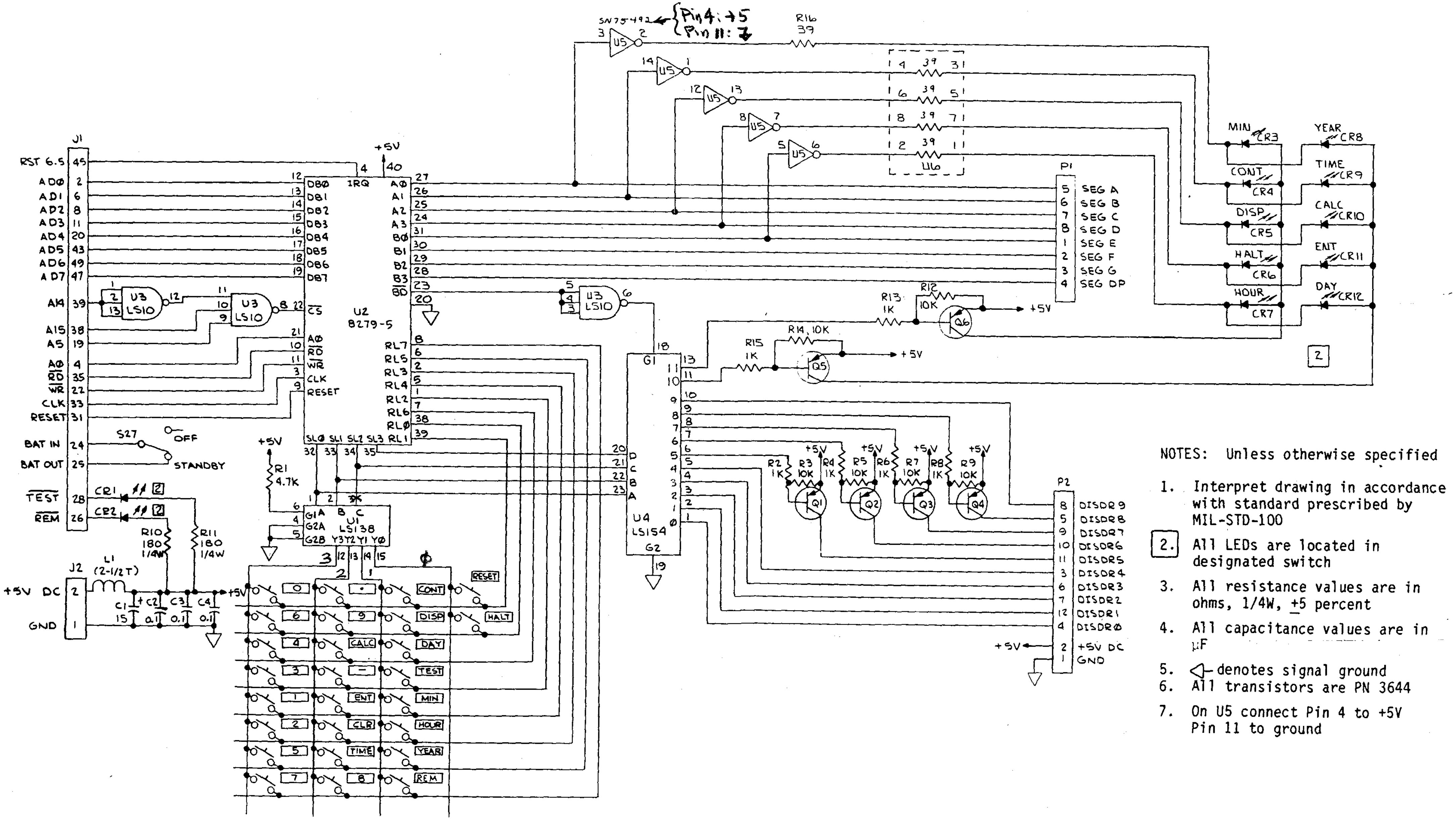
Figure 5.3 AS210-01A Extended PROM GPIA and Timer Logic Assembly A1, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100
2. All resistance values are in ohms, 1/4W, ±5 percent
3. All capacitance values are in µF
4. ◁ denotes signal ground

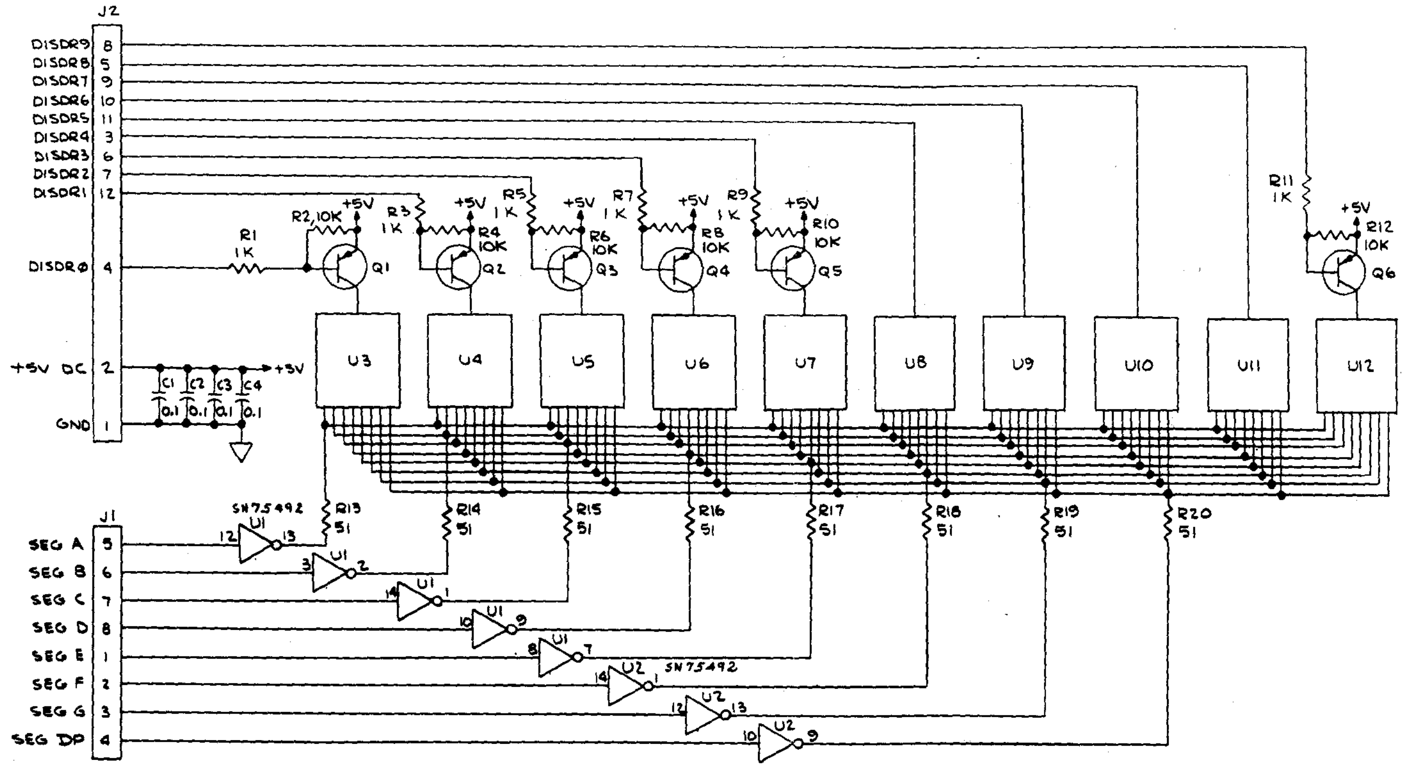
Figure 5.4 AS210-01A CPU and EPROM Logic Assembly A2, Schematic Diagram

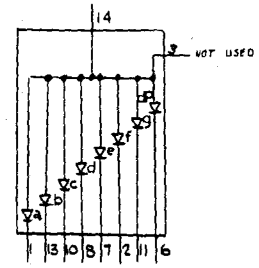


NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100
2. All LEDs are located in designated switch
3. All resistance values are in ohms, 1/4W, ±5 percent
4. All capacitance values are in µF
5. ◁ denotes signal ground
6. All transistors are PN 3644
7. On U5 connect Pin 4 to +5V Pin 11 to ground

Figure 5.5 AS210-01A Keyboard Logic Assembly A3, Schematic Diagram





TYPICAL PIN NUMBERING FOR U3 THRU U12

NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/8W, ±5 percent.
3. All capacitance values are in μF.
4. ⊲— denotes signal ground.
5. All transistors are PN3644.
6. U3 through U12 are 7 segment displays, HP5082-7730.

Figure 5.6 AS210-01A Display Logic Assembly A4, Schematic Diagram

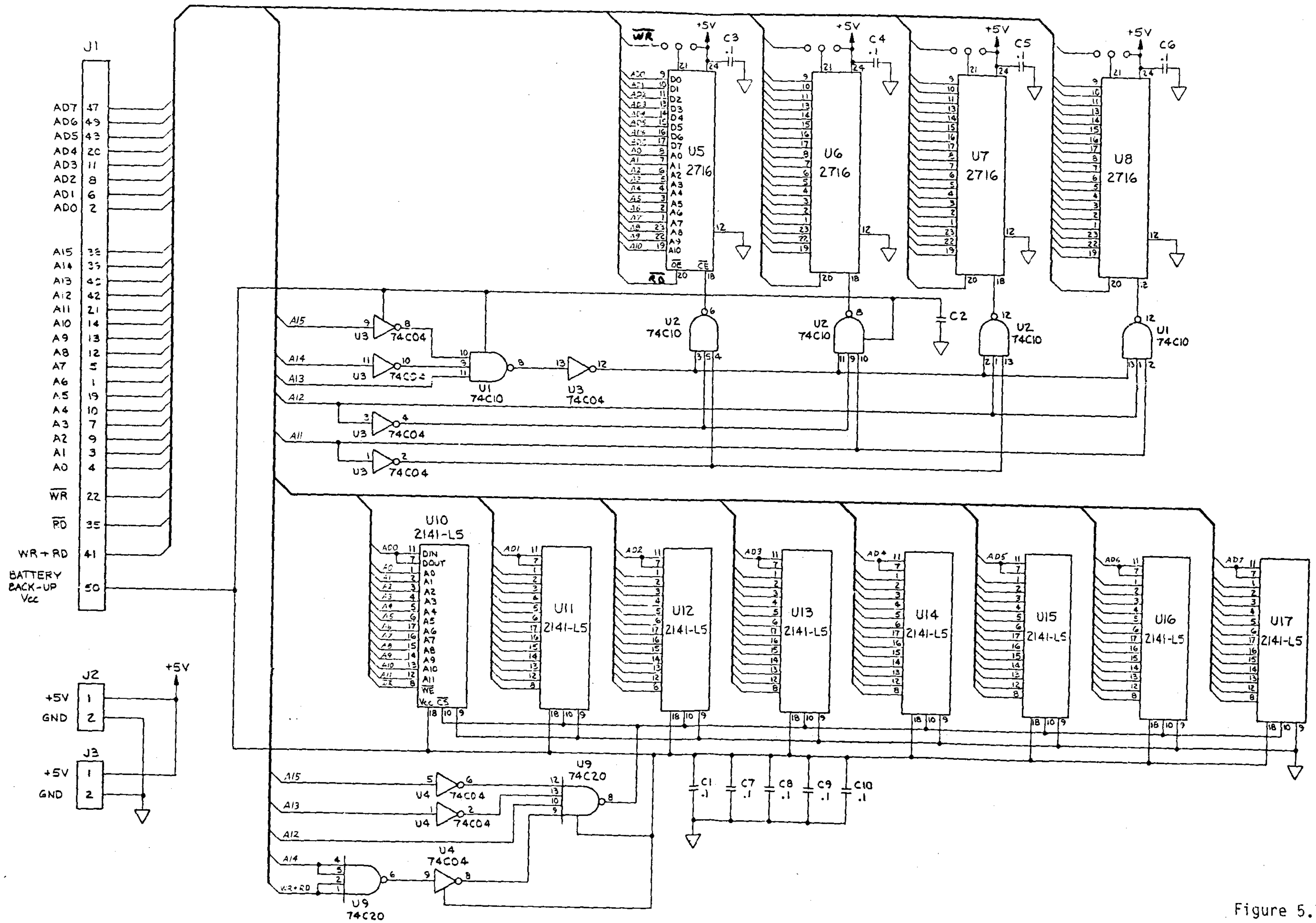


Figure 5.7 AS210-01A Memory Expansion Board A5, Schematic Diagram

Two thumbscrews on the rear panel secure the power module to the chassis. Loosen the thumbscrews and place the mainframe on end with the power module on the bottom. Lift the chassis vertically to separate the power module from the chassis. It may be necessary to use force between the motherboard and the chassis to loosen the power module. Do not operate the system with the chassis removed any longer than necessary. Reinstall the power module to protect the interior from dust and to avoid personnel shock hazards, as well as provide proper ventilation.

When reinstalling the power module in the chassis, set the chassis with the power module compartment facing up. Align the power module guide pins with their respective holes in the chassis. Tighten the thumbscrews of the power module with a straight-blade screwdriver. Plug-in modules may now be installed.

5-11 ACCESS TO MAINFRAME CIRCUITS

A. Ensure that the power is disconnected before beginning this procedure.

B. Follow the procedure described in paragraph 5-9 of this chapter to remove the power module from the AS210 chassis.

C. Using a phillips screwdriver, remove the two screws holding the internal/external time base circuit card.

D. Tilt the internal/external time base select circuit board up. This exposes filter capacitors and bridge rectifiers for troubleshooting. This also provides access to the tuning coil located on the internal/external time base circuit board.

5-12 AS210 INTERNAL FREQUENCY STANDARD CALIBRATION

The highly accurate internal rubidium frequency standard of the AS210 system is aligned initially at the factory. Figure 5.4 shows the calibration test equipment setup. Table 5-4 lists the recommended test equipment to calibrate the rubidium frequency standard. The output frequency (10 MHz) of the rubidium which is being calibrated or tested is compared to the output frequency (5 MHz) of a reference standard by the Tracor 537A Frequency Difference Meter. Refer to the Tracor 537A operator's manual for specific operation procedures for this instrument. The output of the Tracor instrument is a voltage proportional to the difference in frequency of the test source and the reference source. This voltage is put through a lowpass filter and then applied to an HP-7132A chart recorder. This Hewlett-Packard instrument uses HP-9280-0444 strip chart paper. The chart recorder gives a chart record of the frequency difference versus time. When the Tracor 537A unit is selected to an accuracy of 1 part in 10^{10} and the HP-7132A unit is properly adjusted to center the recording pen at the center of the strip chart, a range of $\pm 5 \times 10^{-10}$ parts with a resolution of 1×10^{-11} parts per minor division on the strip chart is achievable. The paper chart output of this calibration process shows the difference in frequency between the frequency standard and the output frequency of the AS210 unit under test as well as the frequency drift in time between the two sources. The AS210 Rubidium Frequency Standard should be warmed-up sufficiently before any alignment is attempted. See paragraph 5-13 of this chapter for the rubidium frequency standard output frequency adjustment procedure.

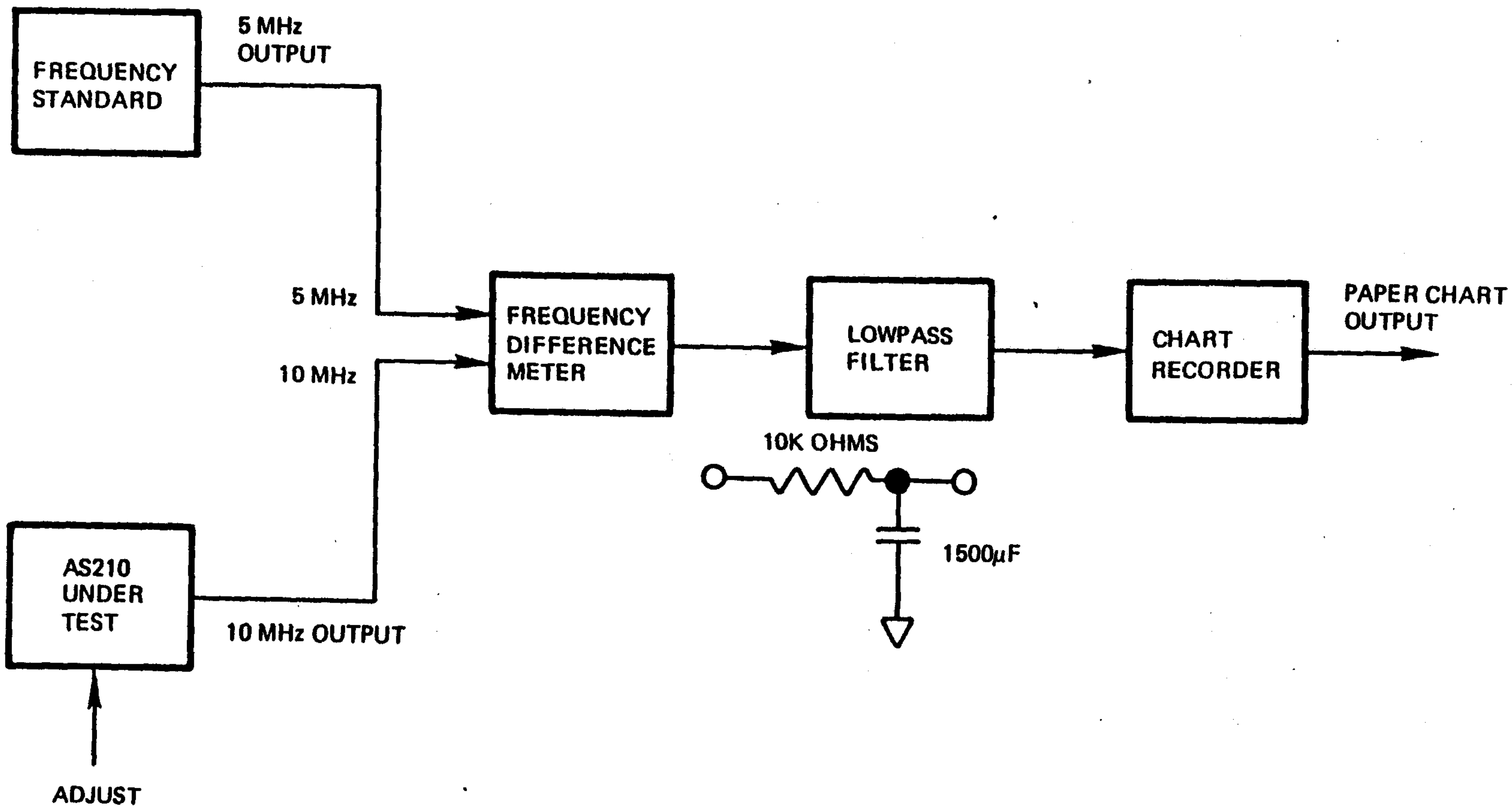


Figure 5.4 Block Diagram of Rubidium Frequency Standard Calibration Configuration

Table 5-4

TEST EQUIPMENT FOR THE AS210 INTERNAL FREQUENCY STANDARD CALIBRATION CONFIGURATION

ITEM	RECOMMENDED TEST EQUIPMENT
FREQUENCY STANDARD	HP-5061A or 5062C OPT 010
FREQUENCY DIFFERENCE METER	TRACOR 537A
LOWPASS FILTER	10 Kohms, 1500 F
CHART RECORDER	HP-7132A
PAPER CHART REFILL	HP-9280-0444
COAXIAL CABLE (4 Required)	3-foot long, 50 ohm, BNC

5-13 AS210 INTERNAL RUBIDIUM STANDARD OUTPUT FREQUENCY ADJUSTMENT

The highly accurate internal rubidium standard may be adjusted within the range of $\pm 5 \times 10^{-10}$ with a resolution of 3×10^{-11}. The reference frequency adjustment control is located on the rear panel labeled ADJUST. After the AS210 Rubidium Frequency Standard has sufficiently warmed up, the frequency may be changed by monitoring the output with the test setup described in paragraph 5-4. Turn the ADJUST control until the desired output is achieved.

5-14 AS210 TIME BASE SELECTOR PHASE-LOCKED OSCILLATOR ALIGNMENT PROCEDURE

In the AS210 Mainframe there is a phase-locked oscillator (PLO) located on the internal/external time base selector assembly. Table 5-5 lists the recommended test equipment to align the PLO. To align the mainframe PLO, use the following procedure:

A. Obtain access to the mainframe internal/external time base selector assembly by applying the disassembly procedures discussed in first part of this section.

B. Apply an RF signal to input BNC on the rear panel. The input signal must be 1, 5, or 10 MHz of a level equal to or greater than 1.0 VRMS.

C. Set the reference frequency internal/external selector switch located on the rear panel, to the EXT position.

D. With the oscilloscope, monitor the TUNE test point on the internal/external time base selector assembly. The TUNE test point should have a dc voltage between +2V and +8 Vdc. If this voltage is not within +2V and +8 Vdc, then go to E. Otherwise go to F.

E. With L2 at fully CCW, adjust in a CW direction. The tune TP should start at a +12 Vdc level. Adjust L2 until the level on the TUNE test point passes through a minimum dc level. Continue adjustment until a level of +8 Vdc is obtained.

F. Reassemble the mainframe.

Table 5-5

TEST EQUIPMENT FOR ALIGNMENT OF THE EXTERNAL TIME BASE SELECTOR PHASE-LOCKED OSCILLATOR

ITEM	RECOMMENDED TEST EQUIPMENT
FREQUENCY SYNTHESIZER	HP-8656A
OSCILLOSCOPE WITH PROBES	Tektronix 465 or Equivalent
COAXIAL CABLE	3-foot long, 50 ohm, BNC

SECTION IV

5-15 TROUBLESHOOTING PROCEDURES

Troubleshooting of the AS210 system mainframe is facilitated by error codes displayed on the AS210 Module Controller. Table 5-6 correlates the error code displayed on the module controller when a fault occurs to the malfunction. An explanation of the problem is provided with possible solutions.

5-16 POWER SUPPLY FAILURE

If a power failure occurs in any of the supplies, check the fuses located on the front of the motherboard. Fuse F1 is a five ampere SLO-BLO and fuses F2-F5 are three ampere SLO-BLO. If one of the +5 volt regulated supplies fails and fuse F1 is not open, then check fuses F6 and F7 located on the lower center part of the motherboard. If the same problem arises after replacing the fuse(s), check the load on the failed supply for shorts.

5-17 COMPENSATION OF CRYSTAL AGING

Remove power module from chassis as described in paragraph 5-9. Monitor the dc voltage on pin 6 of the rubidium frequency standard; that voltage should be approximately +8 volts ±2 volts. If the quartz crystal oscillator voltage approaches the end of the control range, a correction of the crystal oscillator base frequency must be made. This is accomplished by adjusting the oscillator trimmer. The trimmer is located on the side of the rubidium under the phillips screw, which is visible when looking at the side of the power supply where the rubidium is located. A clockwise adjustment of the trimmer causes an increase in control voltage. The adjustment should be made after the unit has been operated for at least one hour. The control voltage should be set for 8 Vdc.

Table 5-6

ERROR CODE LISTING

ERROR CODE	PROBLEM	RECOMMENDED SOLUTION
0-00	Rubidium frequency source is not phase locked	Phase lock should be obtained within 10 minutes of power turn-on and is indicated by a logic low at pin 5 on the rubidium standard. Pin 6 on the rubidium standard should have a voltage of +8 volts ±2 volts. If not, refer to troubleshooting paragraph 5-17. If the rubidium lamp is operating properly, a voltage betweem 5 volts and 12 volts will be present at pin 7 on the rubidium standard. An inoperative lamp is indicated by a signal of approximately 3 volts at pin 7. Return defective Rubidium Standards to ARGOSystems.
0-01	External frequency source selected with INT/EXT switch with no signal present at external input connector	Change switch setting to INT position or connect external frequency source.

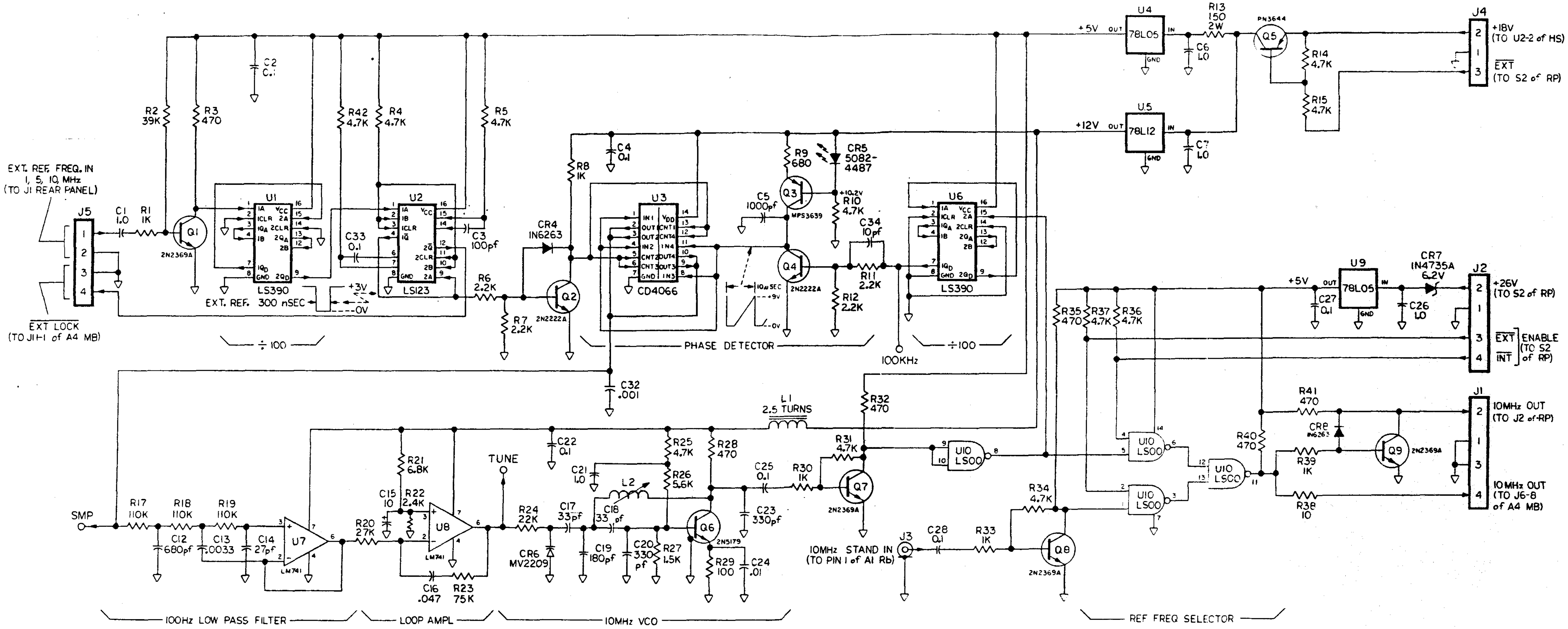


Figure 5.6 Internal/External Time Base Selector Assembly A2, Schematic Diagram

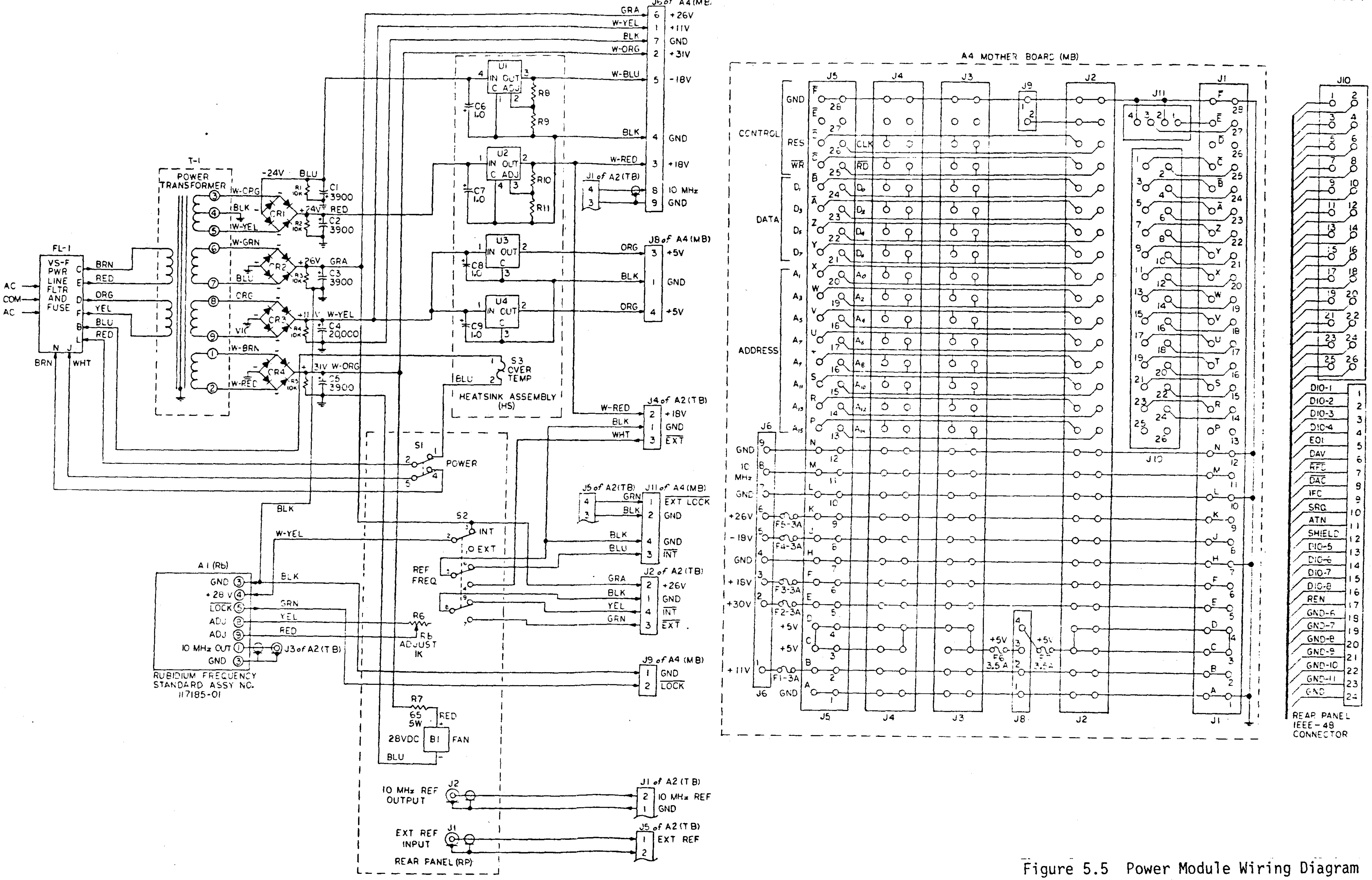


Figure 5.5 Power Module Wiring Diagram

CHAPTER 6
ILLUSTRATED PARTS LIST

6-1 INTRODUCTION

This section contains an illustrated parts list for the AS210A-PM Portable Mainframe. The assembly number and title are listed at the top of the parts list. The parts lists are divided into six columns and arranged in the following order:

Column 1 - Item Number
Column 2 - Quantity per Assembly
Column 3 - Manufacturer's Code
Column 4 - Part Number
Column 5 - Description
Column 6 - Reference Designation

ASSEMBLY NUMBER 125470 - INTERNAL/EXERNAL TIME BASE SELECTOR AS210A-PM

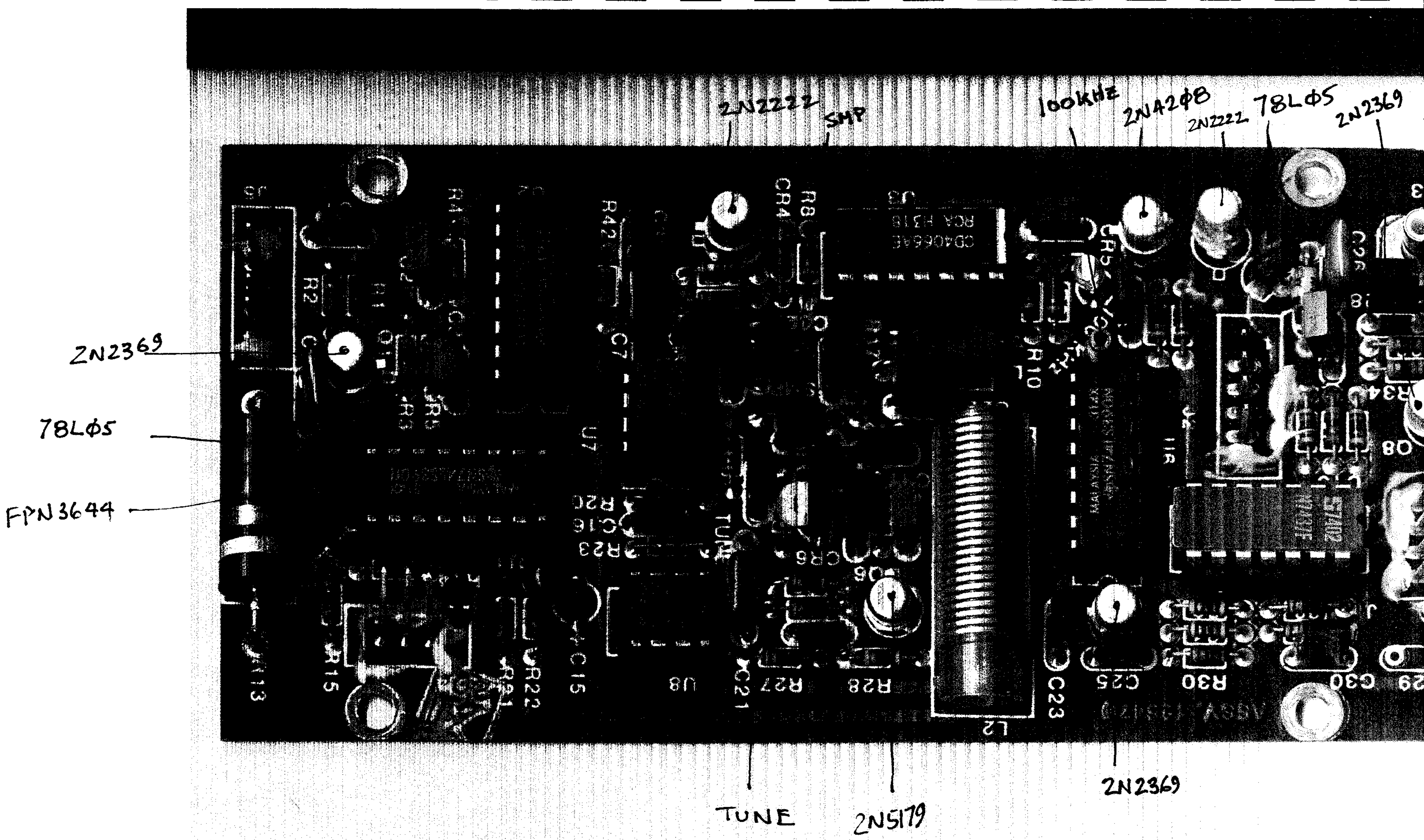
ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	125473	PWB 125473	
2	REF	33472	125471	Schematic	
3	REF	33472	125472	Master Pattern	
4	REF	33472	125474	Silk screen	
5	2	01295	74LS390N	Dual Decade Counter	U1,U6
6	1	01295	74LS123N	Dual One Shot	U2
7	1	01295	74LS00N	Quad NAND Gate	U10
8	1	02735	CD4066A	Quad FET Switch	U3
9	2	27014	741CN	OP Amp	U7,U8
10	4	27014	2N2369A	NPN Transistor	Q1,Q7,Q8,Q9
11	2	27014	2N2222A	NPN Transistor	Q2,Q4
12	1	27014	2N5179	NPN Transistor	Q6
13	1	81349	CK05BX473K	.047 pF 10%, Ceramic Capacitor	C16
14	5	51642	300-50-601-105M	1 µF, 20%, Ceramic Capacitor	C1,C6,C7, C26,C2
15	7	81349	CK05BX104K	.1 µF, 10%, Ceramic Capacitor	C2,C33,C4,C27, C22,C25,C28
16	1	81349	CK05BX101K	100 pf, 10%, Ceramic Capacitor	C3
17	1	81349	CK05BX473K	.047 µF 10%, Ceramic Capacitor	C16
18	2	81349	CK05BX102K	.001 µF, 10%, Ceramic Capacitor	C32,C5
19	1	81349	CK05BX151K	150 pF, 10%, Ceramic Capacitor	C19
20	2	81349	CK05BX100K	10 pF, 10%, Ceramic Capacitor	C34,C30
21	2	81349	CK05BX331K	330 pf, 10%, Ceramic Capacitor	C20,C23
22	1	81349	CK05BX681K	680 pf, 10%, Ceramic Capacitor	C12

ASSEMBLY NUMBER 125470 - INTERNAL/EXERNAL TIME BASE SELECTOR AS210A-PM (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
23	2	81349	CK05BX330K	33 pF, 10%, Ceramic Capacitor	C17,C18
24	1	81349	CK05BX332K	.0033 μF, 10%, Ceramic Capacitor	C13
25	1	81349	CK05BX270K	27 pf, 10%, Ceramic Capacitor	C14
26	1	81349	196D156X902KAI	15 μF, 20V Electrolytic Capacitor	C15
27	1	81349	CK05BX103K	.01 μF, 10%, Ceramic Capacitor	C24
28	1	04713	MPS3639	PNP Transistor	Q3
29	1	27014	PN3644	PNP Transistor	Q5
30	2	27014	78L05-Cz	5V Regulator	U4,U9
31	1	27014	78L12-CZ	12V Regulator	U5
32	2	54893	1N6263	Schottky Diode	CR4,CR8
33	1	50434	5082-4487	Light Emitting Diode	CR5
34	1	04713	MV2209	Tuning Diode	CR6
35	1	04713	1N4735A	Zener Diode 6.2V	CR7
36	3	27264	22-03-2041	4 Pin Connector	J5,J1,J2
37	1	27264	22-03-2031	3 Pin Connector	J4
38	1	98291	51-051-0000	Conhex Connector, Snap-on	J3
39	1	02114	VK200-20/4B	Wideband Choke	L1
40	1	02114	SK460-1	3 μH Variable Inductor	L2
41	3	00779	20101B-1	Terminal	
42	3	01295	C9316-02	IC Socket, 16 Pin	
43	2	01295	C9314-02	IC Socket, 14 Pin	
44	2	01295	C9308-02	IC Socket, 8 Pin	
45	5	81349	RCR05G102	1K ohm 5% 1/8W Carbon Comp	R1,R8,R30, R33,R39
46	1	81349	RCR05G393JS	39K ohm 5% 1/8W Carbon Comp.	R2

ASSEMBLY NUMBER 125470 - INTERNAL/EXERNAL TIME BASE SELECTOR AS210A-PM (Continued)

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
47	7	81349	RCR05G471JS	470 ohm 5% 1/8W Carbon Comp	R3,R4, R28, R32,R35,R40, R41
48	11	81349	RCR05G472JS	4.7K ohm 5% 1/8W Carbon Comp.	R4,R42,R5, R10,R25,R36, R14,R15,R31, R34,R37
49	4	81349	RCR05G222JS	2.2K ohm 5% 1/8W Carbon Comp	R6,R7,R11, R12
50	1	81349	RCR05G681JS	680 ohms 5% 1/8W Carbon Comp	R9
51	1	81349	RCR42G151JS	150 ohm 5% 2W Carbon Comp.	R13
52	3	81349	RCR05G114JS	110K ohm 5% 1/8W Carbon Comp	R17,R18,R19
53	1	81349	RCR05G273JS	27K ohms 5% 1/8W Carbon Comp	R20
54	1	81349	RCR05G332JS	3.3K ohms 5% 1/8W Carbon Comp.	R22
55	1	81349	RCR05G682JS	6.8 ohms 5% 1/8W Carbon Comp.	R21
56	1	81349	RCR05G333JS	33K ohm 5% 1/8W Carbon Comp.	R23
57	1	81349	RCR05G223JS	22K ohm 5% 1/8W Carbon Comp	R24
58	1	81349	RCR05G152JS	1.5K ohm 5% 1/8W Carbon Comparator	R27
59	1	81349	RCR05G562JS	5.6K ohm 5% 1/8W Carbon Comp	R26
60	2	81349	RCR05G101JS	100 ohm 5% 1/8W Carbon Comp	R29,R39
61	1	81349	RCR05G100JS	10 ohm 5% 1/8W Carbon Comp	R38


2N2222
SMP
100KHz
2N42Ø8
2N2222
78LØ5
2N2369
2N2369
78LØ5
FPN3644
TUNE
2N5179
2N2369

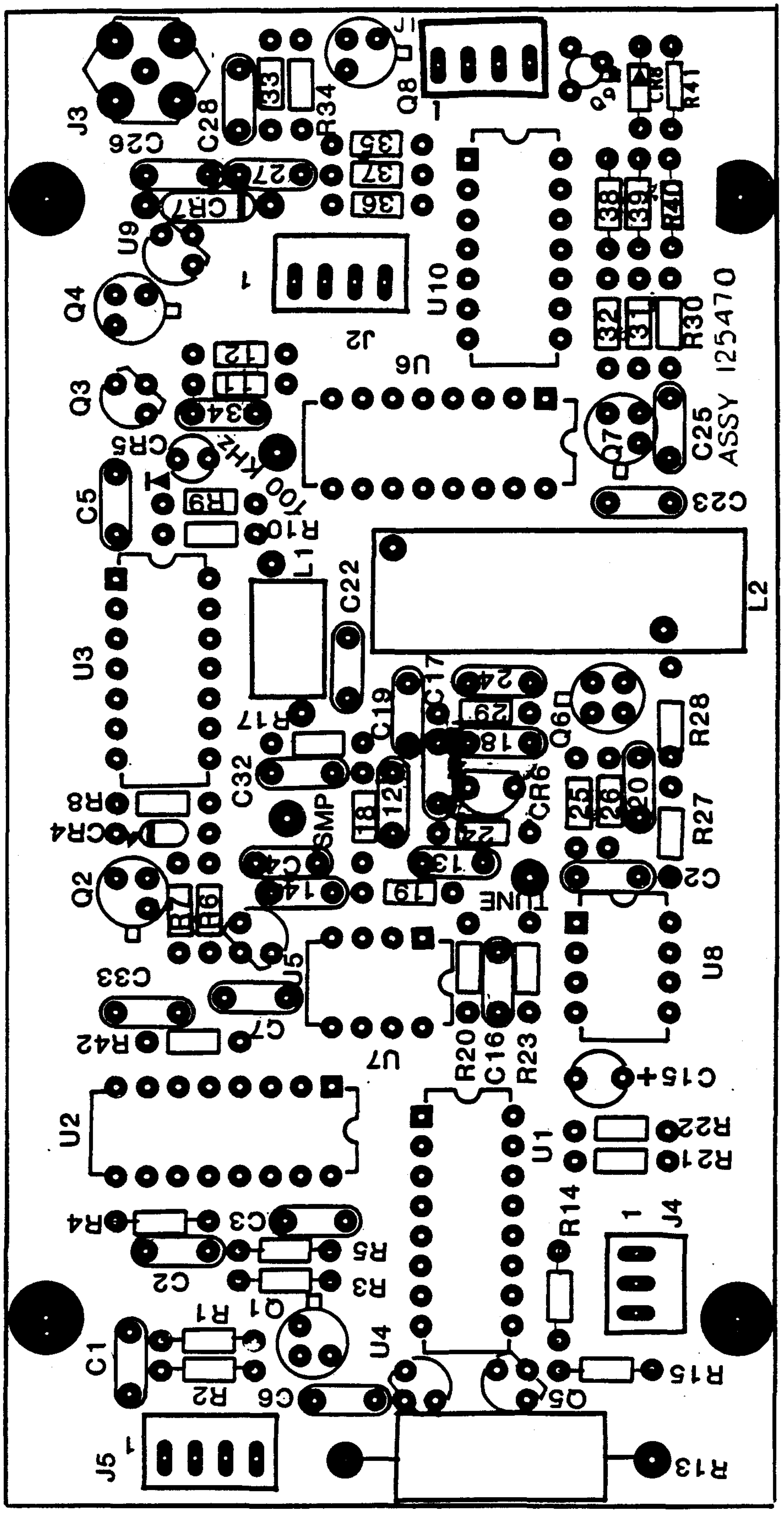


Figure 6.1 AS210A-PM Internal/External Time Base Selector Assembly (A2)

ASSEMBLY NUMBER 125550 - MAINFRAME ASSEMBLY AS210A-PM

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	80009	390-0529-00	Case and Covers	
2	1	05245	80-1245	Power Cord	
3	1	80009	348-0476-00	Stand	
4	1	33472	125551	Power Module	
5	1	33472	117166	Logo Strip	
6	1	12136	367-0215	Handle Black	

ASSEMBLY NUMBER 125551 - POWER MODULE ASSEMBLY AS210A-PM

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	REF	33472	125551	Power Module Assembly AS-210A-PM	
2	REF	33472	12552	Wiring Diagram	
3	1	33472	125558	Rear Panel Assembly	
4	1	33472	125554	Deck Assembly	
5	1	75915	313005	Fuse, 5 Amp, Slo-Blow	
6	1	33472	125566	Motherboard	
7	2	80009	426-1350-01	Guide Pin	
8	1	33472	125470	Internal/External Time-Base Selector	
9	1	33472	125556	Harness Assembly	
10	1	33472	125570	Mounting Bracket for Timebase Board	
11	1	33472	125571	Mounting Bracket for Timebase Board	
12	2	81349	NAS671-C4	Small Pattern Hex Nut #4	
13	7	81349	NAS620-C4	Reduced O/D Flatwasher #4	
14	7	81349	MS35338-135	Lockwasher #4	
15	5	81349	MS51957-13	Screw PH 4-40x1/4	
16	2	81349	MS24C93-C2	Screw FH 4-40x1/2	
17	2	81349	MS24C93-C6	Screw FH 4-40x1/2	
18	2	81349	2051-440-A-0	Standoff 3/16 x4-40x1/8	
19	8	81349	MS51957-27	Screw PH 6-32 x 5/16	
20	4	81349		Fillester Head 6-32x3/8	
21	8	81349	MS35338-136	Lockwasher #6	
22	8	81349	NAS620-C6	Reduced O/D Flat Washer #6	
23	2	81349	MS51957-43	Screw PH 8-32x3/8	

ASSEMBLY NUMBER 125551 - POWER MODULE ASSEMBLY AS210A-PM (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
24	2	81349	MS35338-137	Lockwasher #8	
25	2	81349	NAS620-C8	Reduced O/D Flat Washer #8	
26	2	55566	351	Hinged Standoff	
27	2	80009	213-0726-00	Screw, Retaining 6-32 x 6.0002	

ASSEMBLY NUMBER 125554 - DECK ASSEMBLY AS210A-PM

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	125555	Deck Plate	
2	1	33472	125564	Heat Sink Assembly	
3	1	90201	CGR203U016R-4C3PL	Capacitor 20000 MFD 16 Vdc	
4	4	90201	CGR392U040R-3C3PL	Capacitor, 3900 MFD 49 Vdc	
5	2	33472	125562	Side Frame	
6	8	81349	M2.6	Metric Screw, Flat head, 90°, 6mm LG (.236)	
7	1	81349	MS24693-C32	Screw FLH 6-32X1	
8	1	81349	NAS671-C6	Small Pattern Nut #6	
9	1	81349	NAS620-C6	Flat Washer R OD #6	
10	1	81349	MS35338-136	Split Lock Washer #6	
11	3	81349	MS24693-C2	Screw FLH 4-40x1/4	
12	3	81349	MS21044-C04	Nylon Stop Nuts #4	
13	4	81349	MS24693-C25	Screw FLH 6-32x5/16	
14	3	04713	MDA-970-A2	4 amp Diode Bridge	CR1-2-4
15	1	33900	SCBA-2	Bridge Rectifier	CR3
16	1	33472	125563	Cap Bracket	
17	3	81349	NAS620-C4	Reduced O/D Flat Washer #4	
18	3	81349	MS24693-C7	Screw FLH 4-40x5/8	
19	4	81349	MS35275-228	Fillester Hd Screw 6-32x3/8	
20	4	06383	08427	Cable Ties	
21	1	81349	SE26XF03	Terminal Multi-Tie	

ASSEMBLY NUMBER 125556 - HARNESS ASSEMBLY POWER MODULE AS210A-PM

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	REF		12555	Harness Drawing	
2	REF		125557	Wire List	
3	4	27264	22-01-2041	4 Pin Connector	J1,J2,J5,J11
4	1	27264	22-01-2031	3 Pin Connector	J4
5	1	27264	22-01-2021	2 Pin Connector	J9
6	21	27264	08-50-0114	Pin	J1-4,J9,J11
7	1	27264	09-50-7091	9 Pin Connector	J6
8	1	27264	09-50-7041	4 Pin Connector	J8
9	13	27264	08-50-0108	Pin	J6,J8
10	A/R		E-20	Wire 20 AWG	
11	A/R		E-22	Wire 22 AWG	
12	A/R		E-24	Wire 24 AWG	
13	A/R		E-26	Wire 26 AWG	

ASSEMBLY NUMBER 125558 - REAR PANEL ASSEMBLY AS210A-PM

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	125559	Panel, Rear	
2	REF	33472	125560	Silkscreen, Rear Panel	
3	REF	33472	125557	Wire List	
4	1	33472	125414	Power Transformer	
5	4	33472	117173	Standoff, Legs	
6	1	05345	85-1507	Equipment Rating Label	
7	1	09353	9201-J3-E	Switch, Rocker, DPDT	
8	1	95345	6J4	EMI Line Filter	
9	1	23936	8124	Fan	
10	1	23936	5508	Finger Guard	
11	1	77969	RC#2-1/6WG	Grommet, Rubber, Black .188	
12	2	91836	KC-79-35	BNC Bulkhead Receptacle	
13	1	33472	150X750A	ARGOSystems I.D. Label	
14	1	09353	7301-P3YZQ-E	Switch Toggle DPDT	
15	2	33472	117301	Standoff, Stud Mount	
16	1	33472	117352-01	Cable Assembly IEEE	
17	1	32997	3006P-1-102Z	Trimpot, Panel Mount, 1K ohm	R6
18	1	73138	RH-5-5W65	65 ohm 5% 1%	R7
19	1	75915	313005	Fuse, 5 amp, Slo-Blo	F1
20	1	00779	1497	Solder Lug	
21	4	81349	MS51957-50	Screw PH 6-32x1-1/4	
22	2	81349	MS51957-4	Screw PH 2-56x5/16	
23	4	81349	NAS620-C2	Reduced O/D Flatwasher #2	
24	2	81349	MS35338-134	Split Lockwasher #2	
25	2	81349	NAS671-C2	Nut, Small Pattern #2	

ASSEMBLY NUMBER 125558 - REAR PANEL ASSEMBLY AS210A-PM (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
26	8	81349	NAS671-C6	Nut, Small Pattern #6	
27	3	81349	MS51957-29	Screw PH 6-32x7/16	
28	1	81349	MS51957-30	Screw PH 6-32x1/2	
29	4	81349	MS24693-C27	Screw FH 6-32x7/16	
30	8	81349	MS35338-136	Lockwasher #6	
31	12	81349	NAS620-C6	Reduced O/D Flat Washer #6	

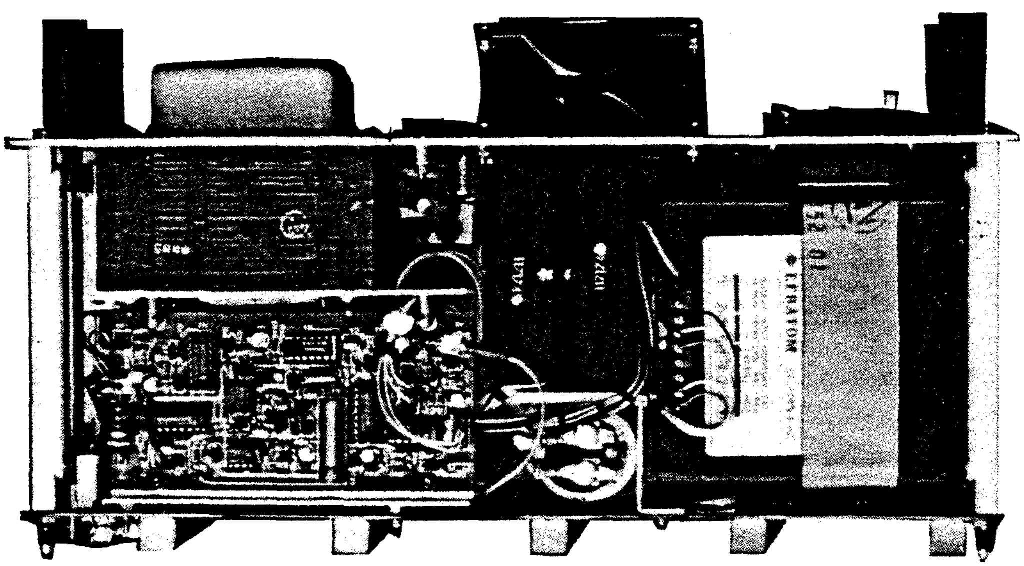


Figure 6.2 AS210-PMA Portable Mainframe Assembly

ASSEMBLY NUMBER 125564 - HEAT SINK ASSEMBLY AS210A-PM

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	33472	117174	Heat Sink	
2	1	80009	260-0907-00	Thermal Switch	
3	1	33472	117172-01	Spacer, Mounting	
4	1	33472	117172-02	Spacer, Mounting	
5	2	18100	UA78H05SC	Voltage Regulator	U3, U4
6	1	18100	UA78HGASC	5 amp Voltage Regulator	U2
7	1	18100	UA79HGSC	5 amp Negative Adj. Voltage Regulator	U1
8	2	81349	1416-6	Solder Lug #6	
9	4	81349	300-50-601-105M	1 fd 20% Ceramic Capacitor	
10	8	81349	MS51957-30	Screw PH 6-32x1/2	
11	20	81349	NAS620-C6	Flat Washer Reduced O/D #6	
12	11	81349	MS35338-136	Split Lockwasher #6	
13	9	81349	NAS671-C6	Small Pattern Nut #6	
14	2	81349	MS51957-14	Screw PH 4-40 x 5/16	
15	2	81349	NAS620-C4	Reduced O/D Flat Washer #4	
16	2	81349	MS35338-135	Split Lockwasher #4	
17	1	81349	RN55D2211FS	2.21K ohm 1% 1/8W	R9
18	1	81349	RN55DXXXXFS	FS ohm 1% 1/8W	R8
19	1	81349	RN55D4221FS	4.22K ohm 1% 1/8W	R11
20	1	81349	RN55DXXXXFS	FS ohm 1% 1/8W	R10
21	1	81349	MS51957-36	Screw PH 6-32x1-1/2	
22	1	81349	MS51957-27	Screw PH 6-32x5/16	
23	1	81349	MS51957-28	Screw PH 6-32x3/8	

ASSEMBLY NUMBER 125566 - MOTHERBOARD ASSEMBLY AS210A-PM

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	125567	Motherboard PWB	
2	REF	33472	125568	Master Pattern	
3	5	1781	K600-11-56Y25	56 Pin Connector (no ears)	J1-J5
4	2	75915	27503.5	Fuse, Axial	
5	10	75915	102071	Fuse Clip, PC Mount	
6	4	71279	1802752-02-05	Terminal, Bifurcated	
7	5	75915	313003	Fuse, 3 amp, Slo-Blo	F1-F5
8	1	27264	09-88-1041	4 Pin con R+angle	J8
9	1	27264	22-05-2041	4 Pin R Angle Connector	J11
10	1	27264	22-05-2021	2 Pin R Angle Connector	J4
11	1	27264	09-60-1091	9 Pin Connector	J6
12	1	27264	3429-1202	Connector, 26 Pin	

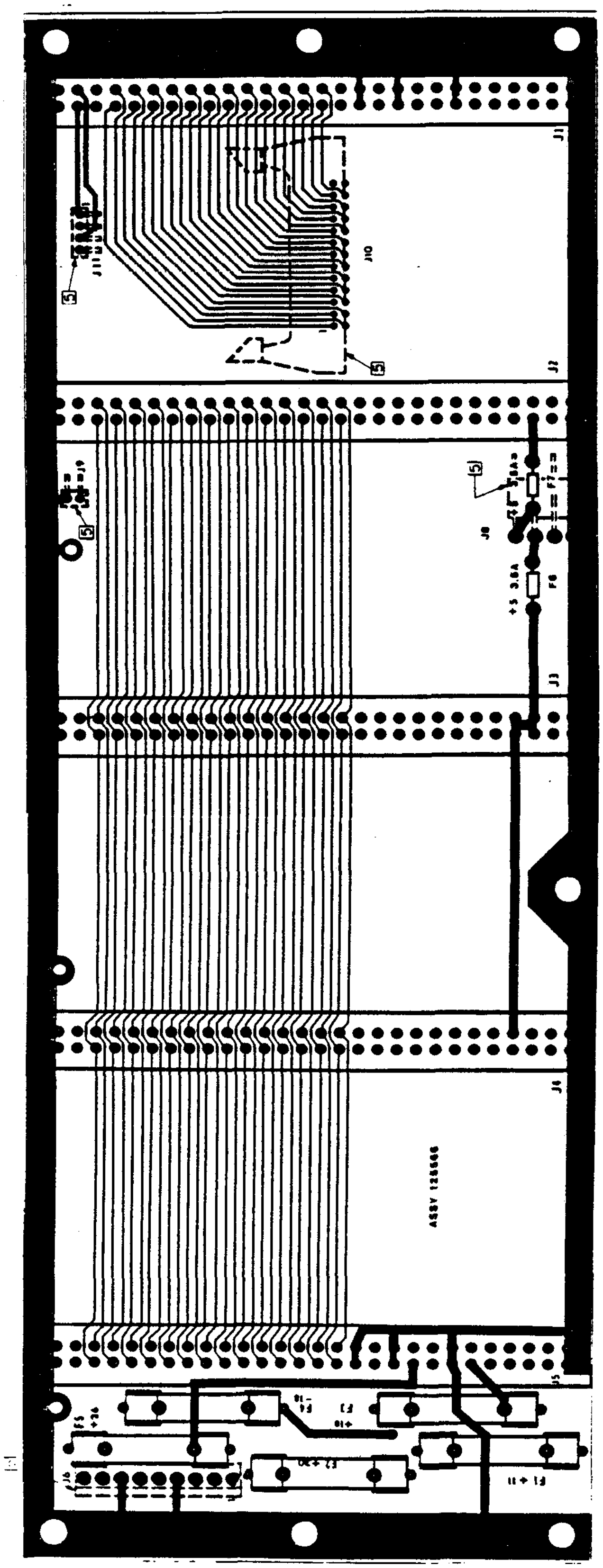


Figure 6.3 AS210A-PM Mainframe Motherboard Assembly

6-2 MANUFACTURER'S LIST CODE TO NAME

This section contains all manufacturer's codes for materials used in the AS210 system. The codes are listed in numerical order by code.

FAIRCHILD

A Schlumberger Company

μA78H05 • μA78H05A 5-Volt 5-Amp Voltage Regulators

Hybrid Products

Description

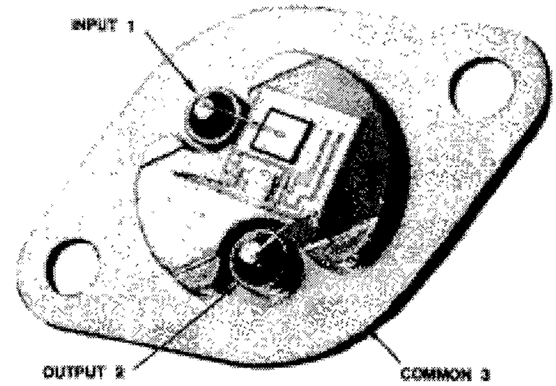
The μA78H05 and μA78H05A are hybrid regulators with 5.0 V fixed outputs and 5.0 A output capabilities. They have the inherent characteristics of the monolithic 3-terminal regulators, i.e., full thermal overload, short-circuit and safe-area protection. All devices are packaged in hermetically sealed TO-3s providing 50 W power dissipation. If the safe operating area is exceeded, the device shuts down rather than failing or damaging other system components (Note 1). This feature eliminates costly output circuitry and overly conservative heat sinks typical of high-current regulators built from discrete components.

- 5.0 A OUTPUT CURRENT
- INTERNAL CURRENT AND THERMAL OVERLOAD PROTECTION
- INTERNAL SHORT CIRCUIT PROTECTION
- LOW DROPOUT VOLTAGE (TYPICALLY 2.3 V @ 5.0 A)
- 50 W POWER DISSIPATION
- STEEL TO-3 PACKAGE
- ALL PIN-FOR-PIN COMPATIBLE WITH THE SH323

Note

1. These voltage regulators offer output transistor safe-area protection. However, to maintain full protection, the devices must be operated within the maximum input-to-output voltage differential ratings, as listed on this data sheet under "Absolute Maximum Ratings." For applications violating these limits, devices will not be fully protected.

Connection Diagram
TO-3 Metal Package



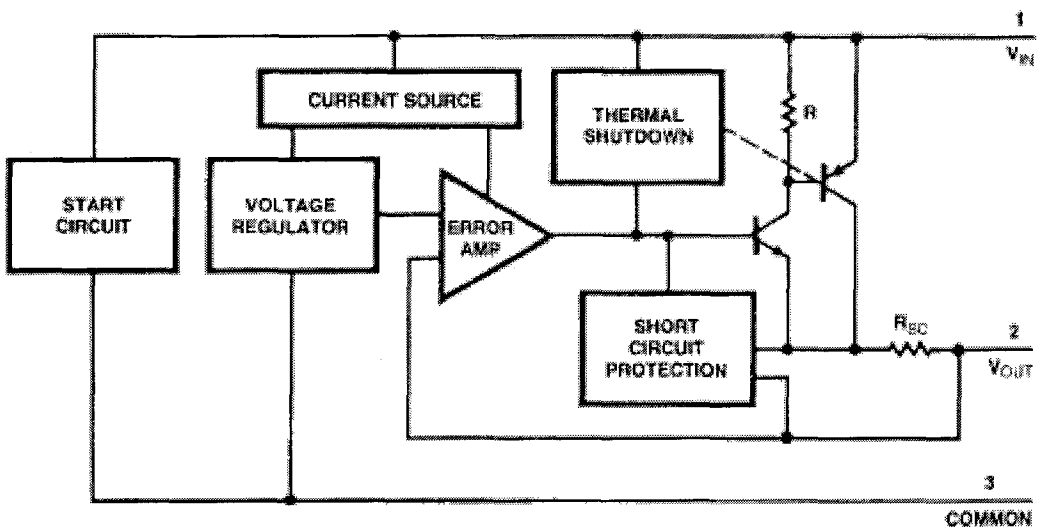
(Top View)

Order Information

Type	Package	Code	Part No.
μA7805	Metal	GN	μA78H05SC
μA7805A	Metal	GN	μA78H05ASC
μA7805	Metal	GN	μA78H05SM
μA7805A	Metal	GN	μA78H05ASM

3

Block Diagram



National Semiconductor

February 2006

LM140QML
Three Terminal Positive Regulators

General Description

The monolithic 3-terminal positive voltage regulators employ internal current-limiting, thermal shutdown and safe-area compensation, making them essentially indestructible. If adequate heat sinking is provided, they can deliver over 0.5A output current. They are intended as fixed voltage regulators in a wide range of applications including local (on-card) regulation for elimination of noise and distribution problems associated with single-point regulation. In addition to use as fixed voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents.

Considerable effort was expended to make the entire series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

Features

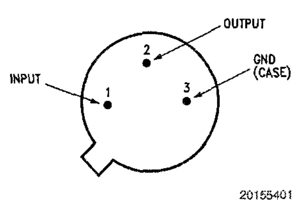
- Complete specifications at 1.0A and 0.5A loads
- No external components
- Internal thermal overload protection
- Internal short circuit current-limiting
- Output transistor safe-area compensation

Ordering Information

NS Part Number	SMD Part Number	NS Package Number	Package Description
LM140H-5.0/883		H03A	3LD TO-39 Metal Can
LM140H-12/883		H03A	3LD TO-39 Metal Can
LM140H-15/883		H03A	3LD TO-39 Metal Can
LM140K-5.0/883		K02C	2LD TO-3 Metal Can
LM140K-12/883		K02C	2LD TO-3 Metal Can
LM140K-15/883		K02C	2LD TO-3 Metal Can

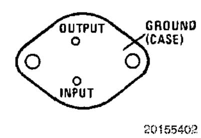
Connection Diagrams

Steel Metal Can TO-39 Package (H)



Bottom View
See NS Package Number H03A

TO-3 Metal Can (K)



Bottom View
See NS Package Number K02C

 DS201554 www.national.com

Figure 2: Output Noise Voltage

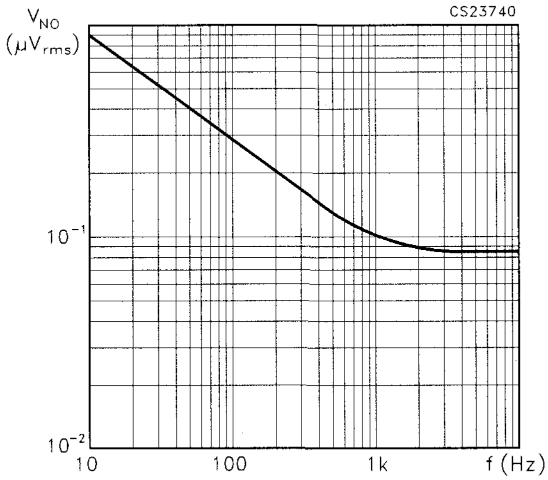


Figure 5: Short Circuit Current

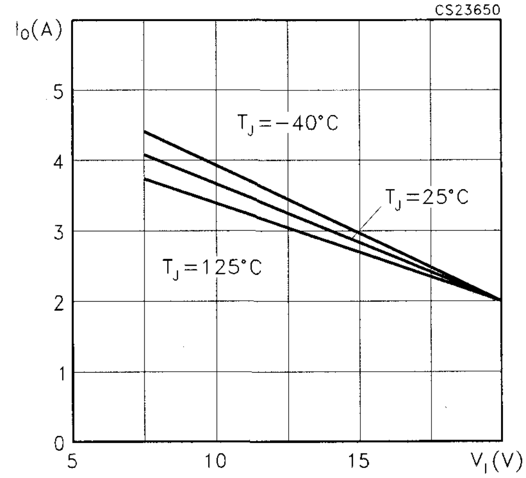


Figure 3: Output Impedance

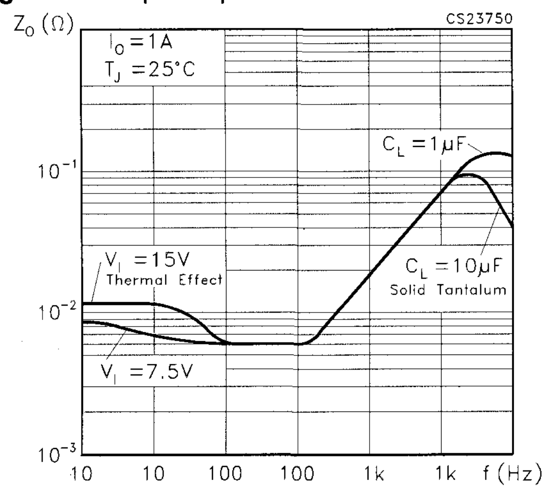


Figure 6: Ripple Rejection

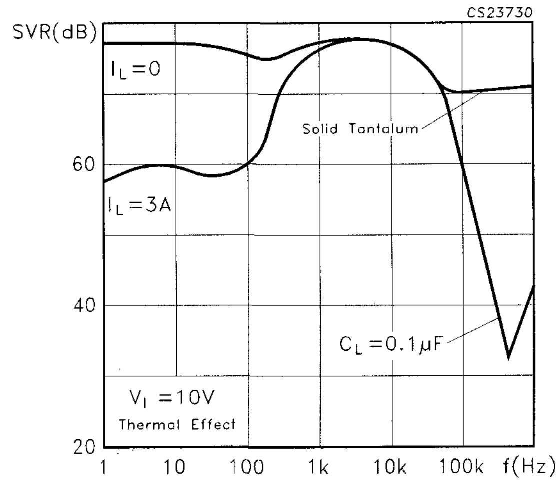


Figure 4: Peak Available Output Current

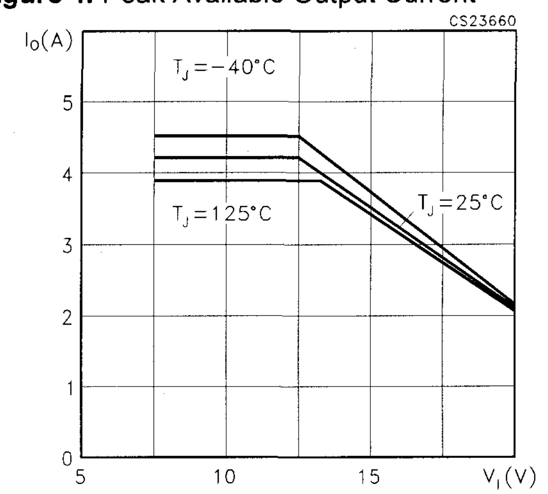


Figure 7: Dropout Voltage

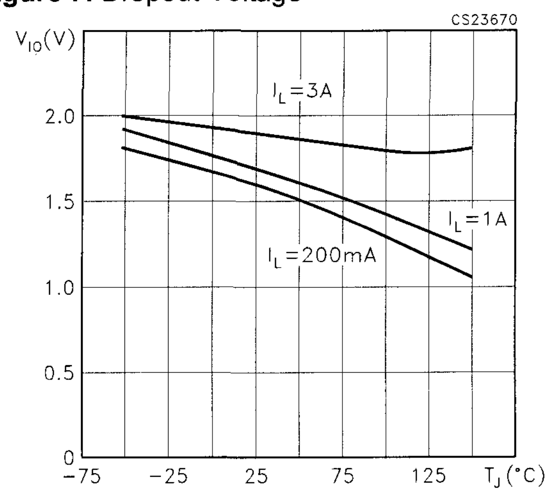


Table 4: Electrical Characteristics Of LM123/LM223 (T_J = -55 to 150°C for LM123, T_J = -25 to 150°C for LM223 unless otherwise specified).

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_O	Output Voltage Range (Note 2)	T_a = 25°C, V_I = 7.5 V, I_O = 0	4.7	5	5.3	V
V_O	Output Voltage Range (Note 2)	$T_J = T_{min}$ to T_{max} $P \leq P_{max}$ V_I = 7.5 to 15 V I_O = 0 to 3 A	4.6		5.4	V
K_{VI}	Line Regulation (Note 3)	V_I = 7.5 to 15 V T_J = 25°C		5	25	mV
K_{VO}	Load Regulation (Note 3)	I_O = 0 to 3 AV_I = 7.5 V T_J = 25°C		25	100	mV
I_{IB}	Quiescent Current	V_I = 7.5 to 15 V I_O = 0 to 3 A		12	20	mA
V_{NO}	Output Noise Voltage	T_a = 25°C f = 10 Hz to 100 KHz		40		μV_{rms}
I_{OS}	Short Circuit Current Limit	V_I = 15 V T_J = 25°C		3	4.5	A
		V_I = 7.5 V T_J = 25°C		4	5	
K_{VH}	Long Term Stability				35	mV

Notes: 1. Although power dissipation is internally limited, specifications apply only for P ≤ 30W.
2. Selected devices with tightened tolerance output voltage available.
3. Load and line regulation are specified at constant junction temperature. Pulse testing is required with a pulse width ≤ 1ms and duty cycle ≤ 5%.

Table 5: Electrical Characteristics Of LM323 (T_J = 0 to 150°C, unless otherwise specified).

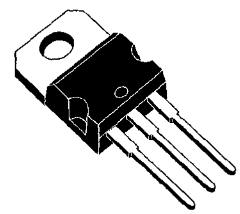
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_O	Output Voltage Range (Note 2)	T_a = 25°C, V_I = 7.5 V, I_O = 0	4.8	5	5.2	V
V_O	Output Voltage Range (Note 2)	$T_J = T_{min}$ to T_{max} $P \leq P_{max}$ V_I = 7.5 to 15 V I_O = 0 to 3 A	4.75		5.25	V
K_{VI}	Line Regulation (Note 3)	V_I = 7.5 to 15 V T_J = 25°C		5	25	mV
K_{VO}	Load Regulation (Note 3)	I_O = 0 to 3 AV_I = 7.5 V T_J = 25°C		25	100	mV
I_{IB}	Quiescent Current	V_I = 7.5 to 15 V I_O = 0 to 3 A		12	20	mA
V_{NO}	Output Noise Voltage	T_a = 25°C f = 10 Hz to 100 KHz		40		μV_{rms}
I_{OS}	Short Circuit Current Limit	V_I = 15 V T_J = 25°C		3	4.5	A
		V_I = 7.5 V T_J = 25°C		4	5	
K_{VH}	Long Term Stability				35	mV

Notes: 1. Although power dissipation is internally limited, specifications apply only for P ≤ 30W.
2. Selected devices with tightened tolerance output voltage available.
3. Load and line regulation are specified at constant junction temperature. Pulse testing is required with a pulse width ≤ 1ms and duty cycle ≤ 5%.

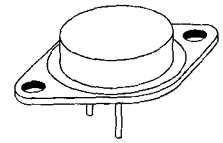
LM123/LM223
LM323

THREE-TERMINAL 3A-5V POSITIVE VOLTAGE REGULATORS

- OUTPUT CURRENT: 3A
- INTERNAL CURRENT AND THERMAL LIMITING
- TYPICAL OUTPUT IMPEDANCE: 0.01Ω
- MINIMUM INPUT VOLTAGE: 7.5V
- POWER DISSIPATION: 30W



TO-220



TO-3

DESCRIPTION

The LM123, LM223, LM323 are three-terminal positive voltage regulators with a preset 5V output and a load driving capability of 3A. New circuit design and processing techniques are used to provide the high output current without sacrificing the regulation characteristics of lower current devices.

The 3A regulator is virtually blowout proof.

Current limiting, power limiting and thermal shut-down provide the same high level of reliability obtained with these techniques in the LM209, 1A regulator. An overall worst case specification for the combined effects of input voltage, load current, ambient temperature, and power dissipation ensure that the LM123, LM223, LM323 will perform satisfactorily as a system element.

SCHEMATIC DIAGRAM

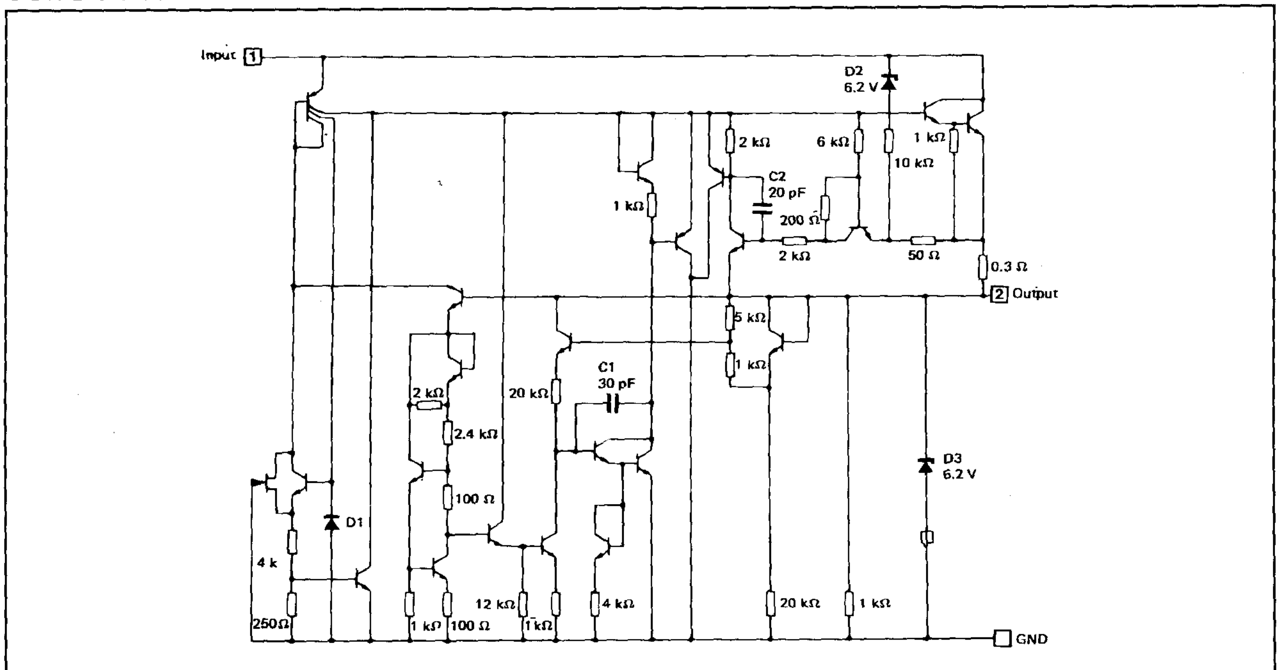


Table 1: Absolute Maximum Ratings

Symbol	Parameter		Value	Unit
V_I	Input Voltage		20	V
I_O	Output Current		Internally Limited	
P_{tot}	Power Dissipation		Internally Limited	
T_{stg}	Storage Temperature Range		-65 to 150	°C
T_{oper}	Operating Junction Temperature Range	LM123	-55 to 150	°C
		LM223	-25 to 125	
		LM323	0 to 125	

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 2: Thermal Data

Symbol	Parameter	TO-220	TO-3	Unit
$R_{thj\text{-}case}$	Thermal Resistance Junction-case Max	3	2	°C/W
$R_{thj\text{-}amb}$	Thermal Resistance Junction-ambient Max	50	35	°C/W

Figure 1: Connection Diagram (top view)

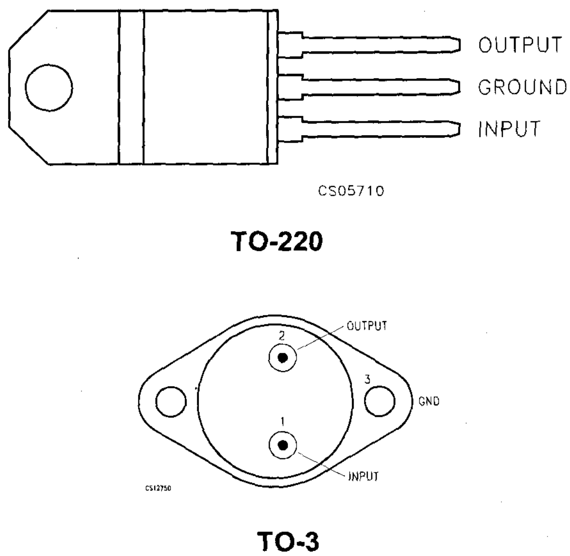


Table 3: Order Codes

TYPE	TO-220	TO-3	TEMPERATURE RANGE
LM123		LM123K	-55°C to 150°C
LM223		LM223K	-25°C to 150°C
LM323	LM323T	LM323K	0°C to 125°C

MANUFACTURER'S LIST CODE TO NAME

CODE	MANUFACTURER	ADDRESS
00779	AMP, INC	P.O. Box 3608 Harrisburg, PA 17105
01121	ALLEN-BRADLEY COMPANY	1202 South 2nd Street Milwaukee, WI 53204
01139	GENERAL ELECTRIC COMPANY	Silicone Products Business Department Waterford, NY 12188 PHONE: 518-237-3330
01281	TRW, INC.	TRW Semiconductor Division 14520 Aviation Boulevard Lawndale, CA 90260
01295	TEXAS INSTRUMENTS, INC.	Semiconductor Group 13500 North Central Expressway P.O.Box 225012 M/S 49 Dallas, TX 75265
02114	AMPEREX ELECTRONIC CORPORATION	Ferroxcub Division 5083 Kings Highway Saugerties, NY 12477
02660	BUNKER RAMO-ELTRA CORPORATION	Amphenol Division 2801 South. 25th Avenue Broadview, IL 60153
02735	RCA CORPORPATION	Solid State Division Route 202 Somerville, NJ 08876
03797	GENISCO TECHNOLOGY CORPORATION	Electronics Division 18435 Susana Road Rancho Dominguez, CA 90221 PHONE: 213-537-4750
04426	ILLINOIS TOOL WORKS, INC.	Licon Division 6615 West Irving Park Road Chicago, IL 60634
04713	MOTOROLA, INC.	Semiconductor Products Sector 5005 East McDowell Road Phoenix, AZ 85008 PHONE: 602-244-7100

CODE	MANUFACTURER	ADDRESS
05245	CORCOM, INC.	1600 Wincheste Road Libertyville, IL 60048
06090	RAYCHEM CORPORATION	300 Constitution Drive Menlo Park, CA 94025
06383	PANDUIT CORPORATION	17301 Ridgeland Tinley Park, IL 60477
06540	MITE CORPORATION	Amatom Electronic Hardware Division 446 Blake Street New Haven, CT 06515
07263	FAIRCHILD CAMERA & INSTRUMENT CORPORATION	Sub of Schlumberger LTD North American Sales Mail Stop 14-1053 401 Ellis Street P. O. Drawer 7284 Mt. View, CA 94042
09353	C AND K COMPONENTS, INC.	15 Riverdale Avenue Newton, MA 02158 PHONE: 617-964-6400
11237	CTS KEENE, INC.	P.O. Box 1977 Paso Robles, CA 93446
12136	PHC INDUSTRIES, INC.	1643 Haddon Avenue Camden, NJ 08103
13103	THERMALLOY COMPANY, INC.	2021 West Valley View Lane P. O. Box 340839 Dallas, TX 75234
13556	TRW CINCH CONNECTORS	Nuline Facility Division of TRW, Inc. New Hope, MN
14099	SEMTECH CORPORATION	652 Mitchell Road Newbury Park, CA 91320 PHONE: 213-628-5392
14655	CORNELL-DUBILIER ELECTRONICS	Div. of Federal Pacific Electric Co. Government Contracts Department 150 Avenue L Newark, NJ 07101

CODE	MANUFACTURER	ADDRESS
15542	MINI-CIRCUITS LABORATORY	Div. of Scientific Components Corp. 2625 East 14th Street Brooklyn, NY 11235
16428	BELDEN ELECTRONIC WIRE & CABLE	Sub of Cooper Industries, Inc. 2200 U.S. Highway 27 South P.O. Box 1980 Richmond, IN 47374 PHONE: 317-983-5200
18612	VISHAY INTERTECHNOLOGY, INC.	Vishay Resistor Products Division 63 Lincoln Highway Malvern, PA 19355
19209	GENERAL ELECTRIC COMPANY	Battery Business Department 441 Highway N P. O. Box 861 Gainesville, FL 32602 PHONE: 904-462-3911
23936	PAMOTOR DIVISION OF WILLIAM J. PURDY COMPANY	770 Airport Boulevard Burlingame, CA 94010
26805	OMNI SPECTRA, INC.	Microwave Connector Division Waltham, MA
26806	AMERICAN ZETTLER, INC.	16881 Hale Avenue Irvine, CA 92714
27014	NATIONAL SEMICONDUCTOR CORPORATION	2900 Semiconductor Drive Santa Clara, CA 95051
27264	MOLEX, INC.	2222 Wellington Court Lisle, IL 60532
32997	BOURNS, INC.	Trimpot Division 1200 Columbia Avenue Riverside, CA
33472	ARGOSYSTEMS, Inc.	884 Hermosa Court Sunnyvale, CA 94086
34649	INTEL CORPORATION	3585 SW 198th Avenue Aloha, OR 97005

CODE	MANUFACTURER	ADDRESS
50088	MOSTEK CORPORATION	Sub of United Technologies Corp. 1215 West Crosby Road P.O. Box 169 Carrollton, TX 75006
50434	HEWLETT-PACKARD COMPANY	Optoelectronics Division 640 Page Mill Road Palo Alto, CA 94304
51642	CENTRE ENGINEERING, INC.	2820 E. College Avenue State College, PA 16801
53387	MINNESOTA MINING AND MANUFACTURING COMPANY	Electronic Products Division 3M Center St. Paul, MN 55101
54893	HEWLETT-PACKARD COMPANY	Microwave Semiconductor Division 350 West Trimble Road San Jose, CA 95131
55154	PLESSEY PERIPHERAL SYSTEMS, INC.	17466 Daimler Avenue P. O. Box 19616 Irvine, CA 92714
55566	R A F ELECTRONIC HARDWARE, INC.	95 Silvermine Road Seymour, CT 06483 PHONE: 203-888-2133
56289	SPRAGUE ELECTRIC COMPANY	87 Marshall Street North Adams, MA 01247
58910	ABBOTT TRANSISTOR LABORATORIES, INC.	Transformer Division 639 South Glenwood Place Burbank, CA 91506
59660	TUSONIX, INC.	2155 North Forbes Boulevard Suite 107 Tucson, AZ 85745
59705	STANDEX INTERNATIONAL CORPORATION	United Service Equipment Co. Div. 1152 Park Avenue Murfreesboro, TN 37130

CODE	MANUFACTURER	ADDRESS
71279	MIDLAND-ROSS CORPORATION	Cambion Division One Alewife Place Cambridge, MA 02140 PHONE: 617-491-5400
71450	CTS CORPORATION	905 North West Boulevard Elkhart, IN 46514
71984	DOW CORNING CORPORATION	3901 South Saginaw Road Midland, MI 48640
73138	BECKMAN INSTRUMENTS, INC.	Helipot Division Sub of Smith Kline/Beckman Corp. 2500 Harbor Boulevard Fullerton, CA 92634
75915	TRACOR LITTLEFUSE, INC.	800 East Northwest Highway Des Plaines, IL 60016
77969	RUBBERCRAFT CORPORATION OF CALIFORNIA LTD.	1800 West 220th Street P.O. Box B Torrance, CA 90507 PHONE: 213-328-5402
78277	SIGMA INSTRUMENTS, INC.	170 Pearl Street South Braintree, MA 02184 PHONE: 617-853-5000
80009	TEKTRONIX, INC.	4900 Southwest Griffith Drive P. O. Box 500 Beaverton, OR 97077
81349	MILITARY SPECIFICATIONS	Promultgated by Military Departments/Agencies Under Authority of Defense Standard- ization Manual 4120 3-M
83330	SMITH HERMAN H. INC.	A North American Philips Company 1913 Atlantic Avenue Manasquan, NJ 08736
88245	WINCHESTER ELECTRONICS	Litton Systems-Useco Division 1536 Saticoy Street Van Nuys, CA 91409
90201	MALLORY CAPACITOR COMPANY	Sub of Emhart Industries, Inc. 4760 Kentucky Avenue P. O. Box 372 Indianapolis, IN 46206

CODE	MANUFACTURER	ADDRESS
91506	AUGAT, INC.	33 Perry Avenue P. O. Box 779 Attleboro, MA 02703
91637	DALE ELECTRONICS, INC.	2064 12th Avenue P.O. Box 609 Columbus, NE 68601 PHONE: 402-563-6301
91836	KINGS ELECTRONICS COMPANY, INC	40 Marbledale Road Tuckahoe, NY 10707 PHONE: 914-793-5000
92194	ALPHA WIRE CORPORATION	71 Lidgerwood Avenue Elizabeth, NJ 07207 PHONE: 201-925-8000
95146	ALCO ELECTRONIC PRODUCTS, INC.	1551 Osgood Street North Andover, MA 01845
95238	CONTINENTAL CONNECTOR CORPORATION	34-63 56th Street Woodside, NY 11377 PHONE: 212-899-4422
95987	WECKESSER COMPANY, INC.	Chicago, IL
98291	SEALECTRO CORPORATION	225 Hoyt Mamaroneck, NY 10544
99800	AMERICAN PRECISION INDUSTRIES, INC.	Delevan Division 270 Quaker Road East Aurora, NY 14052 PHONE: 716-652-3600

M83-0005

AS210-01A
MODULE CONTROLLER

Revised 7/85

ARGOSystems, Inc. / 884 Hermosa Court, Sunnyvale, California 94086
Telephone (Area Code 408) 737-2000 / Telex No. 352077

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LIST OF ILLUSTRATIONS

LIST OF TABLES

PREFACE

This manual contains installation, operation, and maintenance instructions for the AS210-01A Module Controller. The data contained herein is arranged as follows:

Chapter 1	General Information
Chapter 2	Installation
Chapter 3	Operation
Chapter 4	Theory of Operation
Chapter 5	Maintenance and Calibration
Chapter 6	Illustrated Parts List

Reference Publications

AS210A-PM	Portable Mainframe Operation and Maintenance Manual
AS210RM,LM	Mainframe Operation and Maintenance Manual
AS210-02	Frequency Comparator Operation and Maintenance Manual
AS210-03	Frequency Generator Operation and Maintenance Manual
AS210-04	Digital Delay Generator Operation and Maintenance Manual
AS210-05	Standby Battery Operation and Maintenance Manual
AS210-06	Microwave Generator Operation and Maintenance Manual
AS210-08	Distribution Amplifier Operation and Maintenance Manual
AS210-20	Time Clock Operation and Maintenance Manual

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

The AS210-01A Module Controller, illustrated in Figure 1.1, provides control of the other modules in an AS210 Electronic Counter and Frequency Standard Calibration system. The module also provides self-test capability for itself and other modules installed in the mainframe. A built-in memory battery allows the unit to retain data through a two-hour power outage. The module controller can be programmed through its front panel keyboard or through the IEEE-488 interface. Descriptions of other modules in the AS210 series are described in separate publications available from ARGOSystems and listed in the Preface.

1-2 PHYSICAL AND ELECTRICAL DESCRIPTION

The module controller contains a front panel keyboard, LED display, and pushbutton controls for operating the AS210 modules. Interface with some modules is transparent from an operator's viewpoint as the built-in microprocessor handles the transmission of instructions and processing of data. In the case of the AS210-02 Frequency Comparator Module and the AS210-20 Time Clock, the module controller interfaces directly with the operator. The programs for calculating drift rate are written into the controller memory and are put into action by keyboard control. The circuitry of the module is mounted on five printed circuit card assemblies. Power is provided by the AS210 Mainframe. The module controller provides control and processing functions only, thus no specification of its operation is applicable outside of environmental and physical data. This information is provided in Table 1-1.

Table 1-1
AS210-01A ENVIRONMENTAL AND PHYSICAL DATA

OPERATING TEMPERATURE	0 to 40°C
POWER	AS210 Mainframe
WEIGHT	3 pounds

CHAPTER 2
INSTALLATION

2-1 INTRODUCTION

The AS210-01A Module Controller plugs into the AS210 Mainframe. The module is electrically connected through the rear connector and mechanically retained via a front panel locking bar on the mainframe. Power and signal interface is provided through the AS210 Mainframe. The module must be inserted into the right side of the mainframe. This is the only location designed for it.

NOTE 1: Power must be off in the AS210 Mainframe when the module controller is removed or installed.

NOTE 2: Due to the high retention force of the module controller's card edge connector, it will be necessary to remove the adjacent single width module, reach behind the module controller, and pull it out while actuating the front panel release mechanism (Figure 3.1).

CAUTION

Do not attempt to use the AS210 series modules in a Tektronix mainframe as severe damage will result.

CHAPTER 3
OPERATION

3-1 INTRODUCTION

The AS210-01A Module Controller monitors and controls the modules of the AS210 series. The microprocessor is located in the module controller and operates in conjunction with each of the modules installed to transmit and receive data, process the data, and perform various calculations relative to the module's operation. Most of these functions are transparent to the operator. Both the frequency comparator module and the time clock module, however, operate in conjunction with the controller. This chapter contains operating instructions for the use of the module controller with the AS210-02 Frequency Comparator Module, and the AS210-20 Time Clock Module. These instructions are essentially duplicated in the AS210-02 and AS210-20 manuals. The operating instructions provided are keyed to Figure 3.2, Operational Flow Diagram. A standby battery, located on the rear panel, is used to retain the data in memory if ac power is disconnected. A self-test can be started by the operator with the front panel SELF-TEST pushbutton. This activates a routine that scans the other modules in the system, except the AS210-05 Standby Battery Module and the AS210-08 Distribution Amplifier. The self-test routine detects errors and displays a fault-locating code on the front panel LED display. When an error is found, the program halts and displays an error code. The routine will continue when the CONT function button is pressed. Table 3-2 is an error listing. If the AS210-06 Microwave Generator Module is in the system, a YIG filter tuning calibration is done as part of the self-test.

3-2 CONTROLS AND INDICATORS

Table 3-1 and Figure 3.1 describe and illustrate the front panel controls and indicators of the module controller.

TABLE 3-1

AS210-01A FRONT PANEL CONTROLS AND INDICATORS

INDEX NO. FIGURE. 3.1	PANEL MARKING	FUNCTION
1	REM	The illuminated pushbutton enables control of the unit through IEEE-488 interface bus.
2	SELF TEST	This illuminated pushbutton starts a self-test scenario that tests all plug-ins installed in the AS210 Mainframe except the AS210-05 and AS210-08. The self-test mode is also initiated automatically when power is applied to the AS210 Mainframe (see Table 3-2).
3	MEMORY BATTERY STBY-OFF	The STBY position enables a built-in microprocessor battery to supply power to the memory when external power is disconnected.
4	ENTER	Press to enter numerical data.
	CLR	Clears display.
	HALT	Stops the procedure in progress.
	RESET	Returns to start of procedure.
	TIME - DAY, HOUR, MINUTE	Enters or displays time in Julian day, hour, and minute.
	CALC - YEAR, DAY, HOUR	Calculates drift rate per year, day, or hour.
	DSPL	Press to display numerical data or IEEE-488 address.
	CONT	Continues procedure to next operation.
5	NONE	10-digit LED display unit.
6	0-9, -,	Keyboard used to enter numerical data.
7	NONE	Release mechanism.

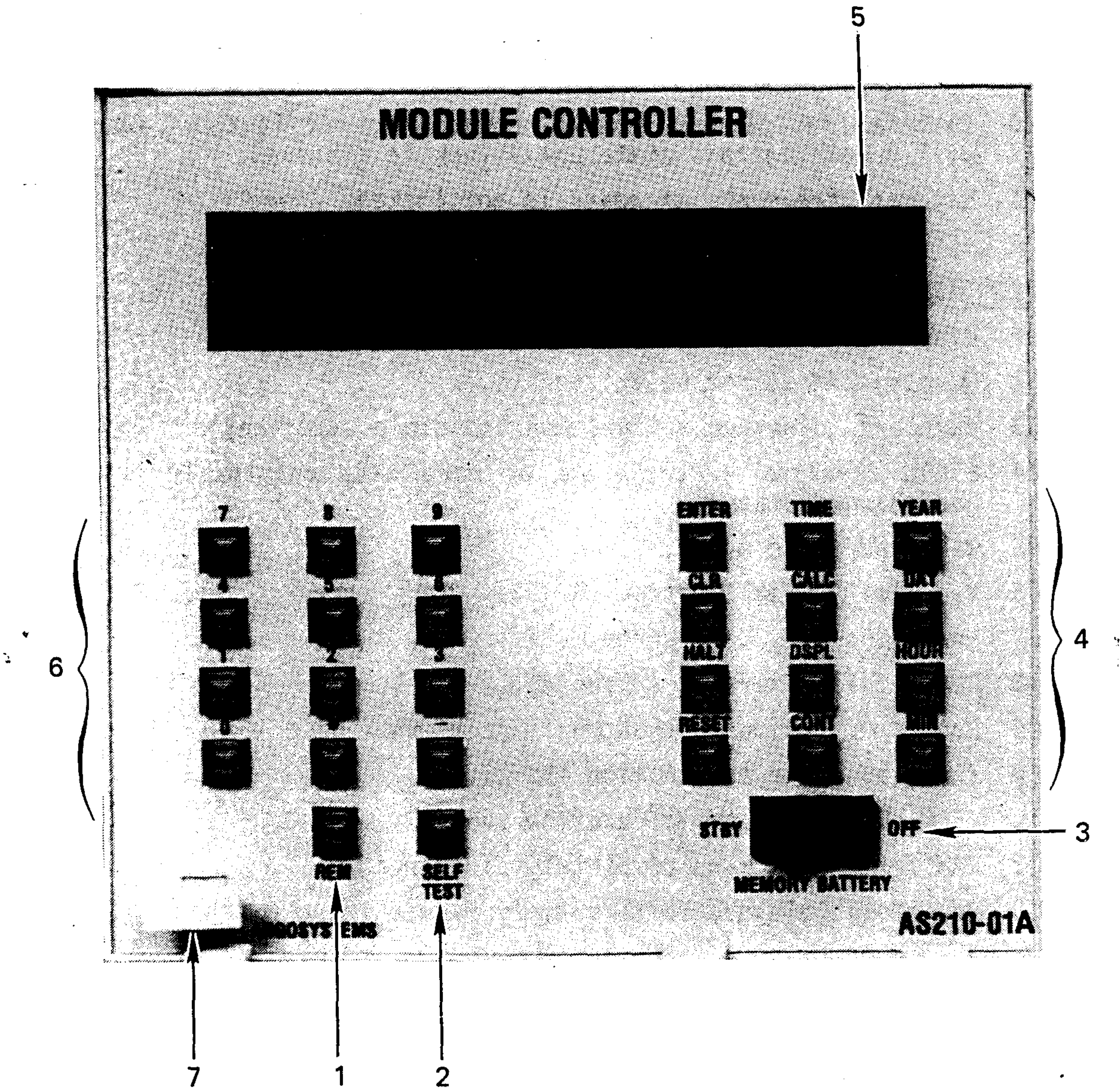


Figure 3.1 AS210-01A Front Panel Controls and Indicators

Table 3-2

ERROR CODE DISPLAYS

MAINFRAME	
Err 0-00	Internal rubidium frequency standard is not locked. Controller will remain in this state until lock is achieved.
Err 0-01	External frequency standard is not locked.
MODULE CONTROLLER	
Err 1-01	Display RAM cannot be cleared.
Err 1-02	Display RAM cannot be written to.
Err 1-03	Keyboard interface malfunction (possible stuck key).
Err 1-04	EPROM checksum error. One or more bits originally programmed has changed states.
Err 1-05	RAM read/write error.
Err 1-06	Parallel I/O malfunction (8755).
Err 1-07	No 10 pps to CPU interrupt 7.5.
Err 1-08	Power fail timer not advancing.
Err 1-09	Power fail timer advancing faster than once every 10 seconds.
Err 1-10	Interval timer malfunction (8253).
Err 1-11	IEEE-488 interface malfunction (68488).
Err 1-12	RAM battery back-up completely discharged.
Err 1-13	No modules plugged in to satisfy remote learn command.
FREQUENCY COMPARATOR MODULE	
Err 2-01	Output decade registers cannot be cleared.
Err 2-02	Self-test failed to phase lock.
Err 2-03	Measurement complete flip/flop (RR) cannot be reset.
Err 2-04	Self-test measurement did not complete within 0.5 seconds.
Err 2-05	Self-test measurement not within ± 1 part in 10^8.
Err 2-1X	Incorrect or missing signal on input X, where X=1 to 6.

Table 3-2 (Continued)

FREQUENCY COMPARATOR MODULE (Continued)

Err 2-20	In drift rate calculation, data points are separated by time interval of less than 1 minute.
Err 2-21	In drift rate calculation, data points are separated by discontinuous time (power failure without frequency standard battery back-up).
Err 2-22	In drift rate calculation, initial data point is overflowed.
Err 2-23	In drift rate calculation, final data point is overflowed.
Err 2-30	Channel number specified has no data associated with it.
Err 2-40	Data points specified are empty (i.e., that number of data points have not previously been stored).
Err 2-50	Remote continue command with module in standby state.

FREQUENCY GENERATOR MODULE

Err 3-03	1 MHz malfunction, no leveling loop indication.
Err 3-04	10 MHz malfunction, no leveling loop indication.
Err 3-X1	Frequency X did not phase lock.
Err 3-X2	Frequency X had no leveling loop indication. Where X = 0 = 50 MHz 1 = 100 MHz 2 = 200 MHz 3 = 300 MHz 4 = 400 MHz 5 = 500 MHz

DIGITAL DELAY GENERATOR MODULE

Err 4-00	On 10 kHz setting delay $\geq$99 microseconds or on 1 kHz setting delay $\geq$999 microseconds.
Err 4-2X	Self-test delay error at Prr X. Where X = 0 = 1 Hz 1 = 10 Hz 2 = 100 Hz
Err 4-1X	Self-test Prr not equal to X.
Err 4-30	Self-test delayed pulse not occurring. Unit not able to be self-tested.

Table 3-2 (Continued)

MICROWAVE GENERATOR

Err 6-00	Frequency not available
Err 6-0X	No leveling loop indication at frequency X X = 1 1 GHz X = 2 2 GHz X = 3 3 GHz . . . . . . X = 9 9 GHz
Err 6-1X	No leveling loop indication at frequency X X = 0 10 GHz X = 1 11 GHz X = 2 12 GHz . . . . . . X = 8 18 GHz
Err 6-30	1 GHz source not locked
Err 6-40	Calibration in progress
Err 6-50	Unable to level and level chosen is greater than guaranteed by performance specifications

TIME CLOCK

Err 20-00	Cannot adjust time clock with the SET ENABLE/DISABLE switch in the DISABLE position
Err 20-01	Time clock not advancing once per second
Err 20-02	Unable to synchronize to external 1 pps
Err 20-03	Unable to measure time offset, no external 1 pps signal

3-3 OPERATING INSTRUCTIONS

The following procedures and Figure 3.2 provide the operating instructions for the module controller. Specifically, these instructions tell the operator how to:

A. Set time on the controller's internal clock

B. Determine the IEEE-488 bus address

C. Perform FREQ ERROR measurements with the Frequency Comparator Module

D. Display measurements from memory

E. Perform DRIFT calculations

F. Set time on the AS210-20 Time Clock Module

G. Measure Δ time on the AS210-20 Time Clock module

H. Synchronize the AS210-20 Time Clock Module

The lighted pushbuttons are the only ones that can be used during a routine. The CLR pushbutton only clears the display. In the following procedures, the letters or numbers in parentheses refer to steps on Figure 3.2.

3-4 SET TIME ON THE CONTROLLER'S INTERNAL CLOCK

A. Press the TIME function button (1). Time on internal clock will be displayed (2).

B. Press the illuminated DAY button (3).

C. Enter the number of the Julian day with the keyboard and press the ENTER function button (4). Time on the internal clock will be displayed. The display will return to SEL? after approximately five seconds if no other time button is selected.

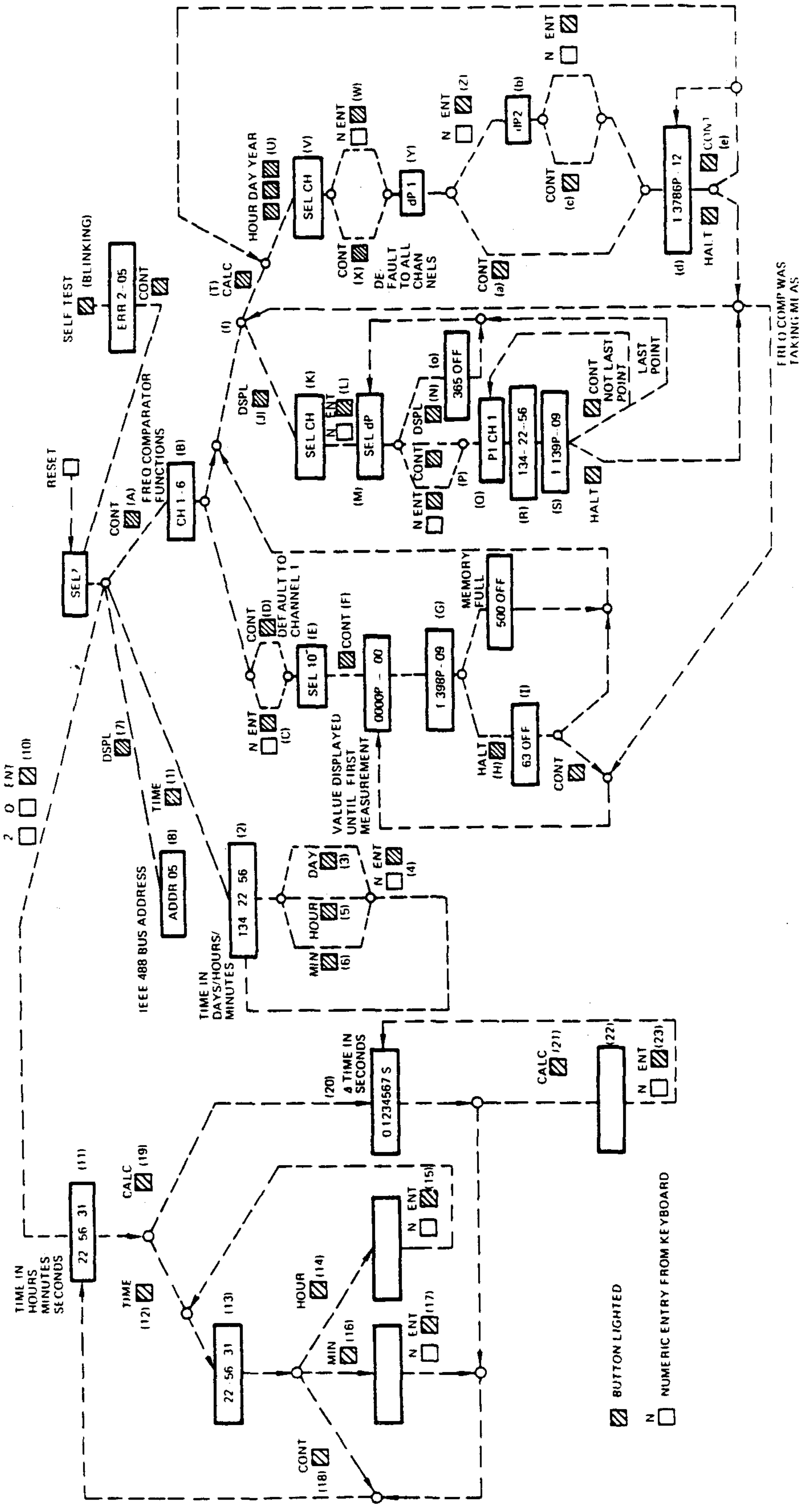


Figure 3.2 Operational Flow Diagram

D. Press the illuminated HOUR button (5) and enter the hour number (0-24) with the keyboard. Press ENTER (4). Time on the internal clock will be displayed. The display will return to SEL? after approximately five seconds if no other time button is selected.

E. Press the illuminated MINUTE button (6), enter the correct minute with the keyboard, then press ENTER (4).

F. The correct time is now entered in the module controller's internal clock and displayed on the LED display (2).

G. The time will remain displayed for five seconds and automatically return to "SEL?." To recall time display, press TIME function button (1).

3-5 DETERMINE IEEE-488 ADDRESS OF MODULE CONTROLLER

Press the lighted DSPL button (7) to display the IEEE-488 bus address of the module controller (8). This address is set internally with a DIP switch. The IEEE-488 bus control is used as described in the Remote Control section of this chapter. The IEEE-488 bus address will automatically clear from the display after five seconds.

3-6 FREQUENCY ERROR MEASUREMENT

A. Connect the frequency source(s) to be measured to the front panel BNC connector(s) on the AS210-02 Frequency Comparator Module.

B. Set the RATE switch on the AS210-02 Frequency Comparator Module to MAX for continuous sampling or 1 PER HOUR for sampling once per hour. The sampling rate is also a function of the resolution selected as follows:

Resolution	Samples Per Hour in MAX Mode
10^{-8}	Approximately 3600
10^{-9}	Approximately 600
10^{-10}	Approximately 70
10^{-11}	7

The memory of the module controller can store 500 samples: therefore, the 1 PER HOUR mode may be more useful than the MAX mode when data for several days elapsed time is desired. Up to six inputs can be connected to the frequency comparator. For the purposes of this procedure, it is assumed that only Channel 1 is being used. When more than one signal is connected, the sequence operates so that each channel is observed for one gate period (a function of the resolution selected), then the next channel is observed. It can be seen that as more inputs are connected less samples per hour are taken per input when in the MAX mode.

C. Press lighted CONT pushbutton (A) and CH 1-6 should be displayed (B).

D. Enter a channel number from 1 to 6 with the keyboard and ENTER function button (C). If only channel 1 is used, 1 is automatically selected by the program, by pressing the CONT button.

E. Press CONT (D) and SEL 10^{-} should be displayed (E). Select the desired frequency resolution with the RANGE switch on the AS210-02 Frequency Comparator Module.

F. Press CONT (F). The frequency offset measurement routine now proceeds. 0000P-00 will be displayed until the first measurement is made. Thereafter, the channel number and frequency offset (error) will be displayed for each measurement as it is made until 500 measurements have been taken. A display of 1 398P-09, as shown in Figure 3.2 (G), indicates a freauency offset of 398 x 10^{-9} on Channel 1. When 500 measurements have been completed without interruption, the program will halt automatically and 500 oFF will be displayed, indicating that 500 data points have been taken and the program is in an OFF condition. The measurement cycle can also be stopped with the HALT function button. The data point number and oFF will be displayed (I). Measurements can be resumed by pressing CONT.

3-7 DISPLAY FREQUENCY MEASUREMENTS FROM MEMORY

A. Press HALT (H) (if program is running) and then DSPL (J). SEL CH should be displayed (K).

B. Enter a channel number with the keyboard and ENTER function button (L) or push CONT to select channel one. SEL dP should now be displayed (M).

C. Enter a data point number with the keyboard and ENTER function button or push CONT to read the first data point in memory. The number of data points taken during the measurement cycle can be found by pressing DSPL (N). The number of data points and oFF should be displayed (O). For example, 365 oFF. The display will now return to SEL dP (M).

D. After a data point number and ENTER button is pressed, or CONT is pressed, the display will read out in sequence the data point number and channel number (Q) (e.g., P1 CH1), then the time the data point measurement was taken (R) (e.g., 134-22-56), then the frequency measurement at that data point (S) (e.g., 1 139P-09) is displayed.

E. The measurement process can be resumed by pressing HALT. If frequency comparisons have not been in process, the routine will return to (f) and either more data points displayed or a drift rate calculation performed. If CONT is pressed, the next data point in memory will be displayed as in paragraph D. If the last data point has been displayed, the routine will return to (M) and a new data point can be selected.

3-8 DRIFT CALCULATIONS

A. At any time after two or more data points have been collected over a time interval of more than one minute, a frequency drift calculation can be made.

B. Press HALT, then press CALC function button (T). Press HOUR, DAY, or YEAR function button (U) to select period for drift calculation.

C. SEL CH will be displayed (V). Enter the desired channel number with the keyboard and ENTER function button (W). (If CONT is pressed (X), all channels will be computed for frequency drift.)

D. dP 1 will be displayed (Y). Enter the desired number for the data point with the keyboard and ENTER function button (Z). The number entered can be anything within the data field from 1 to 500 depending on the resolution selected, length of measurement, time, number of data points, etc. If CONT is pressed (a) the drift calculation will automatically be made on the first through last data points. If CONT is not pressed, then dP 2 will be displayed (b). Enter the desired data point number as with dP 1(Z).

E. The CALC button will flash while the drift rate is being calculated. This may take tens of seconds. The drift rate will then be displayed for the selected channel (d). For example, 1 3786P-12 indicates a frequency drift over the period of time selected in step B of 3786 parts out of 10^{12} for Channel 1. The microprocessor computes the best fit line for the data in memory and displays the slope of that line as the drift rate.

F. Pressing CONT (e) at this time will return the routine to point (U) where new timeframes and channels can be selected for a drift calculation, or if CONT were pressed at point (X) the drift rate on the next channel will be displayed.

G. Pressing HALT returns the routine to displaying the frequency offset calculations in process at point (G). If frequency comparisons are not in progress, the routine blanks the display and goes to point (f). The DSPL and CALC buttons are illuminated.

3-9 SETTING ΔTIME ON AS210-20 CLOCK

A. To address any of the AS210-20 Time Clock functions, the -01A module controller must have SEL? displayed. The -20 is then addressed by pressing the number 2 key, then number 0 key, and then the ENTER key (10). The -01A display will then display the same time as is displayed on the -20 time display. At this point (11), the TIME and CALC function buttons will be illuminated. If the operator does not push either button, the display will revert to SEL? in approximately ten seconds.

B. To set the time on the -20 module, the SET ENABLE/DISABLE switch located on the -20 module must be in the ENABLE position. When the -20 module has been addressed (10) and the time is being displayed (11), the time can be set by pushing the TIME function button (12). When the TIME button is pressed (12) the -01A display will hold the last time displayed (13). The HOUR (14), MIN (16), and CONT (18) buttons will be illuminated. The hour can be changed by pressing the HOUR button (14). The -01A display will be blanked and the desired hour entered via the numeric keys and the ENTER button (15). The -20 display will update immediately but the -01A display will return to the last time displayed (13).

The change time routine can be exited by pressing the CONT button (18). The -01A will show the -20 clock time for approximately 10 seconds (11). If no action is taken, the -01A will then go back to displaying the SEL? message.

If the change routine was not exited, the minutes can be changed by pressing the MIN button (16). The -01A display will be blanked and the desired minutes entered via the numeric keys and the ENTER button (17). When the ENTER button (17) is pressed, the seconds are set to zero, the new minute value is entered and both the -20 and -01 displays (11) will show the updated time. If no further operator action is taken, the -01 display will return to SEL? in approximately ten seconds. The SET ENABLE/ DISABLE switch on the -20 should always be returned to the DISABLE position.

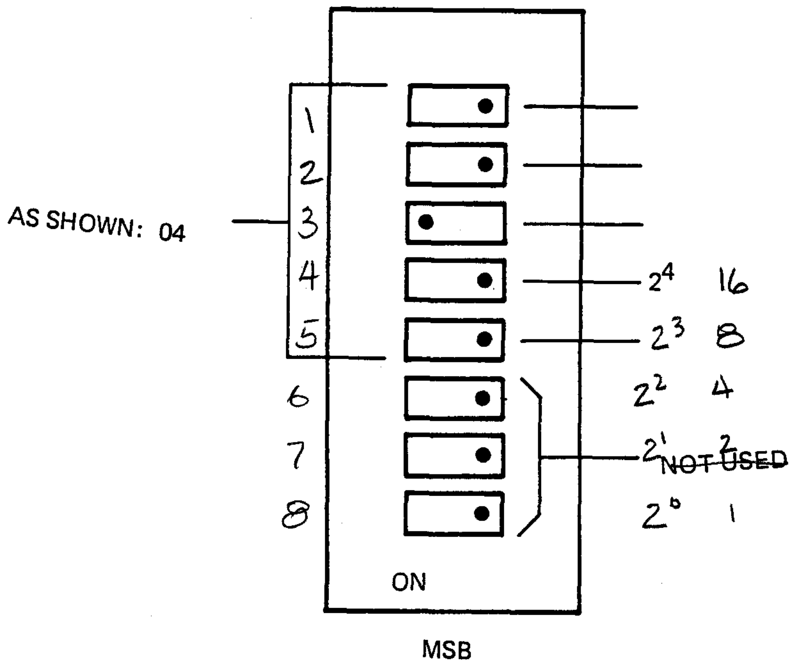
3-10 READING ΔTIME ON THE AS210-20 CLOCK

A. To read the time differential between the 1 pps signal generated by the -20 circuitry and the external 1 pps applied to the -20 1 pps IN connector, the -20 module is addressed by pressing 2, 0, ENTER (10) and then pressing the CALC button (19). The -01A will then display the time difference in seconds between the rising edge of the -20 1 pps signal and the rising edge of the external 1 pps signal (20). After five seconds, if the operator has not taken any further action, the -01A will display the -20 time (11). After displaying the time for approximately ten seconds, the -01A will return to displaying the SEL? message.

B. If it is desired to synchronize, or change the offset of, the internal 1 pps with respect to the external 1 pps, the following sequence of operations would be performed. Place the SET ENABLE/DISABLE switch on the -20 to the ENABLE position. Then address the -20 module (10) and go to the Δtime mode by pressing the CALC button (19). The -01A will display the Δtime (20). Press the CALC button again (21) and the display will go blank (22). Enter the desired offset, from 0 to 999999.9 microseconds, via the numeric keyboard and press the ENTER button (23). When entering the desired offset, do not press the decimal point button. The numbers pressed are automatically right justified. For example, pressing 1, 2, 3, and then ENTER, enters an offset of 12.3 microseconds. When the ENTER button is pressed, the microprocessor in the -01A computes the difference between the measured offset and the desired offset, then instructs the -20 module to make a one-time change in the phase to achieve the desired offset. After the adjustment is made, the offset will again be measured and displayed (20) on the -01A display. The SET ENABLE switch on the -20 should <u>always</u> be returned to the DISABLE position after adjustments are complete.

3-11 REMOTE CONTROL

The AS210 system can be remotely controlled via an IEEE-488 instrumentation bus. The DIP switch A2U24 must be set to the desired address (see Figure 3.3). Table 3-3 lists the active controller commands with which the AS210 will respond. The ASCII character strings sent to the AS210 when it is in the listen mode can be terminated in one of two ways.



NOTE: This switch is located on circuit card assembly A2 in the Module Controller.

Figure 3.3 IEEE-488 Interface Bus Address Select Switch

Table 3-3

AS210-01A GPIB MESSAGE SET

MESSAGE[1]	DESCRIPTION	CLASS	OCTAL CODE	REN	IFC	INSTRUMENT RESPONSE
GTL	Return to Local	Addressed CMD	001	T		The AS210-01A returns to local mode
MLA	My Listen Address	Addressed CMD	(2)			AS210-01A becomes addressed to listen
MTA	My Talk Address	Addressed CMD	(2)			AS210-01A becomes addressed to talk
UNL	Unlisten	Addressed CMD	077			Becomes unaddressed to listen
UNT	Untalk	Addressed CMD	137			Becomes unaddressed to talk
SPE	Serial Poll Enable	Universal CMD	030			Configures the AS210-01A into the serial poll mode
SPD	Serial Poll Disable	Universal CMD	031			Exits serial poll mode
IFC	Interface Clear	Single Line Message			T	Unaddresses the AS210-01A as a talker and as a listener and clears serial poll mode
REN	Remote Enable			T		Programs the AS210-01A to remote (concurrent with MLA)
				F		Returns the AS210-01A to local

[1]All Multiline (DIO 1-8) messages are sent with ATN true.

[2]DIO 1-5 are the instrument address. DIO 6-7 define talk (10) or listen (01).

B. A line feed character (carriage returns are ignored).

The following paragraphs describe the programming syntax that should be followed by a controller and the syntax of responses by the AS210 system. Commas should be included in the commands as shown. When the AS210 is in the remote control mode, the REM function button on the module controller front panel is illuminated.

3-12 AS210-01A TIME REMOTE COMMANDS

3-13 SETTING THE AS210-01A TIME - REMOTE COMMAND

T,Dxxx,Hxx,Mxx (controller to AS210)

where

T = set time command

D = day (up to 3 digit number)

H = hour (1 or 2 digit number < 24)

M = minute (1 or 2 digit number < 60)

x = integer number

3-14 READING THE AS210-01A TIME - REMOTE COMMAND

T?

response from AS210: xxx-xx-xx<CR> <LF>

Days Hours Minutes ↑ EOI

3-15 FREQUENCY GENERATOR MODULE REMOTE COMMANDS (AS210-03)

S3,Lx,Fy (controller to AS210)

where S3 = module select command

L = output level select

x = 1 = 1 mV
2 = 10 mV
3 = 20 mV
4 = 32 mV
5 = 40 mV
6 = 50 mV

7 = 100 mV
8 = 500 mV
9 = 1000 mV

F = frequency select

y = 1 = 1 MHz
2 = 10 MHz
3 = 50 MHz
4 = 100 MHz
5 = 200 MHz
6 = 300 MHz
7 = 400 MHz
8 = 500 MHz

3-16 DIGITAL DELAY GENERATOR MODULE REMOTE COMMANDS (AS210-04)

S4,Dxxxxx,Py (controller to AS210)

where S4 = module select command

D = delay select

x = delay in 10's of nanoseconds

$(0 \leq x \leq 99999)$

P = pulse rate select

y = 1 = 1 pps
2 = 10 pps
3 = 100 pps
4 = 1K pps
5 = 10K pps

3-17 FREQUENCY COMPARATOR MODULE REMOTE COMMANDS (AS210-02)

3-18 REMOTE MEASUREMENT COMMANDS

S2,Ax,Ry,Iz (controller to AS210)

where S2 = module select command

A = accuracy range select

x = 1 = parts in 10^8
2 = parts in 10^9
3 = parts in 10^{10}
4 = parts in 10^{11}

R = measurement rate select
    y = 1 = MAX
        2 = 1 PER HOUR
I = input channel select
    z = # of inputs to be measured ($1 \leq z \leq 6$)

A service request is sent when the data memory is full (paragraph 3-21). After each frequency measurement is made, the measured value is placed on the bus in the following format:

x∆yyyyP-zz<CR><LF>
↑ EOI

where x = input channel number
y = mantissa
z = exponent
∆ = ASCII space

Before the next measurement is taken, the interface controller must read the measured value from AS210-01A Module Controller.

If the measurement command is sent with a measurement rate select of Ry with either

y = 3 = maximum
    4 = 1 per hour

The measurement value will not be placed on the bus. The value is stored in memory. The measurements will be taken at the rate selected. The measurements can be halted, and the data examined at any time, by the commands listed in the following paragraphs.

3-19 REMOTE DETERMINATION OF NUMBER OF DATA POINTS TAKEN

Any time during the AS210-02 measurement sequence the measurement cycle may be interrupted and the number of data points taken read out.

S2? (controller to AS210)

The AS210 will then report the number of data points taken in the following format:

xxx OFF<CR><LF> where Δ = ASCII SPACE

↑ EOI ($1 \leq x \leq 500$)

The AS210-02 may be commanded to resume its current measurement cycle by the following command:

S2,GO (controller to AS210)

3-20 REMOTE DRIFT RATE CALCULATION COMMAND

S2? ,Fw, Ix, Xy, Yz (controller to AS210)

where S2? = Module select command

F = Drift rate calculation interval select

w = 1 = drift rate per year
2 = drift rate per day
3 = drift rate per hour

I = Channel number select

x = input channel that calculation is to be made on ($1 \leq x \leq 6$)

X = Initial data point select

y = data point number ($1 \leq y \leq 500$) (If this part of the command string is omitted, the initial data point will default to 1.)

Y = Final data point select

z = data point number ($2 \le z \le 500$) (If this part of the command string is omitted, the final data point will default to the last point taken.)

This drift rate calculation may take tens of seconds to perform. When the calculation is complete, a service request will be sent (value 76). The calculated value can then be read.

The drift rate number is reported by the AS210 in the following format

x(-)yyyyP-zz<CR><LF>

EOI

where x = channel number

y = mantissa of drift rate

z = exponent

This command instructs the AS210 to perform a drift rate calculation using all of the data pointsbetween and including those specified by Xy and Yz. The calculation performed is a least mean square error straight line fit.

3-21 REMOTE TWO POINT DRIFT RATE CALCULATION COMMAND

S2?,Cw,Ix,Xy, Yz (controller to AS210)

where S2? = Module select command

C = Drift rate calculation interval select

w = 1 = drift rate per year
2 = drift rate per day
3 = drift rate per hour

I = Channel number select

x = input channel that calculation is to be made on ($1 \leq x \leq 6$)

X = Initial data point select

y = data point number ($1 \leq y \leq 500$) (If this part of the command string is omitted, the initial data point will default to 1.)

Y = Final data point select

z = data point number ($2 \leq z \leq 500$) (If this part of the command string is omitted, the final data point will default to the last point taken.)

This drift rate calculation is performed quickly. The calculated value can be read almost immediately after sending the command.

The drift rate number is reported by the AS210 in the following format

```
x(-)yyyyP-zz<CR><LF>
                 ↑
                EOI
```

where x = channel number

y = mantissa of drift rate

z = exponent

This command instructs the AS210 to perform a drift rate calculation using only the two data points specified by Xy and Yz. The calculation performed is

$$\frac{D_2 - D_1}{T_2 - T_1}$$

where D_2 = frequency difference data of point Yz
D_1 = frequency difference data of point Xy
T_2 = time data point Yz was measured
T_1 = time data point Xy was measured

3-22 REMOTE DATA POINT READOUT

S2?,Dx (controller to AS210)

where S2? = module select command

D = data channel select
x = channel number ($1 \le x \le 6$)

The AS210 reports all data points taken for the particular channel in the following format:

```
(First data point)  Pxxx CHy<CR><LF>
                    aaa-bb-cc<CR><LF>
                    Δ(Δ̄)zzzzP-ee<CR><LF>
(Last data point)   Pxxx CHy<CR><LF>
                    aaa-bb-cc<CR><LF>
                    Δ(Δ̄)zzzzP-ee<CR><LF>
                                 ↑
                                EOI
```

where x = data point number ($1 \le x \le 500$)
y = channel number ($1 \le y \le 6$)
a = day data point was taken
b = hour data point was taken
c = minute data point was taken
z = mantissa of frequency difference data
e = exponent of frequency difference data

where x = module generating the error
y = error code

3-25 AS210 SERVICE REQUESTS

When the AS210 needs to communicate with the controller, it enables the SRQ control line and when the serial poll is enabled, sends out a status byte describing the reason for alerting the controller. Table 3-4 gives a listing of the serial poll status bytes that can be generated by the AS210 and their meaning.

3-26 READING THE AS210-20 TIME - REMOTE COMMAND

```
S20,T?   (controller to AS210)
S20,T,HXX,MXX,SXX<CR><LF>
                    ↑  (response from AS210)
                   EOI
```

3-27 SETTING TIME IN THE AS210-20 - REMOTE COMMAND

NOTE

The time on the AS210-20 Module can only be set when the SET ENABLE/DISABLE switch on the AS210-20 Front Panel is in the ENABLE position. This prevents software/hardware malfunctions in devices on the GPIB from resetting the time or resynchronizing the 1 pps output of the AS210-20.

```
S20,T,HXX,MXX,SXX        (controller to AS210)
```

3-28 READING ΔTIME FROM THE AS210-20 - REMOTE COMMAND

```
S20,D?   (controller to AS210)
S20,D,0.XXXXXXX S <CR><LF>
                   ↑   (response from AS210)
                  EOI
```

3-23 REMOTE LEARN COMMAND

L? (controller to AS210)

For each module present in the system, the front panel control settings are given back to the controller in the exact format needed to command those modules. As an example, if modules 2, 3, and 4 were present, the following might be returned by the AS210:

S2,A1,R1,I2<CR><LF>
S3,L8,F2<CR><LF>
S4,D98316,P5<CR><LF>
↑
EOI

If the AS210-06 module were in the system, its status would be reported as:

S6,LX,FX<CR><LF>

If the AS210-20 module were in the system, its status would be reported as:

S20,T,HXX,MXX,SXX<CR><LF>

3-24 REMOTE SELF-TEST COMMAND

C? (controller to AS210)

This causes the AS210 to enter the self-test cycle. When the self-test cycle is complete, an SRQ is sent (see paragraph 3-22). If any errors are found, an SRQ is sent (see paragraph 3-22) followed by the specific error message in the following format:

ERR x-yy<CR><LF>
↑
EOI

Table 3-4

SERIAL POLL STATUS DESCRIPTION

BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	STATUS DESCRIPTION
0	1	0	0	0	0	0	0	Frequency standard error*
0	1	0	0	0	0	0	1	AS210-01A module error*
0	1	0	0	0	0	1	0	AS210-02 module error*
0	1	0	0	0	0	1	1	AS210-03 module error*
0	1	0	0	0	1	0	0	AS210-04 module error*
0	1	0	0	0	1	0	1	AS210-06 module calibration complete/ error condition corrected
0	1	0	0	0	1	1	0	AS210-06 Module Error*
0	1	0	0	0	1	1	1	Remote programming syntax error
0	1	0	0	1	0	0	0	AS210 self-test cycle is complete
0	1	0	0	1	0	0	1	The AS210 frequency comparator measurement cycle is complete
0	1	0	0	1	0	1	0	The frequency standard has gone from an unlocked to a locked condition
0	1	0	0	1	1	0	0	The drift rate calculation is complete*
0	1	0	1	0	1	0	0	AS210-20 module error*

*After serial poll is complete, AS210 must be put in talk mode and the specific message read out.

3-29 SYNCHRONIZING 1 pps IN THE AS210-20 - REMOTE COMMAND

S20,DXXXXXXX (controller to AS210)

7 digits representing the desired Δtime in tenths of a microsecond.

3-30 MEMORY BATTERY OPERATION

The MEMORY BATTERY switch enables an internal nickel cadium battery to supply power to the random access memory (RAM) circuits and internal clock when placed in the STANDBY position. The OFF position of the MEMORY BATTERY switch disconnects the internal battery from the circuit. This switch should be left in the OFF position when the AS210 is not in operation or during equipment storage. In the STANDBY position, frequency measurements will be saved in memory for a period of three hours during system transport or line power failures.

CAUTION

If the AS210 system is to be without power for a period in excess of four hours, place the MEMORY BATTERY in the OFF position. The MEMORY BATTERY may be damaged from prolonged discharge and a corrosive alkali may leak from the nickel cadium batteries. The leakage will cause damage to the surrounding electrical circuitry.

For more information regarding the MEMORY BATTERY, refer to Theory of Operation, Section 4-6.1.

NOTE

In the event battery leakage is encountered, a boric acid solution may be used to neutralize and clean the corrosion from the batteries and electrical circuits.

3-31 MICROWAVE FREQUENCY GENERATOR MODULE REMOTE COMMANDS (AS210-06)

S6, Lx, Fy (controller to AS210)

where S6 = module select command

L = output level select

x = 1 = -35 dBm
2 = -30 dBm
3 = -25 dBm
4 = -20 dBm
5 = -15 dBm
6 = -10 dBm
7 = - 5 dBm

F = frequency select

y = 1 = 1 GHz
2 = 2 GHz
3 = 3 GHz
4 = 4 GHz
5 = 5 GHz
6 = 6 GHz
7 = 7 GHz
8 = 8 GHz
9 = 9 GHz
10 = 10 GHz
11 = 11 GHz
12 = 12 GHz
13 = 13 GHz
14 = 14 GHz
15 = 15 GHz
16 = 16 GHz
17 = 17 GHz
18 = 18 GHz

CHAPTER 4
THEORY OF OPERATION

4-1 INTRODUCTION

This chapter contains a theory discussion of the AS210-01A Module Controller. The unit is preprogrammed to control modules of the AS210 Electronic Counter and Frequency Calibration system. The other modules of this series are described in separate publications listed in the preface. The AS210-01A operates as the control and diagnostic center when installed in the AS210 Mainframe with the other modules. The modules can also be remotely programmed via an IEEE-488 interface bus. In this case, control is deferred to the bus. The module is physically comprised of five circuit card assemblies A1 through A5. The following description pertains to the hardware aspects of these circuit areas and is keyed to Figure 4.1, Module Controller Functional Block Diagram. The circuit card prefixes are used to identify the location of the circuit on the schematic diagrams of Chapter 5.

4-2 MODULE FUNCTIONAL DESCRIPTION

The module controller consists of a CPU, 16K x 8 erasable programmable read only memory (EPROM) for storage of the program, 4K x 8 random access memory (RAM) used as data memory and scratch pad, and an IEEE-488 interface for remote control of the system. When the unit has been addressed over the IEEE-488 bus, control of the system is deferred to the IEEE-488 controller (e.g., keyboard terminal). When the REM button on the module controller front panel is illuminated, the IEEE-488 interface is always in control of the unit and system. Normally, the system is controlled through the module controller's front panel keyboard. A keyboard logic unit and display circuit provide for manual entry and display of data. Data is entered via

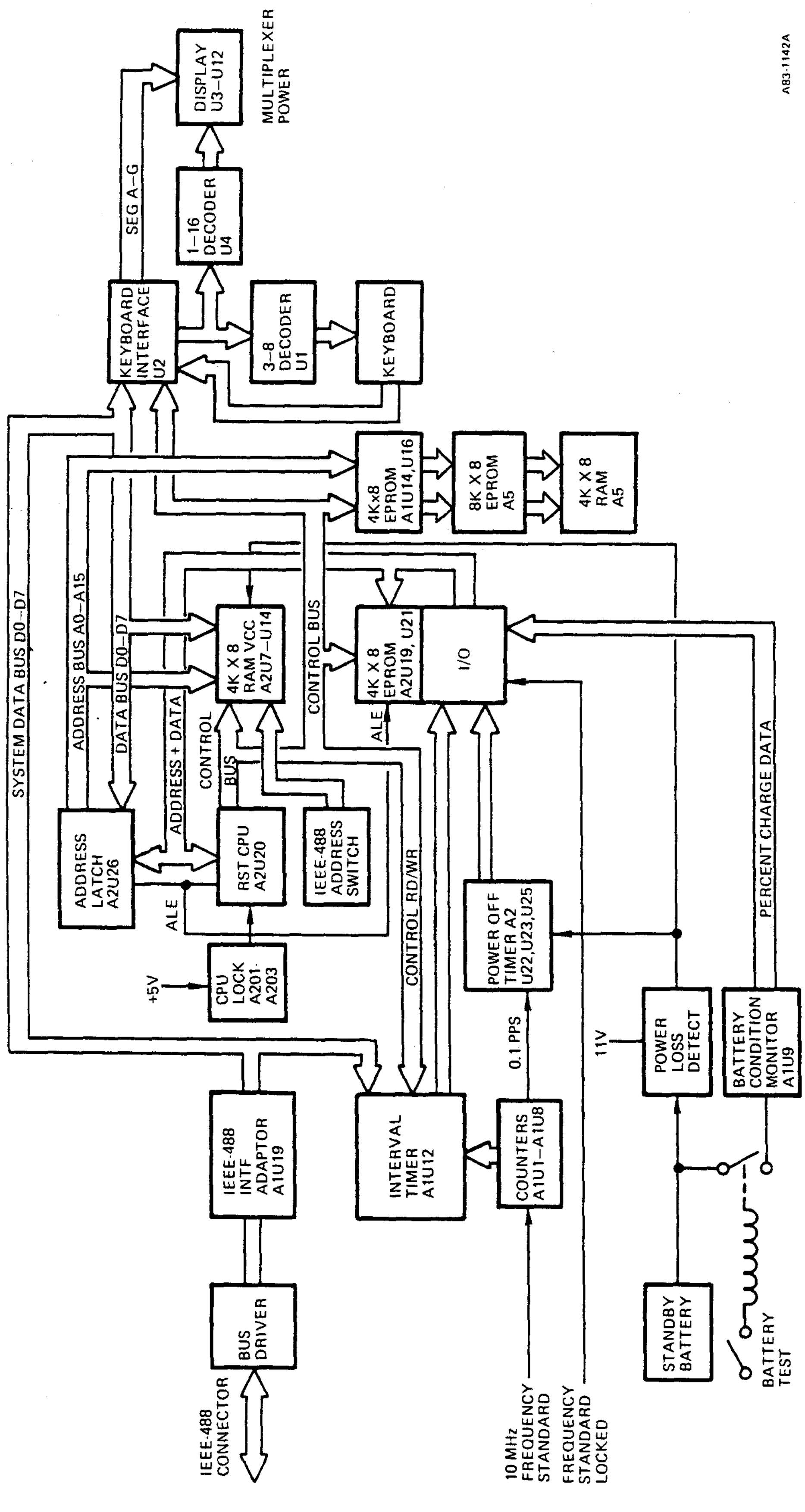


Figure 4.1 Module Controller Functional Block Diagram

the keyboard and displayed on a 10-digit LED display. Programs for entry of the data, calculation of frequency drift rate, and self-diagnosis of the system reside in the firmware (EPROM logic).

4-3 KEYBOARD LOGIC, CIRCUIT CARD A3

The purpose of the keyboard logic circuit is transmission of keyboard entries to the CPU, reception of display data from the CPU, and interface between the CPU, RAM, keyboard, and display. Keyboard interface A3U2 is the basic component of the keyboard logic circuit card. A3U2 transmits the keyboard entries to the CPU over the CPU bus DB0 to DB7. SL0 through SL1 on A3U2 scan the keyboard, via decoder A3U1, and the display via display MUX A3U4. The SL0 through SL1 outputs of A3U2 can be in one of four states, "0", "1", "2", or "3". These states are decoded by A3U1 as follows: State "0" drives RESET and HALT buttons. State "1" drives CONT, DISP, DAY, SELF TEST, MIN, HOUR, YEAR, and REM buttons. State "2" drives ".", 9, CALC, "-", ENT, CLR, TIME, and "8" buttons. State "3" drives "0", "6", "4", "3", "1", "2", "5", and "7" buttons. Pressing one of the above buttons connects the driving signal to one of the sense inputs RL0-RL7 on A3U2. The CPU is then interrupted by A3U2 and transmits the switch position to the CPU. Display data is transmitted from the CPU to the RAM in A3U2. The display is driven and refreshed by A3U2 without disturbing the CPU. Outputs SL0 through SL3 from A3U2 are applied to 1 of 16 decoder A3U4. The outputs of A3U4 turn on display driver transistors A3Q1 through A3Q6 and A4Q1 through A4Q6 on the display logic circuit card A4. These transistors are turned on one at a time while the seven-segment display data for the turned-on digit is on the A0-A3 and B0-B3 outputs of A3U2. The LEDs from the pushbuttons are handled like segments on the numeric readout except that the CPU turns on the appropriate segments (numerals). The LEDs in the SELF-TEST and REM buttons are driven separately from I/O ports on A2U19 of the CPU circuit card.

4-4 DISPLAY LOGIC CIRCUIT CARD, A4

The purpose of the display logic circuit is driving segments of the module controller's 10-digit readout in accordance with signals from the keyboard logic card A3. The LED driver inputs DISDR0 through DISDR9 have been decoded in the keyboard logic card as described in paragraph 4-3. DISDR0 through DISDR4 and DISDR9 turn on transistors A4Q1 through A4Q6 providing five volts to LEDs A4U3 through A4U7 and A4U12. The remaining LEDs (A4U8 through A4U11) are supplied by the transistor drivers in the keyboard logic card, A3. The segment data (SEG A through SEG DP) is provided by the data outputs of A3U2 in the keyboard logic card described in paragraph 4-3. Segment data is provided to the LEDs through drivers A4U1 and A4U2 simultaneously with power to the appropriate digit.

4-5 MODULE CONTROLLER CPU AND MEMORY ASSEMBLIES

The controller CPU and memory is constructed on three circuit card assmblies A1, A2, and A5. A2 contains the single chip CPU, 4K of EPROM, 4K of RAM, counters, I/O devices, and drivers. A1 contains 4K of EPROM, a programmable timer, counters, IEEE-488 interface and standby battery circuit. A5 contains 8K of EPROM.

4-6 EXTENDED PROM GPIA AND TIMER LOGIC CIRCUIT CARD, A1

4-6.1 STANDBY BATTERY CIRCUITS

Loss of AC power would result in the loss of data in the RAM. A standby 9.6 volt battery is located in the module controller to provide power to the RAM circuits in the event of a power loss. The backup battery supplies power to the power-off timer circuits as well as the RAM. The AS210-05 Standby Battery Module must also be installed in the mainframe and set in the standby position for the power-off timer to function. The standby battery module is needed to maintain the Rubidium frequency standard in the power-off mode. The system clock is updated to the correct time when normal power is is restored. Loss of normal power to the module is detected in a power loss detection circuit consisting of A1CR1 and A1CR2 which allows the 9.6 volt module controller battery to supply power to the RAM and power-off timer when the +11V UNREG line to board A1 goes out. The 9.6 volt module controller battery voltage is regulated to five volts through A1U17 and applied to the battery backup V_{CC} terminal of the circuit card. This voltage is also applied to transistor A1Q1 which gates the 10 MHz standard freqquency to the power-off timer circuit. Relay A1K1 is used to check the condition of the module controller memory battery. When a BATTERY TEST signal is received the relay closes, applying the module controller battery voltage to load resistor A1R9 and battery condition monitor A1U9. This device has been calibrated via A1R3, A1R2, and A1R6 for four charge conditions, b-100, b-75, b-50, and b-25, which are displayed on the module controller's display during the self-test routine. The charge condition is monitored by the CPU through outputs O1, O2, O3, and Q4 of A1U9.

4-6.2 POWER-OFF TIMER CIRCUIT

Part of the power-off timer is comprised of transistor driver A1Q1 and frequency dividers A1U1 through A1U8. The frequency divider receives the 10 MHz standard frequency signal from the AS210 Mainframe which is applied to the divider and divided by 10^8, 10^7, 10^6, 10^5, and 10^4. The 0.1 pps signal (÷10) drives counters A2U22, A2U23, and A2U25. The binary output of these counters represents time in 10-second increments. This data (PA0 through PA7, PB0-PB3) is fed to the I/O ports of A2U21. The time data is provided to the CPU over data bus AD0-AD7. The power-off time is calculated by the CPU when power is restored and the CPU is reset. The current value (power restored) of A2U22, A2U23, and A2U25, is read, then the value read just before power failure is subtracted to arrive at the power-off time.

4-6.3 INTERVAL TIMER

The 10 Hz and 1000 Hz signals are clock 0 and clock 2 respectively, used by the interval timer A1U12. The timer is controlled by the CPU via the

CPU data bus AD0 through AD7. When a $\overline{WR}$ signal is received over the control bus and the timer is appropriately addressed by address bits A0 and A1, a value is loaded into the timer from the CPU data bus. When a $\overline{RD}$ signal is received, the timer sends the CPU a counter value over the CPU data bus. The timer also produces three clocks (one is used) for use by the I/O on circuit card A2.

The remaining portions of circuit card A1 are the 4K x 8 EPROM (A1U14 and A1U16) and the IEEE-488 interface. A1U14 and A1U16 are an extension of the EPROMs located on circuit card A2 used for program storage. A1U19 is a general purpose interface adapter that provides an IEEE-488 bus capability for the AS210 system. A1U21 through A2U23 and A1U26 are bidirectional latches controlled by the GPIA A1U19. A1U21 and A1U22 receive and transmit data from the IEEE-488 data bus DIO1 through DIO8. The GPIA is addressed by the CPU via A0, A1, and A2. Data is transferred to and from the CPU and the GPIA over the CPU data bus AD0 through AD7. Bus control signals from and to the GPIA are supplied through bidirectional drivers A1U23 and A1U26. The CPU control bus contains the CLK, $\overline{RD}$, $\overline{WR}$, RESET, READY, and ALE signals used by the interval timer, extended PROMs and GPIA.

4-7 CPU AND EPROM LOGIC CIRCUIT CARD, A2

The CPU and EPROM card contains the CPU, frequency standard lock detection, external standard lock detection, INT/EXT timebase detection, CPU reset, RAM, EPROM, and I/O. The CPU, A2U20, is an 8-bit data/16-bit address bus device. One-half of the 16-bit address is multiplexed with the eight data bits. An address latch, A2U26, is enabled by the Address Latch Enable (ALE) signal from the CPU to latch the lower eight address bits when they are available on the data bus. EPROMs A2U19 and A2U21 contain their own ALE input, therefore, the data/address bus can be applied directly to these EPROMs. The I/O ports on A2U19 receive the mainframe standby battery charge condition from circuit card A1 and a preset IEEE-488 bus address from DIP switch A2U24 (see Figure 3.3). This is an 8-bit switch that uses the five LSBs to set a binary address from 0-31. When this address is received over the IEEE-488 bus, the CPU is informed that data is available to it from the IEEE bus. The bus can be used to remotely control the module controller and all other modules of the AS210 series. The CPU control bus is applied to RAMs A2U7 through A2U14, to the EPROMs, to the keyboard interface in A3 and to the interval timer in A1. When called, programs stored in the EPROMs are fetched by the CPU to perform data processing functions. The I/O ports on A1U21 receive a signal from the mainframe $\overline{\text{FREQ STD LOCK}}$ which alerts the CPU to an unlock condition in the 10 MHz frequency standard circuits. When an external frequency standard is being used, an EXT LOCK signal is received by A2U21 from the external time base selector circuits in the AS210 Mainframe, which informs the CPU of a locked condition. The INT/EXT signal from the mainframe is transferred to the CPU via I/O A2U21 to inform the CPU of the use of the internal Rubidium frequency standard or an external standard. Transistors A2Q1, Q2, and Q3 are a part of a power loss circuit to sense a power loss and lock up the CPU via the $\overline{\text{RESET}}$ input. This prevents the CPU from processing data incorrectly when power is restored. The 2 MHz crystal is part of the CPU clock circuit.

4-8 MEMORY EXPANSION CIRCUIT CARD, A5

The AS210-01A contains the memory expansion card A5 to accommodate the additional software/firmware for operating the AS210-06 and AS210-20 plug-ins, and to perform the least-mean-squares curve fit routine for the drift rate calculation. When fully populated, U5 through U8 (EPROM) will contain an additional 8K of program storage, and U10 through U17 (RAM) will contain an additional 4K words of variable storage. As used in the AS210-01A, this board will contain three EPROMs (U5, U6, U7) and its associated address decoding circuitry. The remaining EPROMs and RAM storage will be used for future expansion.

CHAPTER 5
MAINTENANCE AND CALIBRATION

5-1 INTRODUCTION

The purpose of this chapter is to provide maintenance and calibration data for the AS210-01A Module Controller. Section I covers routine preventive maintenance procedures. Section II outlines performance tests for the module controller and Section III describes troubleshooting data. The AS210-01A Module Controller does not require any calibration. Figures 5.3 through 5.7 are the schematic diagrams of the AS210-01A. Please contact the factory for any assistance required in the maintenance or servicing of the AS210-01A.

SECTION I

5-2 PREVENTIVE MAINTENANCE

Table 5-1 lists preventive maintenance checks and services which should be performed regularly.

Table 5-1

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURES
CABLES	Visually inspect cables for strained, cut, frayed, or other damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfaces as follows: A. Remove the dust and loose dirt with a clean soft cloth. B. Remove dust or dirt from plugs and jacks with a brush. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle.
CORROSION	Make sure exterior surfaces of unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: A. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. B. Brush two coats of paint on base metal to protect it from further corrosion.

SECTION II

5-3 PERFORMANCE TESTS

Figure 5.1 is a flow chart for the performance tests required to determine if the AS210-01A Module Controller is operating properly. Please contact the factory for any assistance required.

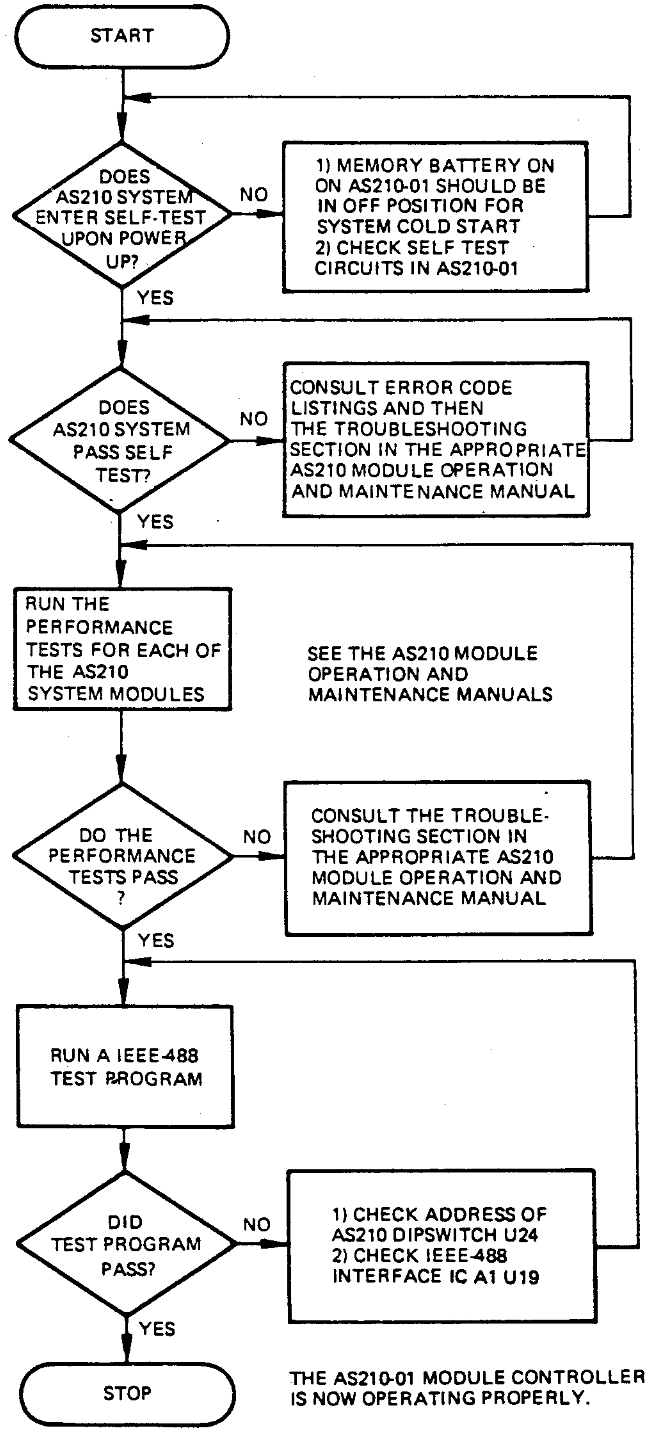


Figure 5.1 Flow Diagram of the Troubleshooting Procedure for the AS210-01A Module Controller

SECTION III

5-4 TROUBLESHOOTING PROCEDURE

Troubleshooting of the module controller is generally limited to observation of the error codes displayed on the front panel. Table 5-2 lists the error codes that are displayed when a malfunction occurs with recommended solutions. Table 5-3 contains common problem symptoms with possible locations of malfunctions.

5-5 ACCESS TO AS210-01A MODULE CONTROLLER

Please reference the AS210 Mainframe Manual for the disassembly procedure of the AS210 system to allow access to the AS210-01A Module Controller. Access to the module circuitry itself is gained by removing the two metal side covers with a small straight-blade screwdriver. Place the module on its side so that the cover is facing up. Starting with the end toward the edge connector, insert the screwdriver into one of the slots where the cover mates with the module chassis and pry the cover up. It will be necessary to move toward the front panel of the module while continuing the prying action to loosen one side of the cover from the module, then the other side. Repeat this technique to remove the cover on the other side of the module also.

5-6 TROUBLESHOOTING THE STANDBY MEMORY BATTERY

If the Error Code, Err 1-12, continues to appear during self-test and the system has been operated for at least four hours with the memory battery in the off position, then check fuse F1 located on the A1 circuit board in the module controller. If the fuse F1 is not blown then the memory battery may need to be replaced.

Table 5-2

ERROR CODE LISTING

ERROR CODE	PROBLEM	RECOMMENDED SOLUTION
1-01	Display RAM cannot be cleared	Check RAMs (A2U7-A2U14) and associated circuits
1-02	Display RAM cannot be written to	Check RAMs (A2U7-A2U14) and associated circuits
1-03	Keyboard interface malfunction	Possible stuck key
1-04	EPROM checksum error; one or more bits originally programmed has changed states	Check EPROMs (A1U14, A1U16, A2U19, A2U21, A5U5 through through A5U8)
1-05	RAM read/write error	Check RAMs (A2U7-A2U14) and associated circuits
1-06	Parallel I/O malfunction	Check 8755's (A2U19, A2U21)
1-07	No 10 pps to CPU interrrupt 7.5	Check internal timer (A1U12)
1-08	Power fail timer not advancing	Check counters (A1U1-A1U8)
1-09	Power fail timer advancing faster than once every 10 seconds	Check counters (A1U1-A1U8)
1-10	Interval timer malfunction	Check interval timer (A1U12)
1-11	IEEE-488 interface malfunction	Check IEEE-488 interface I.C. (A1U19)
1-12	RAM battery back-up completely discharged	Press CONT; charge battery by continuing to run AS210 system; if battery does not charge, refer to Section 5-6
1-13	No modules plugged in to satisfy remote learn command	Install AS210-type modules to satisfy this command

Table 5-3

COMMON PROBLEMS AND POSSIBLE PROBLEM LOCATION
IN THE AS210-01 MODULE CONTROLLER

COMMON PROBLEM	POSSIBLE PROBLEM LOCATION
RANDOM DISPLAY	CPU (A2U20) or EPROM (A1U14, A1U16, A2U19, A2U21, A5U5, A5U6, A5U7) circuits
SELF-TEST NOT INITIATED UPON POWER-UP	Controller standby battery is not in OFF position upon power-up
BLANK DISPLAY	Check +5 volt power supply to display; check RAMs (A2U7-A2U14)
AS210-01A DOES NOT EXIT SELF TEST	CPU (A2U20) or EPROM (A1U14, A1U16, A2U19, A2U21, A5U5, A5U6, A5U7)
IEEE-488 INTERFACE PROBLEM	Check address DIP switch (A2U24); check IEEE-488 interface I.C. (A1U19)

5-7 REPLACEMENT PROCEDURE FOR THE STANDBY MEMORY BATTERY

The memory battery is located on the inside rear panel of the module controller as in Figure 5.2 Access to the memory battery is obtained by removing the three (3) screws located on the backside in the upper left- and right-hand corners of the module controller's rear panel. The two (2) screws located along the top of circuit boards A1 and A2 must also be removed. The top cover may now be lifted and slide out the rear of the module controller assembly. After the top cover has been removed, the battery holder can be seen on the rear panel. To remove the battery it is necessary to only remove the top screw which holds the battery holder lid in place. The memory battery may now be replaced and the above procedure reversed to reassemble the module controller assembly.

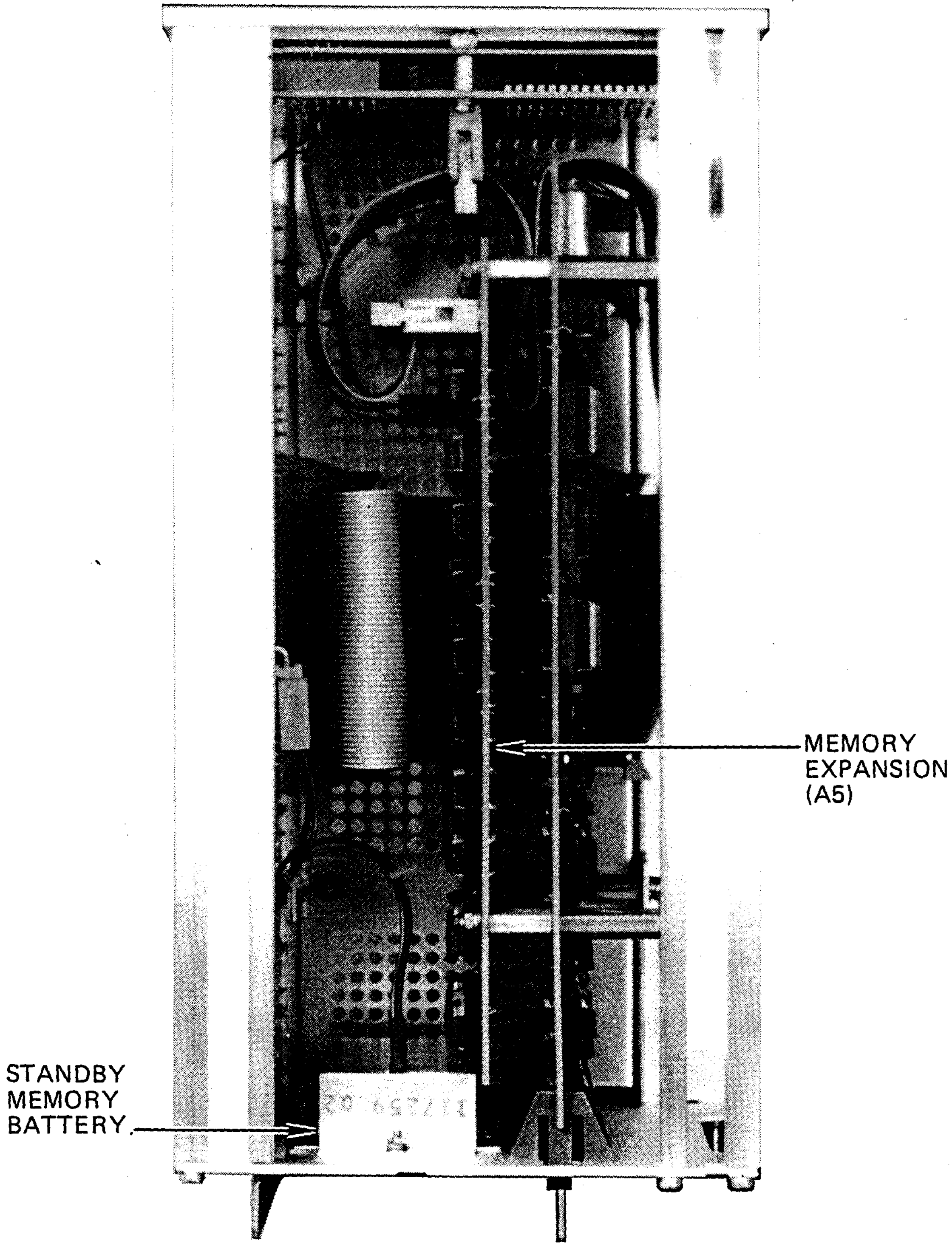


Figure 5.2 Top View of AS210-01A

CHAPTER 6
ILLUSTRATED PARTS LIST

6-1 INTRODUCTION

This chapter contains an illustrated parts list for the AS210-01A Module Controller. The assembly numbers and assembly title are listed at the top of the parts lists. The parts lists are divided into six columns and arranged in the following order:

Column 1 - Item Number

Column 2 - Quantity per assembly.

Column 3 - Manufacturer's Code

Column 4 - Part Number

Column 5 - Description

Column 6 - Reference Designation

ASSEMBLY NUMBER 117168 - MODULE CONTROLLER AS210-01A

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117193	Front panel assembly	
2	1	33472	117255	Module controller assy.	A1
3	1	33472	117260	Module controller assy.	A2
4	1	33472	125465	Memory expansion	A5
5	2	33472	117325	Frame section modification	
6	1	33472	117344	Cable assembly, ribbon 50 wire	
7	1	33472	117350-02	Cable assembly, ribbon 50 wire	
8	2	33472	117353-01	Cable assembly, 2 wire	
9	1	33472	117264	9.6V Nicad battery	
10	1	33472	117259-01	Nicad battery holder	
11	1	33472	117259-02	Nicad battery holder cover	
12	10	81349	MS51957-29	Screw PH #6-32 x 7/16"	
13	12	81349	NAS620-C6	Reduced O/D flat washer	
14	12	81349	MS35338-136	Split lockwasher #6	
15	2	81349	NAS671-C6	Small pat. hex nut #6-32	
16	6	81349	MS51957-15	Screw PH #4-40 x 3/8	
17	4	07540	9742-SS-0632	Standoff, hex, 6-32 thread 7/8	
18	6	81349	MS35338-134	Split lock washer #4	
19	6	81349	NAS671-C4	Small pat. hex nut #4-40	
20	6	81349	NAS620-C4	Reduced O/D flat washer #4	
21	4	80009	4535-632-A-0	Stand-off	
22	1	80009	366-1690-01	Latch pull	

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
23	1	80009	105-0719-00	Latch, retainer	
24	1	80009	105-0718-01	Latch	
25	1	80009	426-1245-00	Frame, left, bottom	
26	2	80009	426-1246-00	Frame, right, bottom and top	
27	4	80009	407-1693-00	Mount	
28	2	80009	200-1837-02	Top and bottom cover	
29	1	80009	426-1245-01	Frame, left, top	
30	1	80009	214-1061-00	Tension spring	
31	2	80009	337-1399-00	Side cover	
32	2	80009	351-0449-00	PWB guide	
33	1	80009	386-3356-00	Panel, rear (altered item)	
34	2	80009	386-3657-01	Guide pin	
35	8	81349	MS24693-C26	Screw 6-32 x 4/8 FLH	
36	1	81349	MS51957-3	Screw 2-56 x 1/4 PNH	
37	4	81349	MS51957-4	Screw 2-56 x 5/16 PNH	
38	4	81349	NAS671-C2	Nut 2-56 SM pattern	
39	4	81349	MS35338-134	Washer #2 split	
40	6	81349	MS51957-30	Screw 6-32 x 1/2 PNH	
41	4	81349	213-0192-00	Screw 6-32 x 1/2 self-tapping, fillester head	

ASSEMBLY NUMBER 117193 - FRONT PANEL ASSEMBLY, MODULE CONTROLLER AS210-01A

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117275	Keyboard logic assembly	A3
2	1	33472	117280	Display logic assembly	A4
3	1	33472	117180-01	Panel, front, lexan	
4	5	06540	9725-A-0440	Standoff, hex, 3/16" x 5/16"	
5	3	06540	4505440-A0	Standoff, hex 3/16 x 1/2"	
6	5	06540	2051440-A0	Standoff, hex, 3/16 x 2/16"	
7	3	81349	MS24693-C9	Screw, flathead, #4-40 x 7/8L	
8	8	81349	MS35338-135	Split lockwasher #4	
9	5	81349	MS24693-C6	Screw, flathead, #4-40 x 1/2L	
10	16	81349	NAS620-C4	Reduced O/D flatwasher #4	
11	8	81349	NAS671-C4	SM pat hex nut #4	
12	1	33472	117180-02	Subpanel, plastic	
13	1	33472	117180-03	Panel, rear	

ASSEMBLY NUMBER 117255 - EXTENDED PROM, GPIA AND TIMER LOGIC (A1)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117258	PWB 117258	
2	REF	33472	117256	Schematic 117256	
3	REF	33472	117255	Assembly drawing 117255	
4	12	81349	CK05BX104K	.1ufd, 10%, ceramic capacitor	C3-C14
5	3	51642	300-50-601-105M	1ufd, 20%, ceramic capacitor	C1,C2,C16
6	1	81349	CK05BX473K	.047 ufd, 10%, ceramic capacitor	C15
7	1	78277	60-RE1S-5DC	SPDT 5V relay	K1
8	4	27014	1N4002	Semiconductor	CR1-4
9	2	81349	RCR07G103JS	10K ohm 5%, 1/4W, carbon comp	R1,R15
10	3	81349	RCR07G472JS	4.7K ohm 5%, 1/4W, carbon comp	R7,R8,R12
11	1	81349	RN55D5360F	536 ohm 1%, 1/4W, fixed film	R2
12	1	81349	RN55D4220F	422 ohm 1%, 1/4W, fixed film	R3
13	1	81349	RN55D2261F	2.26K ohm 1%, 1/4W, fixed film	R6
14	1	81349	RCR42G151JS	150 ohm 5%, 2W, carbon comp	R9
15	3	81349	RCR07G102JS	1K ohm 5%, 1/4W, carbon comp	R10,R13,R14
16	1	81349	RCR07G471JS	470 ohm 5%, 1/4W, carbon comp	R11
17	1	81349	RCR42G751JS	750 ohm 5%, 2W, carbon comp	R4
18	1	27014	2N2369A	NPN transistor	Q1

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
19	1	75915	27502.0	Fuse, axial 2 amp	F-1
20	2	71279	1802752-02-5	Terminal, bifurcated	
21	1	02114	VK200-20/4B	Wideband choke	L1
22	1	53387	3433-2202	Male header, 50 pin	J2
23	3	59730	TYB-23M	TY-RAP, cable tie	
24	1	27014	74LS73N	JK flip flop	U20
25	2	27014	74C04N	Hex inverter	U18,U11
26	1	27014	74C10N	3 input nand	U15
27	2	27014	74C20N	4 input nand	U10,U13
28	7	27014	74C90N	Decade counter	U1-U6,U8
29	1	01295	74LS90	Decade counter	U7
30	2	34649	MK2716T-6	EPROM 2K x 8	U14,U16
31	1	34649	C8253-5	Timer	U12
32	2	01121	316E302622	Resistor network	U24,U25
33	1	27014	LM3914	Dot/bar display driver	U9
34	4	04713	MC3448AL	Transceiver	U21-U23,U26
35	1	04713	MC68488P	GPIA	U19
36	1	27014	LM340T-5	5V regulator	U17
37	14	01295	C9314-02	IC, socket	
38	6	01295	C9316-02	IC, socket	
39	1	01295	C9318-02	IC, socket	
40	3	01295	C9324-02	IC, socket	
41	1	01295	C9340-02	IC, socket	

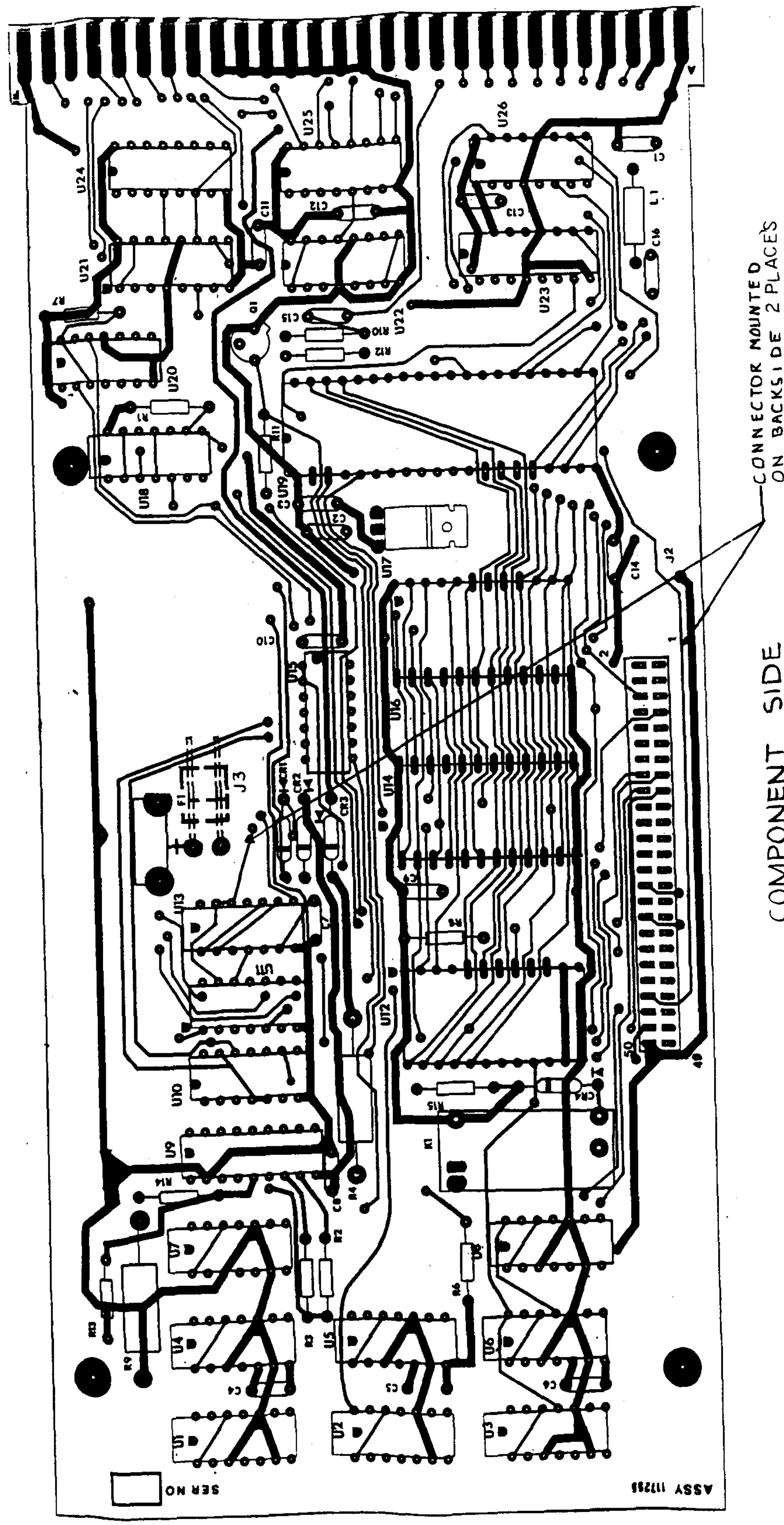


Figure 6.1 AS210-01A Module Contoller Assembly, A1

ASSEMBLY NUMBER 117260 - CPU AND EPROM LOGIC (A2)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117263	PWB 117263	
2	REF	33472	117261	Schematic 117261	
3	REF	33472	117260	Assembly drawing 117260	
4	1	81349	CM05ED220J03	22pfd dipped silver mica capacitor	C3
5	2	56289	196D156X9020 KA1	15 ufd 10%, solid tantalum capacitor	C1,C4
6	7	81349	CK05BX104K	.1 ufd 10%, ceramic capacitor	C5-C11
7	2	27014	2N2222A	Transistor	Q2,Q3
8	1	27014	PN3644	Transistor	Q1
9	1	27014	1N4002	Semiconductor	CR1
10	1	50434	5082-4487	Light emitting diode	CR2
11	6	81349	RCR07G103JS	10K ohm 5%, 1/4W, carbon composition	R2-R3,R5 R8,R18,R19
12	4	81349	RCR07G102JS	1K ohm 5%, 1/4W, carbon composition	R4,R6,R7 R9
13	1	75378	MP020	Crystal, 2 MHz	Y1
14	1	81349	RCR07G333JS	33K ohm 5%, 1/4W, carbon composition	R1
15	1	27264	09-60-1021	Wafer, 2 pin	J4
16	2	53387	3433-2202	Male header, 50 pin	J2,J3
17	1	02114	VK200-20/4B	Wideband choke	L1
18	2	27014	74C00N	Quad 2-input nand	U1,U2
19	1	27014	74C04N	Hex inverter	U6
20	1	27014	74C20N	Dual 4 input nand	U5
21	3	27014	74C93N	Counter	U22,U23,U25
22	1	01295	75492	Counter	U17
23	1	34649	8085	CPU	U20

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
24	1	34649	8212	Latch	U26
25	7	3464	P8216	Bus driver	U3,U4,U15, U16,U27,U28, U29
26	2	34649	8755	E PROM 2K x 8	U19,U21
27	8	34649	P2141L-5	4K x 1 RAM	U7-14
28	1	01121	316A103	Resistor pack	U18
29	1	53387	435166-5	Dip switch (install after W. solder)	U24
30	1	01121	110A472	Resistor network	U30
31	8	01295	C9314-02	IC, socket	
32	9	01295	C9316-02	IC, socket	
33	8	01295	C9318-02	IC, socket	
34	1	01295	C9324-02	IC, socket	
35	3	01295	C9340-02	IC, socket	

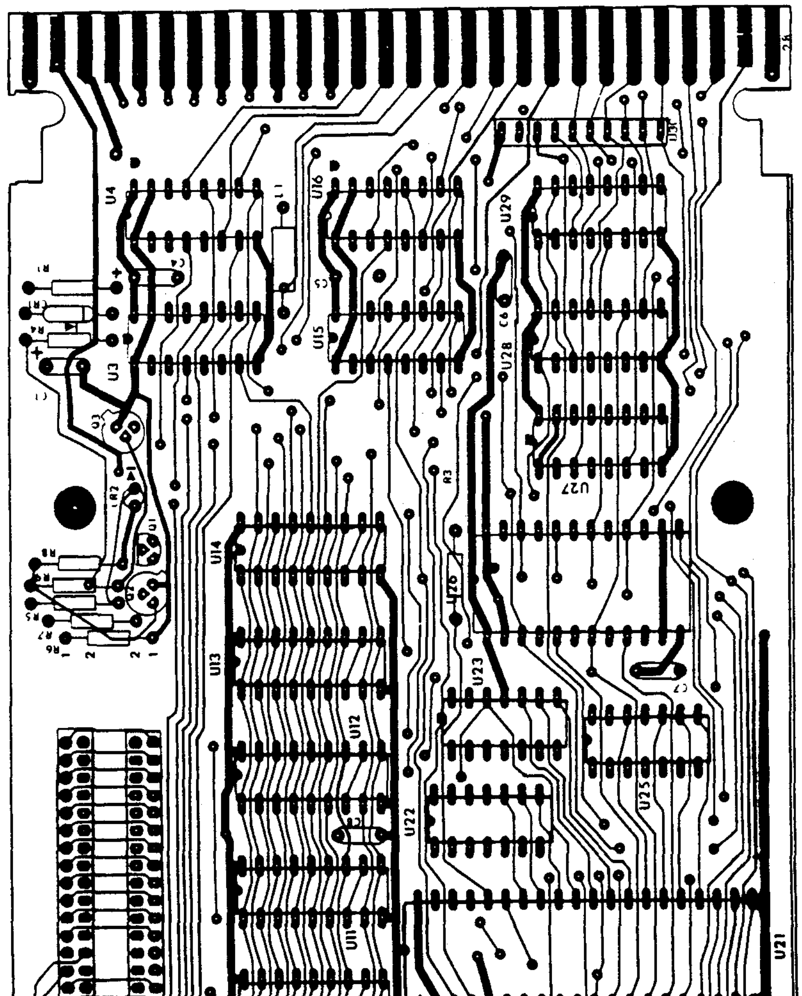


Figure 6.2 AS210-01A Module Controller Assembly, A2

ASSEMBLY NUMBER 117275 - KEYBOARD LOGIC ASSEMBLY (A3)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117278	PWB 117278	
2	REF	33472	117267	Schematic 117276	
3	REF	33472	117275	Assembly Drawing 11725	
4	1	27264	22-03-2081	Wafer, 8 pin	P1
5	1	27264	22-03-2121	Wafer, 12 pin	P2
6	3	81349	CK05BX104K	.1ufd 10% ceramic capacitor	C2,C3,C4
7	1	56289	196D156X9020 KA1	15 ufd, 10% solid tantalum capacitor	C1
8	1	02114	VK200-20/4B	Wideband choke	L1
9	14	04426	39-12101	Switch, pushbutton	S1-10,S12 S16,S25,S14
10	12	04426	39-12201	Switch, LED pushbutton	S11,13,15, 17,S18-24, S26
11	1	09353	7101-J1-CQ-E	Switch, rocker, SPDT	S27
12	1	53387	33433-2202	Male header, 50 pin	J1
13	1	27264	09-60-1021	Wafer, 2 pin	J2
14	1	01295	74LS138N	IC	U1
15	1	01295	74LS154N	IC	U4
16	1	01295	75492N	IC	U5
17	1	75378	750-83-R33	Sip resistor pack	U6
18	1	34649	P8279-5	Keyboard/display interface	U2
19	6	27014	74C10N	IC	U3
20	6	27014	PN3644	Transistor	Q1-Q6
21	6	81349	RCR05G103JS	10K ohm 5%, 1/8W, carbon composition	R3,R5,R7, R9,R12,R14

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
22	6	81349	RCR05G102JS	1K ohm 5%, 1/8W, carbon composition	R2,R4,R6, R8,R13,R15
23	1	81349	RCR05G472JS	4.7K ohm 5%, 1/8W, carbon composition	R1
24	1	81349	RCR05G390JS	39 ohm 5%, 1/8W, carbon composition	R16
25	2	81349	RCR07G181JS	180 ohm 5%, 1/4W, carbon composition	R10,R11

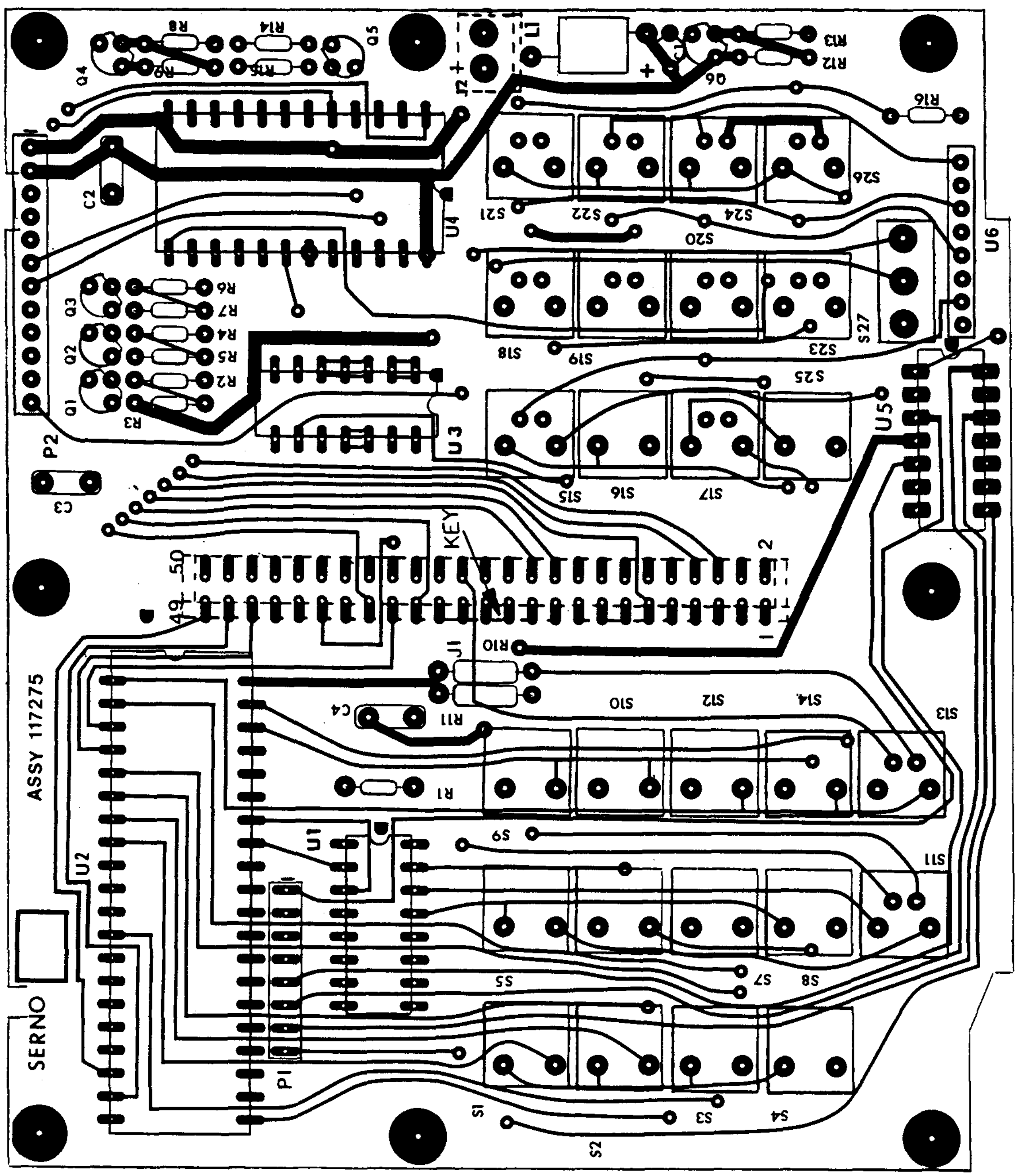


Figure 6.3 AS210-01A Keyboard Logic Assembly, A3

ASSEMBLY NUMBER 117280 - DISPLAY LOGIC ASSEMBLY (A4)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117283	PWB 117283	
2	REF	33472	117281	Schematic 117281	
3	REF	33472	117280	Assembly Drawing 117280	
4	4	81349	CK05BX104K	.1ufd 10%, ceramic capacitor	C1-C4
5	1	27264	22-02-2081	Connector 8 pin	J1
6	1	27264	22-02-2121	Connector 12 pin	J2
7	6	27014	PN3644	Transistor	Q1-Q6
8	6	81349	RCR05G103JS	10K ohm 5%, 1/8W, carbon composition	R2,R4,R6, R8,R10,R12
9	6	81349	RCR05G102JS	1K ohm 5%, 1/8W, carbon composition	R1,R3,R5, R7,R9,R11
10	8	81349	RCR05G510JS	51 ohm 5%, 1/8W, carbon composition	R13-R20
11	10	50434	5082-7730	7 segment display	U3-U12
12	2	01295	75492	Hex driver	U1,U2

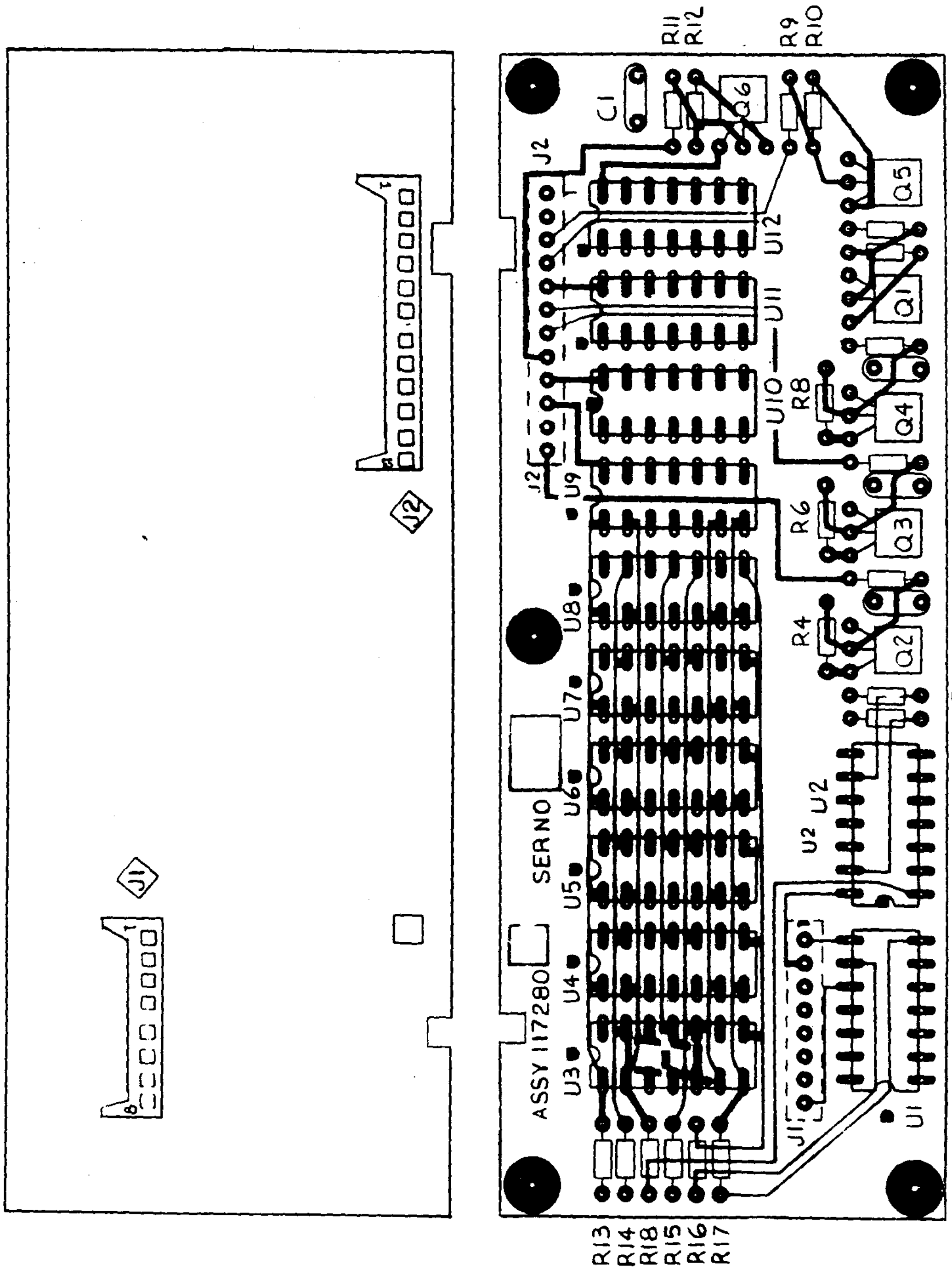


Figure 6.4 AS210-01A Display Logic Assembly, A4

ASSEMBLY NUMBER 117344 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	3	53387	3425-6000	Connector, 50 pin	
2	16"	53387	3365-50	Cable, 50 wire ribbon	

ASSEMBLY NUMBER 117350 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	3	53387	3425-6000	Connector, 50 pin	
2	2	53387	3425-6000	Connector, 50 pin	
3	2	53387	3425-6000	Connector, 50 pin	
4	16"	53387	3365-50	Cable, 50 wire ribbon	
5	8"	53387	3365-50	Cable, 50 wire ribbon	
6	6"	53387	3365-50	Cable, 50 wire ribbon	

ASSEMBLY NUMBER 117353-01 and 02 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	27264	09-50-7021	Connector, 2 pin	
2	2	27264	09-50-7021	Connector, 2 pin	
3	4	27264	08-50-0132	Pin, crimp	
4	4	27264	08-50-0132	Pin, crimp	
5	9"	29005	EXE26 19/38	Wire, 26 gauge	
6	A/R		EXE20	Wire, 20 gauge	

ASSEMBLY NUMBER 125465 - MEMORY EXPANSION (A5)

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	125468	PWB	
2	REF	33472	125467	Master pattern	
3	REF	33472	125469	Silkscreen	
4	REF	33472	125466	Schematic	
5	4	34649	D2716	IC PROM	U5,6,7,8
6	2	81349	74C04N	IC hex inverter	U3,4
7	1	04713	MM74C20N	IC, 4 input nand gate	U9
8	2	04713	MM74C10N	IC, 3 input nand gate	U1,2
9	10	81349	CK05BX104K	.1uF, 10%, ceramic capacitor	C1-C10
10	1	53387	3433-2202	Connector, 50 pin	J1
11	2	27264	09-60-1021	Connector, 2 pin	J2-3
12	8	01295	C9318-02	Socket, 18 pin	
13	5	01295	C9314-02	Socket, 14 pin	
14	4	01295	C9324-02	Socket, 24 pin	
15	4	55566	4535-632-A-0	Standoff 6-32 x 9/16	
16	4	81349	NAS671-C6	Nut, small pattern hex	
17	4	81349	NAS620-C6	Washer, reduced O/D flat, #6	
18	4	81349	MS35338-136	Washer, split, #6	

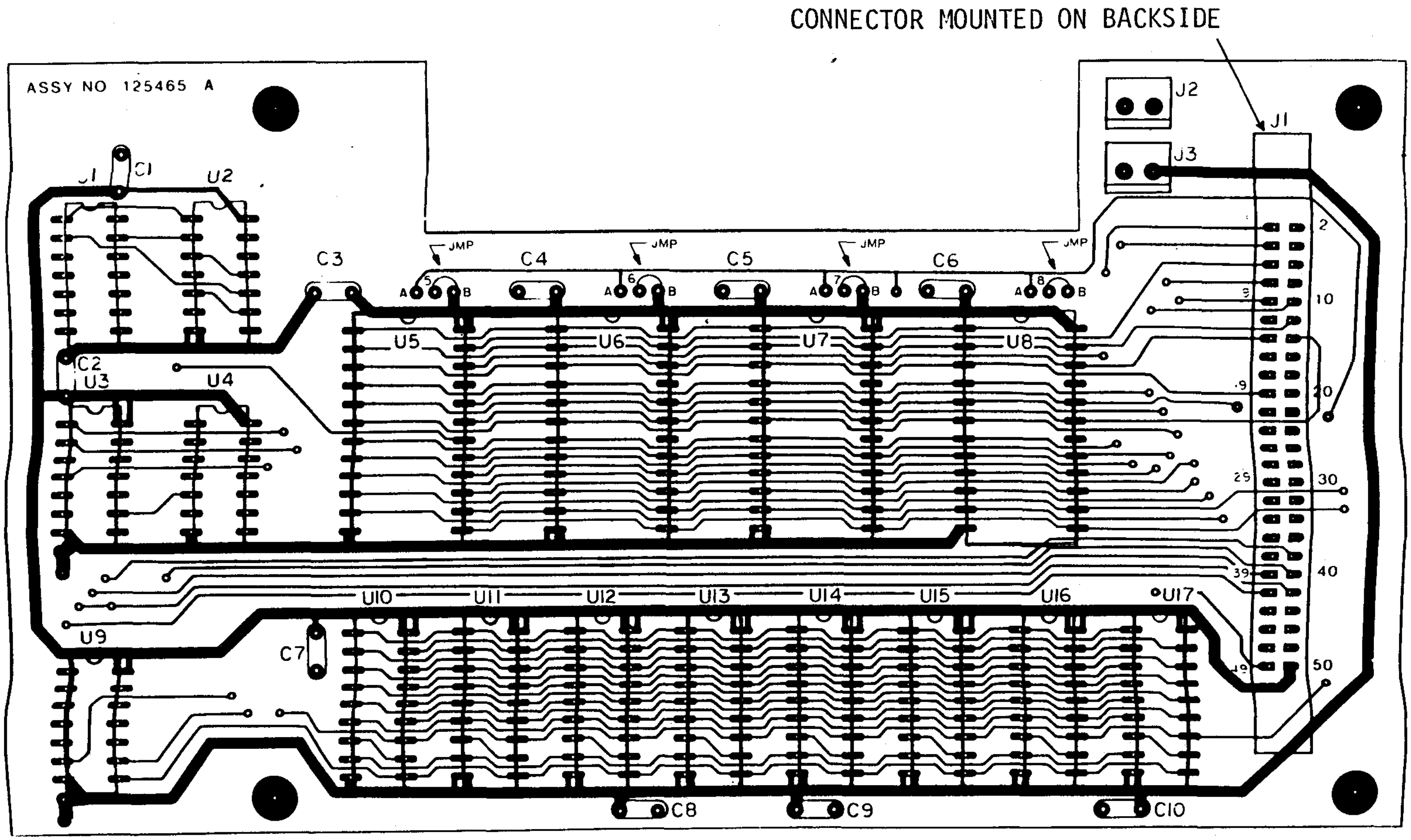


Figure 6.5 AS210-01A Memory Expansion Assembly, A5

6-2 MANUFACTURER'S CODE LIST

This section includes all manufacturer's of materials used in the AS210 system. The list is arranged in numerical order by code.

CODE	MANUFACTURER	ADDRESS
00779	AMP, INC	P.O. Box 3608 Harrisburg, PA 17105
01121	ALLEN-BRADLEY COMPANY	1202 South 2nd Street Milwaukee, WI 53204
01139	GENERAL ELECTRIC COMPANY	Silicone Products Business Department Waterford, NY 12188 PHONE: 518-237-3330
01281	TRW, INC.	TRW Semiconductor Division 14520 Aviation Boulevard Lawndale, CA 90260
01295	TEXAS INSTRUMENTS, INC.	Semiconductor Group 13500 North Central Expressway P.O.Box 225012 M/S 49 Dallas, TX 75265
02114	AMPEREX ELECTRONIC CORPORATION	Ferroxcub Division 5083 Kings Highway Saugerties, NY 12477
02660	BUNKER RAMO-ELTRA CORPORATION	Amphenol Division 2801 South. 25th Avenue Broadview, IL 60153
02735	RCA CORPORPATION	Solid State Division Route 202 Somerville, NJ 08876
03797	GENISCO TECHNOLOGY CORPORATION	Electronics Division 18435 Susana Road Rancho Dominguez, CA 90221 PHONE: 213-537-4750
04426	ILLINOIS TOOL WORKS, INC.	Licon Division 6615 West Irving Park Road Chicago, IL 60634
04713	MOTOROLA, INC.	Semiconductor Products Sector 5005 East McDowell Road Phoenix, AZ 85008 PHONE: 602-244-7100
05245	CORCOM, INC.	1600 Wincheste Road Libertyville, IL 60048
06090	RAYCHEM CORPORATION	300 Constitution Drive Menlo Park, CA 94025

CODE	MANUFACTURER	ADDRESS
06383	PANDUIT CORPORATION	17301 Ridgeland Tinley Park, IL 60477
06540	MITE CORPORATION	Amatom Electronic Hardware Division 446 Blake Street New Haven, CT 06515
07263	FAIRCHILD CAMERA & INSTRUMENT CORPORATION	Sub of Schlumberger LTD North American Sales Mail Stop 14-1053 401 Ellis Street P. O. Drawer 7284 Mt. View, CA 94042
09353	C AND K COMPONENTS, INC.	15 Riverdale Avenue Newton, MA 02158 PHONE: 617-964-6400
11237	CTS KEENE, INC.	P.O. Box 1977 Paso Robles, CA 93446
12136	PHC`INDUSTRIES, INC.	1643 Haddon Avenue Camden, NJ 08103
13103	THERMALLOY COMPANY, INC.	2021 West Valley View Lane P. O. Box 340839 Dallas, TX 75234
13556	TRW CINCH CONNECTORS	Nuline Facility Division of TRW, Inc. New Hope, MN
14099	SEMTECH CORPORATION	652 Mitchell Road Newbury Park, CA 91320 PHONE: 213-628-5392
14655	CORNELL-DUBILIER ELECTRONICS	Div. of Federal Pacific Electric Co. Government Contracts Department 150 Avenue L Newark, NJ 07101
15542	MINI-CIRCUITS LABORATORY	Div. of Scientific Components Corp. 2625 East 14th Street Brooklyn, NY 11235
16428	BELDEN ELECTRONIC WIRE & CABLE	Sub of Cooper Industries, Inc. 2200 U.S. Highway 27 South P.O. Box 1980 Richmond, IN 47374 PHONE: 317-983-5200

CODE	MANUFACTURER	ADDRESS
18612	VISHAY INTERTECHNOLOGY, INC.	Vishay Resistor Products Division 63 Lincoln Highway Malvern, PA 19355
19209	GENERAL ELECTRIC COMPANY	Battery Business Department 441 Highway N P. O. Box 861 Gainesville, FL 32602 PHONE: 904-462-3911
23936	PAMOTOR DIVISION OF WILLIAM J. PURDY COMPANY	770 Airport Boulevard Burlingame, CA 94010
26805	OMNI SPECTRA, INC.	Microwave Connector Division Waltham, MA
26806	AMERICAN ZETTLER, INC.	16881 Hale Avenue Irvine, CA 92714
27014	NATIONAL SEMICONDUCTOR CORPORATION	2900 Semiconductor Drive Santa Clara, CA 95051
27264	MOLEX, INC.	2222 Wellington Court Lisle, IL 60532
32997	BOURNS, INC.	Trimpot Division 1200 Columbia Avenue Riverside, CA
33472	ARGOSYSTEMS, Inc.	884 Hermosa Court Sunnyvale, CA 94086
34649	INTEL CORPORATION	3585 SW 198th Avenue Aloha, OR 97005
50088	MOSTEK CORPORATION	Sub of United Technologies Corp. 1215 West Crosby Road P.O. Box 169 Carrollton, TX 75006
50434	HEWLETT-PACKARD COMPANY	Optoelectronics Division 640 Page Mill Road Palo Alto, CA 94304
51642	CENTRE ENGINEERING, INC.	2820 E. College Avenue State College, PA 16801

CODE	MANUFACTURER	ADDRESS
53387	MINNESOTA MINING AND MANUFACTURING COMPANY	Electronic Products Division 3M Center St. Paul, MN 55101
54893	HEWLETT-PACKARD COMPANY	Microwave Semiconductor Division 350 West Trimble Road San Jose, CA 95131
55154	PLESSEY PERIPHERAL SYSTEMS, INC.	17466 Daimler Avenue P. O. Box 19616 Irvine, CA 92714
55566	R A F ELECTRONIC HARDWARE, INC.	95 Silvermine Road Seymour, CT 06483 PHONE: 203-888-2133
56289	SPRAGUE ELECTRIC COMPANY	87 Marshall Street North Adams, MA 01247
58910	ABBOTT TRANSISTOR LABORATORIES, INC.	Transformer Division 639 South Glenwood Place Burbank, CA 91506
59660	TUSONIX, INC.	2155 North Forbes Boulevard Suite 107 Tucson, AZ 85745
59705	STANDEX INTERNATIONAL CORPORATION	United Service Equipment Co. Div. 1152 Park Avenue Murfreesboro, TN 37130
71279	MIDLAND-ROSS CORPORATION	Cambion Division One Alewife Place Cambridge, MA 02140 PHONE: 617-491-5400
71450	CTS CORPORATION	905 North West Boulevard Elkhart, IN 46514
71984	DOW CORNING CORPORATION	3901 South Saginaw Road Midland, MI 48640
73138	BECKMAN INSTRUMENTS, INC.	Helipot Division Sub of Smith Kline/Beckman Corp. 2500 Harbor Boulevard Fullerton, CA 92634

CODE	MANUFACTURER	ADDRESS
75915	TRACOR LITTLEFUSE, INC.	800 East Northwest Highway Des Plaines, IL 60016
77969	RUBBERCRAFT CORPORATION OF CALIFORNIA LTD.	1800 West 220th Street P.O. Box B Torrance, CA 90507 PHONE: 213-328-5402
78277	SIGMA INSTRUMENTS, INC.	170 Pearl Street South Braintree, MA 02184 PHONE: 617-853-5000
80009	TEKTRONIX, INC.	4900 Southwest Griffith Drive P. O. Box 500 Beaverton, OR 97077
81349	MILITARY SPECIFICATIONS	Promultgated by Military Departments/Agencies Under Authority of Defense Standard- ization Manual 4120 3-M
83330	SMITH HERMAN H. INC.	A North American Philips Company 1913 Atlantic Avenue Manasquan, NJ 08736
88245	WINCHESTER ELECTRONICS	Litton Systems-Useco Division 1536 Saticoy Street Van Nuys, CA 91409
90201	MALLORY CAPACITOR COMPANY	Sub of Emhart Industries, Inc. 4760 Kentucky Avenue P. O. Box 372 Indianapolis, IN 46206
91506	AUGAT, INC.	33 Perry Avenue P. O. Box 779 Attleboro, MA 02703
91637	DALE ELECTRONICS, INC.	2064 12th Avenue P.O. Box 609 Columbus, NE 68601 PHONE: 402-563-6301
91836	KINGS ELECTRONICS COMPANY, INC	40 Marbledale Road Tuckahoe, NY 10707 PHONE: 914-793-5000
92194	ALPHA WIRE CORPORATION	71 Lidgerwood Avenue Elizabeth, NJ 07207 PHONE: 201-925-8000

AS210-02
FREQUENCY
COMPARATOR MODULE

ARGOSystems, Inc. / 884 Hermosa Court, Sunnyvale, California 94086
Telephone (Area Code 408) 737-2000 / Telex No. 352077

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LIST OF TABLES

PREFACE

This manual contains operation and maintenance instructions for the AS210-02 Frequency Comparator. The data contained herein is arranged as follows:

Chapter 1	General Information
Chapter 2	Installation
Chapter 3	Operation
Chapter 4	Theory of Operation
Chapter 5	Maintenance and Calibration
Chapter 6	Illustrated Parts List

<u>Reference Publications</u>

AS210	Mainframe Instruction Manual
AS210-01	Module Controller Instruction Manual
AS210-03	Frequency Generator Instruction Manual
AS210-04	Digital Delay Generator Instruction Manual
AS210-05	Standby Battery Instruction Manual

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

The AS210-02 Frequency Comparator illustrated in Figure 1.1 is a modular plug-in of the AS210 Electronic Counter and Frequency Standard Calibration system. The unit plugs into the AS210 Mainframe which provides power and control. Up to six different time bases can be connected to the AS210-02 front panel for measurement of frequency accuracy. The internal circuitry of the AS210-02 automatically adapts to any of the allowable standard input frequencies to be measured. Samples are taken at a maximum rate or once per hour and up to 500 samples can be stored for computation of warm-up characteristics, drift rate, and aging. This module can be programmed through the IEEE-488 interface in the AS210-01 Module Controller.

1-2 PHYSICAL AND ELECTRICAL DESCRIPTION

The AS210-02 Frequency Comparator is a single width plug-in unit. Front panel controls select frequency resolution and sampling rate. Six BNC input connectors on the front panel permit connection of the time bases or frequency standards to be measured. The circuitry of the module is mounted on two printed circuit card assemblies. Basically, the Frequency Comparator converts the input to be measured to a 100 KHz test signal, then compares it to the 10 MHz Rubidium Frequency Standard in the AS210 Mainframe. The difference between the standard and measured signal is accumulated in registers and reviewed periodically by the microprocessor in the Module Controller which then performs calculations of drift rate. Table 1-1 is an equipment specification for the AS210-02 Frequency Comparator as installed in the AS210 Mainframe with the AS210-01 Module Controller. The Module Controller and Mainframe are covered in separate publications listed in the preface.

Figure 1.1 AS210-02 Frequency Comparator

Table 1-1

AS210-02 EQUIPMENT SPECIFICATION

INPUTS	Six
INPUT VOLTAGE RANGE	0.5V to 10V RMS
INPUT IMPEDANCE	1000 ohms nominal
INPUT FREQUENCY	0.1, 1, 5, or 10 MHz
RESOLUTION	10^{-8}, 10^{-9}, 10^{-10}, or 10^{-11} selectable
SAMPLE TIME	0.5 seconds for 10^{-8} resolution 5.0 seconds for 10^{-9} resolution 50 seconds for 10^{-10} resolution 500 seconds for 10^{-11} resolution
SAMPLE RATE	
MAX MODE	Approximately 0.5 seconds between readings
1-PER-HOUR MODE	Each input sampled once per hour
RESOLUTION ACCURACY	
10^{-8} RANGE	± 1 part in 10^{-8}
10^{-9} RANGE	± 1 part in 10^{-9}
10^{-10} RANGE	± 1 part in 10^{-10}
10^{-11} RANGE	± 1 part in 10^{-11}
OPERATING TEMPERATURE	0° to 40°C
POWER	Supplied by AS210 Mainframe
WEIGHT	2.0 lbs

CHAPTER 2
INSTALLATION

2-1 INTRODUCTION

The AS210-02 Frequency Comparator plugs into the AS210 Mainframe. The module is electrically connected through the rear connector and mechanically retained via a front panel locking bar on the Mainframe. A release mechanism is located in the lower left hand corner of the front panel. Power and signal interface is provided through the Mainframe. The signals to be measured are connected to the BNC connectors located on the front panel.

NOTE 1: The Frequency Comparator Module is held in the card edge connector with high retention force. In order to remove the module, it may be necessary to pull on the front panel RANGE switch while the release mechanism is pulled.

NOTE 2: Ensure that power is turned OFF in the AS210 Mainframe before installing or removing the AS210-02.

CAUTION

Do not attempt to use the AS210 series modules in a Tektronix Mainframe as severe damage will result.

CHAPTER 3
OPERATION

3-1 INTRODUCTION

This chapter describes the operation of the AS210-02 Frequency Comparator. This module works in conjunction with the AS210-01 Module Controller when they are installed in an AS210 system. Figure 3.1 and Table 3-1 illustrate and describe the operator controls, indicators, and connectors of the Frequency Comparator. The operating instructions are essentially identical to those provided in the manual for the Module Controller since most of the operator controls are located on that unit.

3-2 CONTROLS, INDICATORS, AND CONNECTORS

Figure 3.1 illustrates the front panel of the AS210-02, and is indexed to Table 3-1.

3-3 OPERATING PROCEDURES

The following paragraphs and Figure 3.2 are the operating instructions for the Frequency Comparator. Figures in ( ) refer to Figure 3.2 Operational Flow Diagram. Specifically, these instructions tell the operator how to perform frequency error measurements, display measurements from memory, and perform drift calculations. Only the lighted pushbuttons can be used during a routine. CLR is for display clearing only.

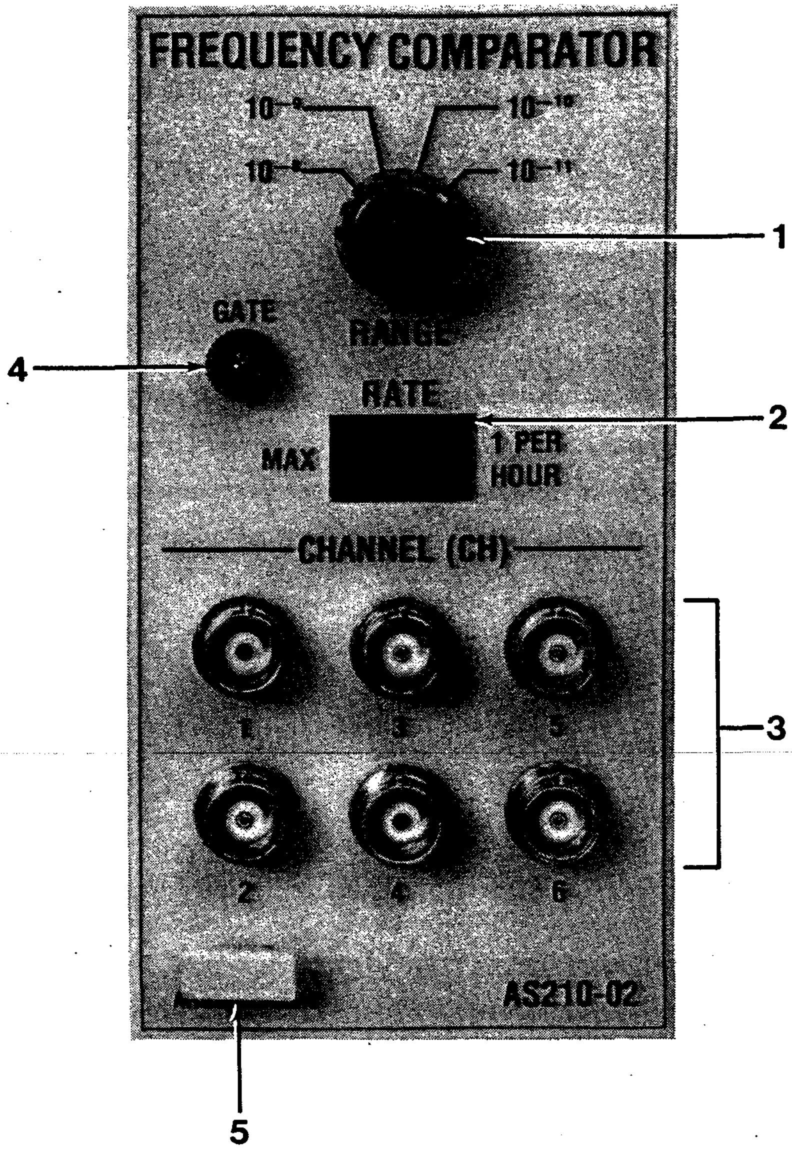

Figure 3.1 AS210-02 Front Panel Controls, Indicators, and Connectors

Table 3-1

AS210-02 FRONT PANEL CONTROLS, INDICATORS, AND CONNECTORS

INDEX NO. Figure 3-1	PANEL MARKING	FUNCTION
1	RANGE	Rotary switch for selection of frequency resolution. Four resolutions available: 10^{-8}, 10^{-9}, 10^{-10}, 10^{-11}.
2	RATE	In the MAX position, the Module Controller continuously samples each channel connected (maximum 6) in sequence, starting with channel 1 and ending with the channel selected by the user via the module controller keyboard.
		In the 1 per hour position, the Module Controller samples once per hour each channel connected (maximum 6) in sequence, starting with channel 1 and ending with the channel selected by the user via the module controller keyboard.
3	CHANNEL (CH)	Input connectors (6) for signals to be measured.
4	GATE	LED indicator lights during the period that counting is taking place, 500 seconds for 10^{-11} resolution, 50 seconds for 10^{-10} resolution, 5 seconds for 10^{-9} resolution, 0.5 seconds for 10^{-8} resolution.
5	None	Release mechanism for removal and retention of module.

FREQUENCY ERROR MEASUREMENT

A. Connect the frequency source to be measured to the front panel BNC connectors on the AS210-02 Frequency Comparator module.

B. Set the RATE switch on the AS210-02 Frequency Comparator module to MAX for continuous sampling or 1 PER HOUR for sample once per hour. The sampling rate is also a function of the resolution selected as follows:

Resolution	Samples per hour in MAX Mode
10^{-8}	Approximately 3600
10^{-9}	Approximately 600
10^{-10}	Approximately 70
10^{-11}	7

The memory of the Module Controller can store 500 samples, therefore the 1 PER HOUR mode may be more useful than the MAX mode when data for several days elapsed time is desired. Up to six inputs can be connected to the Frequency Comparator. For the purposes of this procedure, it is assumed that only channel 1 is being used. When more than one signal is connected, the sequence operates so that each channel is observed for one gate period (a function of the resolution selected), then the next channel is observed. It can be seen that as more inputs are connected, less samples per hour are taken per input when in the MAX mode.

C. Press lighted CONT pushbutton (A) and CH 1-6 should be displayed (B).

D. Enter a channel number from 1 to 6 with the keyboard and press the ENTER function button (C). The number of channels should be

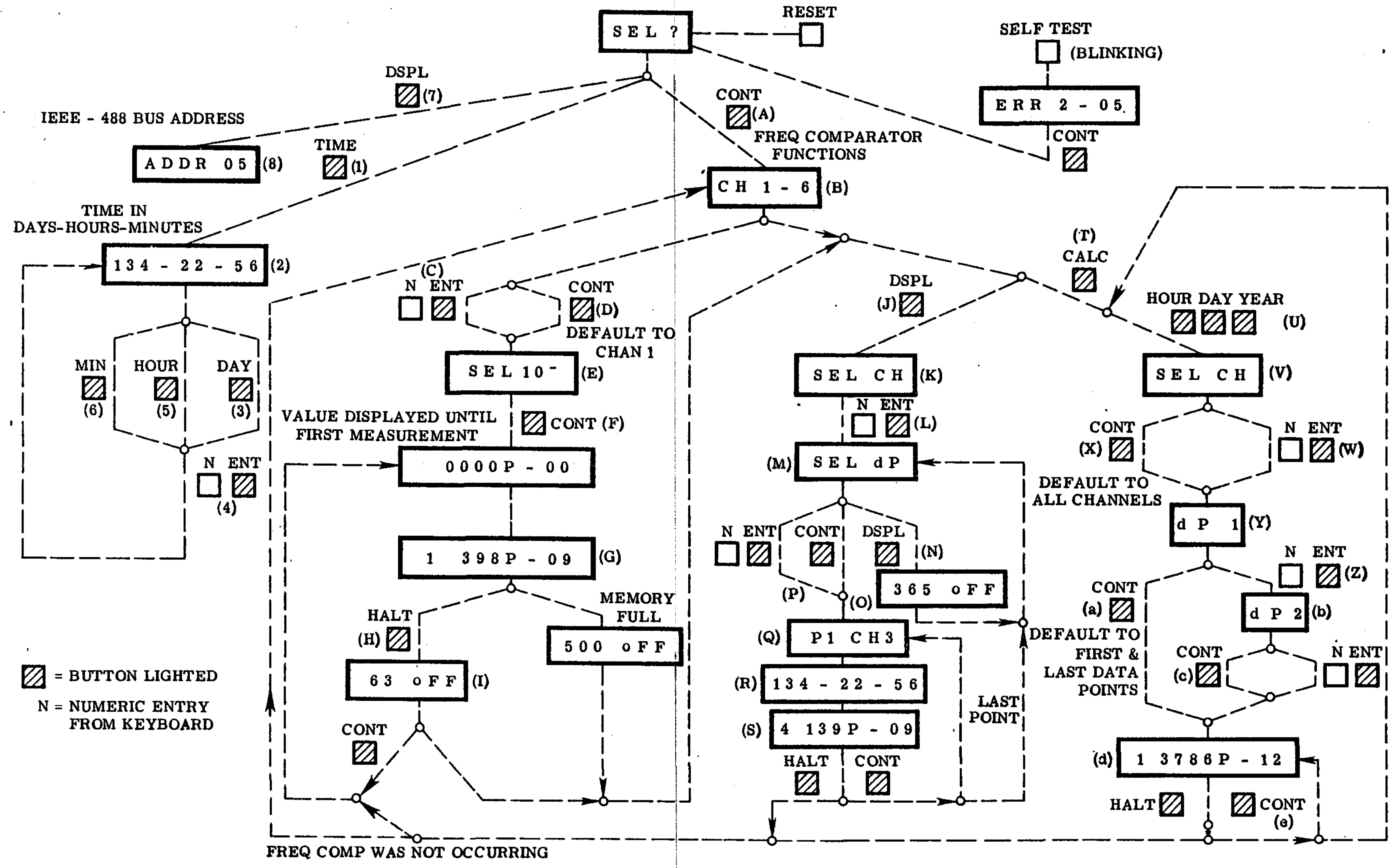

Figure 3.2 Operational Flow Diagram

displayed on the LED display. If only one channel is used, channel 1 is automatically selected by the program, by pressing the CONT button.

E. Press CONT (D) and SEL 10⁻ should be displayed (E). Select the desired frequency resolution with the RANGE switch on the AS210-02 Frequency Comparator module.

F. Press CONT (F). The frequency offset measurement routine now proceeds. 0000P-00 will be displayed until the first measurement is made. Thereafter, the channel number and frequency offset (error) will be displayed for each measurement as it is made until 500 measurements have been taken. A display of 1 398P-09 as shown in Figure 3.2 (G) indicates a frequency offset of 398 x 10^{-9} on channel 1. When 500 measurements have been completed without interruption, the program will halt automatically and 500 oFF will be displayed, indicating that 500 data points have been taken and the program is in an OFF condition. The measurement cycle can also be stopped at any time with the HALT (H) function button. The data point number and oFF will be displayed (I). Measurement can be resumed by pressing CONT.

DISPLAY FREQUENCY MEASUREMENTS FROM MEMORY

A. Press HALT (H) (if program is running) and then DSPL (J). SEL CH should be displayed (K).

B. Select a channel number with the keyboard and press the ENTER function button (L). SEL dP should now be displayed (M).

C. Select a data point number with the keyboard and press the ENTER function button. The number of data points taken during the measurement cycle can be found by pressing DSPL (N). The number of data points and oFF should be displayed (O). For example, 365 oFF. The display will now return to SEL dP (M).

D. Press CONT (P) and the display will read out in sequence the data point number and channel number (Q) (e.g., P1 CH 3), then the time the data point measurement was taken (R) (e.g., 134-22-56), then the frequency offset (error) at that data point (S) (e.g., 4 139P-09).

E. The measurement process can be resumed by pressing HALT. If frequency comparisons have not been in progress, the routine will return to (B) and a channel number can be selected.

DRIFT CALCULATIONS

A. At any time after two or more data points have been collected over a time interval of more than 1 minute, a frequency drift calculation can be made.

B. Press HALT, then select the CALC function button (T). Press HOUR, DAY, or YEAR function button (U) to select period for drift calculation.

C. SEL CH will be displayed (V). Select the desired channel number with the keyboard and press the ENTER function button (W). (If CONT is pressed (X), all channels will be computed for frequency drift.)

D. DP 1 will be displayed (Y). Select the desired number for data point one with the keyboard and press the ENTER function button (Z). The number entered can be anything within the data field from 1 to 500, depending on the resolution selected, length of measurement, number of data points, time, etc. If CONT is pressed (a) the drift calculation will automatically be made on the first and last data points. If CONT is not pressed, then dP 2 will be displayed (b). Enter the desired second data point number as with dP 1 (Z).

E. The drift rate will now be displayed for the selected channel (d). For example, 1 3786P-12 indicates a frequency drift over the period of time selected in step 2 of 3786 parts out of 10^{12}.

F. Pressing CONT (e) at this time will return the routine to the point (U) where new time frames, channels, and data points can be selected for a drift calculation.

G. Pressing HALT returns the routine to displaying the frequency offset calculations in process at point (G). If frequency comparisons are not in progress, the routine returns to display CH 1-6 at point (B).

CHAPTER 4

THEORY OF OPERATION

4-1 INTRODUCTION

This chapter describes the theory of operation for the AS210-02 Frequency Comparator. The description is keyed to Figure 4.1, Functional Block Diagram and the schematics in Chapter 5. The three circuit boards are designated A1, A1A1, and A2. Details of common types of circuits (power supplies, etc.) have been omitted. Reference is made in the description to data that comes from and is returned to the CPU. The CPU is located in the AS210-01 Module Controller that is used in conjunction with the Frequency Comparator. Details regarding the operation of the Module Controller may be obtained from the Module Controller manual.

The Frequency Comparator circuit obtains the signal to be measured and compares it with the 10 MHz Rubidium frequency standard. Resolution of Parts in 10^{-11} is achieved through the use of a 200 MHz phase-locked oscillator (PLO) in the counting circuit. The frequency comparator circuits consist of the 10 MHz standard division circuit, input signal conversion circuit, clock circuit, and data processing circuit. The standard input signal can be 0.1, 1, 5, or 10 MHz. Up to six inputs may be accommodated by the AS210-02. The input signal is frequency divided to 100 KHz and used to phase lock the 200 MHz PLO. The PLO signal is gated by the clock enable signal derived from the 10 MHz reference standard. Pulses from the 200 MHz PLO are counted in the accumulator circuit that is periodically scanned by the CPU. Resolution changes are made by varying the clock enable period.

Six input channels are applied to the Input Multiplexer Assembly A1A1. The input select data is obtained from latch A1U10 which holds

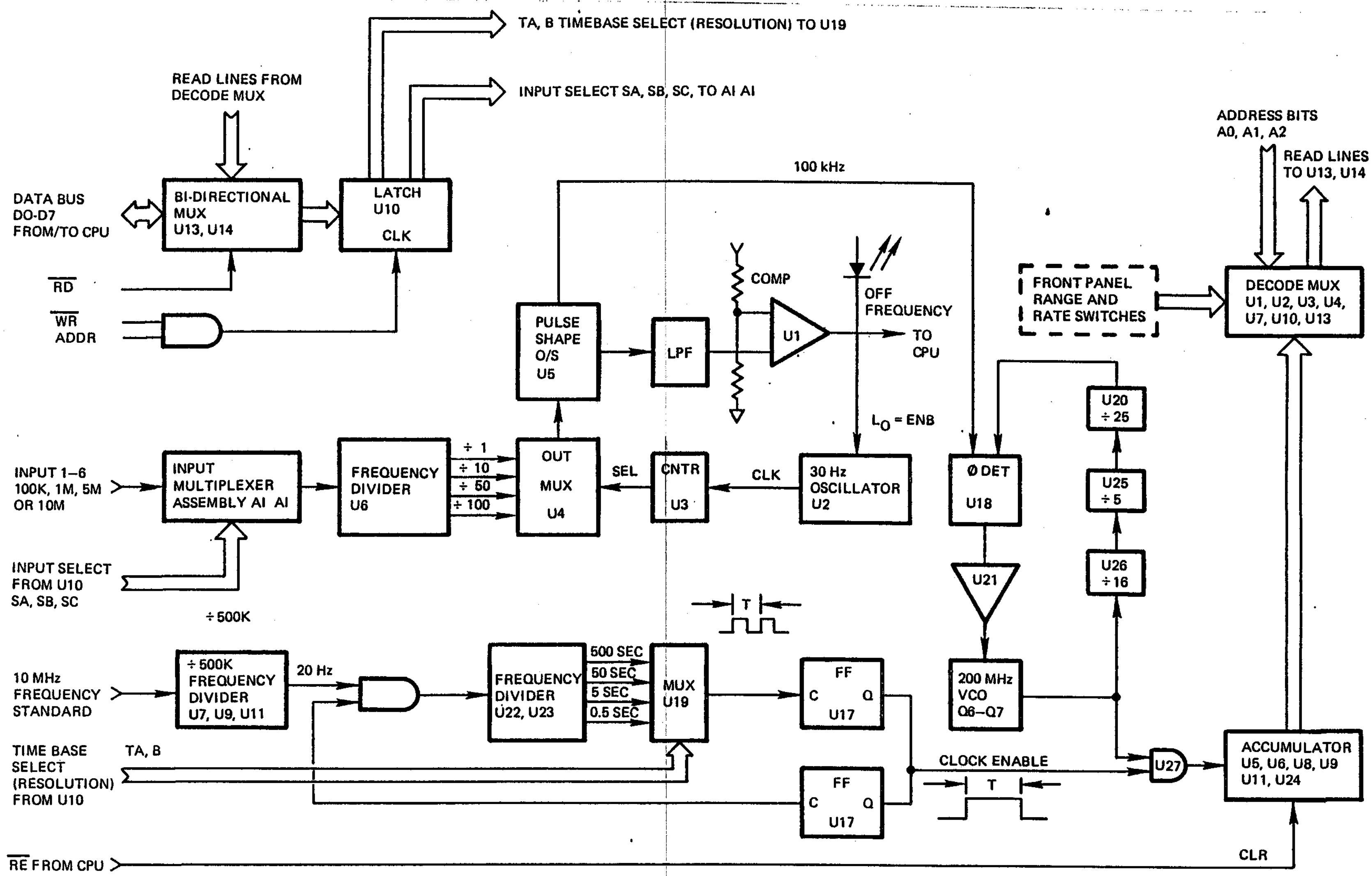

Figure 4.1 Frequency Comparator Functional Block Diagram

information from the Module Controller's CPU selecting the channel to be analyzed. The CPU data is applied to the A1U10 via bidirectional MUX A1U13 and A1U14. This channel number is initially selected by the operator at the Module Controller. The input channels may also be sequentially scanned by the CPU. The Module Controller manual contains more details regarding the CPU operation. The selected input signal is next applied to frequency divider A1U6. The input signal may be 0.1, 1, 5, or 10 MHz. The frequency divider A1U6 contains ÷1, ÷10, ÷50, and ÷100 outputs. A 100 KHz output from A1U6 is desired regardless of the frequency of the input signal. This is achieved by a 100 KHz search circuit consisting of multiplexer A1U4, pulse shaper A1U5, a low pass filter, comparator A1U1, oscillator A1U2, and counter A1U3. The output of A1U4 is pulse shaped by one-shot A1U5 and applied to a low pass filter. The filter's output is a dc voltage that is proportional to frequency. This voltage is applied to the variable input of comparator A1U1. The reference input of A1U1 is set to a voltage that causes the comparator to go high when the variable dc input is equivalent to a 100 KHz signal. When the comparator is low, a ground is provided to an LED that lights to indicate OFF FREQ. The low is also sent to the CPU. While the comparator's output is low (not 100 KHz), a 30 Hz oscillator A1U2, is enabled. The oscillator increments counter A1U3 which sequentially selects inputs to the multiplexer A1U4. The select line sequentially outputs the multiplexer's ÷1, ÷10, ÷50, and ÷100 input until the 100 KHz signal is found. When the line containing the 100 KHz signal is located, the search loop stops as comparator A1U1 goes high, inhibiting A1U2. Assuming an input signal of 1 MHz, the ÷10 multiplex input line will contain the 100 KHz. If the input were 5 MHz, the ÷50 multiplex input line would contain the 100 KHz signal, etc. The 200 MHz VCO, A2Q6, A2Q7 is phase locked to the 100 KHz signal by phase detector A2U18. A2U20, A2U25, and A2U26 divide the 200 MHz signal to 100 KHz. The output of A2U18, filtered and amplified by A2U21, tunes the VCO. Any changes that occur in the input signal are therefore reflected in the output of the 200 MHz VCO. The 200 MHz output is applied to an accumulator circuit consisting of 6 dual decade counters A2U5, A2U6, A2U8, A2U9, A2U11, and A2U24. If the 200 MHz oscillator is gated into the accumulator for 0.5 seconds, 100×10^6 or 10^8 pulses would be counted. This corresponds to a frequency resolution of 1 x 10^{-8} or 1 pulse out of 10^{8} pulses. Similarly, if the oscillator were gated for periods of 5, 50, or 500 seconds, frequency resolutions of 10^{-9}, 10^{-10}, and 10^{-11} are obtained. In order to provide a precise clock gating period, the 10 MHz Rubidium reference standard signal is divided by 500 in frequency divider A1U7, A1U9, and A1U11. The 20 Hz signal is appied to divider A2U22-A2U23 that has four outputs: ÷10, ÷100, ÷1000, and ÷10000 corresponding to sampling periods of 0.5 seconds, 5 seconds, 50 seconds, and 500 seconds. The four signals are applied to time base multiplexer A2U19. Select lines are obtained from the CPU depending on the resolution selected by the operator at the Module Controller. If, for example, the resolution selected was 10^{-9}, the 5 second period line would be output by the multiplexer. Flip-flop A2U17 goes high on the leading edge of the pulse train and thus provides a 5-second gating pulse for clock gate A2U27. This permits 10^{9} pulses to be counted in the accumulator (provided that the input frequency were exact). The accumulator's output is read by the CPU via a decoding multiplexer (A2U1-A2U4, A2U7, A2U10, A2U13, A2U14). The other inputs to the multiplexers are the front panel RANGE switch and RATE switch. The CPU scans the switches ten times per second to determine the correct data to be applied to the various multiplexers previously described. When a read signal ($\overline{RE}$) is received from the CPU, the accumulator is read and cleared. The $\overline{RE}$ signal also turns off the front panel GATE LED through driver A2Q1. The accumulator's contents are transmitted through the data bus to the Module Controller where calculations are performed. These calculations allow the operator to determine frequency drift over variable periods of time with varying degrees of resolution. This process is explained more fully in the section on operation and in the Module Controller Manual.

CHAPTER 5
MAINTENANCE AND OPERATION

5-1 INTRODUCTION

The purpose of this chapter is to provide maintenance and calibration data for the AS210-02 Frequency Comparator. Section I covers routine preventive maintenance procedures. Section II outlines performance tests for the Frequency Comparator. Section III contains the calibration/ alignment procedures for the AS210-02 module, and Section IV describes troubleshooting data. Please contact the factory for any assistance required in the maintenance or servicing of the AS210-02.

SECTION I

5-2 PREVENTIVE MAINTENANCE

Table 5-1 lists preventive maintenance checks and services which should be performed regularly.

Table 5-1

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURES
CABLES	Visually inspect cables for strained, cut, frayed, or other damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfaces as follows: A. Remove the dust and loose dirt with a clean soft cloth. B. Remove dust or dirt from plugs and jacks with a brush. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle and break.
CORROSION	Make sure exterior surfaces of unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: A. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. B. Brush two coats of paint on base metal to protect it from further corrosion.

SECTION II

5-3 PERFORMANCE TESTING

This section describes the procedure to test the AS210-02 Frequency Comparator to assure proper performance of the instrument. The AS210-02 must be used in conjunction with the AS210-01 Module Controller since the CPU in the AS210-01 monitors the controls and operates on the data collected by the AS210-02. The AS210-02 Frequency Comparator will not operate without the AS210-01 Module Controller installed. If the AS210-02 fails any of the performance tests, please see Section III, Calibration/Alignment procedures and/or Section IV, Troubleshooting procedures in this chapter.

5-4 INPUT FREQUENCY PERFORMANCE TESTS

The following is a procedure for testing the input frequency performance of the AS210-02 frequency comparator. Table 5-2 contains the required test equipment for this procedure.

Table 5-2

REQUIRED TEST EQUIPMENT FOR THE INPUT FREQUENCY PERFORMANCE TEST

ITEM	RECOMMENDED TEST EQUIPMENT
Frequency Synthesizer	Hewlett-Packard 8656A
Coaxial Cable (2 required)	3 foot long, 50 ohm, BNC
RF Voltmeter	Boonton 92BD OPT 01, 09 with 50 ohm BNC adapter

5-5 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Tune the frequency synthesizer for a 100 KHz signal. Monitor the output of the signal synthesizer with the RF voltmeter and adjust the signal for an output level greater than or equal to 0.5 volts RMS.

C. Connect the equipment as indicated in Figure 5.1 and apply power to the AS210. The Rubidium Frequency Standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

D. Set the AS210-02 Frequency Comparator RANGE switch to 10^{-8} and set the RATE switch to MAX.

E. Press RESET on the AS210-01 Module Controller. The display of the AS210-01 should indicate "SEL?"

F. Press CONT. The AS210-01 display should indicate "CH 1-6."

G. Press 1, press ENTER. The display should read "SEL 10."

H. Press CONT. The GATE LED on the AS210-02 Frequency Comparator should light for 0.5 second at a time. Monitor the display for 30 seconds. The display should read "1....0P-08" plus or minus 1 part in 10^{-8} during this time.

I. Repeat steps B through H for the frequency synthesizer tuned to 1 MHz, 5 MHz, and 10 MHz.

J. If further verification of proper performance of the AS210-02 Frequency Comparator is desired, this procedure may be repeated for each of the other three RANGE positions (10^{-9}, 10^{-10}, 10^{-11}). Please note that the GATE LED will light for 5 seconds for the 10^{-9} setting, 50 seconds for the 10^{-10} setting, and 500 seconds for the 10^{-11} setting. This procedure may also be run with the RATE switch set on 1-PER-HOUR.

K. Disconnect the frequency synthesizer from the AS210-03.

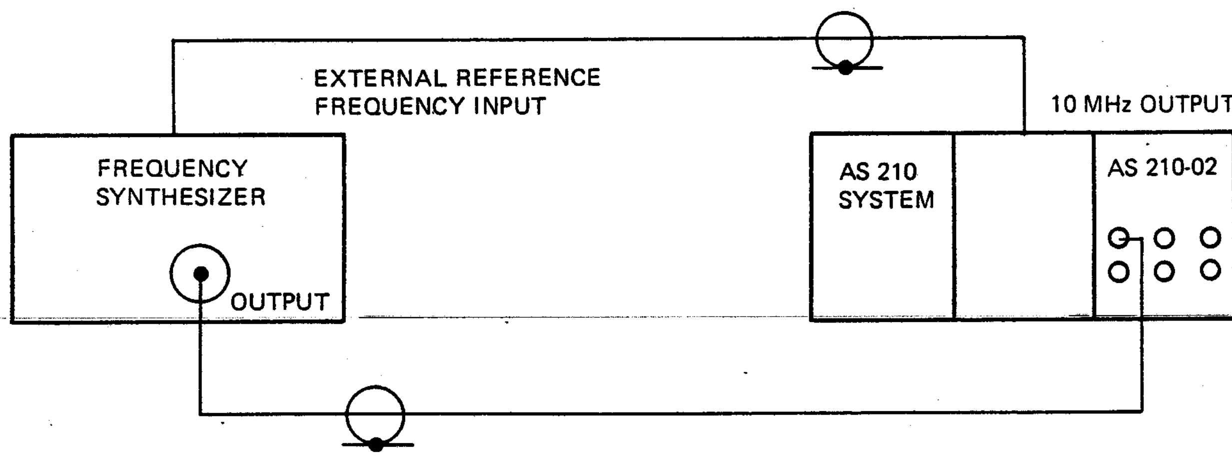

Figure 5.1 AS210-02 Frequency Comparator Input Frequency Performance Test Configuration

SECTION III

5-6 CALIBRATION/ALIGNMENT PROCEDURE

WARNING

The following Calibration/Alignment Procedures (Chapter 5, Section III), and Troubleshooting Procedures (Chapter 5, Section IV) are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that of Routine Maintenance (Chapter 5, Section I, and Performance Testing (Chapter 5, Section II) unless you are qualified to do so.

Figure 5.2 is a flow diagram of the Calibration/Alignment Procedure for the AS210-02 Frequency Comparator. Use this flow diagram with the theory of operation in Chapter 4, the text in this chapter, and the illustrated parts lists in Chapter 6. The Rubidium frequency standard calibration procedure which is contained in the AS210 mainframe operation and maintenance manual is also referenced in this flow diagram. Please note it is not necessary to disassemble the AS210 system to determine if the calibration/alignment is needed. For any assistance needed in performing this calibration/alignment procedure, please contact the factory.

5-7 ACCESS TO AS210-02 FREQUENCY COMPARATOR MODULE

Please reference the AS210 mainframe manual for the disassembly procedure of the AS210 system to allow access to the AS210-02 Frequency Comparator module. Access to the module circuitry itself is gained by removing the two metal side covers with a small straight-blade screwdriver. Place the module on one of its sides so that one cover is facing up. Starting with the

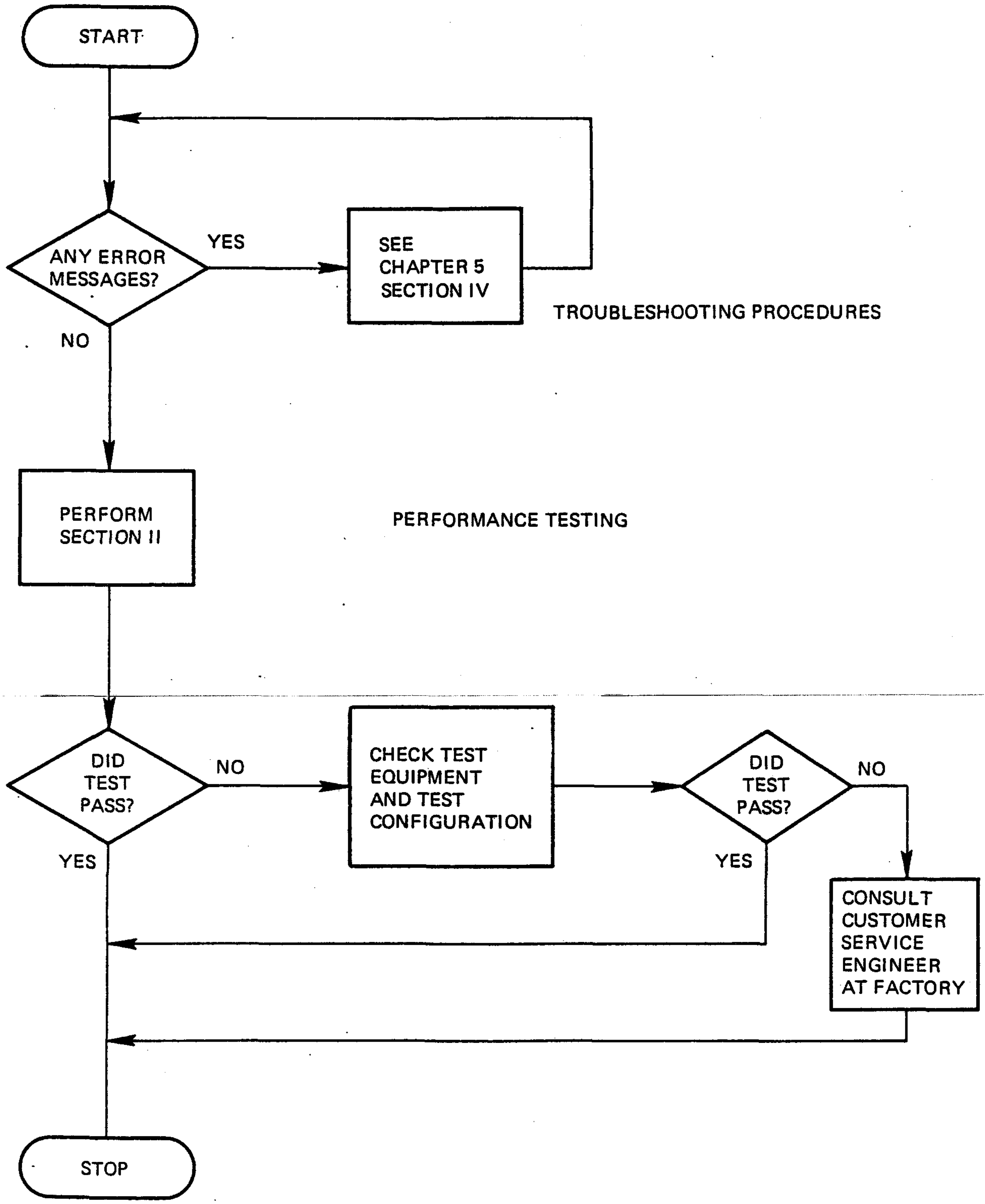

Figure 5.2 Flow Diagram of Calibration/Alignment Procedure for AS210-02 Frequency Comparator

end toward the edge connector, insert the screwdriver into one of the slots where the cover mates with the module chassis and pry the cover up. It will be necessary to move along the slot toward the front panel of the module and repeat the prying action to loosen the side of the cover from the module. Repeat this technique to free the other side of the cover from the chassis. Set the free cover clear of the module and flip the module over so that the second cover is now facing up. Repeat the above procedure to free this cover. The circuit card assemblies are removed from the module by removing four screws.

5-8 200 MHz PLO ALIGNMENT PROCEDURE

The following is the alignment procedure for the 200 MHz phase-locked oscillator (PLO) in the AS210-02 Frequency Comparator. This is the only alignment operation necessary for the AS210-02. Table 5-3 contains the required test equipment for this alignment procedure.

Table 5-3

REQUIRED TEST EQUIPMENT FOR THE 200 MHz PLO ALIGNMENT PROCEDURE

ITEM	RECOMMENDED TEST EQUIPMENT
Oscilloscope with Probes	Tektronix 465 or equivalent
Frequency Synthesizer	Hewlett Packard 8656A
Coaxial Cable (2 required)	3 foot long, 50 ohm, BNC
RF Voltmeter	Boonton 92BD OPT01, 09 with 50 ohm BNC adapter

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Obtain access to the AS210-02 module circuits by referencing paragraph 5-7 in this chapter.

C. Tune the frequency synthesizer for a 1 MHz signal. Monitor the output of the signal synthesizer with the RF voltmeter and adjust the signal for an output level greater than or equal to 0.5 volts RMS.

D. Connect the equipment as indicated in Figure 5.1 and apply power to the AS210. The Rubidium Frequency Standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

E. With an Oscilloscope, monitor the DC level at the test point TV* on pin (6) six of A2U21 located on Assembly A2..

F. In a CW direction, adjust A2C8 located on Assembly A2*, until the voltage level passes through a minimum DC level. Continue until the level equals a -4 VDC level.

The AS210-02 Frequency Comparator should now be aligned. To confirm that the Frequency Comparator is operating properly, reference Section II, Performance Testing of the AS210-02, contained in this chapter.

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* On units with serial number 178 and above, C8 and test point TV are located on the back side of assembly 117226 for easy access.

SECTION IV

5-9 TROUBLESHOOTING PROCEDURES

Troubleshooting of the Frequency Comparator is facilitated by a combination of error codes displayed on the Module Controller and LED indicators on the two circuit card assemblies. The circuit cards are illustrated in Figures 6.2 (A1) 6.3 (A2), and 6.4 (A1A1). Table 5-4 correlates the error codes, displayed on the Module Controller when a fault occurs, to the malfunction. An explanation of the problem is provided with possible solutions. Table 5-5 is a list of visual indicators on circuit cards A1 and A2 and the meaning of their indications. Figures 5.3, 5.4, and 5.5 are schematic diagrams of assemblies A1, A1A1, and A2, respectively.

Table 5-4

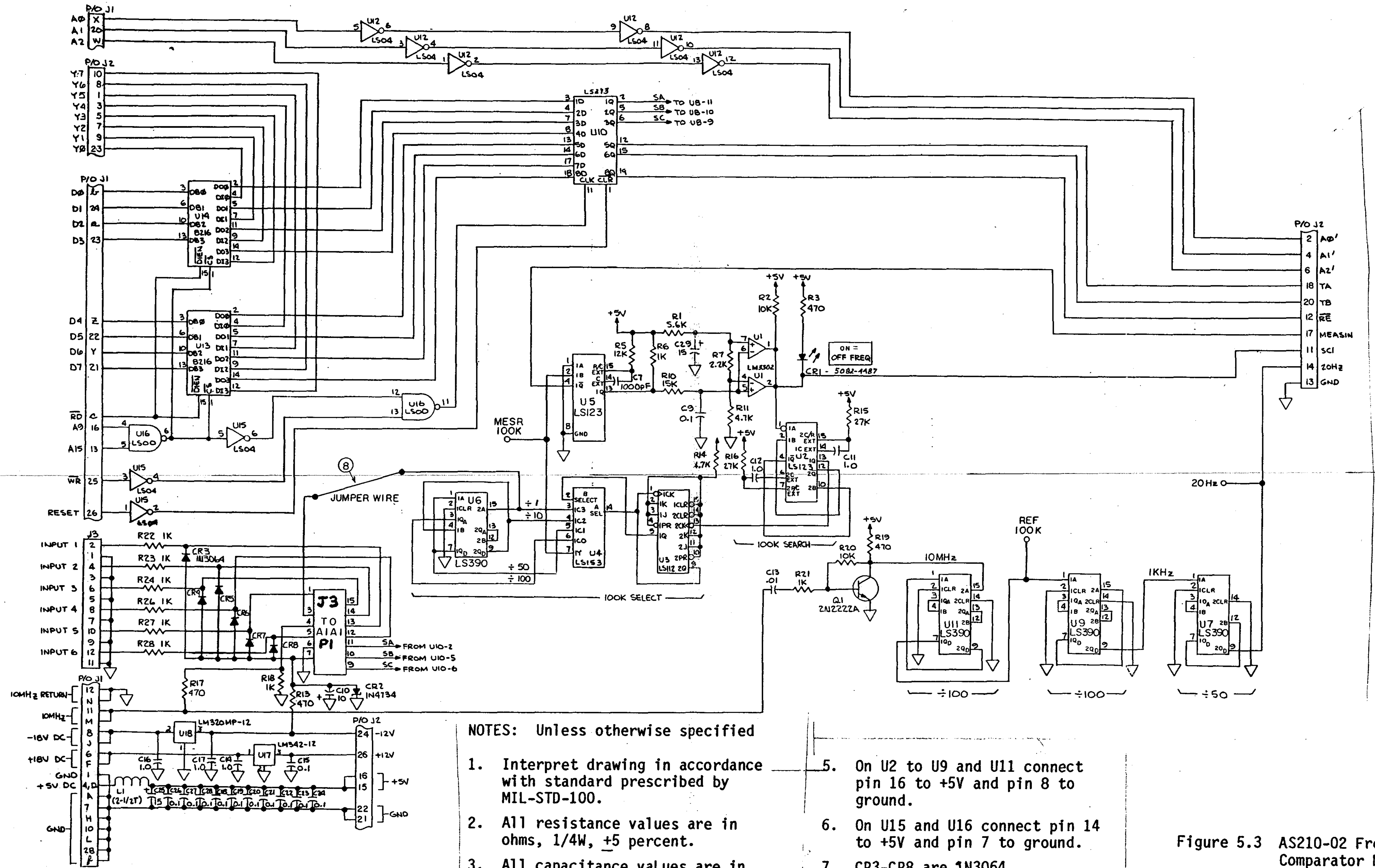
ERROR CODE LISTING

ERROR CODE	PROBLEM	RECOMMENDED SOLUTION
2-01	Output decade registers cannot be cleared	Check A2U5, U6, U9, U11, U15, A1U10, U13, U14, A1A1U1, U2, U3.
2-02	Input selector circuit not working properly (See Table 5-5, A1CR1)	
2-03	Measurement complete, flip flops will not reset	Check A2U17 or A1U10, U13, U14.
2-04	No measurement timebase	Check 10 MHz standard, A1Q1, U11, U9, U7, or A2U15, U23, U22, U19, or U17.
2-05	Self test measurement not within ±1 part in 10^8.	Check 200 MHz phase lock loop or counters A2U5, U6, U9, U11, A1A1U1, U2, U3. See paragraph 5-18.
2-11 to 2-16	No signal present at indicated (1-6) input or signal output is not one of the allowable standard frequencies	Check input signal and input signal frequency on the indicated input.
2-20	Data points selected for drift rate calculation are separated by less than 1 minute.	Choose new data points accuracy of drift rate calculation improved by increasing time between measurements.
2-21	Data points separated by discontinuous time (power failure without battery backup of frequency standard).	
2-22	Initial data point in drift rate calculation overflowed.	
2-23	Final data point overflowed.	
2-30	Channel number specified has no data associated with it.	
2-40	Data point specified is empty.	
2-50	Remote continue comand with module in standby mode.	

Table 5-5

VISUAL INDICATORS

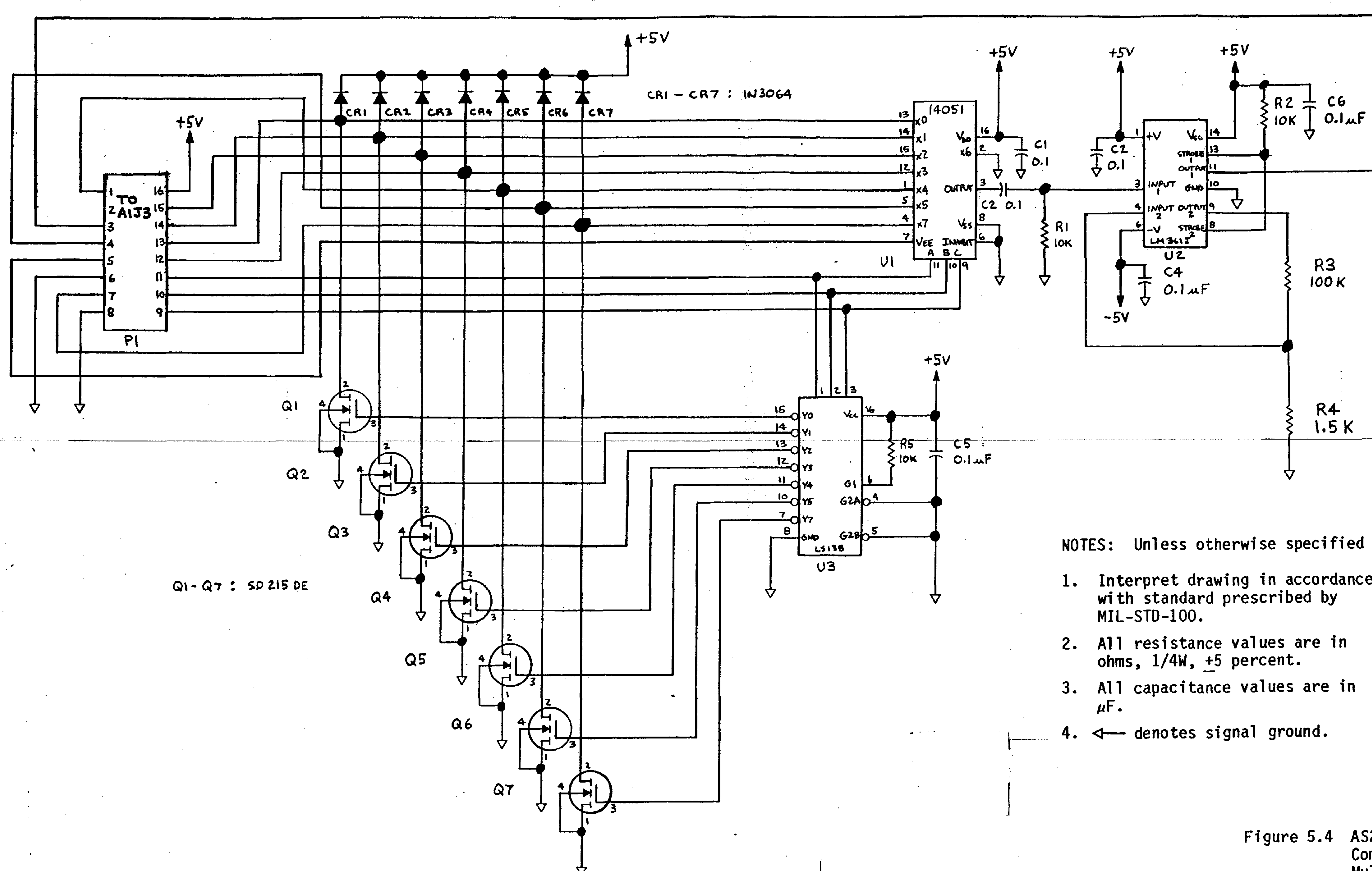
INDICATOR	PROBLEM	RECOMMENDED SOLUTION
A1CR1 ON	Off frequency. Input selector malfunction.	Check A1A1, U6, U5, U1, U4, U2, or U3.
A2CR1 ON	Unlock. 200 MHz oscillator malfunction.	Check A2Q6, Q7, or A2U18, U20, U25, Q8, U26, U27, U21. See paragraph 5-8.



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/4W, ±5 percent.
3. All capacitance values are in µF.
4. ◁ denotes signal ground.
5. On U2 to U9 and U11 connect pin 16 to +5V and pin 8 to ground.
6. On U15 and U16 connect pin 14 to +5V and pin 7 to ground.
7. CR3-CR8 are 1N3064.
8. Modification 125392 Q2, C8, R4, R8, R9, R12 removed.

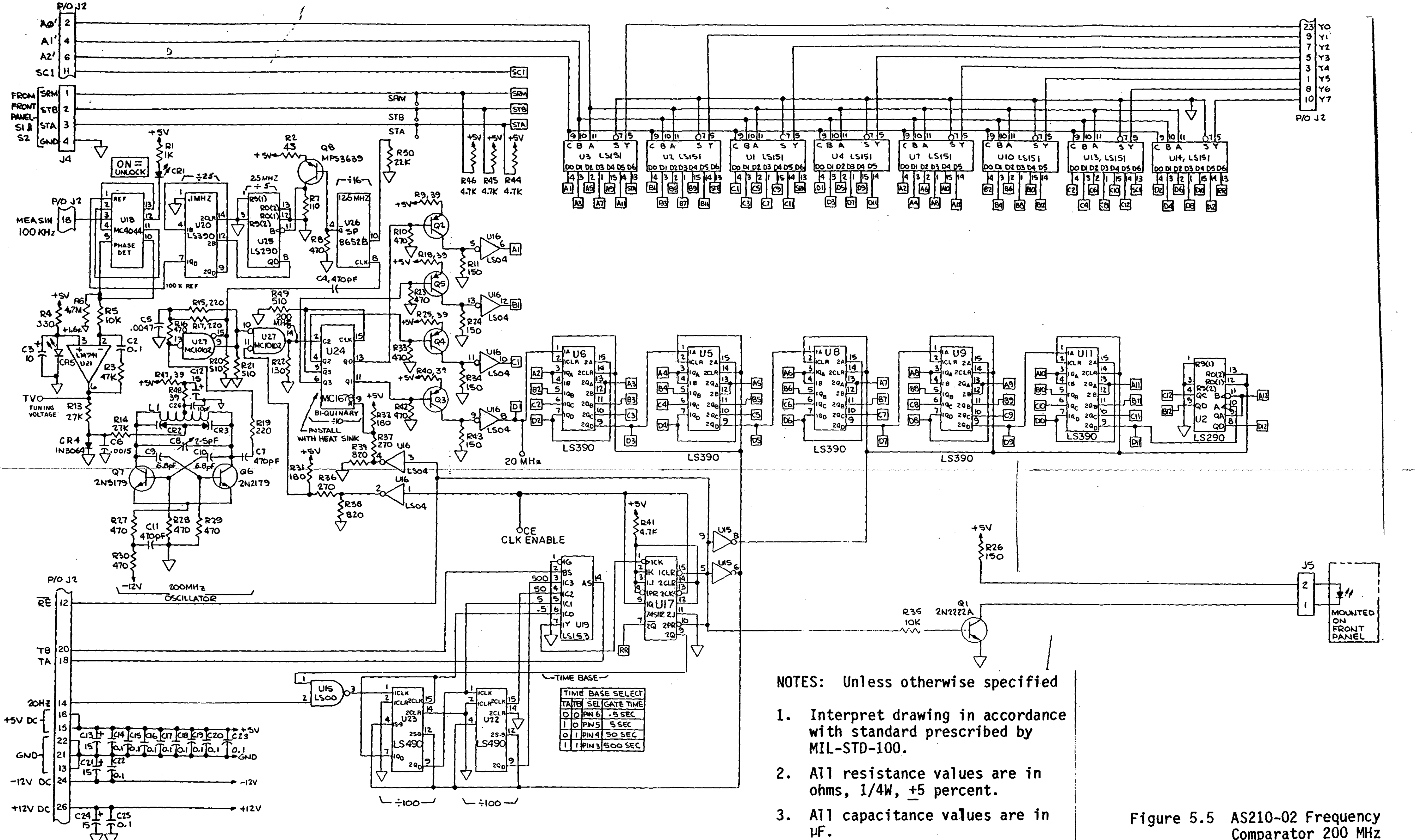
Figure 5.3 AS210-02 Frequency Comparator Microprocessor Interface and Input Select Schematic Diagram, A1



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/4W, ± 5 percent.
3. All capacitance values are in µF.
4. ◁— denotes signal ground.

Figure 5.4 AS210-02 Frequency Comparator Input Multiplexer Schematic Diagram, A1A1



TA	TB	SEL	GATE TIME
0	0	PIN 6	.5 SEC
1	0	PIN 5	5 SEC
0	1	PIN 4	50 SEC
1	1	PIN 3	500 SEC

NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/4W, ±5 percent.
3. All capacitance values are in µF.
4. ◁ denotes signal ground.
5. □ denotes interconnection on this drawing.

Figure 5.5 AS210-02 Frequency Comparator 200 MHz Phase-Locked Oscillator and Time Base Select Schematic Diagram

CHAPTER 6
ILLUSTRATED PARTS LIST

6-1 INTRODUCTION

This chapter contains an illustrated parts list for the AS210-02 Frequency Comparator Module. The assembly numbers and assembly title are listed at the top of the parts lists. The parts lists are divided into five columns and arranged in the following order:

Column 1 - Item Number

Column 2 - Quantity
Quantity per assembly.

Column 3 - Manufacturer's Part Number
Please disregard the first two digits before the dash when referencing these part number.

Column 4 - Description
A brief description of the item.

Column 5 - Reference Designation and Remarks
The electrical or electronic designation of the item as shown on the schematic diagram, wiring diagram or interconnect diagram, and the Federal Supply Code for manufacturers.

ASSEMBLY NUMBER 00-117169-01 FREQ. COMPARATOR AS 210-02

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
10	1.	01-117220-01	FREQ COMPARATOR ASSY A1	ARGOSYSTEMS, 33472
11	1.	01-117225-01	FREQ COMPARATOR ASSY A2	ARGOSYSTEMS, 33472
14	4.	12-8225-SS-0632	STANDOFF, 6-32 THREAD 1 1/4	AMATOM, 06540
17	2.	12-NAS662-C2R8	SCREW, FLH 2-56 X 1/2	
18	0.	**-117326	FRAME SECTION MODIFICATION	ARGOSYSTEMS, 33472
20	1.	00-117351-01	CABLE ASSY	ARGOSYSTEMS, 33472
21	8.	12-MS51957-27	SCREW, PH 6-32 X 5/16	
22	8.	12-NAS620-C6	REDUCED OD FLAT WASHER #6	
23	8.	12-MS35338-136	SPLIT LOCK WASHER #6	
24	1.	10-117181-01	PANEL, FRONT, LEXAN	ARGOSYSTEMS, 33472
25	1.	65-B127	KNOB, BLACK	NOBEX
26	1.	65-14378-01	SWITCH, ROTARY 30 DEGREE	ROSE ELECTRONICS
27	1.	65-7101-J1-ZQ	ROCKER SWITCH, SPDT	C&K, 09353
28	6.	18-KC-79-35	BNC BULKHEAD, RECEPTACLE	KINGS, 91836
29	1.	13-Q086-13D	SOCKET, LED	ELDEMA, 03797
30	1.	60-5082-4957	LED	H.P., 50434
31	1.	65-765-55	BUTTON, PLASTIC, BLUE	NOBEX ,
33	0.	16-RG178	COAX CABLE, 50 OHM	AS REQUIRED
35	1.	17-22-01-2121	CONNECTOR, PLUG, 12 PIN	MOLEX, 27264
36	1.	17-22-01-2041	CONNECTOR, PLUG 4 PIN	MOLEX, 27264

ASSEMBLY NUMBER 00-117169-01 FREQ. COMPARATOR AS 210-02

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
37	1.	17-22-01-2021	CONNECTOR, PLUG 2 PIN	MOLEX, 27264
38	18.	17-08-50-0114	PIN, CRIMP	MOLEX, 27264
40	6.	13-1497	GROUND LUG	H.H.SMITH, 83330
42	0.	WL-117194	WIRE LIST	ARGOSYSTEMS, 33472
44	1.	10-117181-02	SUB-PANEL,PLASTIC	ARGOSYSTEMS, 33472
45	1.	10-117181-03	PANEL, REAR	ARGOSYSTEMS, 33472
46	0.	16-ET26 AWG	WIRE STRANDED TEFLON INSULATED	AS REQUIRED
47	1.	11-366-1690-01	LATCH PULL	TEKTRONIX, 80009
48	1.	11-386-2402-05	PLASTIC PANEL	TEKTRONIX, 80009
49	1.	11-105-0718-01	LATCH	TEKTRONIX, 80009
50	1.	11-105-0719-00	LATCH RETAINER	TEKTRONIX, 80009
51	1.	11-426-0724-00	BOTTOM	TEKTRONIX, 80009
52	2.	11-337-1399-00	SIDE COVER	TEKTRONIX, 80009
53	1.	11-214-1061-00	TENSION SPRING	TEKTRONIX, 80009
54	1.	11-426-0725-00	TOP	TEKTRONIX, 80009
55	2.	11-386-3657-01	GUIDE PIN	TEKTRONIX, 80009
56	1.	12-00000000	SCREW,FLH,STL,SHTMTL,#2X1/4	
57	4.	12-MS24693-C26	SCREW,FLH, 6-32 X 3/8	
58	4.	12-000000000	SCREW,PNH,STL,SHTMTL, #6 X 3/8	

**** END OF LIST ****

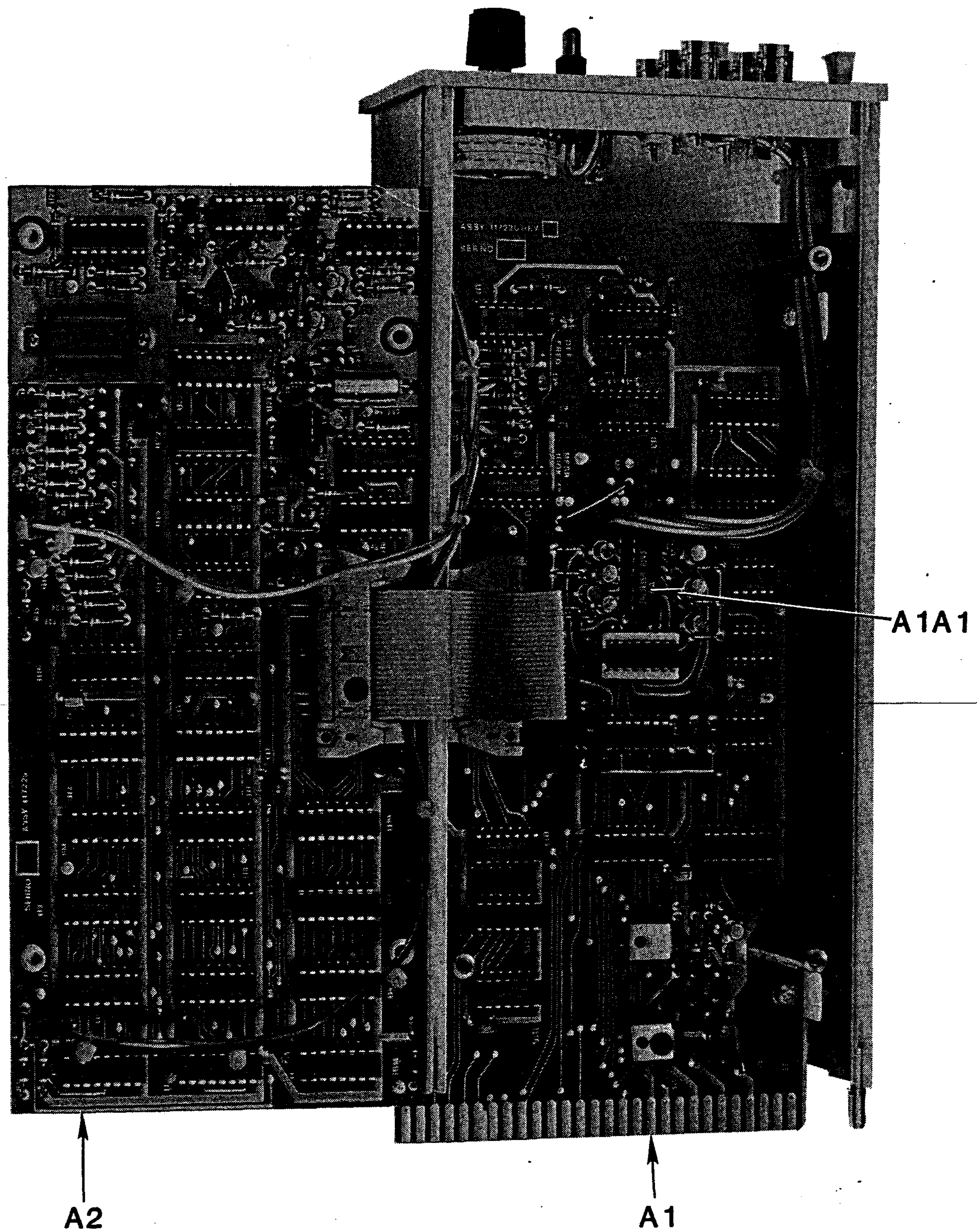


Figure 6.1 Frequency Comparator Module

ASSEMBLY NUMBER 01-117220-01 FREQUENCY COMPARATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117223-01	PWB	ARGOSYSTEMS, 33472
5	0.	**-117221	SCHEMATIC	ARGOSYSTEMS, 33472
6	0.	**-117220	ASSEMBLY DRAWING	ARGOSYSTEMS, 33472
27	1.	30-CK05BX102K	.001UFD 10% CERAMIC CAPACITOR	C7 81349
28	1.	30-CK05BX103K	.01UFD 10% CERAMIC CAPACITOR	C13 81349
29	13.	30-CK05BX104K	.1UFD 10% CERAMIC CAPACITOR	C9, C15, C17-24, C26-28 81349
30	4.	30-300-50-601-105M	1UFD 20% CERAMIC CAPACITOR	C11-12, C14, C16 CENTRE ENG., 51642
35	1.	30-CSR13G106KL	10UFD, 50V, ELECTROLYTIC CAP	C10 81349
37	2.	30-196D156X9020KA1	15UFD, 10% SOLID TANTALUM CAP	C29, C25 SPRAGUE, 56289
47	3.	13-2010B-1	TERMINAL	USECO, 15849
50	1.	60-5082-4487	LIGHT EMITTING DIODE	CR1 H.P., 50434
54	1.	55-1N4734	5.2V ZENER DIODE	CR2 MOTOROLA, 04713
56	6.	55-1N3064	DIODE	CR3-CR8 NATIONAL, 27014
59	1.	18-3429-1202	26 PIN PC MOUNT MALE HEADER	J2 3M
61	1.	18-22-03-2121	WAFER, 12 PIN	J3 MOLEX, 27264
64	1.	25-VK200-20/4B	WIDE BAND CHOKE	L1 FERROXCUBE, 02114
66	1.	50-2N2222A	NPN TRANSISTOR	Q1 NATIONAL, 27014
73	9.	35-RCR07G102JS	1K 5% 1/4W CARBON COMP	R6, R18, R21, R22-24, R26-28 81349
74	2.	35-RCR07G103JS	10K 5% 1/4W CARBON COMP	R2, R20 81349

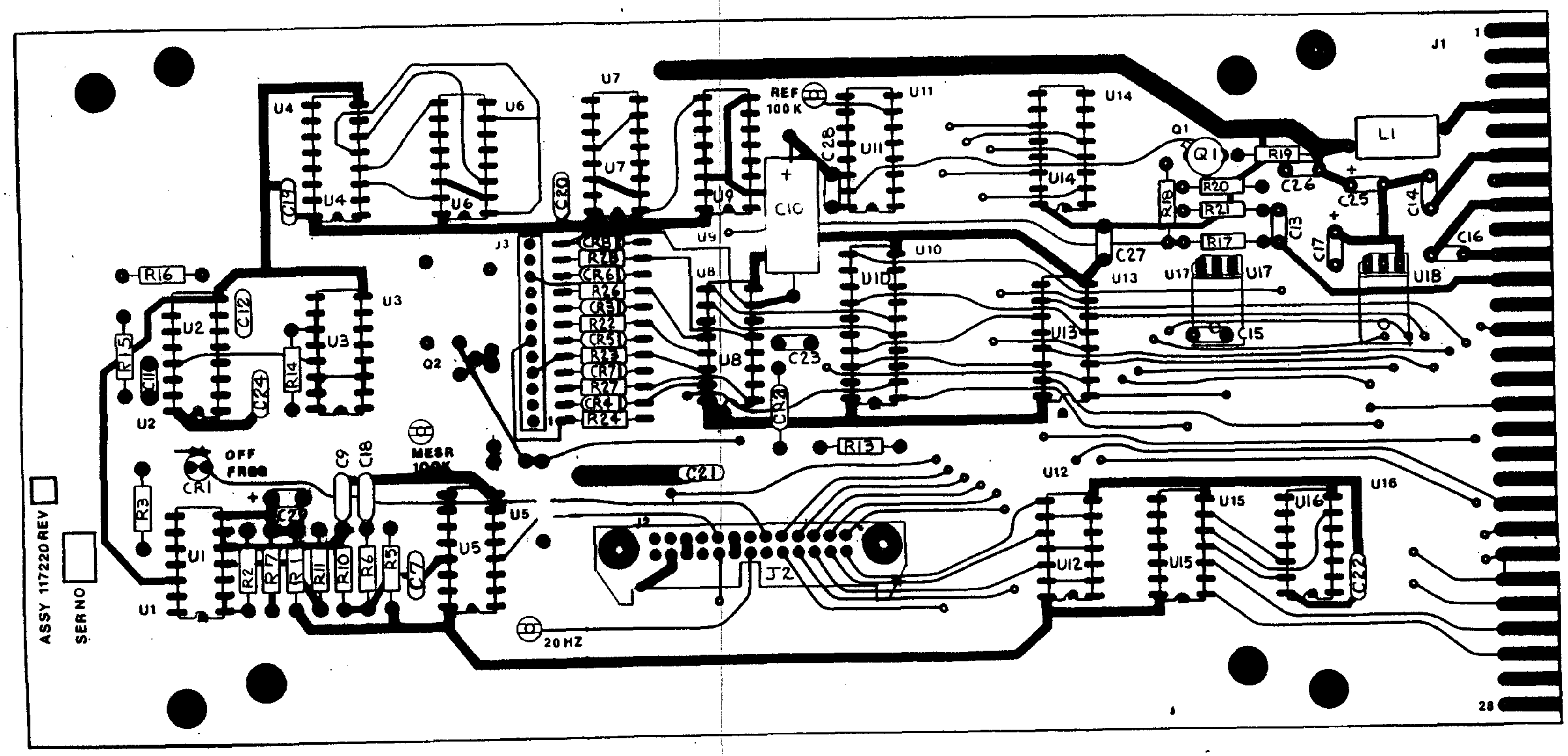
ASSEMBLY NUMBER 01-117220-01 FREQUENCY COMPARATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
75	1.	35-RCR07G123JS	12K 5% 1/4W CARBON COMP	R5 81349
76	1.	35-RCR07G153JS	15K 5% 1/4W CARBON COMP	R10 81349
77	1.	35-RCR07G222JS	2.2K 5% 1/4W CARBON COMP	R7 81349
79	2.	35-RCR07G273JS	27K 5%, 1/4W CARBON COMP	R15,16 81349
80	4.	35-RCR07G471JS	470 5% 1/4W CARBON COMP	R3, R13, R17, R19 81349
81	2.	35-RCR07G472JS	4.7K 5% 1/4W CARBON COMP	R11, R14 81349
82	1.	35-RCR07G562JS	5.6K 5%, 1/4W CARBON COMP	R1 81349
96	1.	47-LM320MP-12	12V REGULATOR	U18 NATIONAL,27014
97	1.	47-LM342P-12	12V REGULATOR	U17 NATIONAL,27014
98	1.	47-LM3302N	DUAL COMPARATOR	U1 NATIONAL,27014
101	1.	47-74LS00N	QUAD 2 INPUT NAND GATE	U16 T.I.,01295
102	2.	47-74LS04N	HEX INVERTER	U12, U15 T.I.,01295
103	1.	47-74LS112N	DUAL JK FLIP FLOP	U3 T.I. ONLY,01295
104	2.	47-74LS123N	DUAL ONE SHOT	U2, U5 T.I. ONLY,01295
105	1.	47-74LS153N	MULTIPLEXER	U4 T.I. ONLY,01295
106	1.	47-74LS273N	OCTAL D FLIP FLOP	U10 T.I.,01295
107	4.	47-74LS390N	DECADE COUNTER	U6,U7, U9, U11 T.I.,ONLY,01295
110	1.	01-125383	A1A1,INPUT ANALOG MULTIPLEXER	U8 ARGOSYSTEMS,33472
113	2.	47-P8216	BUS DRIVER]	U13,14 INTEL,34649

ASSEMBLY NUMBER 01-117220-01 FREQUENCY COMPARATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
117	4.	13-C9314-02	14 PIN SOCKET	T.I.,01295
119	11.	13-C9316-02	16 PIN SOCKET	T.I.,01295
121	1.	13-C9320-02	20 PIN SOCKET	T.I.,01295

**** END OF LIST ****



COMPONENT SIDE

Figure 6.2 AS210-02 Frequency Comparator Microprocessor Interface and Input Select Assembly, A1

ASSEMBLY NUMBER 01-117225-01 FREQUENCY COMPARATOR A2

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117228-01	PWB	ARGOSYSTEMS,33472
5	0.	**-117226	SCHEMATIC	ARGOSYSTEMS,33472
6	0.	**-117225	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
28	11.	30-CK05BX104K	.1UFD 10% CERAMIC CAPACITOR	C2, C14-20, C22, C23, C25 81349
29	1.	30-CK05BX152K	.0015 UFD 10% CERAMIC CAP	C6 81349
30	3.	30-CK05BX471K	470PFD 10% CERAMIC CAPACITOR	C4, C7, C11 81349
31	1.	30-CK05BX472K	.0047UFD 10% CERAMIC CAPACITOR	C5 81349
32	4.	30-196D156X9020KA1	15UFD 10% SOLID TANTALUM CAP	C12, C13, C21, C24 SPRAGUE,56289
35	1.	30-CSR13G106KL	10UFD, 50V ELECTROLYTIC CAP	C3 81349
38	1.	30-513-010-A2-10	2-10PFD VARIABLE CAPACITOR	C8 ERIE,72982
39	2.	30-100-100COG689J	6.8PFD 5% CERAMIC CAPACITOR	C9, C10 CENTRE ENG.,51642
47	7.	13-20108-1	TERMINAL	USECO,15849
50	2.	60-5082-4487	LIGHT EMITTING DIODE	CR1, CR5 H.P.,50434
52	2.	55-MV2203	TUNING DIODE	CR2, CR3 MOTOROLA,04713
54	1.	55-1N3064	DIODE	CR4 NATIONAL,27014
58	1.	18-3429-1202	26 PIN PC MOUNT CONNECTOR	J2 3M
60	1.	18-22-03-2021	2 PIN WAFER	J5 MOLEX,27264
61	1.	18-22-03-2041	4 PIN WAFER	J4 MOLEX,27264
64	1.	14-6007A	HEAT SINK BASE & CAP	THERMALLOY,13103

ASSEMBLY NUMBER 01-117225-01 FREQUENCY COMPARATOR A2

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
73	1.	25-117305-10	INDUCTOR	L1 ARGOSYSTEMS,33472
76	2.	12-MS51957-4	SCREW,PHH, 2-56 X 5/16	
78	2.	12-NAS620-C2	REDUCED OD FLAT WASHER #2	
79	2.	12-MS35338-134	SPLIT LOCK WASHER #2	
80	2.	12-NAS671-C2	SMALL PATTERN HEX NUT #2	
83	1.	50-2N2222A	NPN TRANSISTOR	Q1 NATIONAL,27014
85	2.	50-2N5179	NPN TRANSISTOR	Q6,Q7 MOTOROLA,04713
86	5.	50-MPS3639	PNP TRANSISTOR	Q2-Q5, Q8 MOTOROLA,04713
97	1.	35-RCR07G102JS	1K OHM 5% 1/4W CARBON COMP	R1 81349
98	2.	35-RCR07G103JS	10K OHM 5% 1/4W CARBON COMP	R5, R35 81349
99	1.	35-RCR05G475JS	4.7 MEG OHM 5% 1/8W CARBON COM	R6 81349
100	5.	35-RCR07G151JS	150 OHM 5% 1/4W CARBON COMP	R11, R24, R26, R34, R43 81349
101	1.	35-RCR07G223JS	22K OHM 5% 1/4W CARBON COMP	R50 81349
102	3.	35-RCR07G221JS	220 OHM 5% 1/4W CARBON COMP	R15, R17, R19 81349
103	2.	35-RCR07G273JS	27K OHM 5% 1/4W CARBON COMP	R13,R14 81349
104	6.	35-RCR07G390JS	39 OHM 5% 1/4W CARBON COMP	R9, R18, R25, R40, R47, R48 81349
105	1.	35-RCR07G331JS	330K OHM 5% 1/4W CARBON COMP	R4 81349
106	10.	35-RCR07G471JS	470 OHM 5% 1/4W CARBON COMP	R8, R10, R16, R23,R27-30 R33,R42 81349
108	3.	35-RCR07G511JS	510 OHM 5% 1/4W CARBON COMP	R20,R21, R49 81349
109	1.	35-RCR07G430JS	43 OHM 5% 1/4W CARBON COMP	R2 81349

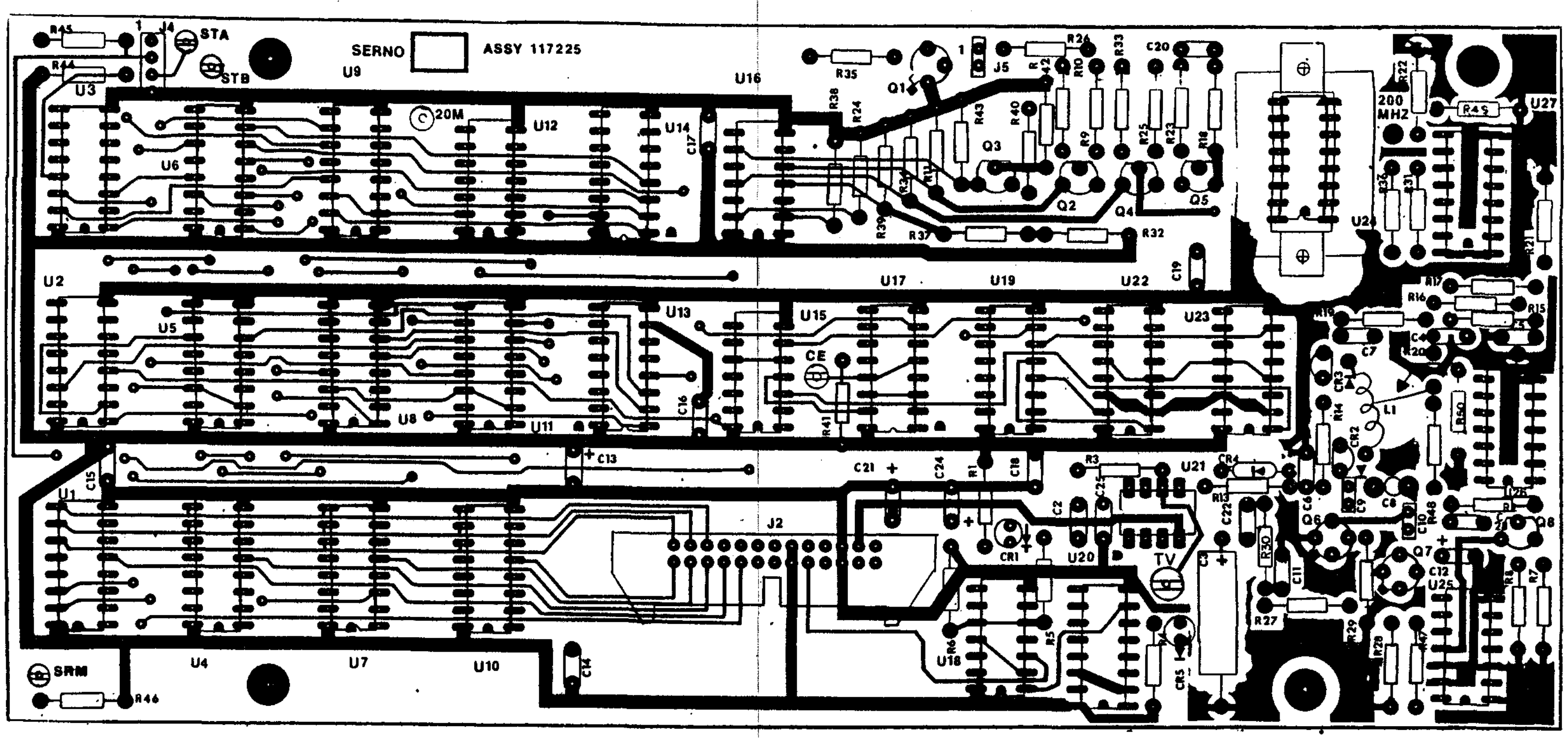
ASSEMBLY NUMBER 01-117225-01 FREQUENCY COMPARATOR A2

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
110	1.	35-RCR07G131JS	130 OHM 5% 1/4W CARBON COMP	R22 81349
111	1.	35-RCR07G473JS	47K OHM 5% 1/4W CARBON COMP	R3 81349
113	1.	35-RCR07G111JS	110 OHM 5% 1/4W CARBON COMP	R7 81349
119	2.	35-RCR07G181JS	180 OHM 5% 1/4W CARBON COMP	R31,R32 81349
120	2.	35-RCR07G271JS	270 OHM 5% 1/4W CARBON COMP	R36,R37 81349
121	4.	35-RCR07G472JS	4.7K OHM 5% 1/4W CARBON COMP	R41, R44-46 81349
122	2.	35-RCR07G821JS	820 OHM 5% 1/4W CARBON COMP	R38,R39 81349
142	1.	47-74LS00N	QUAD 2 INPUT NAND GATE	U15 T.I.,01295
143	1.	47-74S04N	HEX INVERTER	U16 T.I.,01295
144	1.	47-74S112N	DUAL JK FLIP FLOP	U17 T.I.,01295
145	8.	47-74LS151N	7 TO 1 MULTIPLEXER	U1-U4, U7, U10, U13,14 T.I.,01295
146	1.	47-74LS153N	MULTIPLEXER	U19 T.I.,01295
147	2.	47-74LS290N	DECADE COUNTER	U12, U25 T.I.,01295
148	6.	47-74LS390N	DECADE COUNTER]	U5,U6,U8,U9, U11, U20 T.I.,01295
149	2.	47-74LS490N	DECADE COUNTER	U22,U23 T.I.,01295
152	1.	47-MC10102P	QUAD 2 INPUT NAND GATE	U27 MOTOROLA,04713
153	1.	47-MC1678P	DECADE COUNTER	U24 MOTOROLA,04713
154	1.	47-MC4044P	PHASE COMPARATOR	U18 MOTOROLA,04713
157	1.	47-LM741CN	COMPARATOR	U21 NATIONAL,27014

ASSEMBLY NUMBER 01-117225-01 FREQUENCY COMPARATOR A2

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
160	1.	47-SP86508	DECADE COUNTER	U26 PLESSEY,55154
163	6.	13-C9314-02	14 PIN SOCKET	T.I.,01295
165	19.	13-C9316-02	16 PIN SOCKET	T.I.,01295
167	1.	13-C9308-02	8 PIN SOCKET	T.I.,01295
168	1.	30-CM04CD100J03	10 PFD SILVER MICA CAP	C26 81349

**** END OF LIST ****



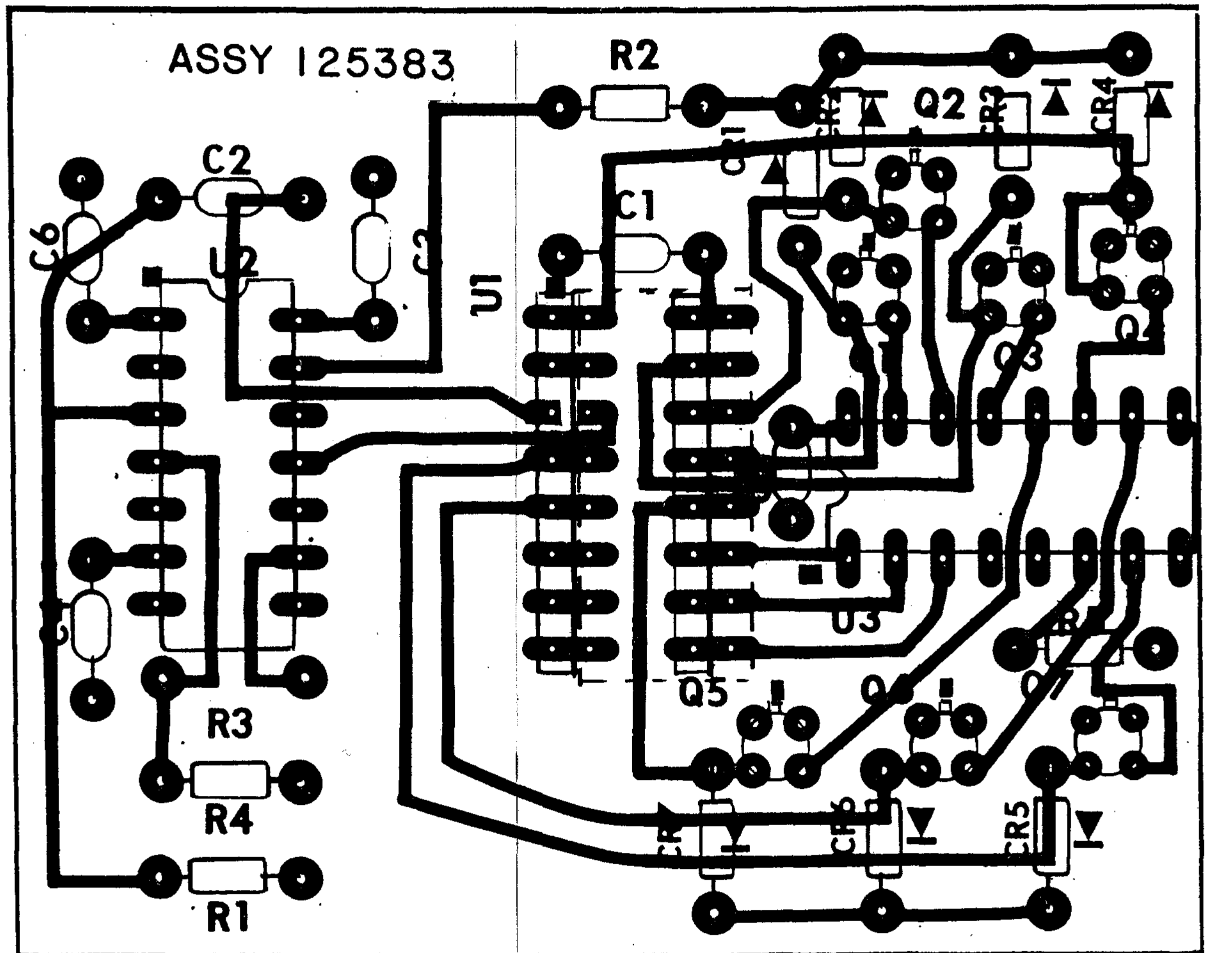
COMPONENT SIDE

Figure 6.3 AS210-02 Frequency Comparator 200 MHz Phase-Locked Oscillator and Time Base Select Assembly, A2

ASSEMBLY NUMBER 00-125383-01 INPUT SWITCHING ASSY. A1A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
1	1.	15-125388	PWB	ARGOSYSTEMS,33472
3	0.	++-125385	SCHEMATIC	ARGOSYSTEMS,33472
5	0.	++-125383-01	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
7	1.	47-MC14051B	3-8 DECODER	U1 MOTOROLA,04713
9	1.	47-LM361N	COMPARATOR	U2 NATIONAL,27014
11	1.	47-74LS138N	DECODER	U3 T.I.,01295
13	1.	13-616-AG16	16 PIN COMPONENT ADAPTOR	P1 AUGAT,91506
15	3.	35-RCR05G103JS	10K OHM 5% 1/8W CARBON COMP	R1,R2,R5 81349
17	1.	35-RCR05G104JS	100K OHM 5% 1/8W CARBON COMP	R3 81349
19	1.	35-RCR05G152JS	1.5K OHM 5% 1/8W CARBON COMP	R4 81349
21	7.	50-SD215	FET	Q1,Q2,Q3,Q4,Q5,Q6,Q7 NATIONAL,27014
23	7.	55-1N3064	DIODE	CR1,CR2,CR3,CR4,CR5,CR6, CR7 MOTOROLA,04713
25	5.	30-CK05BX104K	.1 UFD 10% CERAMIC CAP	C1,C3,C4,C5,C6 81349
27	1.	30-CK05BX103K	.01 UFD 10% CERAMIC CAP	C2 81349
29	1.	13-C9316-02	16 PIN SOCKET	T.I.,01295
31	1.	13-C9314-02	14 PIN SOCKET	T.I.,01295
33	28.	13-2-331272-6	MINI PINS	AMP,09769
35	2.	13-1-583773-5	8 PIN INLINE SOCKET	AMP,09769

**** END OF LIST ****



COMPONENT SIDE

Figure 6.4 AS210-02 Frequency Comparator Input Multiplexer Assembly, A1A1

ASSEMBLY NUMBER 00-117351-01 CABLE ASSEMBLY

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
1	2.	17-3399-6000	CONNECTOR, 26 PIN	3M
2	6.	16-3365/26	CABLE, 26 WIRE, RIBBON	3M

**** END OF LIST ****

AS210-03
FREQUENCY
GENERATOR MODULE

ARGOSystems, Inc. / 884 Hermosa Court, Sunnyvale, California 94086
Telephone (Area Code 408) 737-2000 / Telex No. 352077

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LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

PREFACE

This manual contains operation and maintenance instructions for the AS210-03 Frequency Generator. The data contained herein is arranged as follows:

Reference Publications

AS-210	Mainframe Operation and Maintenance Manual
AS-210-01	Module Controller Operation and Maintenance Manual
AS-210-02	Frequency Comparator Operation and Maintenance Manual
AS-210-04	Digital Delay Generator Operation and Maintenance Manual
AS-210-05	Standby Battery Operation and Maintenance Manual

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

The AS210-03 Frequency Generator illustrated in Figure 1.1 is a modular plug-in used in the ARGOSystems AS210 Electronic Counter and Frequency Standard Calibration system. This module is used for testing the amplitude and frequency specifications of electronic counters. Eight individual frequency outputs at nine selectable output levels are provided by the unit. A leveling loop permits an output accuracy of better than 1 dB over 60 dB of dynamic range. The AS210-03 is programmable through the IEEE 488 interface in the AS210-01 Module Controller. Descriptions of other modules of the AS210 series are provided in separate publications referenced in the preface and available from ARGOSystems.

1-2 PHYSICAL AND ELECTRICAL DESCRIPTION

The AS210-03 Frequency Generator is modularly constructed for insertion in the AS210 Mainframe. The front panel contains controls for selection of frequency, output level, and a BNC connector for the output. The circuitry of the AS210-03 is mounted on one printed circuit card assembly and six Voltage Controlled Oscillator (VCO) subassemblies. The 10 MHz frequency output is provided directly by the Rubidium frequency standard from the Mainframe, while a ÷10 frequency divider provides the 1 MHz signal. Frequencies of 500, 400, 300, 200, 100, and 50 MHz are obtained from the Phase-Locked Oscillators (PLO) locked to the Rubidium frequency standard. Output level is controlled via a digitally controlled step attenuator. The frequency and level controls are scanned periodically by the microprocessor in the AS210-01 Module Controller. This data is returned to the Frequency Generator in the form of commands for switching PLOs or the attenuator. Table 1-1 is an Equipment Specification for the AS210-03 installed in the AS210 Mainframe.

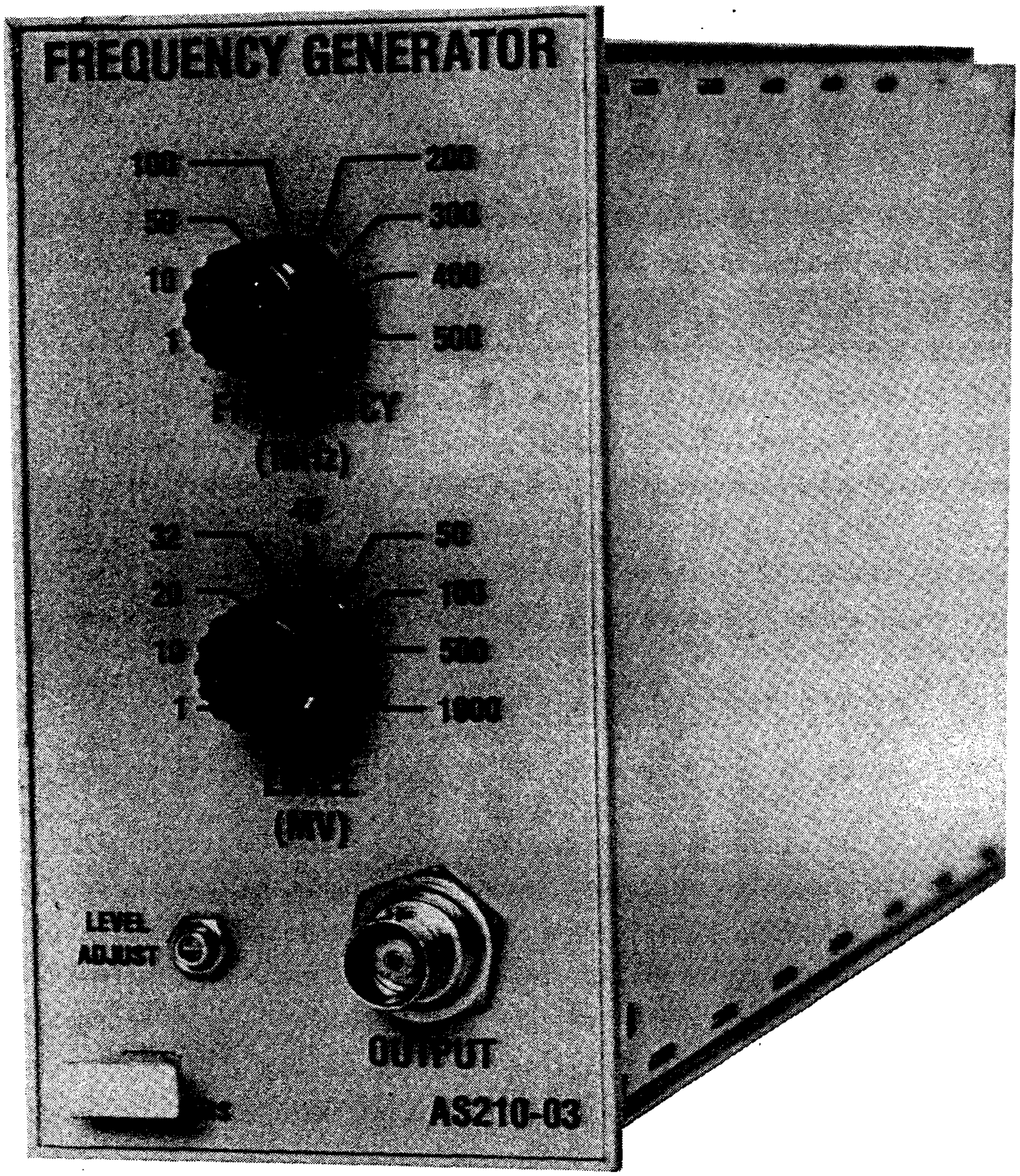


Figure 1.1 AS210-03 Frequency Generator Module

Table 1-1

AS210-03 EQUIPMENT SPECIFICATION

OUTPUT FREQUENCIES	1, 10, 50, 100, 200, 300, 400, or 500 MHz selectable
FREQUENCY ACCURACY	$\pm 6 \times 10^{-11}$ maximum from 10°C to 40°C Less than $\pm 5 \times 10^{-11}$ maximum per day
HARMONIC CONTENT	
2nd HARMONIC	24 dB minimum below desired frequency
3rd HARMONIC AND ABOVE	30 dB minimum below desired frequency
NON-HARMONIC SPURIOUS RESPONSE	50 dB minimum below desired frequency
OUTPUT LEVELS	1, 10, 20, 32, 40, 50, 100, 500, or 1000 millivolts selectable
OUTPUT LEVEL ACCURACY	
1 MHz TO 300 MHz	±10 percent maximum, 5 percent typical
400-500 MHz	±15 percent maximum, 5 percent typical
OPERATING TEMPERATURE	0° to 40°C
POWER REQUIREMENT	Supplied by AS-210 Mainframe
WEIGHT	2.75 pounds

CHAPTER 2
INSTALLATION

2-1 INTRODUCTION

The AS210-03 Frequency Generator Module plugs into the AS210 Mainframe. The module is electrically connected through a rear edge connector and mechanically retained via a front panel locking bar.

NOTE 1: Because of the high retention force of the rear card edge connector, it may be necessary to pull on the RF LEVEL switch knob at the same time as the release mechanism is pulled, to remove the Frequency Generator from the Mainframe. (See Figure 3.1.)

NOTE 2: The power in the AS210 Mainframe must be turned OFF when inserting or removing the Frequency Generator Module.

CAUTION

AS210 series plug-ins will not work in Tektronix TM-500 series mainframes. Severe damage will result if operation in this mode is attempted.

Power and signal interface is provided through the Mainframe. The signal output is from a BNC connector on the front panel.

CHAPTER 3
OPERATION

3-1 INTRODUCTION

This chapter contains operation data and instructions for the Frequency Generator. Operator interface is provided through three controls and a connector on the front panel of the module. The AS210-03 is designed to be used in conjunction with the AS210-01 Module Controller. However, this interface is transparent to the user of the Frequency Generator. Chapter 5, Maintenance and Calibration, explains the self-diagnostic capability of the AS210-03 when used with the Module Controller.

3-2 CONTROLS AND CONNECTORS

Figure 3.1 is a front panel photograph of the Frequency Generator with index numbers keyed to Table 3-1.

3-3 OPERATING INSTRUCTIONS

The AS210-03 is connected via 50 ohm cable with a BNC connector. Select the desired standard frequency and choose the output level as required. A level adjustment is provided on the front panel for calibrating the LEVEL (mV) control. Specific procedures for this alignment are contained within the Maintenance chapter.

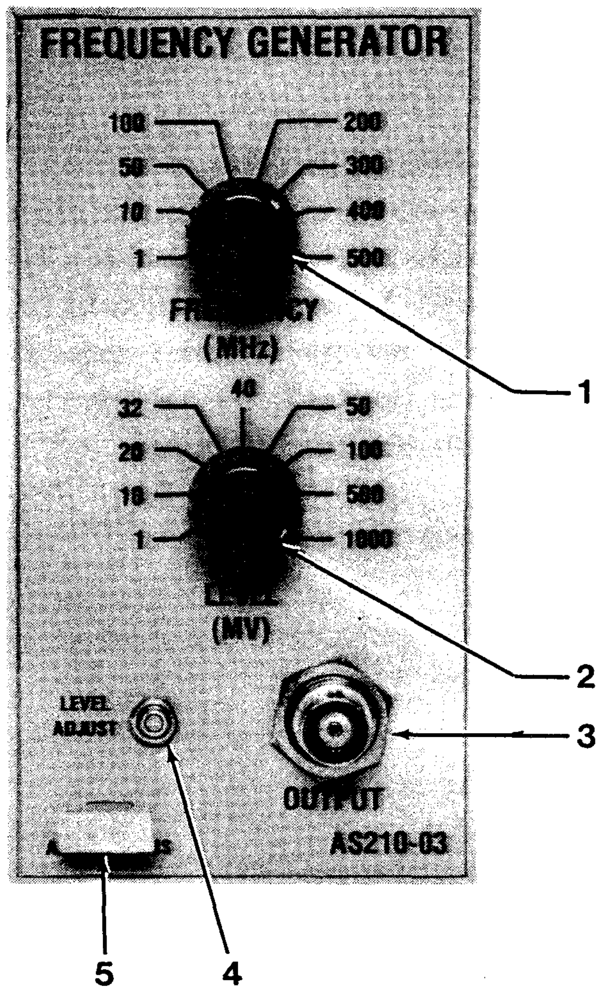


Figure 3.1 AS210-03 Controls and Connectors

Table 3-1

AS210-03 CONTROLS AND CONNECTORS

INDEX NUMBER (Figure 3-1)	PANEL MARKING	FUNCTION
1	FREQUENCY (MHz)	Selects one of eight standard frequencies: 1, 10, 50, 100, 200, 300, 400, or 500 MHz
2	LEVEL (mV)	Selects one of nine output levels: 1, 10, 20, 32, 40, 50, 100, 500, or 1000 millivolts
3	OUTPUT	Output connector - BNC, 50 ohms
4	LEVEL ADJUST	Level calibration adjustment (see Chapter 5)
5	None	Release mechanism for retention and removal of the module

CHAPTER 4
THEORY OF OPERATION

4-1 INTRODUCTION

This chapter provides a description of the circuits used in the Frequency Generator. The circuit description is keyed to a functional block diagram and the schematic diagrams included in Chapter 5. Details of common type circuits (power supplies, etc.) are not included in this description.

4-2 OVERALL DESCRIPTION

The Frequency Generator circuit consists of the front panel controls and the circuit card assemblies. A1 is the main circuit board assembly, the VCOs are A1A1 through A1A6. Figure 4.1 is a functional block diagram of the module depicting how the generator produces standard frequency outputs of 1, 10, 50, 100, 200, 300, 400, and 500 MHz. Front panel controls select the desired frequency and output level. The Frequency Generator's front panel switches are interrogated 10 times per second by the module controller of the AS210 System. The frequency and level data are shifted from the module controller's Central Processing Unit (CPU) into latches (A1U11-frequency, A1U8-level) on the generator through a bidirectional multiplexer A1U4, and A1U6. The CPU $\overline{RD}$ signal determines the direction of data flow through the multiplexer. Address bits A8 and A15 from the CPU are used to load frequency or level data from the data bus. The output of the front panel frequency select switch is also multiplexed with test data in A1U5 by address bit A0. Test data informs the CPU whether the PLOs are locked and that the output is leveled for self-test purposes.

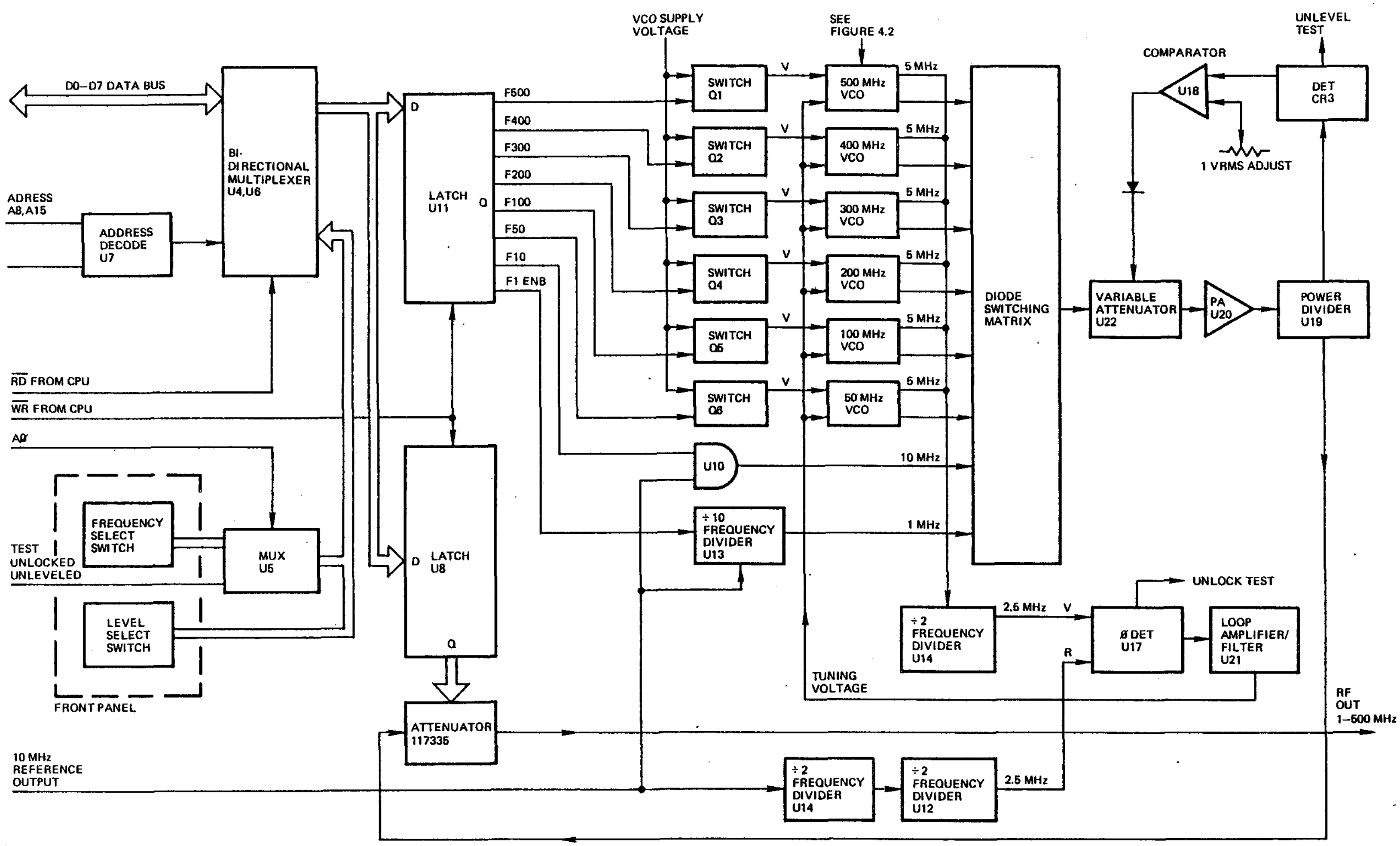


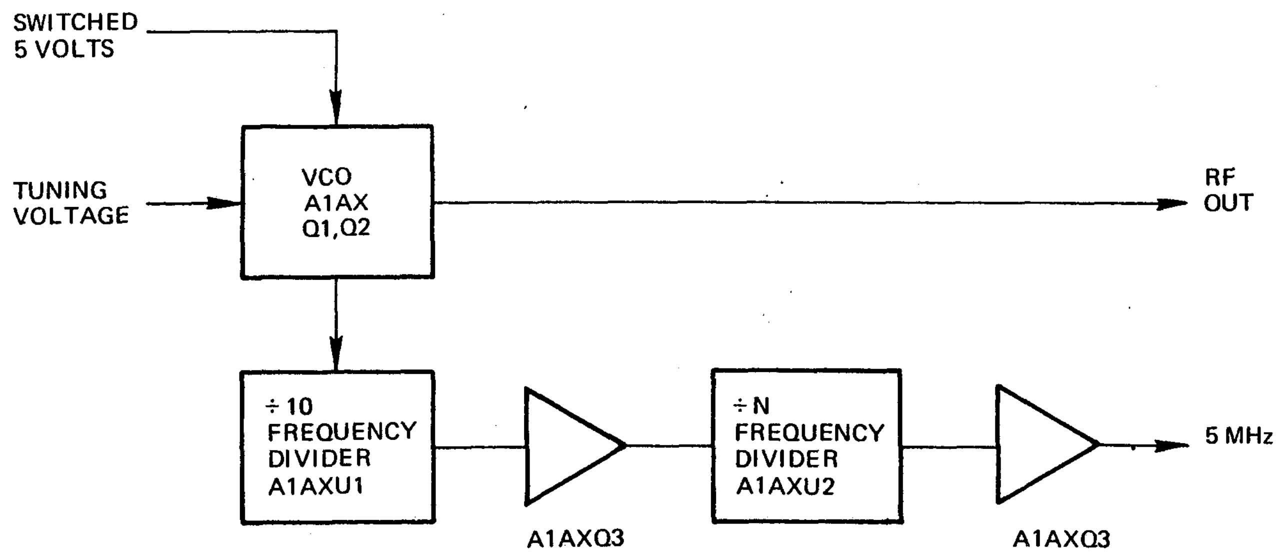
Figure 4.1 Frequency Generator Functional Block Diagram

4-3 FREQUENCY GENERATION

The frequency generation circuits consist of six phase-locked oscillators (PLO), frequency reference dividers, PLO voltage supply gating circuits and the 1 and 10 MHz gating circuit. The PLO circuitry is composed of six voltage controlled oscillators (VCO) with a common frequency divider, phase comparator, and loop amplifier/filter. Six of the standard outputs are provided by the VCOs A1AX (with X equaling 1 through 6 for A1A1 through A1A6). These are the 500, 400, 300, 200, 100, and 50 MHz outputs. The 10 MHz output is obtained directly from the reference input. The 1 MHz output is obtained by dividing the 10 MHz reference input by 10. Only one output frequency can be obtained from the generator at a time. When the front panel switch is set for 50, 100, 200, 300, 400, or 500 MHz, the applicable line from the frequency latch A1U11 (F50, F100, F200, F300, F400, or F500) activates one of six transistor switches (Q6-Q1). The switches allow 11 volts to be applied to the appropriate VCO. Each VCO (Figure 4.2 and schematic diagrams Figures 5.4 through 5.11) is identical except for the frequency-determining circuit elements. Component designators for the VCOs will be preceded by A1AX (with X equaling 1 through 6) to differentiate them from main board components. A varactor-controlled transistor oscillator (A1AXQ1, A1AXQ2) is tuned by a voltage from the phase detector A1U17 through the loop filter/amplifier A1U21. The RF output of the oscillator is provided at connector A1AXJ1.

4-4 PHASE LOCK SIGNAL

The RF output of all the PLOs is divided by 10 in A1AXU1, buffered by A1AXQ3 and divided again by A1AXU2 (except in the 50 MHz PLO). The frequency division accomplished by A1AXU2 is determined by the oscillator frequency. A 5 MHz oscillator output is desired from A1AXU2, therefore the division ratio is $f/n = 5$ MHz. For example, the 400 MHz PLO requires a ÷8 frequency division ($n = 8$) at A1A2U2 since it has been previously divided by 10 at A1A2U1. In the case of the 50 MHz PLO, the original division by 10 yields 5 MHz.



WITH X = 1 THROUGH 6 FOR A1A1 THROUGH A1A6

A1A1 – 500 MHz VCO CIRCUIT CARD
A1A2 – 400 MHz VCO CIRCUIT CARD
A1A3 – 300 MHz VCO CIRCUIT CARD
A1A4 – 200 MHz VCO CIRCUIT CARD
A1A5 – 100 MHz VCO CIRCUIT CARD
A1A6 – 50 MHz VCO CIRCUIT CARD

Figure 4.2 Voltage Controlled Oscillator (VCO) Block Diagram

4-5 PHASE LOCKING

The second output (J2) of the VCO, a 5 MHz signal, is supplied to circuit board A1 and is divided by 2 in A1U14 and applied to the phase detector A1U17 variable input. The 10 MHz reference from the Rubidium standard on the AS210 Mainframe is divided by 4 at A1U14 and A1U12 and the 2.5 MHz resultant signal is applied to the reference input of the phase detector. The phase detector's output is amplified, filtered (A1U21), and applied to the VCO as its tuning voltage. An unlock or unleveled condition test signal is also provided to the CPU for diagnostic purposes through multiplexer A1U5. When the 10 MHz output is selected, the 10 MHz frequency standard is gated to the output by the A1U11 latch's F10 line. When the 1 MHz output is selected, a ÷10 frequency divider A1U13 is enabled by the A1U11 latch's F1 line. The selected RF signal is applied to a leveling circuit by a diode switching network.

4-6 OUTPUT AMPLITUDE LEVELING

The RF leveling circuit is provided to supply a constant one volt RMS signal to the digitally controlled step attenuator (assembly 117335). The level control loop consists of a current controlled variable attenuator A1U22, power amplifier A1U20, 3 dB power divider A1U19, detector A1CR3, and comparator A1U18. The output of the switching network is applied to the input of the variable attenuator A1U22. The signal from the output of the variable attenuator is amplified by A1U20 and applied to the input of the 3 dB power divider A1U19. One output of the power divider A1U19 is applied to the input of the digitally controlled step attenuator (assembly 117335). The other output of the power divider is detected by A1CR3 and then compared to a reference voltage by A1U18. The resulting error voltage is applied to the control input of the variable attenuator A1U22 through diode A1CR2 and resistor A1R19. Note: as the error voltage applied to diode A1CR2 increases, the attenuation of the RF signal passing through the variable attenuator A1U22 decreases. The error voltage may be monitored at the ALC test point on A1. A1R24 and A1C23 comprise a circuit to compensate for non-linearities in the attenuator. A front panel control (1K) adjusts the output level by determining the reference voltage of the comparator. Comparator A1U15 provides an output to the CPU for diagnostic purposes. A1U15 determines when the signal level, detected by A1CR3, exceeds the threshold established by dividers A1R1, A1R3, A1R4, and A1R9. The output of A1U15 goes low to illuminate LED A1CR1 when an unleveled condition exists. This information is also sent to the CPU. An unlocked condition at A1U17 also provides an indication through A1U15 to the CPU. The attenuator level of the output signal is digitally controlled by the data from the level latch A1U8. The RF output signal is therefore provided at the frequency and amplitude selected by the front panel controls.

CHAPTER 5
MAINTENANCE AND CALIBRATION

5-1 INTRODUCTION

The purpose of this chapter is to provide maintenance and calibration data for the AS210-03 Frequency Generator. Section I covers routine preventive maintenance procedures. Section II outlines performance tests for the Frequency Generator. Section III contains the calibration/alignment procedures for the AS210-03 module, and Section IV describes troubleshooting data. Figures 5.4 through 5.11 are the schematic diagrams of the Frequency Generator Module. Please contact the factory for any assistance required in the maintenance or servicing of the AS210-03.

SECTION I

5-2 PREVENTIVE MAINTENANCE

Table 5-1 lists preventive maintenance checks and services which should be performed regularly.

Table 5-1
PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURES
CABLES	Visually inspect cables for strained, cut, frayed, or other damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfaces as follows: A. Remove the dust and loose dirt with a clean soft cloth. B. Remove dust or dirt from plugs and jacks with a brush. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle.
CORROSION	Make sure exterior surfaces of unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: A. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. B. Brush two coats of paint on base metal to protect it from further corrosion.

SECTION II

5-3 PERFORMANCE TESTING

This section describes the procedure to test the AS210-03 Frequency Generator to assure proper performance of the instrument. The AS210-03 must be used in conjunction with the AS210-01 Module Controller since the CPU in the AS210-01 monitors the controls and output of the AS210-03. The AS210-03 Frequency Generator will not operate without the AS210-01 Module Controller installed. If the AS210-03 fails any of the performance tests, please see Section III, Calibration/Alignment procedures, and/or Section IV, Troubleshooting procedures in this chapter.

5-4 RF OUTPUT FREQUENCY PERFORMANCE TEST

The following is a procedure for testing the eight selectable output frequencies of the AS210-03. Table 5-2 contains the required equipment to perform this test.

Table 5-2

REQUIRED TEST EQUIPMENT FOR RF OUTPUT FREQUENCY PERFORMANCE TEST

ITEM	RECOMMENDED TEST EQUIPMENT
ELECTRONIC COUNTER	HEWLETT-PACKARD 5345A
FREQUENCY STANDARD	HEWLETT-PACKARD 5061A OR 5062C OPT 01
COAXIAL CABLE (2 Required)	3 FOOT LONG, 50 OHM, BNC

5-5 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Connect the equipment as indicated in Figure 5.1 and apply power to the AS210. The Rubidium Frequency Standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. Select the 100 millivolt output voltage level on the AS210-03. Starting with the 1 MHz output frequency, compare the frequency displayed by the electronic counter to Table 5-3 to verify the output frequency is within 1,000,000 ±0.01 Hz. Continue this process through the remaining seven output frequencies available from the AS210-03. If any of the frequencies fall out of the limits for acceptable performance please see Section III, Calibration/Alignment Procedures, and/or Section IV, Troubleshooting Procedures.

D. Disconnect the frequency counter from the AS210-03.

Table 5-3
MINIMUM PERFORMANCE LIMITS FOR RF OUTPUT FREQUENCIES OF THE AS210-03

FREQUENCY (MHz)	ACCEPTABLE FREQUENCY RANGE
1	1,000,000 ±0.01 Hz
10	10,000,000 ±0.1 Hz
50	50,000,000 ±0.5 Hz
100	100,000,000 ±1.0 Hz
200	200,000,000 ±2.0 Hz
300	300,000,000 ±3.0 Hz
400	400,000,000 ±4.0 Hz
500	500,000,000 ±5.0 Hz

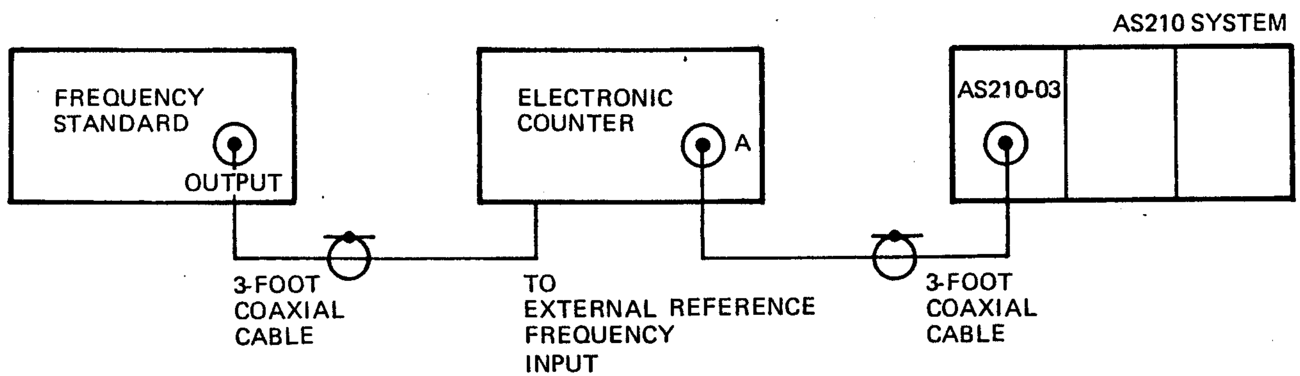


Figure 5.1 AS210-03 Frequency Generator RF Output Frequency Test Configuration

5-6 RF OUTPUT LEVEL PERFORMANCE TEST

The following is a procedure for testing the nine RF output levels for each of the eight selectable output frequencies of the AS210-03. Table 5-4 contains the required equipment for this performance test.

Table 5-4

REQUIRED TEST EQUIPMENT FOR RF OUTPUT LEVEL PERFORMANCE TEST

ITEM	RECOMMENDED TEST EQUIPMENT
RF VOLTMETER	BOONTON 92BD OPT 01, 09 WITH 50 OHM BNC ADAPTER
COAXIAL CABLE	3 FOOT LONG, 50 OHMS, BNC

5-7 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Connect the equipment as indicated in Figure 5.2 and apply power. The Rubidium Frequency Standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. Starting with 1 MHz as the selected output frequency of the AS210-03 and one millivolt as the desired output voltage level, the RF voltmeter should read between 0.9 and 1.1 millivolts for acceptable performance. Next, change the output level to 10 millivolts. The RF voltmeter should read between 9 and 11 millivolts. Continue this process through the

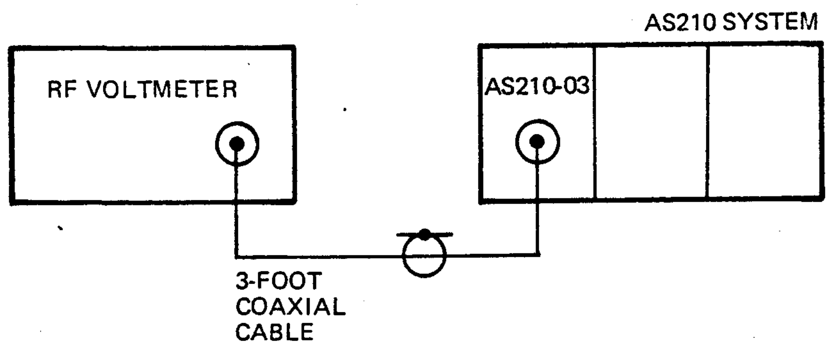


Figure 5.2 AS210-03 Frequency Generator RF Output Voltage Level Test Configuration

remaining six output levels comparing the readings to Table 5-5 for acceptable performance. Select the 10 MHz output frequency and repeat the procedure for each RF voltage level. Continue this process until all output levels for each output frequency have been verified to be within the specified limits of Table 5-5. If any of the levels fall out of the range for acceptable performance, please see Section III, Calibration/ Alignment Procedures, and/or Section IV, Troubleshooting Procedures.

D. Disconnect the RF voltmeter from the AS210-03 output connector.

Table 5-5

MINIMUM PERFORMANCE LIMITS FOR RF OUTPUT VOLTAGE LEVEL OF THE AS210-03

OUTPUT FREQUENCY (MHz)	OUTPUT LEVEL (millivolts) 1		10		20		32		40		50		100		500		1000	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1	0.9	1.1	9	11	18	22	28.8	34.2	36	44	45	55	90	110	450	550	900	1100
10	0.9	1.1	9	11	18	22	28.8	34.2	36	44	45	55	90	110	450	550	900	1100
50	0.9	1.1	9	11	18	22	28.8	34.2	36	44	45	55	90	110	450	550	900	1100
100	0.9	1.1	9	11	18	22	28.8	34.2	36	44	45	55	90	110	450	550	900	1100
200	0.9	1.1	9	11	18	22	28.8	34.2	36	44	45	55	90	110	450	550	900	1100
300	0.9	1.1	9	11	18	22	28.8	34.2	36	44	45	55	90	110	450	550	900	1100
400	0.85	1.15	8.5	11.5	17	23	27.2	36.8	34	46	42.5	57.5	85	115	425	575	850	1150
500	0.85	1.15	8.5	11.5	17	23	27.2	36.8	34	46	4.25	57.5	85	115	425	575	850	1150

SECTION III

5-8 CALIBRATION/ALIGNMENT PROCEDURE

WARNING

The following Calibration/Alignment Procedures (Chapter 5, Section III), and Troubleshooting Procedures (Chapter 5, Section IV) are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that of Routine Maintenance (Chapter 5, Section I), and Performance Testing (Chapter 5, Section II) unless you are qualified to do so.

Figure 5.3 is a flow diagram of the Calibration/Alignment Procedure for the AS210-03 Frequency Generator. Use this flow diagram with the theory of operation in Chapter 4, the text in this chapter, and the illustrated parts lists in Chapter 6. The AS210 internal frequency standard calibration data, contained in the AS210 mainframe operation and maintenance manual, is also referenced in this flow diagram. Please note it is not necessary to disassemble the AS210 system to determine if calibration/alignment is needed. For any assistance needed in performing this calibration/alignment procedure, please contact the factory.

5-9 ACCESS TO AS210-03 FREQUENCY GENERATOR MODULE

Please reference the AS210 mainframe manual for the disassembly procedure of the AS210 system to allow access to the AS210-03 Frequency Generator module. Access to the module circuitry itself is gained by removing the two metal side covers with a small straight-blade screwdriver. Place the module on one of its sides so that one cover is facing up. Starting with the end toward the edge connector, insert the screwdriver into one of the slots

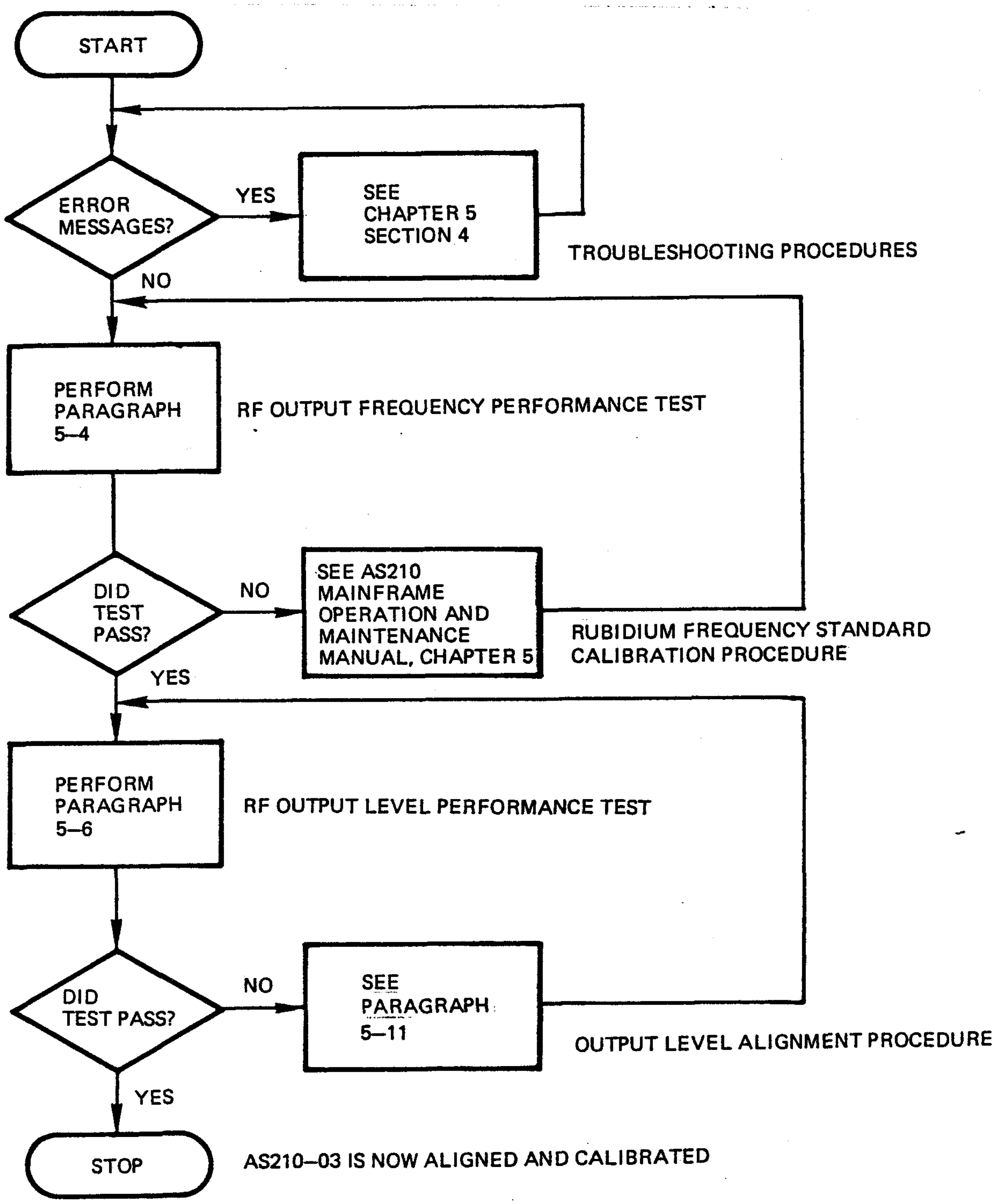


Figure 5.3 Flow Diagram of Calibration/Alignment Procedure for AS210-03 Frequency Generator

where the cover mates with the module chassis and pry the cover up. It will be necessary to move along the slot toward the front panel of the module and repeat the prying action to loosen the side of the cover from the module. Repeat this technique to free the other side of the cover from the chassis. Set the free cover clear of the module and flip the module over so that the second cover is now facing up. Repeat the above procedure to free this cover.

5-10 PLO ALIGNMENT PROCEDURE

The following is the alignment procedure for the six phase-locked oscillators (PLO) in the AS210-03 Frequency Generator. Table 5-6 contains the required test equipment for this alignment procedure.

Table 5-6

REQUIRED TEST EQUIPMENT FOR THE PLO ALIGNMENT PROCEDURE

ITEM	RECOMMENDED TEST EQUIPMENT
OSCILLOSCOPE WITH PROBES	TEKTRONIX 465 OR EQUIVALENT
ELECTRONIC COUNTER	HEWLETT PACKARD 5345A
COAXIAL CABLE	3 FOOT LONG, 50 OHM, BNC

A. Obtain access to the AS210-03 module circuits by referencing paragraph 5-9 in this chapter.

B. The individual frequencies of each PLO may be adjusted by C11 and R7 located on the respective VCO circuit board. In order to adjust the individual frequencies, monitor with the oscilloscope the Automatic Level Control (ALC) (U18 pin 6 or junction C17 and CR2 of assembly A1) and the VCO Tuning Voltage (TV) (junction of C5 and R10 of assembly A1). Please note that the 500 MHz VCO circuit card is located closest to the front panel of the AS210-03. The 400, 300, 200, 100, and 50 MHz VCO circuit cards are located in descending order behind the 500 MHz VCO circuit card. The selected VCO circuit card will have CR3 dimly lit. All other VCO circuit cards will have CR3 brightly lit.

C. Select the desired frequency on the front panel and monitor the output frequency with the electronic counter.

D. Adjust C11 for a minimum ALC voltage of approximately 2 volts ±1 VDC.

E. Now adjust R7 for a tuning voltage of 1 volt ±1 VDC.

NOTE: It may be necessary to readjust C11 and R7 alternately due to the interaction of these adjustments.

F. After PLO adjustment, steps C, D, and E may need to be repeated.

The AS210-03 Frequency Generator output frequencies should now be aligned. To confirm that the Frequency Generator is operating properly, reference Section II, Performance Testing of the AS210-03, contained in this chapter.

5-11 OUTPUT LEVEL ALIGNMENT PROCEDURE

The following is the alignment procedure for the output level of the AS210-03 Frequency Generator. Table 5-7 contains the required test equipment for this alignment procedure.

Table 5-7

REQUIRED TEST EQUIPMENT FOR AS210-03 OUTPUT LEVEL ALIGNMENT PROCEDURE

ITEM	RECOMMENDED TEST EQUIPMENT
RF VOLTMETER	BOONTON 92BD OPT 01, 09 WITH 50 OHM BNC ADAPTER

A. Obtain access to the AS210-03 module circuits by referencing paragraph 5-9 in this chapter.

B. Connect the AS210-03 frequency generator output to the input of the RF voltmeter, as in Figure 5.2.

C. Select the 1000 millivolt output level and the 10 MHz output frequency with the front panel.

D. Adjust the front panel level adjustment for an output level of 1000 millivolts, while monitoring the output of AS210-03 with the RF voltmeter. It may be necessary to change this setting depending on the desired output level.

E. Adjust C23 located on A1 (117236) for a minimum amplitude difference between 400 MHz and 500 MHz by alternately selecting 400 and 500 MHz with frequency select knob on the front panel.

The AS210-03 Frequency Generator output levels should now be aligned. To confirm that the Frequency Generator is operating properly, reference Section II, Performance Testing of the AS210-03, contained in this chapter.

SECTION IV

5-12 TROUBLESHOOTING PROCEDURES

Troubleshooting of the Frequency Generator is facilitated by a combination of error codes displayed on the Module Controller display and LED indicators on the main circuit card assembly, A1. The circuit card is illustrated in Figure 6.2. Table 5-8 correlates the error code, displayed on the Module Controller when a fault occurs, to the malfunction. An explanation of the problem is provided with possible solutions. Table 5-9 is a list of visual indicators on circuit card A1 and the meaning of their indications. Figures 5.4 through 5.11 are the schematic diagrams of the AS210-03. For further assistance, please contact the factory.

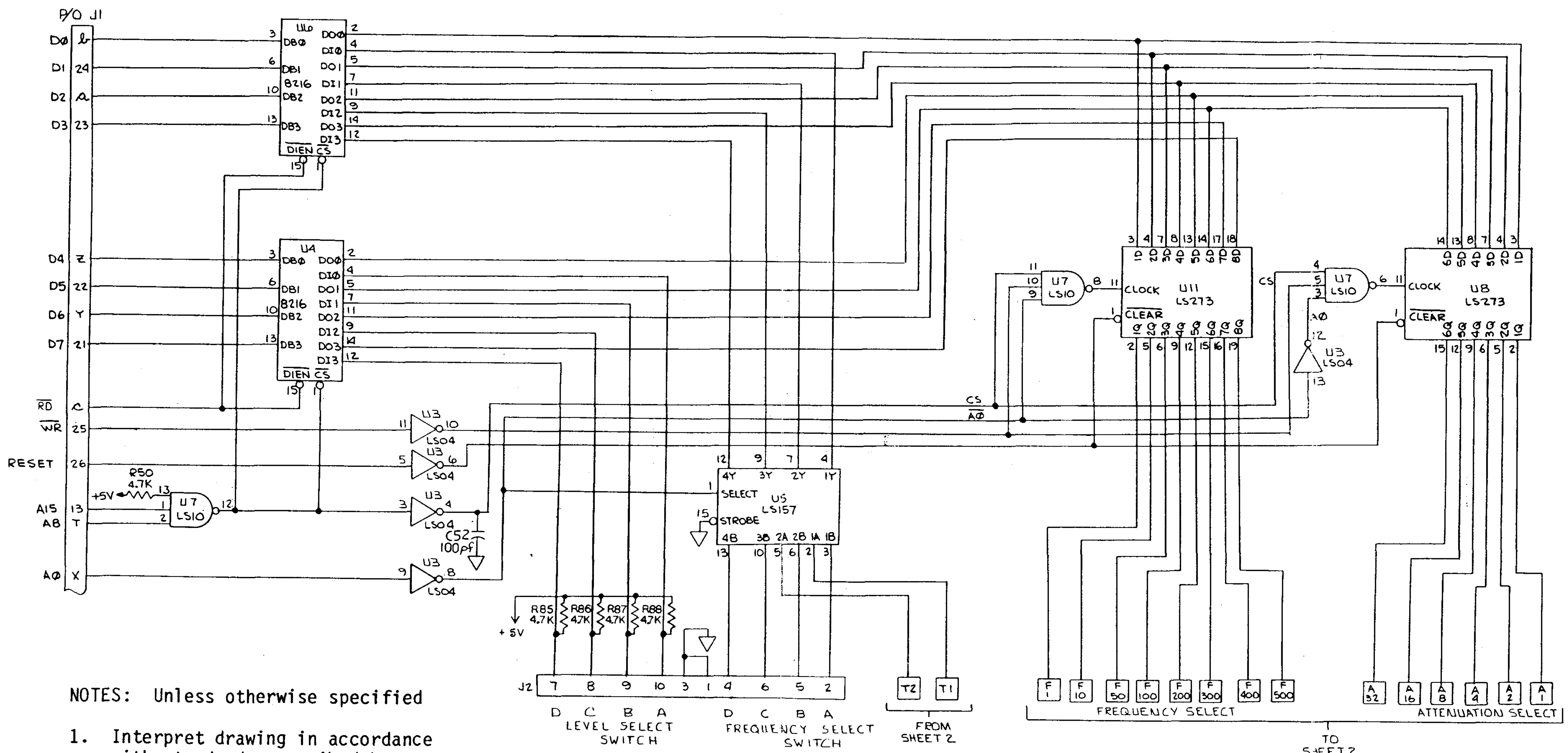
Table 5-8
ERROR CODE LISTING

ERROR CODE	PROBLEM	RECOMMENDED SOLUTION
3-03	1 MHz MALFUNCTION, NO LEVELING LOOP INDICATION	SEE TABLE 5-9
3-04	10 MHz MALFUNCTION, NO LEVELING LOOP INDICATION	SEE TABLE 5-9
3-X1	FREQUENCY X DID NOT PHASE-LOCK WHERE X IS 0 THROUGH 5 AND 0= 50 MHz 1=100 MHz 2=200 MHz 3=300 MHz 4=400 MHz 5=500 MHz	CHECK PLO ALIGNMENT, SECTION III, THIS CHAPTER, AND SEE TABLE 5-9
3-X2	FREQUENCY X HAD NO LEVELING LOOP INDICATION WHERE X IS 0 THROUGH 5 (SEE 3-X1 ABOVE)	CHECK PLO ALIGNMENT, SECTION III, THIS CHAPTER, AND SEE TABLE 5-9

Table 5-9
VISUAL INDICATIONS

INDICATOR	PROBLEM	RECOMMENDED SOLUTION
A1CR1 ON	RF level from U20 is too high or too low (unleveled)	If on at only one frequency check that specific oscillator; if on at all frequencies, check Q7, U22, U20, U19, or U18
A1CR4 ON*	If A1CR5, CR6, CR7, and CR8 are also on (normal) problem with U17, U21, or the oscillator assembly is probable	Check U17, U21, and oscillator assembly
A1CR5,CR6 OFF	10 MHz reference signal Q8, U10, and U14	Check reference signal, Q8, U10, and U14
A1CR7,CR8* OFF	Oscillator assembly or U14	The LEDs are turned on by the 5 MHz output from one of the oscillators (50-500 MHz) through U14; check the oscillator assembly or U14

*No meaning when 1 or 10 MHz selected.

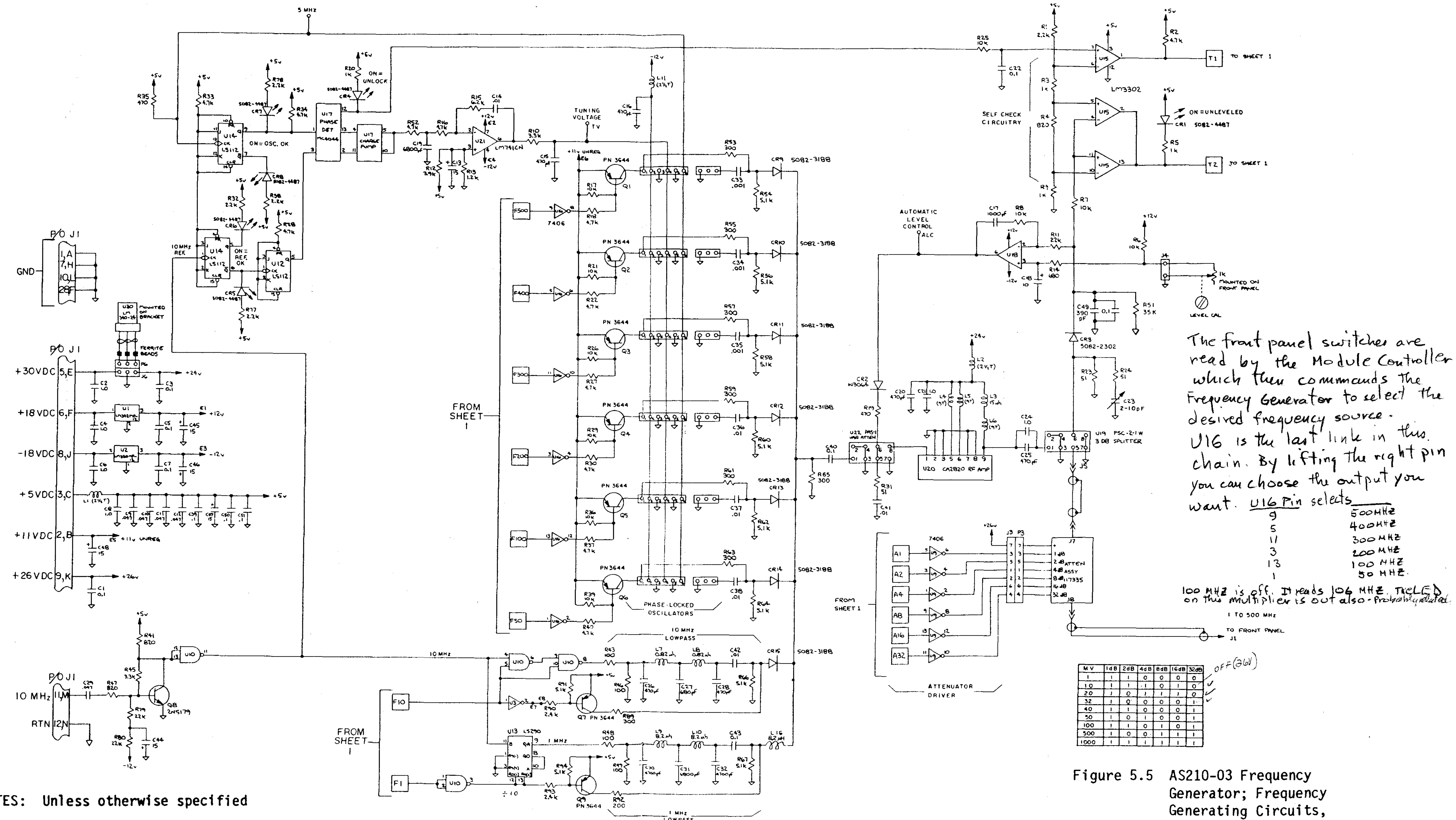


SWITCH POS	FUNCTION FREQUENCY	LEVEL	CODE D	C	B	A
1	1MHZ	1MV	0	0	0	0
2	10MHZ	10MV	0	0	0	1
3	50MHZ	20MV	0	0	1	0
4	100MHZ	32MV	0	0	1	1
5	200MHZ	40MV	0	1	0	0
6	300MHZ	50MV	0	1	0	1
7	400MHZ	100MV	0	1	1	0
8	500MHZ	500MV	0	1	1	1
9	———	1000MV	1	0	0	0

NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/4W, ±5 percent.
3. All capacitance values are in μF.
4. ◁— denotes signal ground.
5. ▢— denotes interconnection on this drawing.

Figure 5.4 AS210-03 Frequency Generator; Microprocessor Interface, A1, Schematic Diagram

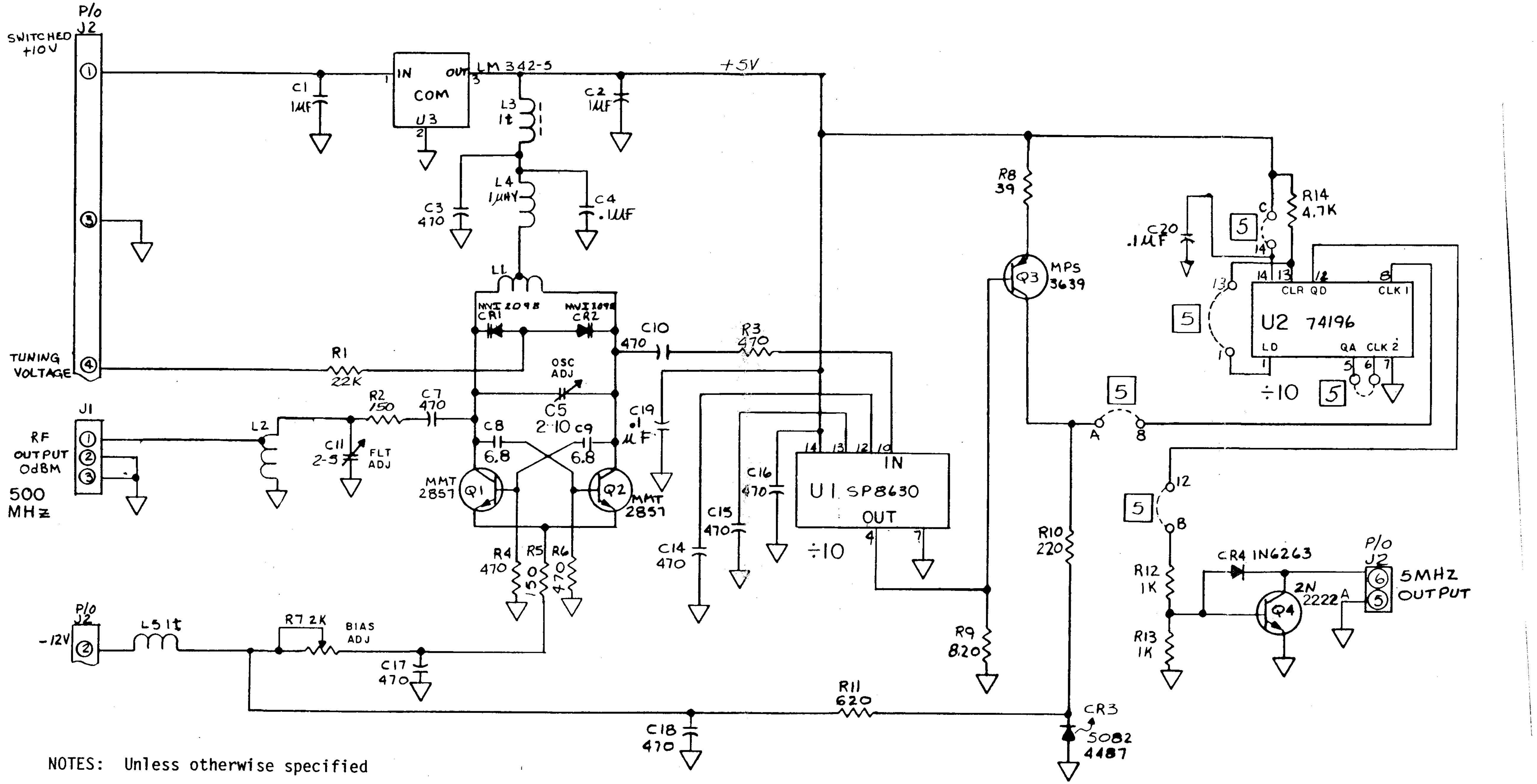


M V	1dB	2dB	4dB	8dB	16dB	32dB
1	1	1	0	0	0	0
10	1	1	1	0	1	0
20	1	0	1	1	1	0
32	1	0	0	0	0	1
40	1	1	0	0	0	1
50	1	0	1	0	0	1
100	1	1	0	1	0	1
500	1	0	0	1	1	1
1000	1	1	1	1	1	1

NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/4W, ±5 percent.
3. All capacitance values are in µF.
4. ◁ denotes signal ground.
5. ▢ denotes interconnection on this drawing.

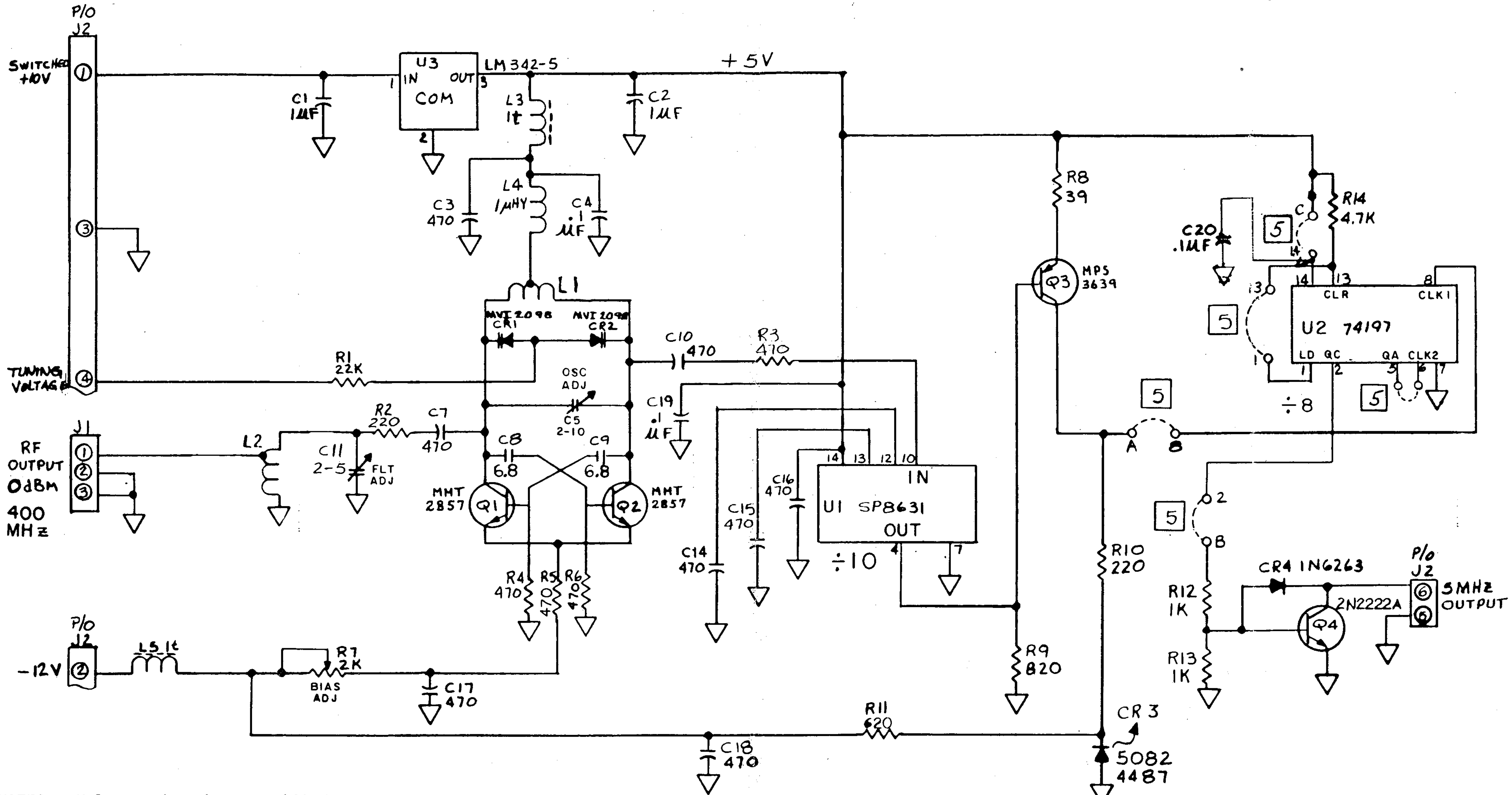
Figure 5.5 AS210-03 Frequency Generator; Frequency Generating Circuits, A1, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistors are 1/8W, 5 percent carbon composition, except as noted.
3. All capacitance values are in ρF, except as noted.
4. ◁— denotes signal ground.
5. Factory selected jumper.

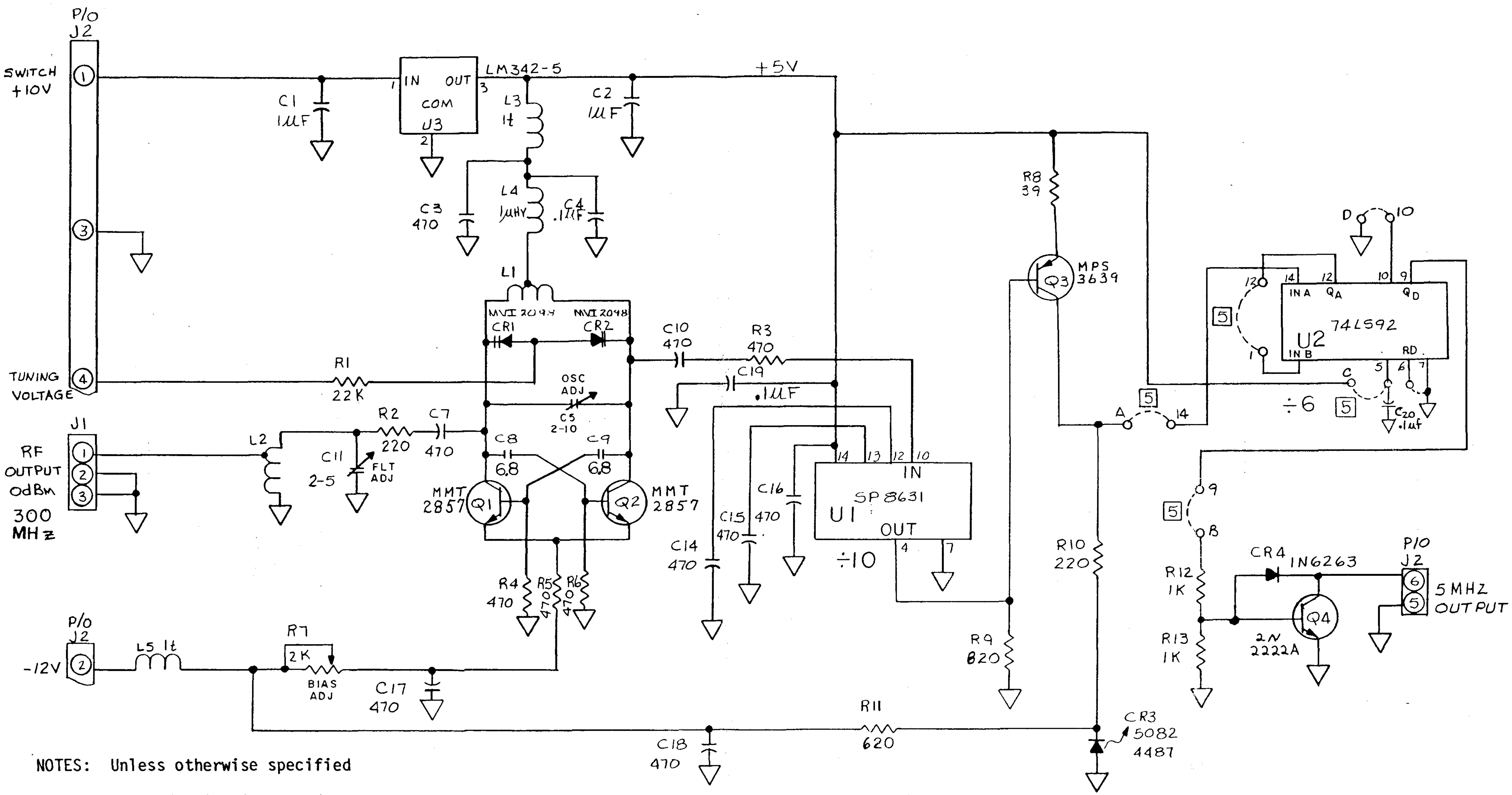
Figure 5.6 AS210-03 Frequency Generator 500 MHz, VCO, A1A1, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistors are 1/8W, 5 percent carbon composition, except as noted.
3. All capacitance values are in pF, except as noted.
4. ◁— denotes signal ground.
5. Factory selected jumper.

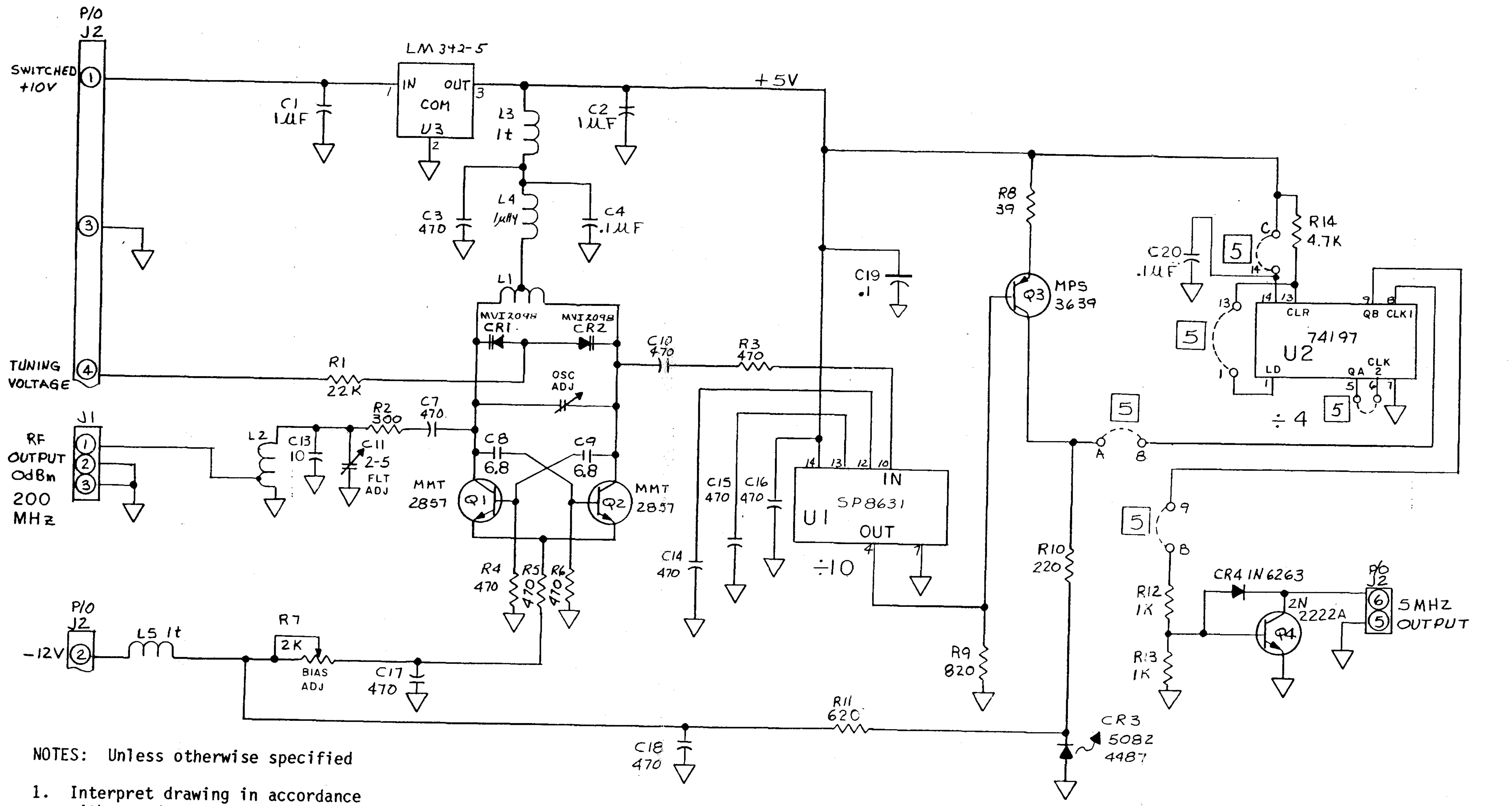
Figure 5.7 AS210-03 Frequency Generator 400 MHz, VCO, A1A2, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistors are 1/8W, 5 percent carbon composition, except as noted.
3. All capacitance values are in pF, except as noted.
4. ◁— denotes signal ground.
5. Factory selected jumper.

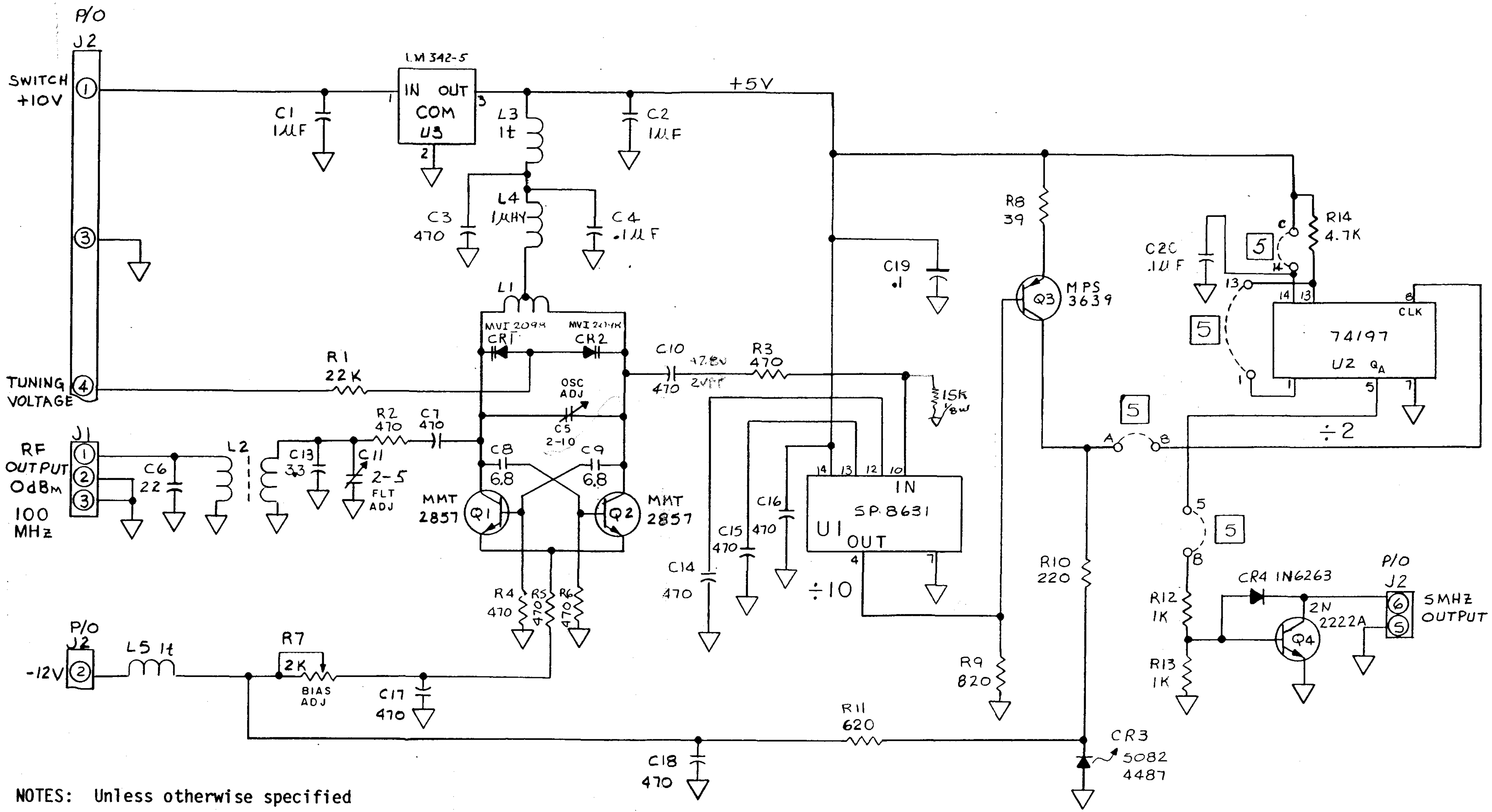
Figure 5.8 AS210-03 Frequency Generator 300 MHz, VCO, A1A3, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistors are 1/8W, 5 percent carbon composition, except as noted.
3. All capacitance values are in pF, except as noted.
4. ◁— denotes signal ground.
5. Factory selected jumper.

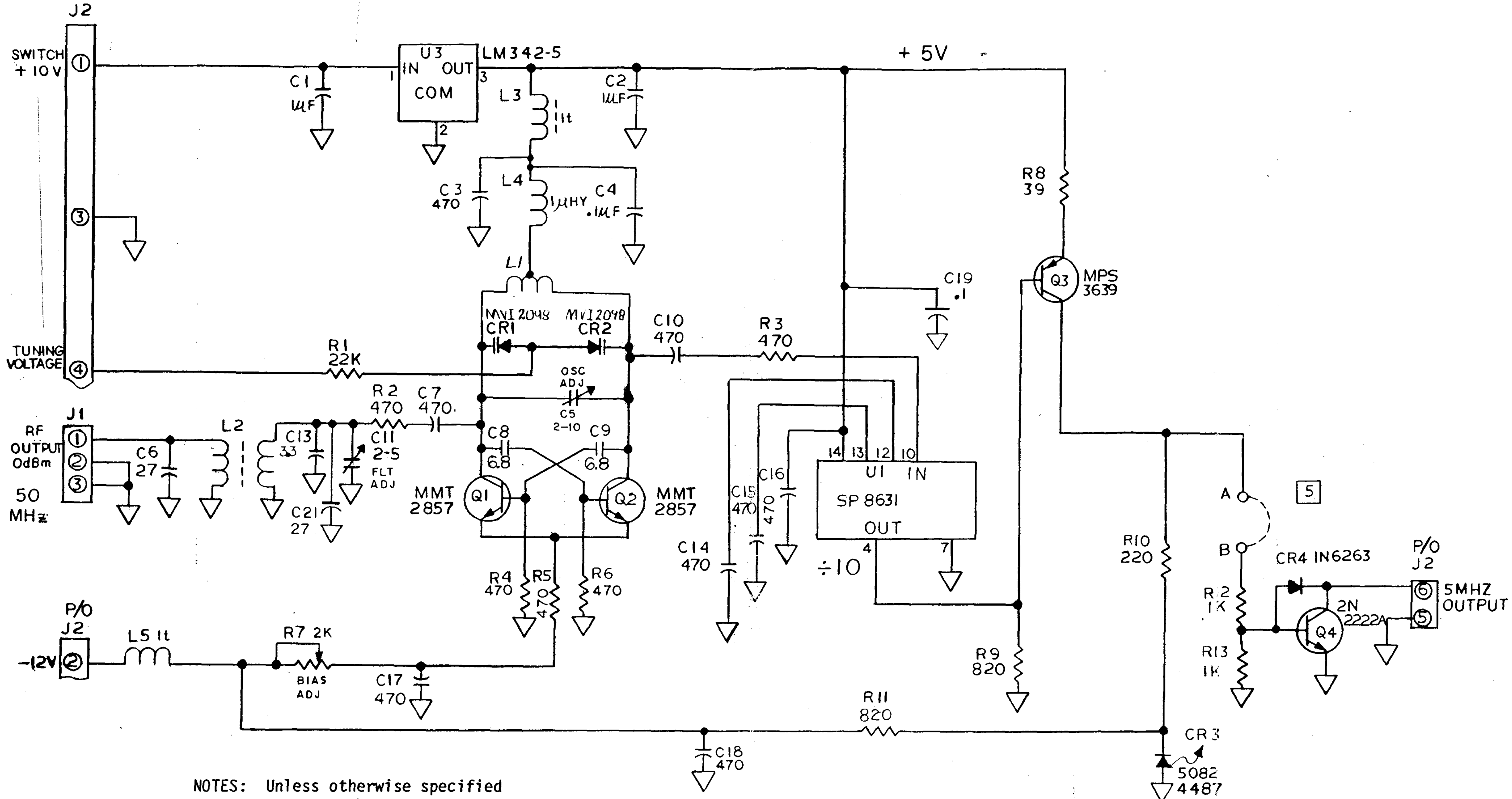
Figure 5.9 AS210-03 Frequency Generator 200 MHz, VCO, A1A4, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistors are 1/8W, 5 percent carbon composition, except as noted.
3. All capacitance values are in pF, except as noted.
4. ◁— denotes signal ground.
5. Factory selected jumper.

Figure 5.10 AS210-03 Frequency Generator 100 MHz, VCO, A1A5, Schematic Diagram



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistors are 1/8W, 5 percent carbon composition, except as noted.
3. All capacitance values are in pF, except as noted.
4. ◁ denotes signal ground.
5. Factory selected jumper.

Figure 5.11 AS210-03 Frequency Generator 50 MHz, VCO, A1A6, Schematic Diagram

CHAPTER 6
ILLUSTRATED PARTS LIST

6-1 INTRODUCTION

This chapter contains an illustrated parts list for the AS210-03 Frequency Generator Module. The assembly numbers and assembly title are listed at the top of the parts lists. The parts lists are divided into five columns and arranged in the following order:

Column 1 - Item Number

Column 2 - Quantity
Quantity per assembly.

Column 3 - Manufacturer's Part Number
Please disregard the first two digits before the dash when referencing these part number.

Column 4 - Description
A brief description of the item.

Column 5 - Reference Designation and Remarks
The electrical or electronic designation of the item as shown on the schematic diagram, wiring diagram or interconnect diagram, and the Federal Supply Code for manufacturers.

ASSEMBLY NUMBER 00-117170-01 FREQUENCY GENERATOR AS210-03

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
10	1.	00-117335-01	ATTENUATOR ASSEMBLY	ARGOSYSTEMS,33472
11	1.	10-117201-01	FRAME SECTION - TOP	ARGOSYSTEMS,33472
12	1.	10-117201-02	FRAME SECTION - BOTTOM	ARGOSYSTEMS,33472
14	1.	01-117235-01	FREQUENCY GENERATOR ASSY	A1 ARGOSYSTEMS,33472
15	1.	01-117205-01	PHASE LOCKED OSC	500 MHZ ARGOSYSTEMS,33472
16	1.	01-117205-02	PHASE LOCKED OSC	400 MHZ ARGOSYSTEMS,33472
17	1.	01-117205-03	PHASE LOCKED OSC	300 MHZ ARGOSYSTEMS,33472
18	1.	01-117205-04	PHASE LOCKED OSC	200 MHZ ARGOSYSTEMS,33472
19	1.	01-117205-05	PHASE LOCKED OSC	100 MHZ ARGOSYSTEMS,33472
20	1.	01-117205-06	PHASE LOCKED OSC	50 MHZ ARGOSYSTEMS,33472
32	1.	10-117302-01	BAR, GROUND TAB	ARGOSYSTEMS,33472
34	0.	14-250	HEATSINK COMPOUND	2 OZ JAR THERMALCOTE
35	1.	00-117357-01	CABLE ASS'Y, COAXIAL	ARGOSYSTEMS,33472
39	6.	12-MS24693-C4	SCREW, FLH 4-40X3/8	
40	2.	12-MS24693-C1	SCREW, FLH 4-40X3/16	
41	1.	12-MS24693-C2	SCREW, FLH4-40X1/4	
42	1.	12-MS51957-26	SCREW PNH 6-32X1/4	
44	2.	12-MS24693-C30	SCREW, FLH 6-32X 3/4	
45	3.	12-NAS620-C6	REDUCED OD FLAT WASHER #6	
46	3.	12-MS35338-136	SPLIT LOCK WASHER #6	
50	3.	12-NAS620-C4	REDUCED OD FLAT WASHER #4	

ASSEMBLY NUMBER 00-117170-01 FREQUENCY GENERATOR AS210-03

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
54	1.	12-MS35338-135	SPLIT LOCK WASHER #4	
55	3.	12-NAS671-C4	SMALL PATTERN HEX NUT #4	
56	3.	12-NAS671-C6	SMALL PATT HEX NUT #6	
57	2.	13-1488-4	LUG #4	
62	1.	00-117354-01	CABLE ASS'Y, 3 WIRE	ARGOSYSTEMS,33472
71	1.	10-117182-01	PANEL, FRONT, LEXAN	ARGOSYSTEMS,33472
72	0.	WL-117199	WIRE LIST	ARGOSYSTEMS,33472
73	2.	65-8127	KNOB, BLACK	NOBEX
74	2.	65-14378-01	SWITCH, ROTARY, 30 DEGREE	ROSE ELECTRONICS
76	2.	65-765-55	BUTTON, PLASTIC, BLUE	NOBEX
80	1.	17-22-01-2101	CONNECTOR, PLUG, 10 PIN	MOLEX,27264
82	10.	17-08-50-0114	PIN, CRIMP	MOLEX,27264
86	1.	00-117358-01	CABLE TRIMPOT	ARGOSYSTEMS,33472
87	3.	12-NAS620-C10	REDUCED OD FLAT WASHER #10	
88	1.	00-117356-01	CABLE, COAXIAL	ARGOSYSTEMS,33472
91	1.	10-117182-02	SUB PANEL, PLASTIC	ARGOSYSTEMS,33472
92	1.	10-117182-03	PANEL, REAR	ARGOSYSTEMS,33472
93	1.	18-3284-2240-00	BNC TO OSM CON.	OMNI SPECTRA
95	1.	11-366-1690-01	LATCH PULL	TEKTRONIX,80009
96	1.	11-386-2402-05	PLASTIC PANEL	TEKTRONIX,80009
97	1.	11-200-1273-02	ALUMINUM PANEL	TEKTRONIX,80009

ASSEMBLY NUMBER 00-117170-01 FREQUENCY GENERATOR AS210-03

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
98	1.	11-105-0718-01	LATCH	TEKTRONIX,80009
99	1.	11-105-0719-00	LATCHER RETAINER	TEKTRONIX,80009
100	1.	11-426-0724-00	BOTTOM	TEKTRONIX,80009
101	2.	11-337-1399-00	SIDE COVER	TEKTRONIX,80009
102	1.	11-214-1061-00	TENSION SPRING	TEKTRONIX,80009
103	1.	11-426-0725-00	TOP	TEKTRONIX,80009
104	2.	11-386-3657-01	GUIDE PIN	TEKTRONIX,80009
105	1.	12-00000	SCREW FLH,STL,SHEETMETAL#2X1/4	
106	4.	12-MS24693-C26	SCREW FLH 6-32X3/8	
107	4.	12-0000	SCREW PNH,STL,SHEETMETAL#6X3/8	

**** END OF LIST ****

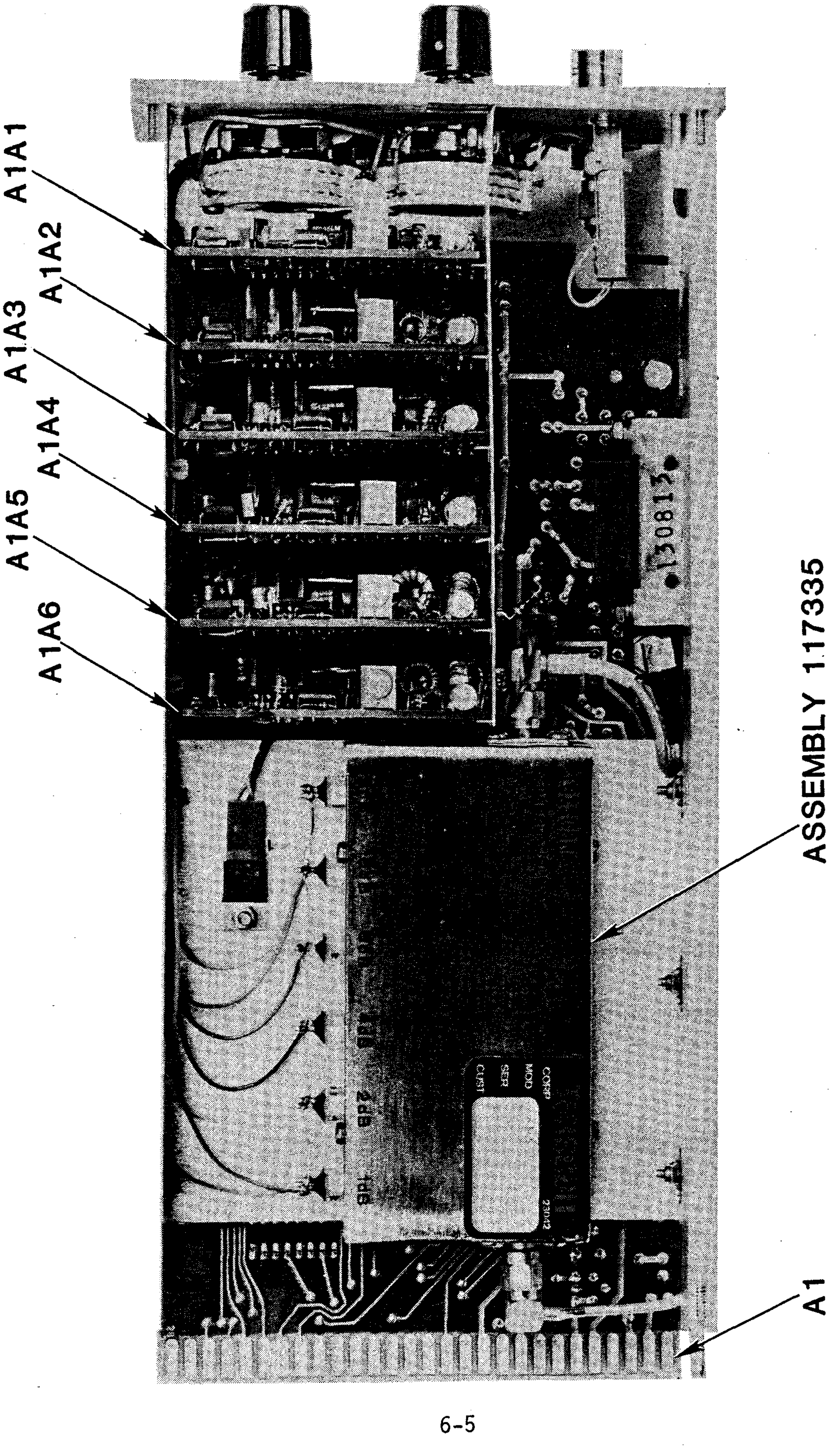


Figure 6.1 AS210-03 Frequency Generator

ASSEMBLY NUMBER 01-117235-01 STANDARD FREQ. GENERATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117238-01	PC BOARD	ARGOSYSTEMS,33472
5	0.	**-117236	SCHEMATIC	ARGOSYSTEMS,33472
6	0.	**-117235	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
25	4.	30-CK05BX102K	.001 UFD 10% CERAMIC CAP	C17, C33, C34, C35 81349
28	6.	30-CK05BX103K	.01UFD 10% CERAMIC CAPACITOR	C14, C36, C41, C42 C37,C38 81349
29	10.	30-CK05BX104K	.1UFD 10% CERAMIC CAPACITOR	C1, C3, C5, C7, C22,C40 C39, C43, C50, C51 81349
30	6.	30-300-50-601-105M	1UFD 20% CERAMIC CAPACITOR	C2, C4, C6, C8, C21, C24 81349
31	6.	30-CK05BX471K	470PFD 10% CERAMIC CAPACITOR	C15, C16, C20, C25, C26 C28 81349
33	5.	30-CK05BX473K	.047UFD 10% CERAMIC CAPACITOR	C9, C10, C11, C12, C29 81349
34	1.	30-CM04FA391JS	390 PF SILVER MICA	C49 81349
35	1.	30-CK05BX104K	.1 UFD 10% CERAMIC CAP	C49 81349
36	6.	30-196D156X9020KA1	15UFD 10% SOLID TANTALUM	C13, C44, C45, C46, C47, C48 81349
38	1.	30-CSR13G106KL	10UFD 50V ELECTROLYTIC CAP	C18 81349
42	1.	30-513-010-A2-10	2-10 PFD VARIABLE CAPACITOR	C23 ERIE,72982
50	2.	30-CK05BX472K	.0047UFD 10% CERAMIC CAPACITOR	C30, C32 81349
51	1.	30-CK05BX681K	680 PFD 10% CERAMIC CAPACITOR	C27 81349
52	2.	30-CK05BX682K	.0068 UFD 10% CERAMIC CAP	C19, C31 81349
53	1.	30-CK05BX101K	100 PF 10% CERAMIC CAPACITOR	C52 81349
73	6.	60-5082-4487	LED	CR1, CR4, CR5, CR6, CR7, CR8 H.P.,50434

ASSEMBLY NUMBER 01-117235-01 STANDARD FREQ. GENERATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
75	7.	55-5082-3188	SWITCHING DIODE	CR9-CR15 H.P.,50434
77	1.	55-1N3064	SWITCHING DIODE	CR2 NATIONAL,27014
83	1.	55-5082-2303	SWICH DIODE	CR3 H.P.,50434
96	1.	18-22-03-2021	2 PIN WAFER	J4 MOLEX,27264
97	1.	17-22-03-2031	3 PIN WAFER	J6 MOLEX,27264
98	6.	18-22-10-2061	6 PIN WAFER	A-F MOLEX,27264
99	1.	18-22-03-2071	7 PIN WAFER	J3 MOLEX,27264
100	1.	18-22-03-2101	10 PIN WAFER	J2 MOLEX,27264
101	6.	18-22-10-2031	3 PIN WAFER	A-F MOLEX,27264
104	1.	18-51-051-0000	SNAP ON CONNECTOR	J5 SEALECTRO,98291
119	3.	25-VK200-20/4B	WIDE BAND CHOKE	L1, L2, L11 FERROXCUBE,02114
123	2.	25-1025-18	.82UHY MOLDED RF CHOKE	L7, L8 DELEVAN,99800
124	3.	25-1025-42	8.2UHY MOLDED RF CHOKE	L9, L10,L16 DELEVAN,99800
125	1.	25-1025-48	15UHY MOLDED RF CHOKE	L3 DELEVAN,99800
129	3.	25-117305-02	9 TURN RF CHOKE	L4, L5, L6 ARGOSYSTEMS,33472
132	8.	50-PN3644	TRANSISTOR	Q1-Q7,Q9 NATIONAL,27014
133	1.	50-2N5179	NPN TRANSISTOR	Q8 NATIONAL,27014
142	4.	35-RCR07G102JS	1K OHM 5% 1/4W CARBON COMP	R3, R5, R9, R20 81349
143	10.	35-RCR07G103JS	10K OHM 5% 1/4W CARBON COMP	R6, R7, R8, R17, R21,R25 R26,R29,R36,R39 81349

ASSEMBLY NUMBER 01-117235-01 STANDARD FREQ. GENERATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
145	1.	35-RCR07G681JS	680 OHM 5% 1/4W CARBON COMP	R14 81349
146	1.	35-RCR07G122JS	1.2K OHM, 5% 1/4W CARBON COMP	R13 81349
147	3.	35-RCR07G223JS	22K OHM 5% 1/4W CARBON COMP	R11, R79, R80 81349
148	2.	35-RCR07G332JS	3.3K OHM 5% 1/4W CARBON COMP	R10, R45 81349
149	1.	35-RCR07G392JS	3.9K OHM 5% 1/4W CARBON COMP	R12 81349
150	2.	35-RCR07G471JS	470 OHM 5% 1/4W CARBON COMP	R19, R35 81349
151	13.	35-RCR07G472JS	4.7 OHM 5% 1/4W CARBON COMP	R16, R18, R22, R27, R30, R37, R40, R2, R28, R33, R34, R50, R52 81349
154	2.	35-RCR07G242JS	2.4K OHM 5% 1/4W CARBON COMP	R90,R93 81349
155	2.	35-RCR07G510JS	51 OHM 5% 1/4W CARBON COMP	R23,R31 81349
157	3.	35-RCR07G821JS	820 OHM 5% 1/4W CARBON COMP	R4, R41, R47 81349
159	1.	35-RCR07G750JS	75 OHM 5% 1/4W CARBON COMP	R24 81349
164	5.	35-RCR07G222JS	2.2K OHM, 5% 1/4W CARBON COMP	R1, R32, R38, R77, R78 81349
167	1.	35-RCR07G622JS	6.2K OHM 5% 1/4W CARBON COMP	R15 81349
168	1.	35-RCR07G333JS	33K OHM 5% 1/4W CARBON COMP	R51 81349
170	4.	35-RCR07G101JS	100 OHM 5% 1/4W CARBON COMP	R43, R46,R48,R49 81349
171	8.	35-RCR07G301JS	300 OHM 5% 1/4W CARBON COMP	R53,R55,R61,R63,R57,R59, R89,R65 81349
174	1.	35-RCR07G201JS	200 OHM 5% 1/4W CARBON COMP	R92 81349
177	10.	35-RCR07G512JS	5.1K OHM 5% 1/4W CARBON COMP	R54,R56,R58,R60,R62,R64, R66,R67,R91,R94 81349
183	4.	35-RCR05G472JS	4.7K OHM 5% 1/8W CARBON COMP	R85, R86, R87, R88 81349

ASSEMBLY NUMBER 01-117235-01 STANDARD FREQ. GENERATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
186	5.	13-C9316-02	16 PIN SOCKET	T.I.,01295
188	8.	13-C9314-02	I.C., SOCKET, 14 PIN	T.I.,01295
190	2.	13-C9308-02	I.C., SOCKET, 8 PIN	T.I.,01295
192	2.	13-C9320-02	I.C., SOCKET, 20 PIN	T.I.,01295
211	1.	20-PAS-1	DOUBLE BALANCED MIXER	U22 MINI-CIRCUIT LAB.,21912
215	2.	47-LM741CN	DIFFERENTIAL AMP	U18, U21 NATIONAL,27014
216	1.	47-LM3302N	QUAD VOLTAGE COMPARATOR	U15 NATIONAL,27014
219	2.	47-7406N	HEX INVERTER DRIVER	U9, U16 T.I.,01295
220	1.	47-74LS00N	QUAD 2 INPUT NAND GATE	U10 T.I.,01295
221	1.	47-74LS10N	TRIPLE 3 INPUT NAND GATE	U7 T.I.,01295
222	1.	47-74LS157N	MULTIPLEXER	U5 T.I.,01295
223	2.	47-74LS273N	8 TO 1 MULTIPLEXER	U8, U11 T.I.,01295
224	1.	47-74LS290N	DECADE COUNTER	U13 T.I.,01295
227	1.	20-PSC-2	POWER DIVIDER	U19 MINI-CIRCUIT LAB,21912
229	2.	47-P8216	QUAD TRI-STATE BUSS DRIVER	U4, U6 INTEL,34649
230	1.	47-MC4044P	PHASE COMPARATOR	U17 MOTOROLA,04713
258	1.	47-74LS04N	HEX INVERTER	U3 T.I.,01295
259	2.	47-74LS112N	DUAL J-K FLIP FLOP	U12, U14 T.I.,01295
263	1.	47-LM342P-12	+12 VOLT REGULATOR	U1 NATIONAL,27014

ASSEMBLY NUMBER 01-117235-01 STANDARD FREQ. GENERATOR A1

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
264	1.	47-LM320MP-12	-12 VOLT REGULATOR	U2 NATIONAL,27014
268	1.	47-CA2820	RF AMPLIFIER	U20 T.R.W.,01281
270	3.	13-20108-1	TERMINAL	USECO,15849

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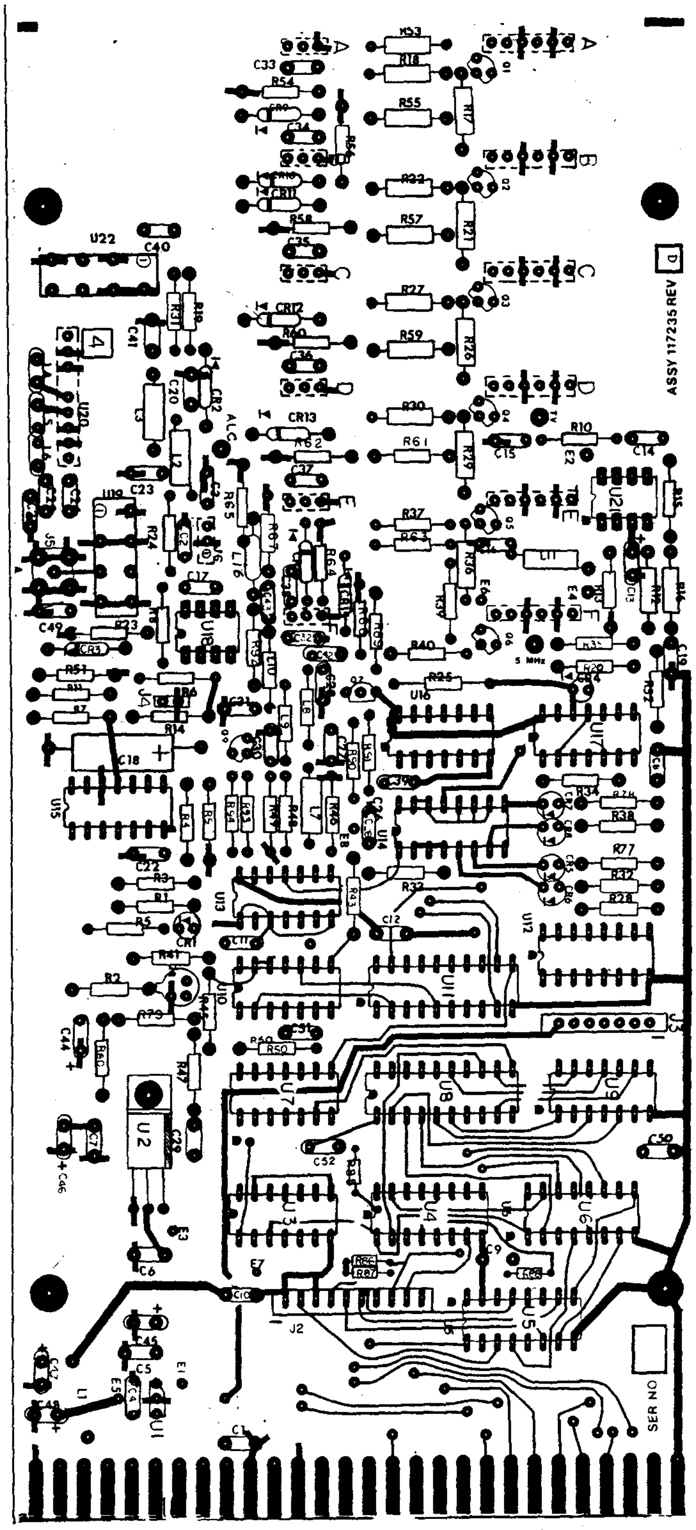


Figure 6.2 AS210-03 Frequency Generator Assembly, A1

ASSEMBLY NUMBER 00-117335-01 ATTENUATOR ASSEMBLY

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
2	1.	10-117200-01	PLATE, MOUNTING	ARGOSYSTEMS,33472
6	1.	20-117191-01	ATTENUATOR, 0-63 DB	ARGOSYSTEMS,33472
8	1.	17-22-01-2071	CONNECTOR, PLUG 7 PIN	MOLEX,27264
10	7.	17-08-50-0114	PIN, CRIMP	MOLEX,27264
12	2.	12-MS24693-C46	SCREW FLH #8-32 X 1/4	
14	4.	12-MS51957-13	SCREW, PNH, 4-40 X 1/4	
15	4.	12-NAS620-C4	REDUCED OD FLAT WASHER #4	
16	4.	12-MS35338-135	SPLIT LOCK WASHER #4	
19	0.	16-ET 26 AWG	WIRE, 26 AWG STRANDED TEFLON	92005
20	1.	47-MC7824CT	24 VOLT REGULATOR	U30 MOTOROLA,27014

**** END OF LIST ****

ASSEMBLY NUMBER 01-117205-01 PHASE-LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117208-01	PC BOARD	ARGOSYSTEMS,33472
5	0.	**-117206-01	SCHEMATIC	ARGOSYSTEMS,33472
6	0.	**-117205-01	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
27	8.	30-100-50-W5R-471J	470 PFD 5% CERAMIC CAPACITOR	C3, C7, C10, C14, C15 CENTRE ENG.,51642
28	2.	30-100-100-COG689J	6.8 PFD 5% CERAMIC CAPACITOR	C8, C9 CENTRE ENG.,51642
31	2.	30-300-50-601-105M	1UFD 20% CERAMIC CAPACITOR	C1, C2 CENTRE ENG.,51642
35	3.	30-CK05BX104K	.1UFD 20% CERAMIC CAPACITOR	C4, C19, C20 81349
38	1.	30-513-010-A2-10	2-10 PFD VARIABLE CAPACITOR	C5 ERIE,72982
39	1.	30-518-002-A2-5	2-5 PFD VARIABLE CAPACITOR	C11 ERIE,72982
50	2.	55-MV12098	TUNING DIODE	CR1, CR2 MOTOROLA,04713
54	1.	55-1N6263	SCHOTTKY BARRIER DIODE	CR4 H.P.,54839
55	1.	60-5082-4487	LIGHT EMITTING DIODE	CR3 H.P.,50434
59	1.	18-22-16-2031	3 PIN CONNECTOR	J1 MOLEX,27264
60	1.	18-22-16-2061	6 PIN CONNECTOR	J2 MOLEX,27264
73	1.	25-117305-08	TAPPED INDUCTOR	L1 ARGOSYSTEMS,33472
74	1.	25-117305-07	TAPPED INDUCTOR	L2 ARGOSYSTEMS,33472
75	2.	25-117305-01	1 TURN FERRITE CHOKE	L3, L5 ARGOSYSTEMS,33472
79	1.	25-1025-20	1UHY RF CHOKE	L4 DELEVAN,99800
83	2.	50-MMT2857	NPN TRANSISTOR	Q1, Q2 MOTOROLA,04713

ASSEMBLY NUMBER 01-117205-01 PHASE-LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
84	1.	50-MPS3639	PNP TRANSISTOR	Q3 MOTOROLA,04713
87	1.	50-2N2222A	NPN TRANSISTOR	Q4 NATIONAL,27014
96	2.	35-RCR05G102JS	1K OHM 5% 1/8W CARBON COMP	R12, R13 81349
97	1.	35-RCR05G221JS	220 OHM 5% 1/8W CARBON COMP	R10 81349
98	1.	35-RCR05G223JS	22K OHM 5% 1/8W CARBON COMP	R1 81349
99	1.	35-RCR05G390JS	39 OHM 5% 1/8W CARBON COMP	R8 81349
100	3.	35-RCR05G471JS	470 OHM 5% 1/8W CARBON COMP	R3, R4, R6 81349
101	1.	35-RCR05G472JS	4.7K OHM 5% 1/8W CARBON COMP	R14 81349
102	1.	35-RCR05G821JS	820 OHM 5% 1/8W CARBON COMP	R9 81349
103	2.	35-RCR05G151JS	150 OHM 5% 1/8W CARBON COMP	R2, R5 81349
104	1.	35-RCR05G621JS	620 OHM 5% 1/8W CARBON COMP	R11 81349
106	1.	36-82-PAR-2K	2K OHM VARIABLE RESISTOR	R7 BECKMAN,73138
109	1.	47-SP8630	DECADE COUNTER	U1 PLESSEY,55154
111	1.	47-LM341P-5	5 VOLT REGULATOR	U3 NATIONAL,27014
113	1.	47-74196N	DECADE COUNTER	U2, (T.I.,ONLY 01295

**** END OF LIST ****

ASSEMBLY NUMBER 01-117205-02 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117208	PC BOARD	ARGOSYSTEMS, 33472
5	0.	**-117206-02	SCHEMATIC	ARGOSYSTEMS, 33472
6	0.	**-117205-02	ASSEMBLY DRAWING	ARGOSYSTEMS, 33472
27	8.	30-100-50-W5R-471J	470PFD 5% CERAMIC CAPACITOR	C3, C7, C10, C14-18 CENTRE ENG., 51642
28	2.	30-100-100-COG689J	6.8 PFD 5% CERAMIC CAPACITOR	C8, C9 CENTRE ENG., 51642
30	2.	30-300-50-601-105M	1UFD 20% CERAMIC CAPACITOR	C1, C2 CENTRE ENG., 51642
34	3.	30-CK05BX104K	.1UFD 10% CERAMIC CAPACITOR	C4, C19, C20 81349
38	1.	30-513-010-A2-10	2-10PFD VARIABLE CAPACITOR	C5 ERIE, 72982
39	1.	30-518-002-A2-5	2-5PFD VARIABLE CAPACITOR	C11 ERIE, 72982
50	2.	55-MV12098	TUNING DIODE	CR1, CR2 MOTOROLA, 04713
54	1.	55-1N6263	SCHOTTKY BARRIER DIODE	CR4 H.P., 54893
55	1.	60-5082-4487	LIGHT EMITTING DIODE	CR3 H.P., 50434
57	1.	18-22-16-2031	3 PIN CONNECTOR	J1 MOLEX, 27264
58	1.	18-22-16-2061	6 PIN CONNECTOR	J2 MOLEX, 27264
73	1.	25-117305-08	TAPPED INDUCTOR	L1 ARGOSYSTEMS, 33472
74	1.	25-117305-07	TAPPED INDUCTOR	L2 ARGOSYSTEMS, 33472
75	2.	25-117305-01	1 TURN FERRITE CHOKE	L3, L5 ARGOSYSTEMS, 33472
78	1.	25-1025-20	1 UHY RF CHOKE	L4 DELEVAN, 99800
81	2.	50-MMT2857	NPN TRANSISTOR	Q1, Q2 MOTOROLA, 04713

ASSEMBLY NUMBER 01-117205-02 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
82	1.	50-MPS3639	PNP TRANSISTOR	Q3 MOTOROLA, 04713
84	1.	50-2N2222A	NPN TRANSISTOR	Q4 NATIONAL, 27014
96	2.	35-RCR05G102JS	1K OHM 5% 1/8W CARBON COMP	R12, R13 81349
97	2.	35-RCR05G151JS	150 OHMS 5% 1/8 CARBON COMP	R2, R10 81349
98	1.	35-RCR05G223JS	22K OHMS 5% 1/8W CARBON COMP	R1 81349
99	1.	35-RCR05G390JS	39 OHM 5% 1/8W CARBON COMP	R8 81349
100	4.	35-RCR05G471JS	470 OHM 5% 1/8W CARBON COMP	R3, R4, R5, R6 81349
101	1.	35-RCR05G472JS	4.7K OHM 5% 1/8W CARBON COMP	R14 81349
102	1.	35-RCR05G821JS	820 OHM 5% 1/8W CARBON COMP	R9 81349
103	1.	35-RCR05G621JS	620 OHM, 5% 1/8 W, CARBON COMP	R11 81349 ,
106	1.	36-82-PAR-2K	2K OHM VARIABLE RESISTOR	R7 BECKMAN, 73139
108	1.	47-SP8630	IC, DECADE COUNTER	U1 PLESSEY, 55154
110	1.	46-LM341P-5	5 VOLT REGULATOR	U3 NATIONAL, 27014
121	1.	47-74197N	DECADE COUNTER	U2 T.I., 01295

**** END OF LIST ****

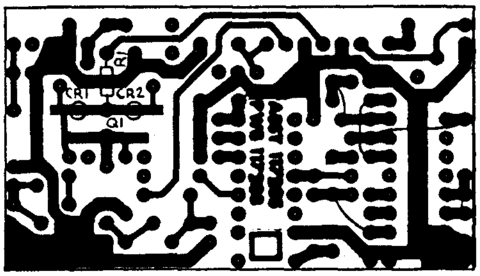
ASSEMBLY NUMBER 01-117205-03 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117208	PC BOARD	ARGOSYSTEMS, 33472
5	0.	**-117206-03	SCHEMATIC	ARGOSYSTEMS, 33472
6	0.	**-117205-03	ASSEMBLY DRAWING	ARGOSYSTEMS, 33472
27	8.	30-100-50-W5R-471J	470 PFD 5% CERAMIC CAPACITOR	C3, C7, C10, C14-18 CENTRE, 51642
28	2.	30-100-100-COG689J	6.8 PFD 5% CERAMIC CAPACITOR	C8, C9 CENTRE, 51642
30	2.	30-300-50-601-105M	1UFD 20% CERAMIC CAPACITOR	C1, C2 CENTRE, 51642
34	3.	30-CK05BX104K	.1UFD 10% CERAMIC CAPACITOR	C4, C19, C20 81349
38	1.	30-513-010-A2-10	2-10PFD VARIABLE CAPACITOR	C5 ERIE, 72982
39	1.	30-518-002-A2-5	2-5PFD VARIABLE CAPACITOR	C11 ERIE, 72982
50	2.	55-MV12098	TUNING DIODE	CR1, CR2 MOTOROLA, 04713
54	1.	55-1N6263	SCHOTTKY BARRIER DIODE	CR4 H.P., 54893
55	1.	55-5082-4487	LIGHT EMITTING DIODE	CR3 H.P., 50434
58	1.	18-22-16-2031	3 PIN CONNECTOR	J1 MOLEX, 27264
59	1.	18-22-16-2061	6 PIN CONNECTOR	J2 MOLEX, 27264
62	1.	25-117305-07	TAPPED INDUCTOR	L1 ARGOSYSTEMS, 33472
63	1.	25-117305-06	TAPPED INDUCTOR	L2 ARGOSYSTEMS, 33472
64	2.	25-117305-01	1 TURN FERRITE CHOKE	L3, L5 ARGOSYSTEMS, 33472
67	1.	25-1025-20	1 UHY RF CHOKE	L4 DELEVAN, 99800
73	2.	50-MMT2857	NPN TRANSISTOR	Q1, Q2 MOTOROLA, 04713

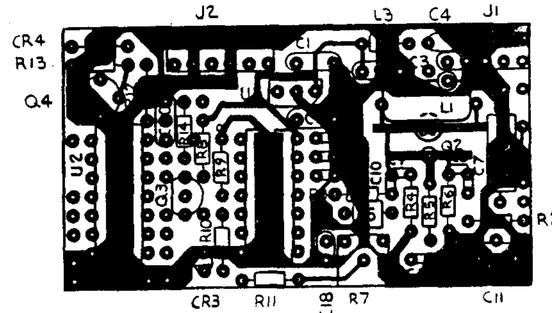
ASSEMBLY NUMBER 01-117205-03 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
74	1.	50-MPS3639	PNP TRANSISTOR	Q3 MOTOROLA,04713
78	1.	50-2N2222A	NPN TRANSISTOR	Q4 NATIONAL,27014
96	2.	35-RCR05G102JS	1K OHM 5% 1/8W CARBON COMP	R12, R13 81349
97	1.	35-RCR05G151JS	150 OHM 5% 1/8W CARBON COMP	R2 81349
98	1.	35-RCR05G223JS	22K OHMS 5% 1/8W CARBON COMP	R1 81349
99	1.	35-RCR05G390JS	39 OHM 5% 1/8W CARBON COMP	R8 81349
100	4.	35-RCR05G471JS	470 OHM 5% 1/8W CARBON COMP	R3, R4, R5, R6 81349
102	1.	35-RCR05G821JS	820 OHM 5% 1/8W CARBON COMP	R9 81349
103	1.	35-RCR05G621JS	620 OHM 5% 1/8W CARBON COMP	R11 81349
104	1.	35-RCR05G221JS	220 OHM 5% 1/8W CARBON COMP	R10 81349
106	1.	36-82-PAR-2K	2K OHM VARIABLE RESISTOR	R7 BECKMAN,73139
109	1.	47-SP8630	IC DECADE COUNTER	U1 PLESSEY,55140
111	1.	46-LM341-5	5 VOLT REGULATOR	U3 NATIONAL,27014
113	1.	47-74LS92N	COUNTER	U2 T.I.,01295

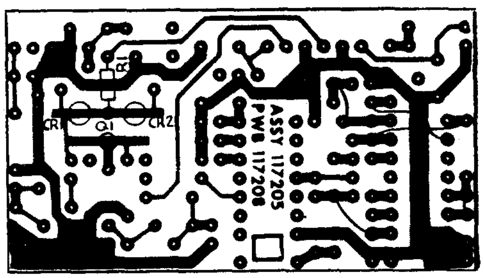
**** END OF LIST ****



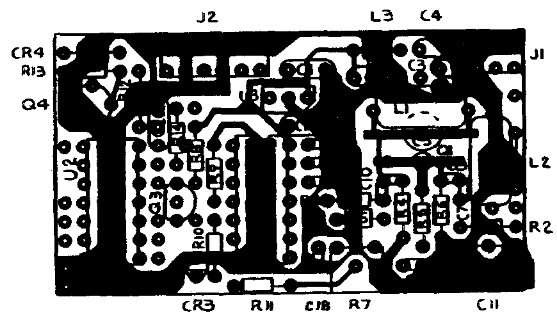
A1A1, 500 MHz
BACK SIDE



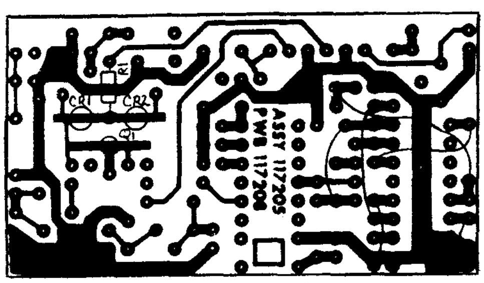
A1A1, 500 MHz
COMPONENT SIDE



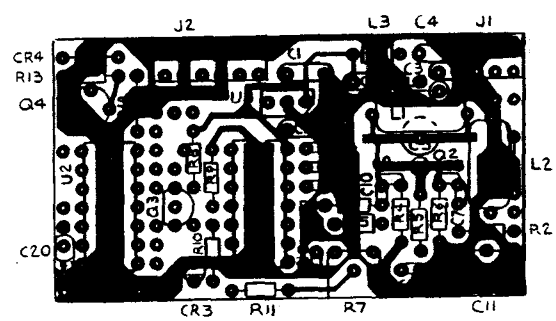
A1A2, 400 MHz
BACK SIDE



A1A2, 400 MHz
COMPONENT SIDE



A1A3, 300 MHz
BACK SIDE



A1A3, 300 MHz
COMPONENT SIDE

Figure 6.3 AS210-03 Frequency Generator VCO Circuit Card Assemblies A1A1 (500 MHz), A1A2 (400 MHz), and A1A3 (300 MHz)

ASSEMBLY NUMBER 01-117205-04 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117208	PC BOARD	ARGOSYSTEMS,33472
5	0.	**-117206-04	SCHEMATIC	ARGOSYSTEMS,33472
6	0.	**-117205-04	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
27	8.	30-100-50-W5R-471J	470 PFD 5% CERAMIC CAPACITOR	C3, C7, C10, C14-18 CENTRE ENG.,51642
28	2.	30-100-100-COG689J	6.8 PFD 5% CERAMIC CAPACITOR	C8, C9 CENTRE ENG.,51642
30	1.	30-200-100-COG100J	10 PFD 5% CERAMIC CAPACITOR	C13 CENTRE ENG.,51642
31	2.	30-300-50-601-105M	1 UFD 20% CERAMIC CAPACITOR	C1, C2 CENTRE ENG.,51642
35	3.	30-CK05BX104K	.1UFD 10% CERAMI CAPACITOR	C4, C19, C20 81349
36	1.	30-513-010-A2-10	2-10PFD VARIABLE CAPACITOR	C5 ERIE,72982
37	1.	30-518-002-A2-5	2-5PFD VARIABLE CAPACITOR*	C11 ERIE,72982
50	2.	55-MV12098	TUNING DIODE	CR1, CR2 MOTOROLA,04713
54	1.	55-1N6263	SCHOTTKY BARRIER DIODE	CR4 H.P.,54893
55	1.	60-5082-4487	LIGHT EMITTING DIODE	CR3 H.P.,50434
60	1.	18-22-16-2031	3 PIN CONNECTOR	J1 MOLEX,27264
61	1.	18-22-16-2061	6 PIN CONNECTOR	J2 MOLEX,27264
74	2.	25-117305-06	TAPPED INDUCTOR	L1, L2 ARGOSYSTEMS,33472
75	2.	25-117305-01	1 TURN FERRITE CHOKE	L3, L5 ARGOSYSTEMS,33472
78	1.	25-1025-20	1 UHY RF CHOKE	L4 DELEVAN,99800
81	2.	50-MMT2857	NPN TRANSISTOR	Q1, Q2 MOTOROLA,04713

ASSEMBLY NUMBER 01-117205-04 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
82	1.	50-MPS3639	PNP TRANSISTOR	Q3 MOTOROLA,04713
84	1.	50-2N2222A	NPN TRANSISTOR	Q4 NATIONAL,27014
96	2.	35-RCR05G102JS	1K OHM 5% 1/8W CARBON COMP	R12, R13 81349
97	1.	35-RCR05G151JS	150 OHM 5% 1/8W CARBON COMP	R10 81349
98	1.	35-RCR05G223JS	22K OHMS 5% 1/8W CARBON COMP	R1 81349
99	1.	35-RCR05301JS	300 OHM 5% 1/8W CARBON COMP	R2 81349
100	1.	35-RCR05G390JS	39 OHM 5% 1/8W CARBON COMP	R8 81349
101	4.	35-RCR05G471JS	470 OHM 5% 1/8W CARBON COMP	R3, R4, R5, R6 81349
102	1.	35-RCR05G472JS	4.7K OHM 5% 1/8W CARBON COMP	R14 81349
103	2.	35-RCR05G821JS	820 OHM 5% 1/8W CARBON COMP	R9 81349
104	1.	35-RCR05G621JS	620 OHM 5% 1/8W CARBON COMP	R11 81349
106	1.	36-82-PAR-2K	2K OHM VARIABLE RESISTOR	R7 BECKMAN,73139
109	1.	47-SP8630	IC DECADE COUNTER	U1 PLESSEY,55154
111	1.	47-LM341P-5	5 VOLT REGULATOR	U3 NATIONAL,27014
113	1.	47-74197N	DECADE COUNTER	U2 T.I.,01295

**** END OF LIST ****

ASSEMBLY NUMBER 01-117205-05 PHASE-LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-117208	PC BOARD	ARGOSYSTEMS,33472
5	0.	**-117206-05	SCHEMATIC	ARGOSYSTEMS,33472
6	0.	**-117205-05	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
27	8.	30-100-50-W5R-471J	470 PFD 5% CERAMIC CAPACITOR	C3, C7, C10, C14-C18 CENTRE ENG.,51642
28	1.	30-100-100-COG339J	3.3PFD 5% CERAMIC CAPACITOR	C13 CENTRE ENG.,51642
29	1.	30-150-100-COG220J	22 PFD 5% CERAMIC CAPACITOR	C6 CENTRE ENG.,51642
30	2.	30-300-50-601-105M	1UFD 20% CERAMIC CAPACITOR	C1, C2 CENTRE ENG.,51642
31	2.	30-100-100-COG-689	6.8 UFD 5% CERAMIC CAP.	C8,C9 CENTRE ENG.,51642
34	3.	30-CK05BX104K	.1UFD 10% CERAMIC CAPACITOR	C4, C19, C20 81349
38	1.	30-513-010-A2-10	2-10PFD VARIABLE CAPACITOR	C5 ERIE,72982
39	1.	30-518-002-A2-5	2-5PFD VARIABLE CAPACITOR	C11 ERIE,72982
50	2.	55-MV12098	TUNING DIODE	CR1, CR2 MOTOROLA,04713
54	1.	55-1N6263	SCHOTTKY BARRIER DIODE	CR4 H.P.,54893
55	1.	55-5082-4487	LIGHT EMITTING DIODE	CR3 H.P.,50434
60	1.	18-22-16-2031	3 PIN CONNECTOR	J1 MOLEX,27264
61	1.	18-22-16-2061	6 PIN CONNECTOR	J2 MOLEX,27264
72	1.	25-117305-09	TAPPED INDUCTOR	L1 ARGOSYSTEMS,33472
73	1.	25-117305-04	TAPPED INDUCTOR	L2 ARGOSYSTEMS,33472
74	2.	25-117305-01	1 TURN FERRITE CHOKE	L3, L5 ARGOSYSTEMS,33472

ASSEMBLY NUMBER 01-117205-05 PHASE-LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
77	1.	25-1025-20	1UHY RF CHOKE	L4 DELEVAN,99800
80	2.	50-MMT2857	NPN TRANSISTOR	Q1, Q2 MOTOROLA,04713
81	1.	55-MPS3639	PNP TRANSISTOR	Q3 MOTOROLA,04713
83	1.	50-2N2222A	NPN TRANSISTOR	Q4 NATIONAL,27014
96	2.	35-RCR05G102JS	1K OHM 5% 1/8W CARBON COMP	R12, R13 81349
97	1.	35-RCR05G151JS	150 OHMS 5% 1/8W CARBON COMP	R10 81349
98	1.	35-RCR05G223JS	22K OHMS 5% 1/8W CARBON COMP	R1 81349
99	1.	35-RCR05G390JS	39 OHM 5% 1/8W CARBON COMP	R8 81349
100	5.	35-RCR05G471JS	470 OHM 5% 1/8W CARBON COMP	R2, R3-R6 81349
101	1.	35-RCR05G472JS	4.7 OHM 5% 1/8W CARBON COMP	R14 81349
102	2.	35-RCR05G821JS	820 OHM 5% 1/8W CARBON COMP	R9 81349
103	1.	35-RCR05G621JS	620 OHM 5% 1/8W CARBON COMP	R11 81349
106	1.	36-82-PAR-2K	2K OHM VARIABLE RESISTOR	R7 BECKMAN,73139
110	1.	47-SP8630	DECADE COUNTER	U1 PLESSEY,55154
112	1.	47-LM341P-5	5 VOLT REGULATOR	U3 NATIONAL,27014
114	1.	47-74197N	DECADE COUNTER	U2 T.I.,01295

**** END OF LIST ****

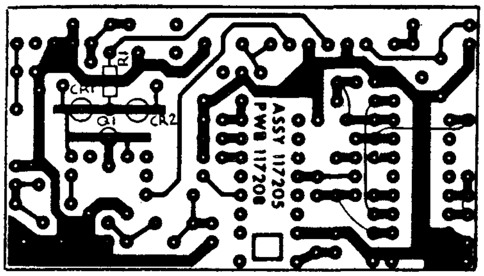
ASSEMBLY NUMBER 01-117205-06 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
4	1.	15-1172086	PC BOARD	ARGOSYSTEMS,33472
5	0.	**-117206-06	SCHEMATIC	ARGOSYSTEMS,33472
6	0.	**-117205-06	ASSEMBLY DRAWING	ARGOSYSTEMS,33472
27	8.	30-100-50-W5R-471J	470 PFD 5% CERAMIC CAPACITOR	C3, C7, C10, C14-C18 CENTRE ENG.,51642
28	1.	30-100-100-COG339J	3.3PFD 5% CERAMIC CAPACITOR	C13 CENTRE ENG.,51649
29	2.	30-100-100-COG689J	6.8 PFD 5% CERAMIC CAP	C8,C9 CENTRE ENG.,51642
30	2.	30-200-100-COG270J	27 PFD 5% CERAMIC CAPACITOR	C6, C21 CENTRE ENG.,51642
31	2.	30-300-50-601-105M	1 UFD 20% CERAMIC CAPACITOR	C1, C2 CENTRE ENG.,51642
35	2.	30-CK05BX104K	.1 UFD 10% CERAMIC CAPACITOR	C4, C19 81349
39	1.	30-513-010-A2-10	2-10PFD VARIABLE CAPACITOR	C5 ERIE,72982
40	1.	30-518-002-A2-5	2-5PFD VARIABLE CAPACITOR	C11 ERIE,72982
50	2.	55-MV12098	TUNING DIODE	CR1, CR2 MOTOROLA,04713
54	1.	55-1N6263	SCHOTTKY BARRIER DIODE	CR4 H.P.,54893
55	1.	55-5082-4487	LIGHT EMITTING DIODE	CR3 H.P.,50434
58	1.	18-22-16-2031	3 PIN CONNECTOR	J1 MOLEX,27264
59	1.	18-22-16-2061	6 PIN CONNECTOR	J2 MOLEX,27264
61	1.	25-117305-03	TAPPED INDUCTOR	L1 ARGOSYSTEMS,33472
62	1.	25-117305-04	TAPPED INDUCTOR	L2 ARGOSYSTEMS,33472
63	2.	25-117305-01	1 TURN FERRITE CHOKE	L3, L5 ARGOSYSTEMS,33472

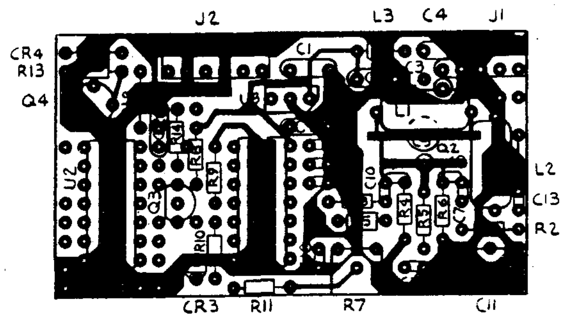
ASSEMBLY NUMBER 01-117205-06 PHASE LOCKED OSCILLATOR

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
66	1.	25-1025-20	1 UHY RF CHOKE	L4 DELEVAN,99800
73	2.	50-MMT2857	NPN TRANSISTOR	Q1, Q2 MOTOROLA,04713
74	1.	50-MPS3639	PNP TRANSISTOR	Q3 MOTOROLA,04713
78	1.	50-2N2222A	NPN TRANSISTOR	Q4 NATIONAL,27014
96	2.	35-RCR05G102JS	1K OHM 5% 1/8W CARBON COMP	R12, R13 81349
97	1.	35-RCR05G151JS	150 OHM 5% 1/8W CARBON COMP	R10 81349
98	1.	35-RCR05G223JS	22K OHMS 5% 1/8W CARBON COMP	R1 81349
99	1.	35-RCR05G390JS	39 OHM 5% 1/8W CARBON COMP	R8 81349
100	5.	35-RCR05G471JS	470 OHM 5% 1/8W CARBON COMP	R2, R3, R4, R5, R6 81349
101	2.	35-RCR05G821JS	820 OHM 5% 1/8W CARBON COMP	R9, R11 81349
105	1.	36-82-PAR-2K	2K OHM VARIABLE RESISTOR	R7 BECKMAN,73139
107	1.	47-SP8630	DECADE COUNTER	U1 PLESSEY,55154
109	1.	47-LM341P-5	5 VOLT REGULATOR	U3 NATIONAL,27014

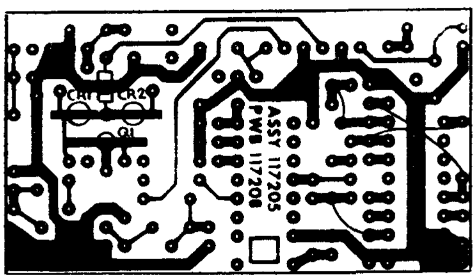
**** END OF LIST ****



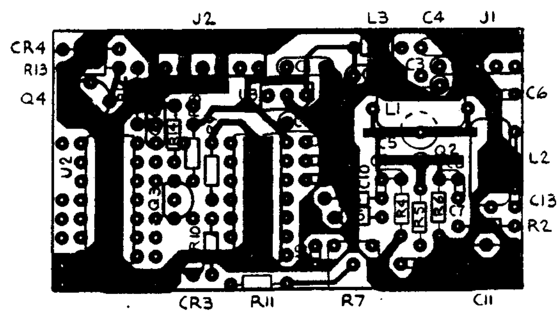
A1A4, 200 MHz
BACK SIDE



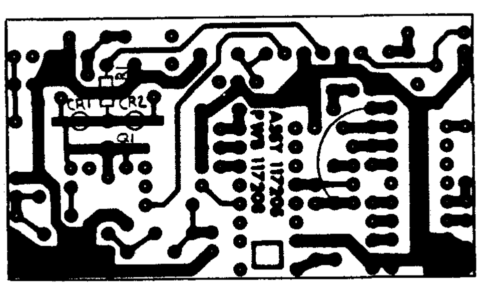
A1A4, 200 MHz
COMPONENT SIDE



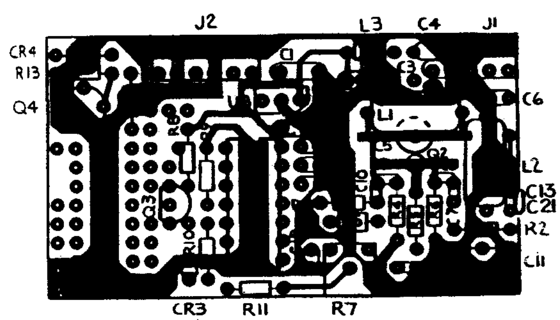
A1A5, 100 MHz
BACK SIDE



A1A5, 100 MHz
COMPONENT SIDE



A1A6, 50 MHz
BACK SIDE



A1A6, 50 MHz
COMPONENT SIDE

Figure 6.4 AS210-03 Frequency Generator VCO Circuit Card Assemblies A1A4 (200 MHz), A1A5 (100 MHz), and A1A6 (50 MHz)

ASSEMBLY NUMBER 00-117354-01 CABLE ASSEMBLY

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
1	2.	17-22-01-2031	3 PIN CONNECTOR	____________ MOLEX, 27264
2	3.	25-56-590-65/3B	SHIELDING BEAD	____________ FERROXCUBE, 02114
3	0.	16-ET 26 AWG	26 AWG, STRANDED, TEFLON WIRE	COLOR AS FOLLOWS: RED,__ VIOLET, BLACK______ ALPHA, 29005
4	6.	17-08-50-0114	CRIMP TERMINAL	____________ MOLEX, 27264

**** END OF LIST ****

ASSEMBLY NUMBER 00-117356-01 CABLE ASSEMBLY

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
5	1.	17-55-607-9172-31	OSM CONNECTOR, STRAIGHT	SEALECTRO, 98291
6	1.	17-55-611-3702-31	OSM CONNECTOR, RIGHT ANGLE	SEALECTRO, 98291
7	0.	16-UT-85CTP	.085 SEMI-RIGID CABLE	

**** END OF LIST ****

ASSEMBLY NUMBER 00-117357-01 CABLE ASSEMBLY

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
1	1.	17-55-628-9188-31	CONNECTOR	SEALECTRO, 98291
2	0.	16-RGU-316	COAX WIRE, 50 OHM	AS REQUIRED
3	1.	17-51-328-3188	CONNECTOR	SEALECTRO, 98291

**** END OF LIST ****

ASSEMBLY NUMBER 00-117358-01 CABLE ASSEMBLY

ITEM	QTY	PART NUMBER	DESCRIPTION	REF. DESIG. AND REMARKS
1	1.	36-78LBWR1K	1K POTENTIOMETER	BECKMAN,73138
2	1.	17-22-01-2021	2 PIN CONNECTOR	MOLEX,27264
3	2.	17-08-50-0114	CRIMP TERMINAL	MOLEX,27264

**** END OF LIST ****

M84-0018

AS210-04
DIGITAL DELAY
GENERATOR MODULE

Revised 8/84

AS210-04
DIGITAL DELAY GENERATOR MODULE

Revised 8/84

ARGOSystems, Inc. / 884 Hermosa Court, Sunnyvale, California 94086
Telephone (Area Code 408) 737-2000 / Telex No. 352077

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LIST OF ILLUSTRATIONS

LIST OF TABLES

PREFACE

This manual contains installation, operation and maintenance instructions for the AS210-04 Digital Delay Generator. The data contained herein is arranged as follows:

Chapter 1	General Information
Chapter 2	Installation
Chapter 3	Operation
Chapter 4	Theory of Operation
Chapter 5	Maintenance and Calibration
Chapter 6	Illustrated Parts List

Reference Publications

AS210A-PM	Portable Mainframe Operation and Maintenance Manual
AS210RM, LM	Mainframe Operation and Maintenance Manual
AS210-01A	Module Controller Operation and Maintenance Manual
AS210-02	Frequency Comparator Operation and Maintenance Manual
AS210-03	Frequency Generator Operation and Maintenance Manual
AS210-05	Standby Battery Operation and Maintenance Manual
AS210-06	Microwave Generator Operation and Maintenance Manual
AS210-08	Distribution Amplifier Operation and Maintenance Manual
AS210-20	Time Clock Operation and Maintenance Manual

CHAPTER 1
GENERAL INFORMATION

1-1 INFORMATION

The AS210-04 Digital Delay Generator illustrated in Figure 1.1 is designed for installation in the ARGOSystems AS210 Electronic Frequency Counter and Frequency Standard Calibration System Mainframe. The Digital Delay Generator provides a means for generating a selectable, precise delay time between a reference pulse train and delayed pulse train. The reference pulses, delayed pulses and the time interval between them are derived from the Rubidium Frequency Standard in the Mainframe. The unit is programmable through an IEEE-488 interface located in the Module Controller. One application of the Digital Delay Generator is determination of performance characteristics of the time interval function of electronic counters.

1-2 PHYSICAL AND ELECTRICAL DESCRIPTION

The Digital Delay Generator consists of two circuit card assemblies and a front panel mounted in a modular type frame. Controls and connectors are on the front panel. Table 1-1 is an electrical specification for the AS210-04 Digital Delay Generator. Functionally the unit accepts a standard frequency input, converts the frequency and splits the signal into two channels, reference and delayed. The Pulse Repetition Frequency (PRF) of the pulse trains and the delay interval can be manually varied by an operator or controlled by a computer through the IEEE-488 bus.

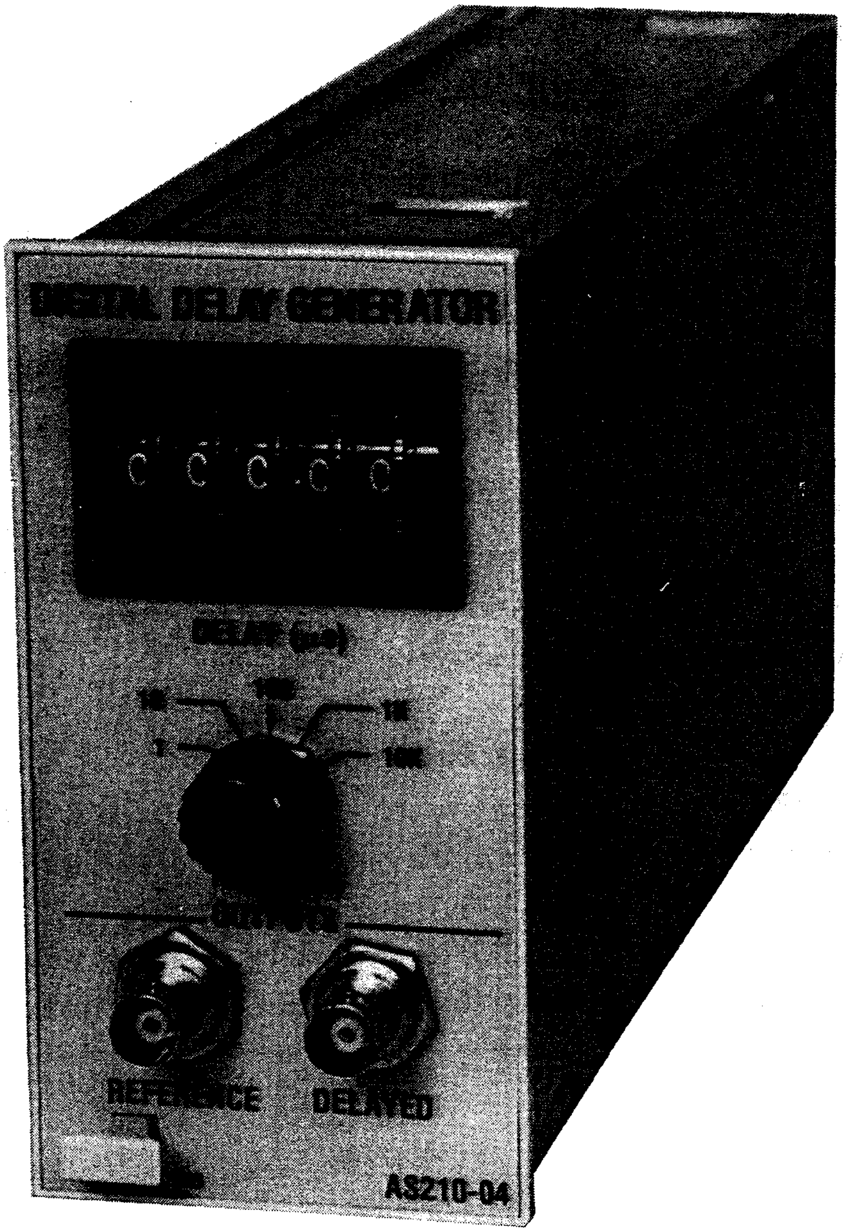


Figure 1.1 AS210-04 Digital Delay Generator

Table 1-1

AS210-04 EQUIPMENT SPECIFICATION

DELAY CHARACTERISTICS BETWEEN REFERENCE PULSE AND DELAYED PULSE	
RANGE	0-999.99 microseconds
RESOLUTION	10 nanoseconds
UNCERTAINTY	.01 - .09 microseconds delay ±1 nanosecond .1 - .99 microseconds delay ±2 nanoseconds 1.0 - 999.99 microseconds delay ±3 nanoseconds
REPEATABILITY	.01 - .99 microseconds ±0.2 nanoseconds maximum 1.0 - 999.9 microseconds ±0.6 nanoseconds maximum
OUTPUT PULSE CHARACTERISTICS WITH A 50 OHM TERMINATION	
	BNC connectors
OUTPUTS AVAILABLE	Referenced and delayed pulses; BNC connectors
TRANSITION TIMES	Less than or equal to 5 nanoseconds
PULSE WIDTH	10 microseconds nominal
LEVEL	-2.5 to +2.5 volts (5 VPP minimum)
PULSE REPETITION RATES	1, 10, 100, 1K or 10 KHz selectable
PHYSICAL CHARACTERISTICS	
OPERATING TEMPERATURE RANGE	0 to 40°C
POWER	Supplied by AS210 mainframe
SIZE	Single width plug-in
WEIGHT	2.25 pounds

CHAPTER 2
INSTALLATION

2-1 INTRODUCTION

The AS210-04 Digital Delay Generator module plugs into the AS210 Mainframe. The module is electrically connected through the rear connector and mechanically retained via a front panel locking bar on the mainframe. Power and singal interface is provided through the mainframe.

NOTE 1: Because of the high retention force of the rear card edge connector, it may be necessary to pull on the RATE control at the same time as the release mechanism is pulled to remove the Digital Delay Generator module from the mainframe.

NOTE 2: The power in the AS210 Mainframe must be turned off when inserting or removing the Digital Delay Generator.

CAUTION

AS210 series plug-ins will not work in Tektronix TM500 series mainframes. Severe damage will result if operation in this mode is attempted.

The signals are output through two BNC connectors. The cables should be equal length to avoid delay errors. There is a delay of approximately 1.5 nanoseconds/foot in RG58/U cable.

CHAPTER 3
OPERATION

3-1 INTRODUCTION

Operator interface with the AS210-04 Digital Delay Generator is provided through two controls and two connectors on the front panel of the module. The CPU interface is transparent to the operator. This chapter contains a front panel illustration keyed to a table explaining the function of the controls and connectors. The operating procedures provide applications and instructions for use of the Digital Delay Generator.

3-2 CONTROLS AND CONNECTORS

Figure 3.1 is a front panel photograph of the Digital Delay Generator with index numbers keyed to Table 3-1.

3-3 OPERATING INSTRUCTIONS

The AS210-04 is connected via 50 ohm cable with BNC connectors. See installation notes. Select the desired delay from 000.00 to 999.99 microseconds with the thumbwheel switch. Select the desired Pulse Repetition Frequency (PRF) of both outputs with the RATE switch.

NOTES

Maximum delay 98 microseconds on 10K Hz range

Maximum delay 998 microseconds on 1K Hz range

Fast rise-time may cause ringing on unterminated cable

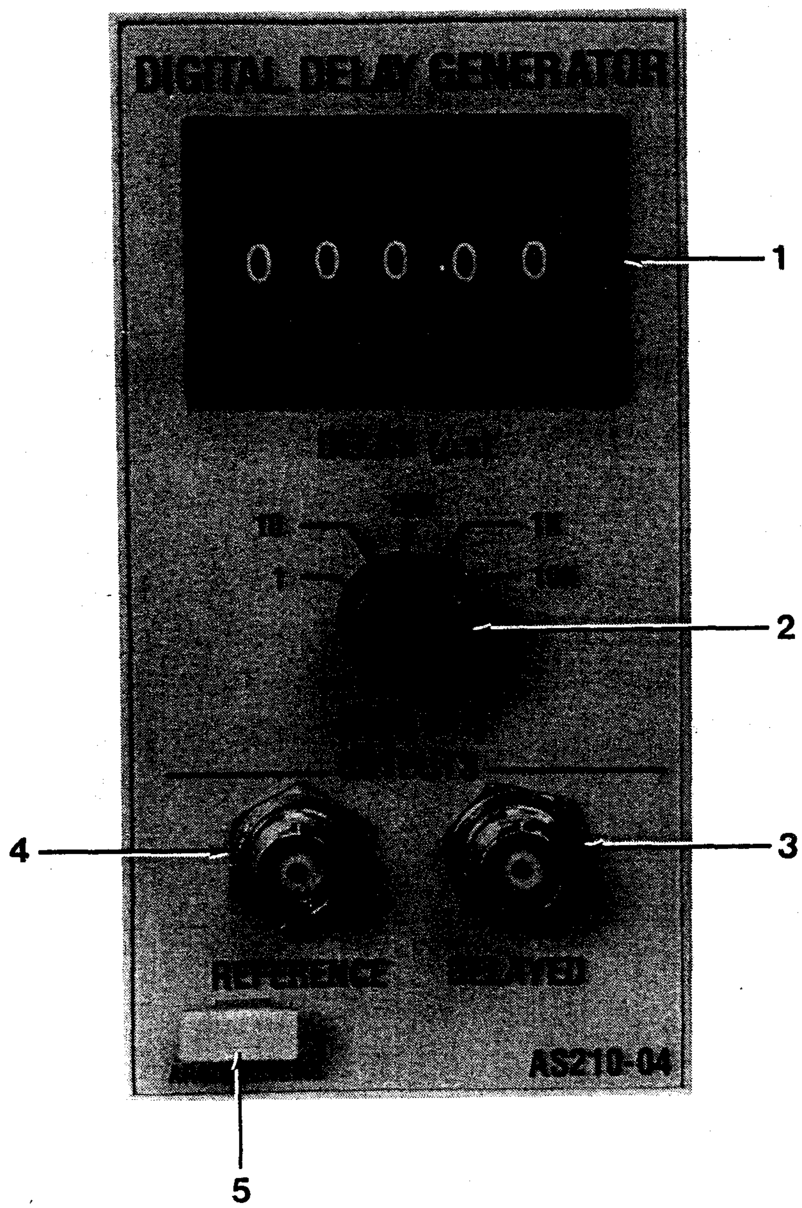


Figure 3.1 AS210-04 Front Panel Controls and Connectors

TABLE 3-1

AS210-04 FRONT PANEL CONTROLS AND CONNECTORS

INDEX NO. FIGURE 3-1	PANEL MARKING	FUNCTION
1	DELAY (microseconds)	Thumbwheel switch selects delay in microseconds between the REFERENCE pulse and DELAYED pulse outputs.
2	RATE (Hz)	Selects the pulse repetition frequency (PRF) of the output pulse signals.
3	DELAYED	The delayed pulse output. The PRF is selected by item 2, delay selected by item 1.
4	REFERENCE	The reference pulse output. The PRF is selected by item 2.
5	None	Release mechanism

CHAPTER 4
THEORY OF OPERATION

4-1 INTRODUCTION

This chapter provides an analysis of the circuits used in the Digital Delay Generator. The circuit descriptions are keyed to block diagrams, timing diagrams, and the schematic diagrams of the Maintenance chapter. Details of common circuits (power supplies, etc.) are not included in this description.

The main circuitry of the AS210-04 is contained on two circuit card assemblies designated A1 and A2. The Digital Delay Generator module receives a 10 MHz standard input signal from the Rubidium Frequency Standard on the AS210 Mainframe and produces two pulsed signal outputs. The PRF of the pulsed signals and the time delay between them are selectable. The AS210-04 is used in conjunction with the AS210-01 Module Controller which provides the CPU control and interface.

4-2 CLOCK CIRCUITS

The AS210-04 has a 100 MHz clock which is used for the timing and generation of the dual pulse trains (Figure 4.1). The 10 MHz standard input is divided by two at A1U12 to produce a 5 MHz reference input for phase detector A1U13. The phase detector output goes to loop amplifier/filter A1U14 providing the tuning voltage for the 100 MHz Voltage-Controlled Oscillator (VCO) A1Q2 and A1Q3. The 100 MHz signal is divided by 20 at A1U19 and A1U20 then applied to the variable input of A1U13. The VCO is thus phase locked to the 10 MHz frequency standard. One output of the VCO is sent to driver A1U21 which translates the signal to ECL levels needed for the delay producing circuits. The second output of the VCO is divided by 10 at A1U20,

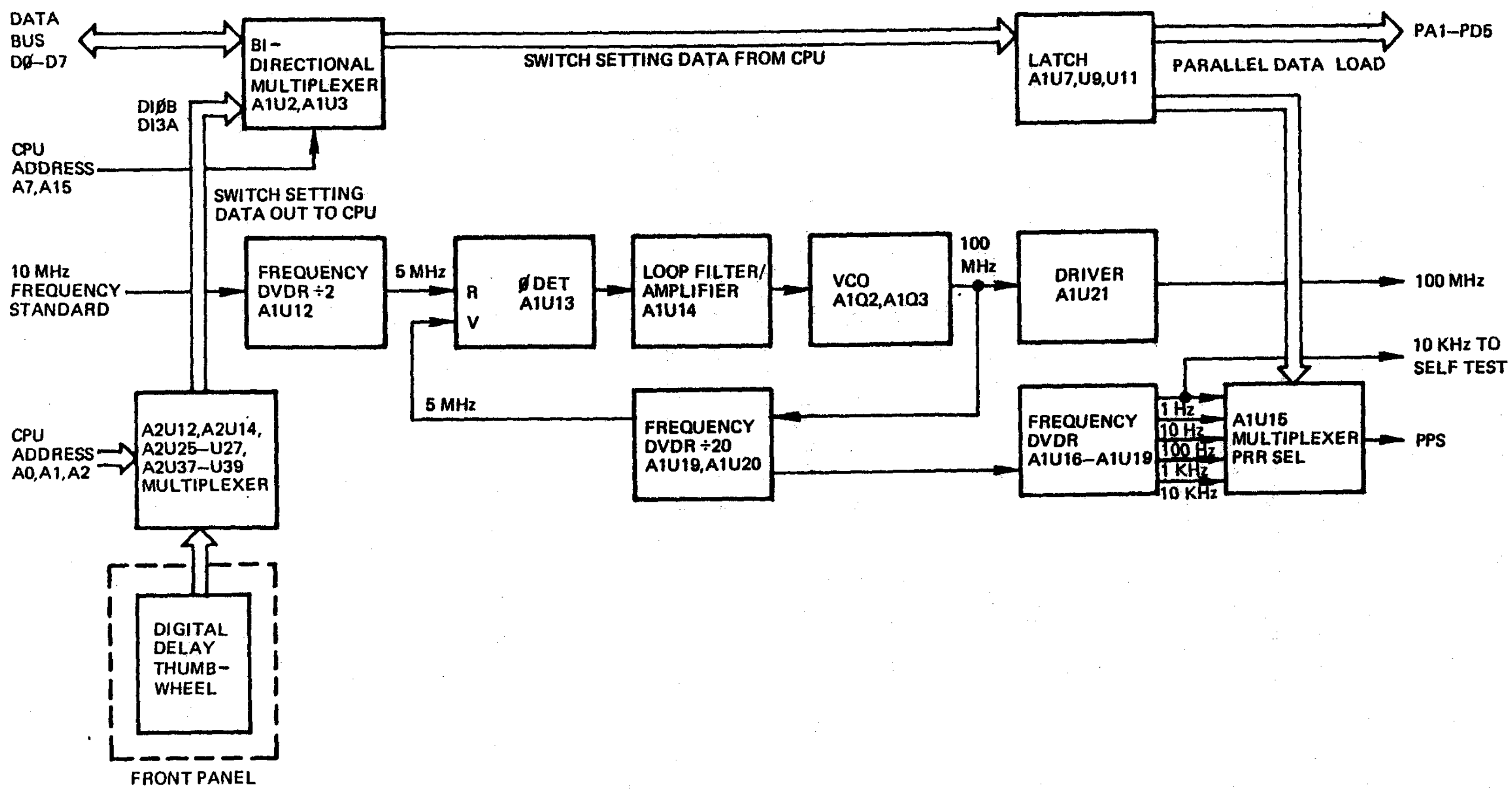


Figure 4.1 Data Interface and Clock Circuits

converted to TTL at A1Q4 and applied to the frequency-division circuit consisting of A1U16, A1U17, A1U18, and A1U19. Signals of 1 Hz, 10 Hz, 100 Hz, 1 KHz and 10 KHz are produced by this division circuit and applied to PRF select multiplexer A1U15. The multiplexer is addressed by the CPU which scans bidirectional multiplexer A1U2 and A1U3 ten times per second to determine the status of the front panel RATE and Delay switches. The 100 MHz clock, 10 KHz clock and one of the five PPS outputs (selected via A1U15) are sent to the timing and reference circuits.

4-3 DATA INTERFACING CIRCUITS

The RATE switch and DELAY thumbwheel switches are connected to the CPU data bus via multiplexers A2U12, A2U14, A2U25-U27 and A2U37-U39 (Figure 4.1). The 8-bit data bus (D11A-D13B) connects to a bidirectional multiplexer A1U2 and A1U3 which is addressed by the CPU (address bits A7, A15) and controlled by the $\overline{RD}$ signal from the CPU. Counters A2U31-U34 and A2U20 (Figure 4.2) are loaded with data from the DELAY thumbwheel as follows. The BCD thumbwheel data is applied to the multiplexer addressed by the CPU as described above. This data is sent over the data bus and returned under program control to be latched into A1U7, A1U9 and A1U11 (Figure 4.1). When these latches are appropriately addressed by the CPU their data is loaded into the counters.

4-4 REFERENCE PULSE AND DELAYED PULSE GENERATION CIRCUITS

The product of the Digital Delay Generator is two pulse trains at a selected PRF (RATE) and selected time delay between pulse trains. Refer to Figure 4.2 throughout the following discussion. The significant signals, developed by previously described circuits, are the 100 MHz phase locked clock signal, the selected rate (PPS) and the delay data dialed by the operator into the thumbwheels and returned to the unit via the CPU data bus. Four bits of the delay data (PA1-PD1) are loaded into ÷10 counter A2U20. This is a high speed ECL counter and the data is converted to ECL levels prior to loading in A2U20. The 100 MHz clock signal is also converted to ECL and applied to the counter's clock input. The $\overline{Q0}$ and $\overline{Q8}$ output of A2U20 are

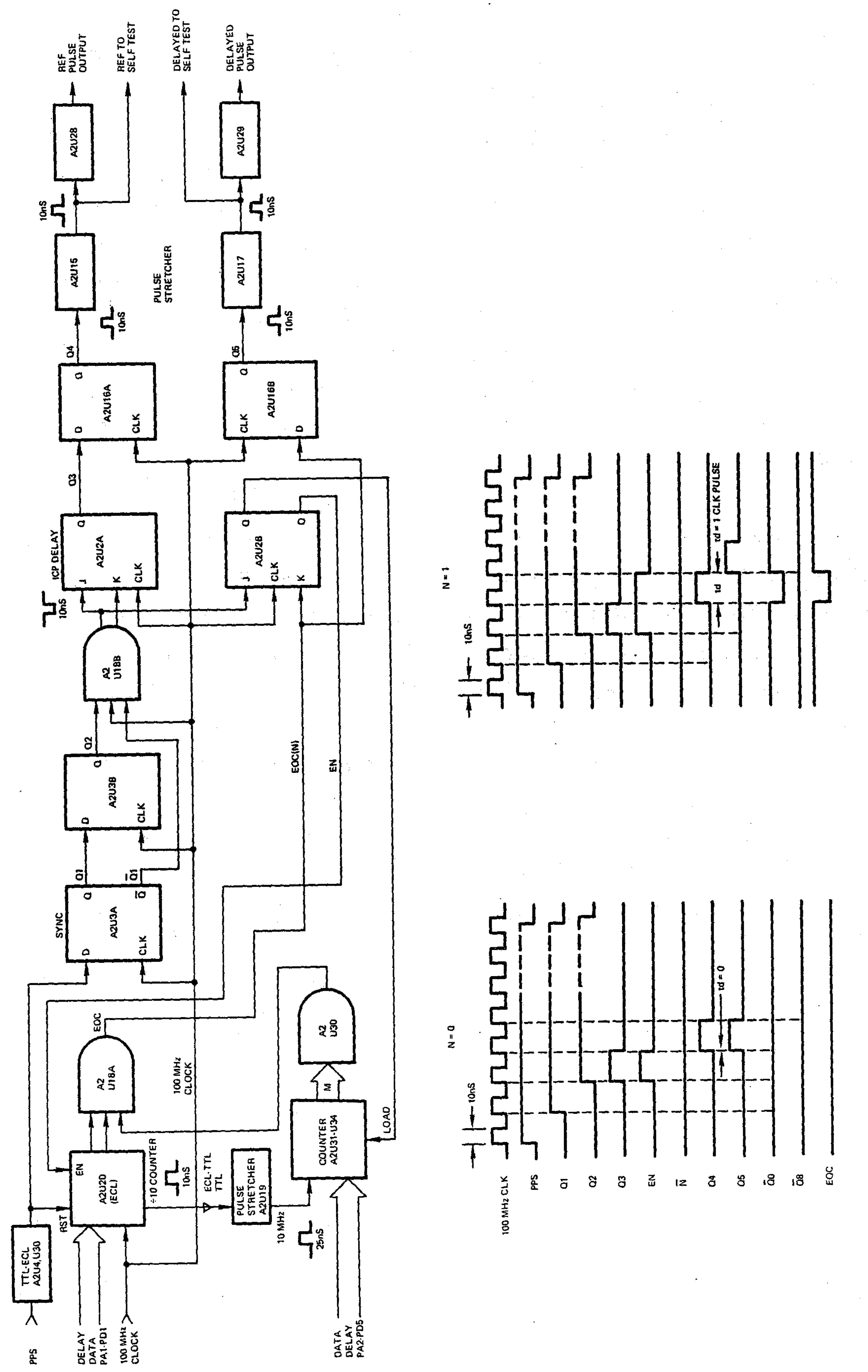


Figure 4.2 Reference and Delay Pulse Generator Circuit Diagram and Timing Diagram

applied to gate A2U18A. The 100 MHz clock is divided by 10 to 10 MHz by A2U20. The 10 MHz pulses are stretched to 25 nanoseconds by one-shot A2U19 and applied to the clock input of ripple counters A2U31-U34. The counters are preloaded with the remaining lines of the data bus (PA2-PD5) containing delay data. As each of these counters reaches zero from its preloaded number, the M/N (minimum/maximum) output is applied to gate A2U30. The output of A2U30 goes low when counters A2U31-U34 have reached the end of their count and is applied to A2U18A with $\overline{Q0}$ and $\overline{Q8}$ from A2U20. The output of A2U18A (EOC) is applied to the K input of A2U2B. The PPS signal is synchronized with the 100 MHz clock by A2U3A. The output of A2U3A (Q1) is applied to the D input of A2U3B with the 100 MHz clock at its CLK input. Signal Q2 is therefore delayed from Q1 by 1 clock pulse. Q2, the 100 MHz clock,and $\overline{Q1}$ are applied to gate A2U18B which goes high 1 clock period behind the PPS signal. The false output of A2U18B is applied to the K input of A2U2A while the true output is applied to the J input of both A2U2A and A2U2B. The 100 MHz clock drives both A2U2A and A2U2B while the EOC signal is applied to the K input of A2U2B. The Q3 signal from the output of A2U2A is delayed from signal Q2 by one 10 nanosecond clock period. The Q output of A2U2B is the load enable (EN) for counters A2U31-U34 while the $\overline{Q}$ output enables counter A2U20. A2U16A and U16B are both clocked by the 100 MHz clock signal. Q3 is the D input of A2U16A and the EOC signal is the D input of A2U16B. The EOC pulse is one clock period wide (10 nanoseconds) and is delayed N clock pulses from Q3. The output of A2U16A (Q4) is a reference pulse train synchronized with the 100 MHz clock while the output of A2U16B (Q5) is a pulse train delayed by the number of clock periods represented in the length of the EN pulse. Both pulse trains are pulse stretched to 10 microseconds by A2U15 and A2U17. A2U28 and A2U29 are current drivers for both outputs.

4-5 SELF-TEST CIRCUITS

The self-test circuits are illustrated in Figure 4.3. The inputs to this circuit are the 100 MHz clock, reference pulse train, delayed pulse train and a 10 KHz clock developed in the timing circuits. The purpose of the self-test function is to ensure that the actual pulse delay equals the

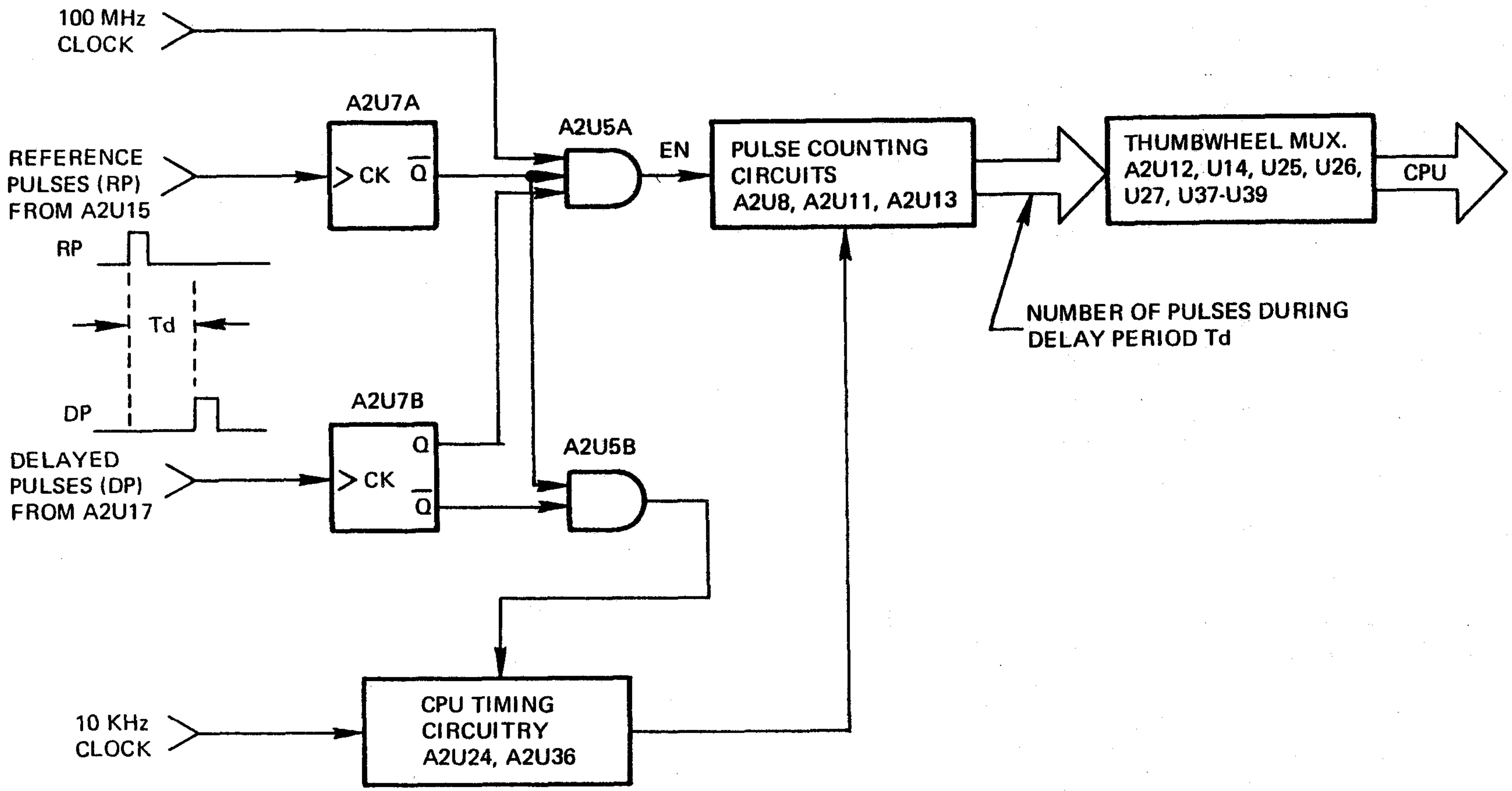


Figure 4.3 Self-Test Circuit

dialed-in thumbwheel setting. Reference pulses from A2U15 and delayed pulses from A2U17 are applied to the D input of A2U7B and A2U7A respectively. The 100 MHz clock signal is applied to the clock inputs of both flip-flops simultaneously. The DP output from A2U7B is thus delayed from the RP output of A2U7A by a time equal to the programmed delay time between the two pulse trains. When these two signals (RP and DP) are input to gate A2U15 with the 100 MHz clock the output is a pulse (EN) whose duration equals the time delay Td. The EN signal is applied to the enable input of pulse counter A2U8 which is driven by the 100 MHz clock. The output of A2U8 represents the number of 100 MHz pulses counted during the delay period Td. This count, accumulated by A2U8, A2U11 and A2U13, goes to thumbwheel multiplexers A2U12, A2U14, A2U25, A2U26, A2U27, A2U37, A2U38, A2U39 where it is scanned by the CPU. The CPU is also scanning the thumbwheel settings as part of the normal program and makes a comparison between the two readings. An error determination is displayed as a fault on the module controller's display unit.

CHAPTER 5
MAINTENANCE AND CALIBRATION

5-1 INTRODUCTION

The purpose of this chapter is to provide maintenance and calibration data for the AS210-04 Digital Delay Generator. Section I covers routine preventative maintenance procedures. Section II outlines performance tests for the Digital Delay Generator. Section III contains the calibration/alignment procedures for the AS210-04 module, and Section IV describes troubleshooting data. Figures 5.4 and 5.5 are the schematic diagrams for the Digital Delay Generator. The two truth tables on Figure 5.5 are for the Thumbwheel switch and RATE switch. For example, if the thumbwheel switch is set at 300.00 microseconds and the RATE switch is set at 1 KHz then input lines A5 on A2U27, B5 on A2U37, RA on A2U12, RB on A2U14, and RC on A2U26 will float high. All other input lines will be low. Please contact the factory for any assistance required in the maintenance or servicing of the AS210-04.

SECTION I

5-2 PREVENTIVE MAINTENANCE

Table 5-1 lists preventive maintenance checks and services which should be performed regularly.

Table 5-1

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURES
CABLES	Visually inspect cables for strained, cut frayed, or other damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfacs as follows: A. Remove the dust and loose dirt with a clean soft cloth. B. Remove dust or dirt from plugs and jacks with a brush. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle.
CORROSION	Make sure exterior surfaces of unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: A. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. B. Brush two coats of paint on base metal to protect it from further corrosion.

SECTION II

5-3 PERFORMANCE TESTING

This section describes the procedure to test the AS210-04 Digital Delay Generator to assure proper performance of the instrument. The AS210-04 must be used in conjunction with the AS210-01 Module Controller since the CPU in the AS210-01 monitors the controls and output of the AS210-04. The AS210-04 Digital Delay Generator will not operate without the AS210-01 Module Controller installed. If the AS210-04 fails any of the performance tests, please see Section III, Calibration/Alignment procedures, and/or Section IV, Troubleshooting procedures in this chapter.

5-4 AS210-04 TIME INTERVAL PERFORMANCE TEST

The following is a procedure for testing the time interval between the reference and delayed output pulse trains of the AS210-04 Digital Delay Generator. Table 5-2 contains the required equipment to perform this test.

Table 5-2

REQUIRED TEST EQUIPMENT FOR THE TIME INTERVAL PERFORMANCE TEST OF THE AS210-04

ITEM	RECOMMENDED TEST EQUIPMENT
ELECTRONIC COUNTER	Hewlett-Packard 545A
FREQUENCY STANDARD	Hewlett-Packard 5061A or 5062C Opt 01
COAXIAL CABLE (3 required)	3 Foot Long, 50 Ohm, BNC

5-5 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Connect the equipment as indicated in Figure 5.1 and apply power to the AS210. The Rubidium Frequency Standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. Set the electronic counter controls to measure time interval, with 50 Ohm input impedance and external time base.

D. Set the AS210-04 Digital Delay Generator to each position listed in Table 5-3. At each setting, verify that the electronic counter indication is within the tolerance limits listed. If any of the indications fall out of the limits for acceptable performance, please see Section III, Calibration/ Alignment Procedures, and/or Section IV, Troubleshooting Procedures.

E. Disconnect the frequency counter from the AS210-04.

5-6 AS210-04 REFERENCE AND DELAYED OUTPUT PULSEWIDTHS PERFORMANCE TESTS

The following is a procedure for testing the reference and delayed output pulse widths of the AS210-04 Digital Delay Generator. Table 5-4 on page 5-7 contains the required equipment for this performance test.

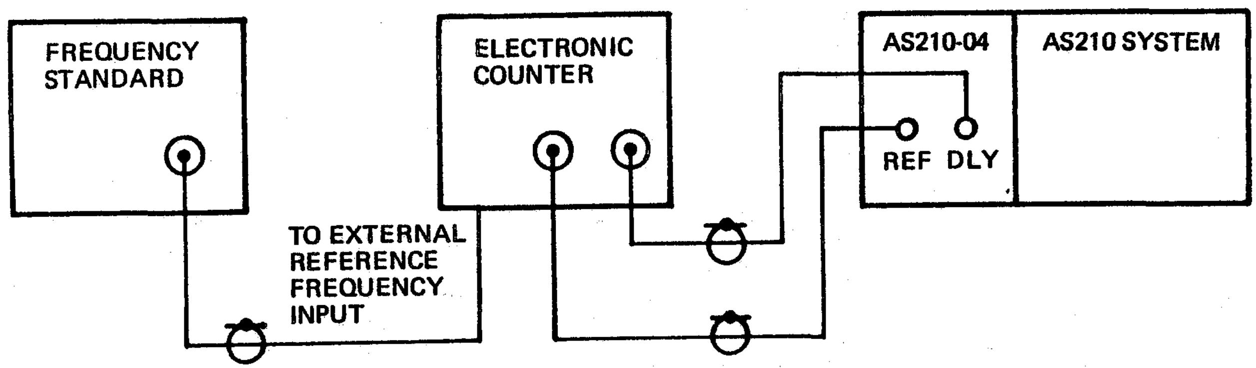


Figure 5.1 Test Configuration for Time Interval Performance Test of the AS210-04

TABLE 5-3

AS210-04 DIGITAL DELAY GENERATOR SWITCH SETTINGS AND CORRESPONDING TIME INTERVAL TOLERANCE LIMITS

DELAY SWITCHES (microseconds)	RATE OUTPUTS SWITCH (Hz)	ELECTRONIC COUNTER TOLERANCE LIMITS
000.02	10K	19 to 21 nanoseconds
000.13	10K	128 to 132 nanoseconds
004.44	10K	4.437 to 4.443 microseconds
055.55	10K	55.547 to 55.553 microseconds
066.66	1K	66.657 to 66.663 microseconds
077.77	1K	77.767 to 77.773 microseconds
088.88	1K	88.877 to 88.883 microseconds
111.11	1K	111.107 to 111.113 microseconds
999.99	100	999.987 to 999.993 microseconds
44.44	100	44.437 to 44.443 microseconds
33.33	100	33.327 to 3.333 microseconds
222.22	100	222.217 to 222.223 microseconds
222.22	10	222.217 to 222.223 microseconds
22.22	10	22.217 to 22.233 microseconds
111.11	10	111.107 to 111.113 microseconds
900.00	10	899.987 to 900.003 microseconds
999.99	1	999.987 to 999.993 microseconds
987.65	1	987.647 to 987.603 microseconds
876.10	1	876.097 to 876.103 microseconds
050.10	1	50.097 to 50.103 microseconds

TABLE 5-4

REQUIRED TEST EQUIPMENT FOR REFERENCE AND DELAYED OUTPUT PULSEWIDTHS OF THE AS210-04

ITEM	RECOMMENDED TEST EQUIPMENT
OSCILLOSCOPE WITH PROBES	Tektronix 465 or Equivalent
COAXIAL CABLE (2 required)	3 Foot Long, 50 Ohm, BNC

5-7 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Connect the equipment as indicated in Figure 5.2 and apply power. The Rubidium Frequency Standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. With an oscilloscope, monitor the reference and delayed output pulse trains at the front panel of the AS210-04. Both the reference and delayed output pulses should be between 9 and 11 microseconds wide. If the output pulses are out of this tolerance then consult Section III, Calibration/Alignment Procedures, and/or Section IV, Troubleshooting Procedures.

D. Disconnect the oscilloscope from the AS210-04 output connectors.

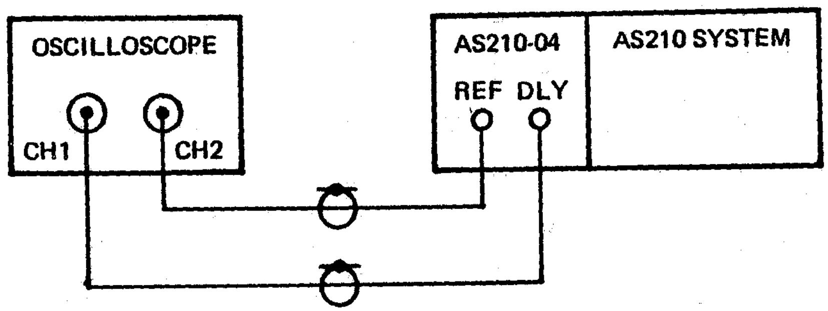


Figure 5.2 Test Configuration for Reference and Delayed Output Pulsewidth Performance Test of the AS210-04

SECTION III

5-8 CALIBRATION/ALIGNMENT PROCEDURE

WARNING

The following Calibration/Alignment Procedures (Chapter 5, Section III) and Troubleshooting Procedures (Chapter 5, Section IV) are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that of Routine Maintenance (Chapter 5, Section I) and Performance Testing (Chapter 5, Section II) unless you are qualified to do so.

Figure 5.3 is a flow diagram of the Calibration/Alignment Procedure for the AS210-04 Digital Delay Generator. Use this flow diagram with the theory of operation in Chapter 4, the text in this chapter, and the illustrated parts lists in Chapter 6. The AS210 internal frequency standard calibration data, contained in the AS210 mainframe operation and maintenance manual, is also referenced in this flow diagram. Please note that it is not necessary to diassemble the AS210 system to determine if calibration/alignment is needed. For any assistance needed in performing this calibration/alignment procedure, please contact the factory.

5-9 ACCESS TO AS210-04 DIGITAL DELAY GENERATOR MODULE

Please reference the AS210 mainframe manual for the disassembly procedure of the AS210 system to allow access to the AS210-04 Digital Delay Generator module. Access to the module circuitry itself is gained by removing the two metal side covers with a small straight-blade screwdriver. Place the module on one of its sides so that one cover is facing up. Starting with the end toward the edge connector, insert the screwdriver into one of the slots where the cover mates with the module chassis and pry the cover up. It will be necessary to move along the slot toward the front panel of the module

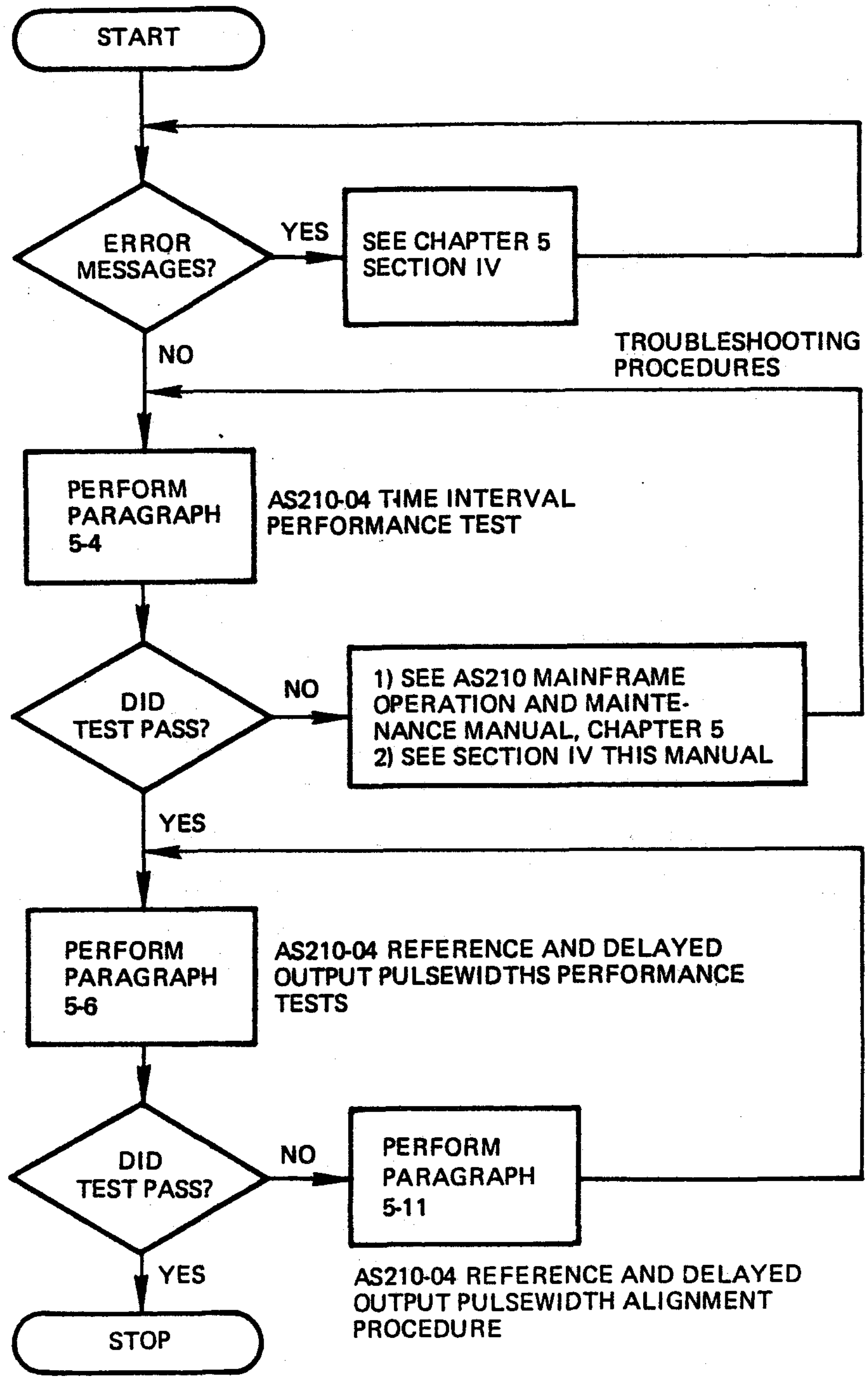


Figure 5.3 Flow Diagram of the Calibration/Alignment Procedure for the AS210-04 Digital Delay Generator

and repeat the prying action to loosen the side of the cover from the module. Repeat this technique to free the other side of the cover from the chassis. Set the free cover clear of the module and flip the module over so that the second cover is now facing up. Repeat the above procedure to free this cover.

5-10 PLO ALIGNMENT PROCEDURE

The following is the alignment procedure for the phase-locked oscillator (PLO) in the AS210-04 Digital Delay Generator. Table 5-5 contains the required test equipment for this alignment procedure.

TABLE 5-5

REQUIRED TEST EQUIPMENT FOR THE PLO ALIGNMENT PROCEDURE

ITEM	RECOMMENDED TEST EQUIPMENT
OSCILLOSCOPE WITH PROBES	Tektronix 465 or Equivalent
ELECTRONIC COUNTER	Hewlett-Packard 5345A
COAXIAL CABLE	3 Foot Long, 50 Ohm, BNC

A. Obtain access to the AS210-04 module circuits by referencing paragraph 5-9 in this chapter.

B. Using the oscilloscope monitor the voltage level on pin six of U14 located on assembly A1 (117241).

C. Adjust the variable capacitor A1C3 in a clock-wise direction until a level of -4VDC is obtained.

The AS210-04 Digital Delay Generator output frequencies should now be aligned. To confirm that the digital delay generator is operating properly, reference Section II, Performance Testing of the AS210-04 contained in this chapter.

5-11 AS210-04 REFERENCE AND DELAYED OUTPUT PULSE WIDTH ALIGNMENT PROCEDURE

The following is the alignment procedure for the referenced and delayed output pulse widths of the AS210-04. Table 5-6 contains the required test equipment for the alignment procedure.

Table 5-6

REQUIRED TEST EQUIPMENT FOR THE AS210-04 REFERENCE AND DELAYED OUTPUT PULSE WIDTH ALIGNMENT PROCEDURE

ITEM	RECOMMENDED TEST EQUIPMENT
OSCILLOSOPE WITH PROBES	Tektronix 465 or Equivalent
COAXIAL CABLE (2 Required)	3 Foot Long, 50 Ohm, BNC

A. Obtain access to the AS210-04 Digital Delay Generator module circuits by referencing paragraph 5-9 in this chapter.

B. Monitor the reference and delayed output pulse widths of the AS210-04 with the oscilloscope as in Figure 5.2.

C. Adjust R17 and R23 for the reference and delayed nominal output pulse widths of 10 microseconds.

The AS210-04 Digital Delay Generator output levels should now be aligned. To confirm that the Digital Delay Generator is operating properly, reference Section II, Performance Testing of the AS210-04, contained in this chapter.

SECTION IV

5-12 TROUBLESHOOTING PROCEDURES

Troubleshooting of the Digital Delay Generator is facilitated by a combination of error codes displayed on the module controller display and LED indicators on the circuit card assembly, A1. The circuit cards A1 and A2 are illustrated in Figure 6.1. Table 5-7 correlates the error code, displayed on the module controller when a fault occurs, to the malfunction. An explanation of the problem is provided with possible solutions. Table 5-8 is a list of visual indicators on circuit card A1 and the meaning of their indications. For further assistance, please contact the factory.

Table 5-7

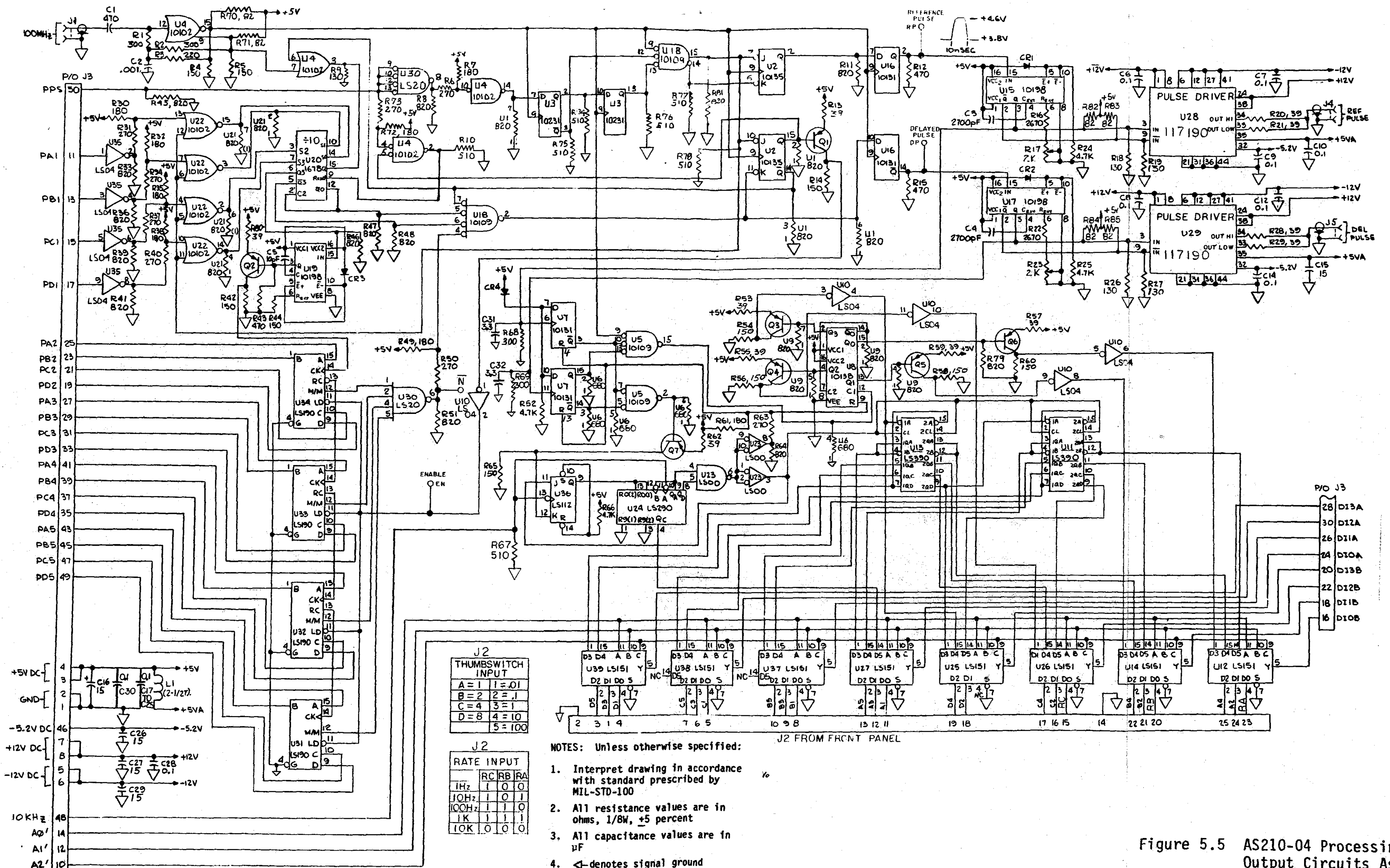
ERROR CODE LISTING

ERROR CODE	PROBLEM	RECOMMENDED SOLUTION
4-00	On 10 KHz setting delay ≥99 microseconds or on 1 KHz setting delay ≥999 microseconds	Reduce delay setting or repetition rate.
4-20 to 4-22	Self-test delay error 20 = 1 Hz 21 = 10 Hz 22 = 100 Hz	Check delay generator circuit.
4-10 to 4-12	Self-test, PRR not equal to 1 pps, 10 pps or 100.	Check repetition rate circuit (see Table 5-2).
4-30	Self-test delayed pulse not occurring.	Self-test circuit failed. Repetition rate generator failed.

Table 5-8

VISUAL INDICATORS

INDICATOR		
A1CR1, CR2 OFF	10 MHz Reference Signal Failure	Check 10 MHz Reference Input, A1Q1, U12.
A1CR3, CR4 OFF	Oscillator	Check A1Q2, Q3, U20, U21, Q4, U19 or U12.
A1CR5 ON	100 MHz Oscillator in Unlock Condition	If CR1-CR4 are OK, check A1U13, U14.



J2

THUMBSWITCH INPUT	
A = 1	1 = .01
B = 2	2 = .1
C = 4	3 = 1
D = 8	4 = 10
	5 = 100

J2

RATE INPUT	RC	RB	RA
1Hz	1	0	0
10Hz	1	0	1
100Hz	1	1	0
1K	1	1	1
10K	0	0	0

NOTES: Unless otherwise specified:

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100
2. All resistance values are in ohms, 1/8W, ±5 percent
3. All capacitance values are in µF
4. ◁- denotes signal ground
5. All transistors are MPS3639
6. All diodes are 1N3064
7. U1, U6 and U9 are resistor packs

Figure 5.5 AS210-04 Processing and Output Circuits Assembly, A2, Schematic Diagram

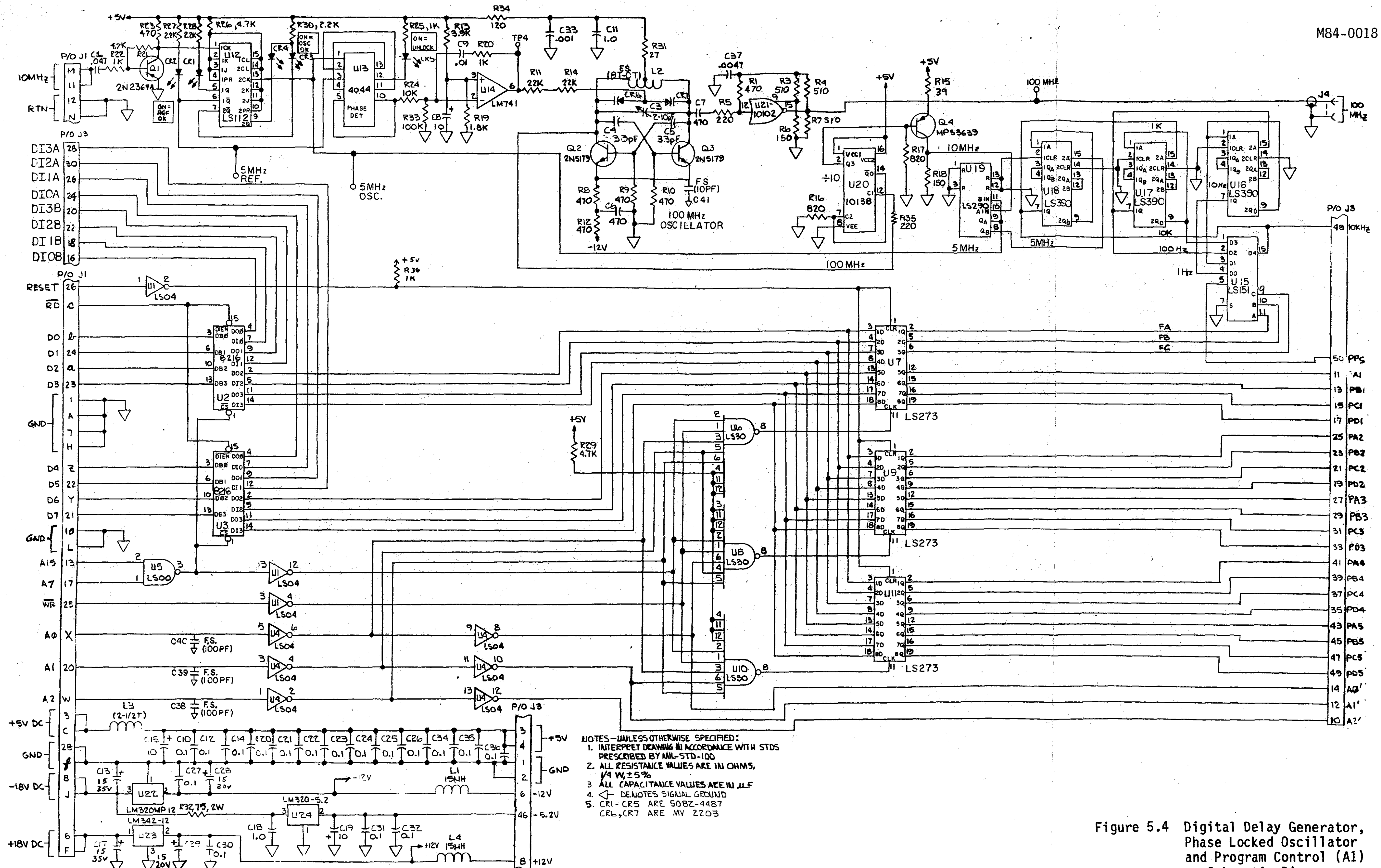


Figure 5.4 Digital Delay Generator, Phase Locked Oscillator and Program Control (A1) - Schematic Diagram

CHAPTER 6
ILLUSTRATED PARTS LIST

6-1 INTRODUCTION

This chapter contains an illustrated parts list for the Digital Delay Generator Module. The assembly numbers and assembly title are listed at the top of the parts lists. The parts lists are divided into six columns and arranged in the following order:

Column 1 - Item Number

Column 2 - Quantity per assembly.

Column 3 - Manufacturer's Code

Column 4 - Part Number

Column 5 - Description

Column 6 - Reference Designation

ASSEMBLY NUMBER 117171-01 - DIGITAL DELAY GENERATOR AS210-04

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117240-01	Digital Delay Generator Assembly	A1
2	1	33472	117245-01	Digital Delay Generator Assembly	A2
3	0	33472	117326	Frame Section Modification	
4	1	33472	117350-03	Cable Assembly Ribbon, 50 Wire	
5	1	33472	117357-02	Cable Assembly Coax	
6	4	06540	8225-SS-0632	Standoff, 6-32x1&5/16" Threaded	
7	8	81349	MS51957-27	Screw, PNH 6-32 x 5/16	
8	8	81349	NAS620-C6	Reduced OD Flat Washer #6	
9	8	81349	MS35338-136	Split Lock Washer #6	
10	1	33472	117183-01	Panel, Lexan	
11	1	33472	117183-02	Subpanel, Plastic	
12	1	33472	117183-03	Panel, Rear	
13	1	95146	PKG-50B 1/4	Knob, Black	
14	1	33472	117347-01	Harness Assembly	
15	1	33472	117356-02	Cable, Coaxial	
16	1	33472	117356-03	Cable, Coaxial	
17	1	80009	366-1690-10	Latch Pull	
18	1	80009	105-0718-01	Latch	
19	1	80009	426-0724-00	Bottom	
20	2	80009	337-1399-00	Side Cover	

ASSEMBLY NUMBER 117171-01 - DIGITAL DELAY GENERATOR AS210-04 (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
21	1	80009	214-1061-00	Tension Spring	
22	1	80009	426-0725-00	Top	
23	2	80009	386-3657-01	Guide Pin	
24	1	81349	00000	Screw FLH STL Sheet Metal #2X1/4	
25	4	81349	MS24693-C26	Screw 6-32X3/8 FLH	
26	4	81349	00000	Screw PNH STL Sheet Metal #6X3/8	

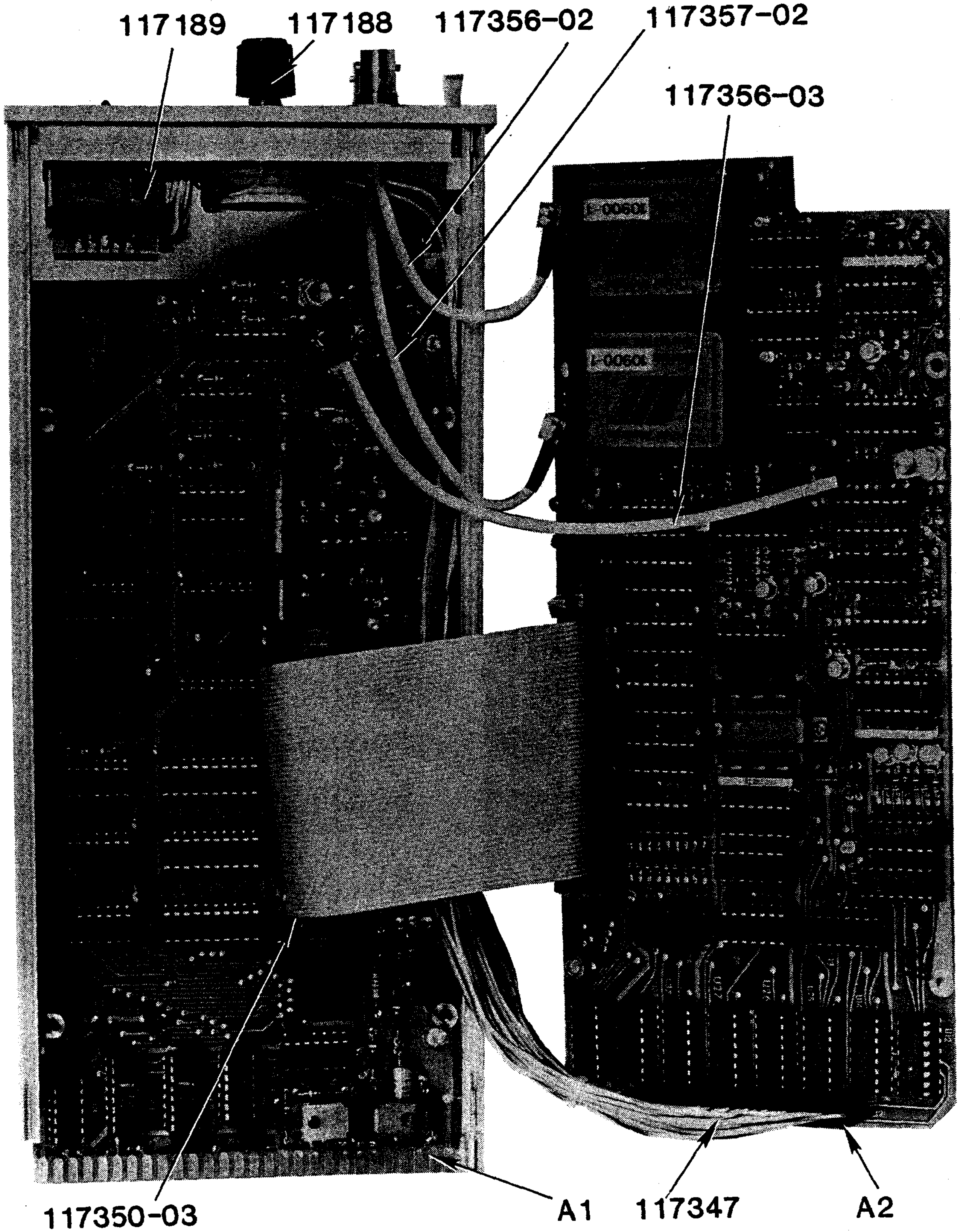


Figure 6.1 AS210-04 Digital Delay Generator

ASSEMBLY NUMBER 117240-01 - DIGITAL DELAY GENERATOR A1

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117243	PWB	
2	0	33472	117241	Schematic	
3	0	33472	117240	Assembly Drawing	
4	1	81349	CK05BX103K	.01 UFD 10% Ceramic Capacitor	C9
5	17	81349	CK05BX104K	.1 UFD 10% Ceramic Capacitor	C10,C12,C14, C20-27, C30-32, C34-36
6	2	51642	300-50-601-105M	1 UFD 20% Ceramic Capacitor	C13,C18
7	2	81349	CK05BX471K	470 PFD 10% Ceramic Capacitor	C6,C7
8	1	81349	CK05BX473K	.047 UFD 10% Ceramic Capacitor	C16
9	1	81349	CK05BX102K	.001 UFD 10% Ceramic Capacitor	C33
10	1	81349	CK05BX472K	.0047 UFD 10% Ceramic Capacitor	C37
11	3	81349	CK05BX101K	100 PF 10% Ceramic Capacitor	C38,C39,C40
12	2	81349	100-100-COG689J	6.8 PFD 5% Ceramic Capacitor	C4,C5
13	1	72982	513-010-A2-10	2-10 PFD Variable Capacitor	C3
14	3	56289	CSR13G106KL	10 UFD, 50V, Electrolytic Cap	C8,C15,C19
15	4	15849	2010B-1	Terminal	
16	2	04713	MV2203	Tuning Diode	CR6,CR7

ASSEMBLY NUMBER 117240-01 - DIGITAL DELAY GENERATOR A1 (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
17	5	50434	5082-4487	Light Emitting Diode	CR1-CR5
18	1	53387	3433-2202	50 Pin PC Mount Male Header	J3
19	1	98291	51-051-0000	Snap On Conhex Connector	J4
20	2	99800	1025-48	15 UHY Molded RF Choke	L1,L4
21	1	33472	117305-05	Center Tapped Inductor	L2
22	1	02114	VK200-20/4B	Wide Band Choke	L3
23	2	04713	2N5179	NPN Transistor	Q2,Q3
24	1	27014	2N2222A	NPN Transistor	Q1
25	1	04713	MPS3639	PNP Transitor	Q4
26	2	81349	RCR07G151JS	150 ohm 5% 1/4W Carbon Comp	R6,R18
27	4	81349	RCR07G102JS	1K 5% 1/4W Carbon Comp	R20,R22,R25, R36
28	1	81349	RCR07G103JS	10K 5% 1/4W Carbon Comp	R24
29	1	81349	RCR07G182JS	1.8K 5% 1/4W Carbon Comp	R19
30	2	81349	RCR07G221JS	220 5% 1/4W Carbon Comp	R19
31	3	81349	RCR07G222JS	2.2K 5% 1/4W Carbon Comp	R5,R35
32	2	81349	RCR07G223JS	22K 5% 1/4W Carbon Comp	R27,R28,R30
33	1	81349	RCR07G390JS	39 ohm 5% 1/4W Carbon Comp	R15
34	1	81349	RCR07G392JS	3.9K 5% 1/4W Carbon Comp	R13
35	4	81349	RCR07G471JS	470 5% 1/4W Carbon Comp	R1,R8-10, R12,R23
36	3	81349	RCR07G472JS	4.7K 5% 1/4W Carbon Comp	R21,R26,R29
37	3	81349	RCR07G511JS	510 5% 1/4W Carbon Comp	R3,R4,R7

ASSEMBLY NUMBER 117240-01 - DIGITAL DELAY GENERATOR A1 (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
38	2	81349	RCR07G821JS	820 ohm 5% 1/4W Carbon Comp	R16,R17,
39	1	81349	RCR07G270JS	27 ohm 5% 1/4W Carbon Comp	R31
40	1	81349	RCR07G104JS	100K ohm 5% 1/4W Carbon Comp	R33
41	1	81349	RCR07G121JS	120 ohm 5% 1/4W Carbon Comp	R34
42	1	81349	RCR42G750JS	75 ohm 5% 2W Carbon Comp	R32
43	1	01295	74LS00N	Quad 2 Input NAND Gate	U5
44	2	01295	74LS04N	Hex Inverter	U1,U4
45	3	01295	74LS30N	Dual 6 Input NAND Gate	U6,U8,U10
46	1	01295	74LS112N	Dual JK	U12
47	1	01295	74LS151N	Multiplexer	U15
48	3	01295	74LS273N	Octal D Flip Flop	U7,U9,U11
49	1	01295	74LS290N	Decade Counter	U19
50	3	01295	74LS390N	Decade Counter	U16,U17,U18
51	1	01295	UA7952CKC	-5.2V Regulator	U24
52	2	34649	P8216	Buss Driver	U2,U3
53	1	04713	MC4044P	Phase Comparator	U13
54	1	04713	MC10102P	Quad 2 Input NAND Gate	U21
55	1	04713	MC10138P	Dual JK	U20
56	1	27014	LM320MP-12	-12V Regulator	U22
57	1	27014	LM342P-12	+12V Regulator	U23
58	1	27014	LM741CN	Op Amp	U14

ASSEMBLY NUMBER 117240-01 - DIGITAL DELAY GENERATOR A1 (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
59	1	01295	C9308-02	8 Pin Socket	
60	8	01295	C9314-02	14 Pin Socket	
61	9	01295	C9316-02	16 Pin Socket	
62	3	01295	C9320-02	20 Pin Socket	
63	2	56289	196D156X-9020K41	15 MFD, 20V, TANT	C27,C29
64	2	56289	196D156X-9035PE4	15 MFD, 35V, TANT	C13,C17

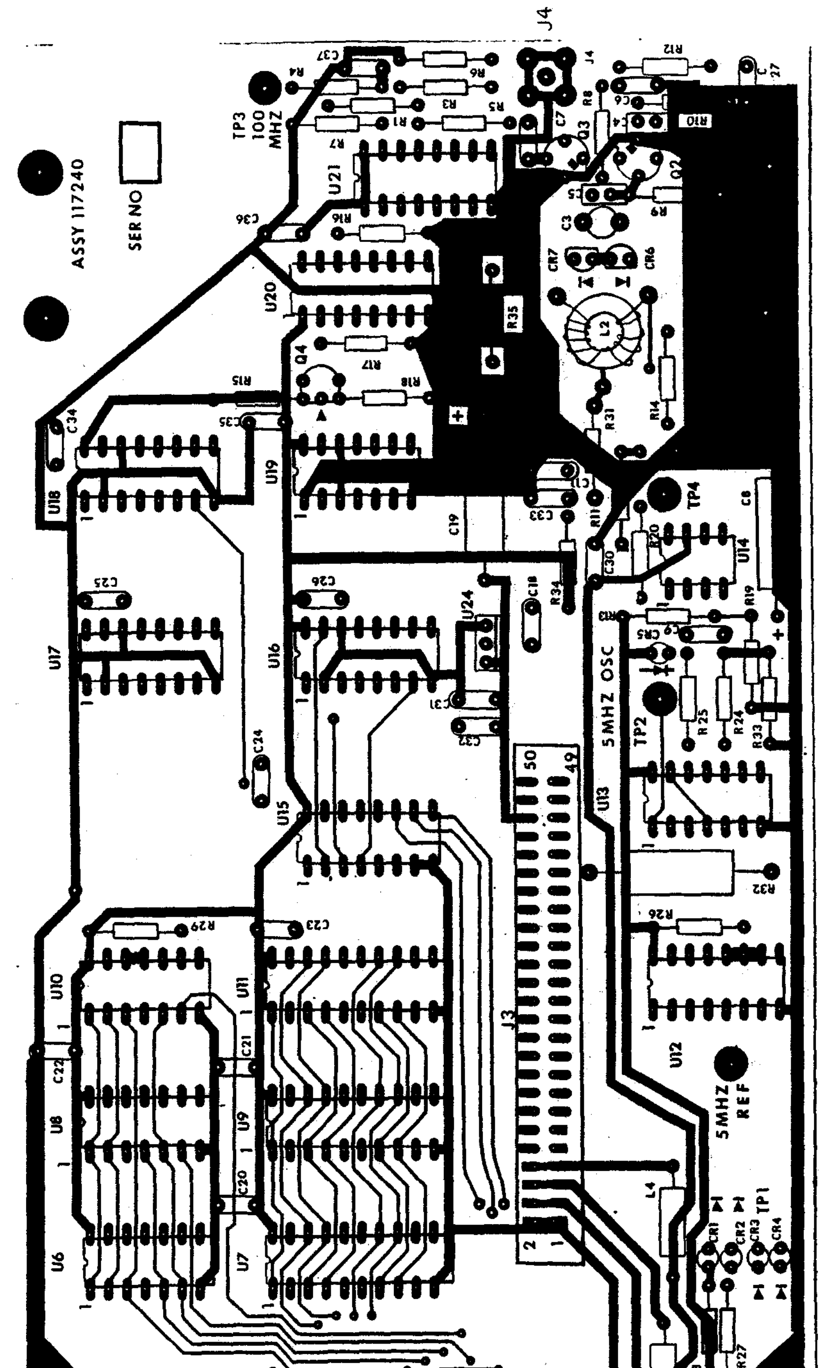


Figure 6.2 AS210-04 Digital Delay Generator Assembly, A1

ASSEMBLY NUMBER 117245-01 - DIGITAL DELAY GENERATOR A2

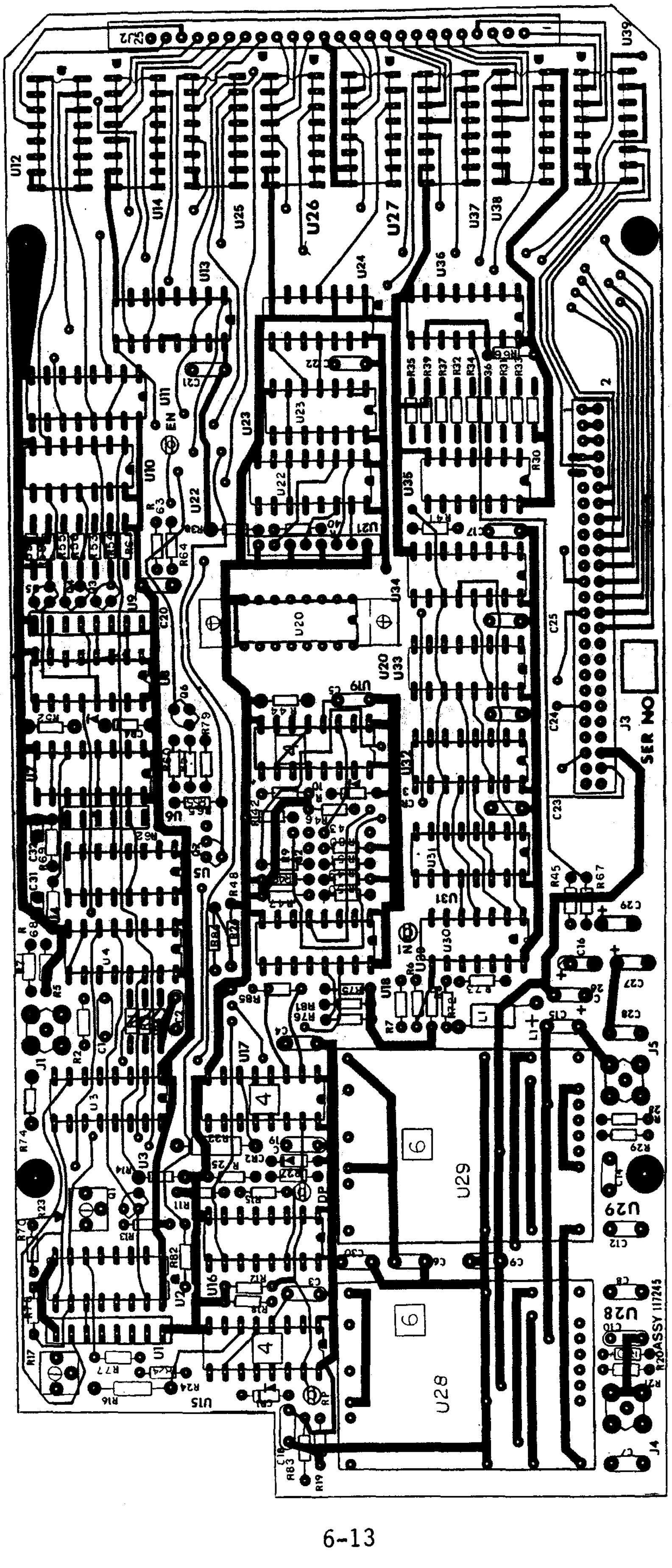
ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117248	PC Board	
2	0	33472	117246	Schematic	
3	0	33472	117245	Assembly Drawing	
4	1	81349	CK05BX102K	.001 UFD 10% Ceramic Capacitor	C2
5	10	81349	CK05BX104K	.1UFD 10% Ceramic Capacitor	C6-C10,C12, C14,C17-C25, C28,C30
6	2	81349	CK05BX272K	2700 PFD 10% Ceramic Capacitor	C3,C4
7	1	81349	CK05BX100K	10 PFD 10% Ceramic	C5
8	1	81349	CK05BX471K	470 PFD 10% Ceramic Capacitor	C1
9	2	81349	100-100-CGS339J	3.3 PFD 5% Ceramic Capacitor	C31,C32
10	5	56289	196D156X-9020KA1	15 UFD 10% Solid Tantalum	C15,C16,C26, C27,C29
11	4	04713	1N3064	Diode	CR1,CR4
12	4	15849	2010B-1	Terminal	
13	36	09769	2-331272-6	Minipin	
14	1	53387	3433-2202	50 Pin PC Mount Male Header	J3
15	1	27264	22-03-2251	25 Pin Wafer	J2
16	3	98291	51-051-0000	Snap-On Conhex Connector	J1,J4,J5
17	1	02114	VK200-20/4B	Wide Band Choke	L1
18	7	04713	MPS3639	PNP Transistor	Q1-Q7
19	2	83149	MS51957-4	Screw PNH 2-56 x 5/16	
20	4	81349	NAS620-C2	Reduced OD Flat Washer #2	
21	2	81349	MS35338-134	Split Lock Washer #2	
22	2	81349	NAS671-C2	Small Pattern Hex Nut #2	
23	6	81349	RCR05G820JS	82 ohm 5% 1/8W Carbon Comparator	R70,R71, R82-R85

ASSEMBLY NUMBER 117245-01 - DIGITAL DELAY GENERATOR A2 (Continued)

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
24	4	81349	RCR05G131JS	130 ohm 5% 1/8W Carbon Comparator	R9,R19,R26, R27
25	5	81349	RCR05G151JS	150 ohm 5% 1/8W Carbon Comparator	R4,R5,R14, R42,R44
26	8	81349	RCR05G181JS	180 ohm 5% 1/8W Carbon Comparator	R7,R30,R32, R35,R38,R49, R61,R72
27	1	81349	RCR05G221JS	220 ohm 5% 1/8W Carbon Comparator	R3
28	8	81349	RCR05G271JS	270 ohm 5% 1/8W Carbon Comparator	R6,R31,R34, R37,R40,R50, R63,R73
29	15	81349	RCR05G301JS	300 ohm 5% 1/8W Carbon Comparator	R1,R2,R18, R68,R69
30	11	81349	RCR05G390JS	39 ohm 5% 1/8W Carbon Comparator	R13,R20,R21, R28,R29,R53, R55,R57,R59, R62,R80
31	3	81349	RCR05G471JS	470 ohm 5% 1/8W Carbon Comparator	R12,R15,R43
32	4	81349	RCR05G472JS	4.7K 5% 1/8W Carbon Comparator	R24,R25,R52, R66
33	7	81349	RCR05G511JS	510 ohm 5% 1/8W Carbon Comparator	R10,R67, R74-R78
34	14	81349	RCR05G821JS	820 ohm 5% 1/8W Carbon Comparator	R8,R11,R33, R36,R39,R41, R45-R48,R51, R64,R79,R81
35	5	81349	RCR05G151JS	150 ohm 5% 1/8W Carbon Comparator	R54,R56,R58, R60,R65
36	2	81349	RN55C2671FM	2670 ohm 1% 1/4W, Metal Film	R16,R22
37	2	73139	82-PAR-2K	2K Variable Resistor	R17,R23
38	1	75378	750-61-R680	Resistor, Network	U6
39	3	75378	750-81-R820	Resistor, Network	U1,U9,U21

ASSEMBLY NUMBER 117245-01 - DIGITAL DELAY GENERATOR A2 (Continued)

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
40	1	01295	74LS00N	Quad 2 Input NAND Gate	U23
41	2	01295	74LS04N	Hex Inverter	U10,U35
42	1	01295	74LS20N	Triple 4 Input NAND Gate	U30
43	1	01295	74LS112N	Dual JK	U36
44	8	01295	74LS151N	Multiplexer	U12,U14,U25, U26,U27,U37, U38,U39
45	4	01295	74LS190N	Decade Counter	U31,U32,U33, U34
46	1	01295	74LS290N	Decade Counter	U24
47	2	01295	74LS390N	Decade Counter	U11,U13
48	1	04713	MC01231P	Dual D Hi-Speed FF	U3
49	1	04713	MC1678P	Decade Counter	U20
50	2	04713	MC10102P	Quad 2 Input NAND Gate	U4,U22
51	2	04713	MC12009P	Triple 4 Input NAND Gate	U5,U18
52	2	04713	MC10131P	Dual D Flip Flop	U7,U16
53	1	04713	MC10135P	Dual JK	U2
54	1	04713	MC10138P	Decade Counter	U8
55	3	04713	MC10198P	One Shot	U15,U17,U19
56	2	33472	117190	Pulse Amplifier	U28,U29
57	1	13103	6007A	Heat Sink, with Cap.	
58	3	13103	6011B	Heat Sink	
59	5	01295	C9314-02	14 Pin Socket	
60	27	01295	C9316-02	16 Pin Socket	



COMPONENT SIDE

Figure 6.3 AS210-04 Digital Delay Generator Assembly, A2

ASSEMBLY NUMBER 117350-03 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	53887	3425-6000	Connector, 50 Pin	
2	0	53887	3365/50	Cable, 50 Wire, Ribbon	Six Inches

ASSEMBLY NUMBER 117356-02 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	0	81349	RGU-316	Coaxial Cable	Five Inches
2	1	02660	86350	Connector, BNC Bulkhead	
3	1	98291	51-328-3188	Connector	

ASSEMBLY NUMBER 117356-03 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	0	81349	RGU-316	Coaxial Cable, 50 ohm	
2	1	02660	86350	Connector, BNC Bulkhead	
3	1	98291	51-328-3188	Connector	

ASSEMBLY NUMBER 117357-02 - CABLE ASSEMBLY

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	0	81349	RG-183		
2	2	98291	51-328-3188	Connector	

ASSEMBLY NUMBER 117347-01 - HARNESS, DIGITAL, DELAY GENERATOR

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117188	Switch, Rotary 30 Degree	
2	0	33472	117347	Wire List	
3	1	33472	117189-01	Switch, Thumbwheel	
4	1	27264	22-01-2251	Connector, 25 Pin	
5	25	27264	08-50-0114	Pin, Crimp	
6	0	81349	16-ET 26 AWG	Wire, 26 AWG Stranded	

6-2 MANUFACTURER'S LIST CODE TO NAME

This section contains all manufacturer's codes for materials used in the AS210 system. The codes are listed in numerical order by code.

MANUFACTURER'S LIST CODE TO NAME

CODE	MANUFACTURER	ADDRESS
00779	AMP, INC	P.O. Box 3608 Harrisburg, PA 17105
01121	ALLEN-BRADLEY COMPANY	1202 South 2nd Street Milwaukee, WI 53204
01139	GENERAL ELECTRIC COMPANY	Silicone Products Business Department Waterford, NY 12188 PHONE: 518-237-3330
01281	TRW, INC.	TRW Semiconductor Division 14520 Aviation Boulevard Lawndale, CA 90260
01295	TEXAS INSTRUMENTS, INC.	Semiconductor Group 13500 North Central Expressway P.O.Box 225012 M/S 49 Dallas, TX 75265
02114	AMPEREX ELECTRONIC CORPORATION	Ferroxcub Division 5083 Kings Highway Saugerties, NY 12477
02660	BUNKER RAMO-ELTRA CORPORATION	Amphenol Division 2801 South. 25th Avenue Broadview, IL 60153
02735	RCA CORPORPATION	Solid State Division Route 202 Somerville, NJ 08876
03797	GENISCO TECHNOLOGY CORPORATION	Electronics Division 18435 Susana Road Rancho Dominguez, CA 90221 PHONE: 213-537-4750
04426	ILLINOIS TOOL WORKS, INC.	Licon Division 6615 West Irving Park Road Chicago, IL 60634
04713	MOTOROLA, INC.	Semiconductor Products Sector 5005 East McDowell Road Phoenix, AZ. 85008 PHONE: 602-244-7100

CODE	MANUFACTURER	ADDRESS
05245	CORCOM, INC.	1600 Wincheste Road Libertyville, IL 60048
06090	RAYCHEM CORPORATION	300 Constitution Drive Menlo Park, CA 94025
06383	PANDUIT CORPORATION	17301 Ridgeland Tinley Park, IL 60477
06540	MITE CORPORATION	Amatom Electronic Hardware Division 446 Blake Street New Haven, CT 06515
07263	FAIRCHILD CAMERA & INSTRUMENT CORPORATION	Sub of Schlumberger LTD North American Sales Mail Stop 14-1053 401 Ellis Street P. O. Drawer 7284 Mt. View, CA 94042
09353	C AND K COMPONENTS, INC.	15 Riverdale Avenue Newton, MA 02158 PHONE: 617-964-6400
11237	CTS KEENE, INC.	P.O. Box 1977 Paso Robles, CA 93446
12136	PHC INDUSTRIES, INC.	1643 Haddon Avenue Camden, NJ 08103
13103	THERMALLOY COMPANY, INC.	2021 West Valley View Lane P. O. Box 340839 Dallas, TX 75234
13556	TRW CINCH CONNECTORS	Nuline Facility Division of TRW, Inc. New Hope, MN
14099	SEMTECH CORPORATION	652 Mitchell Road Newbury Park, CA 91320 PHONE: 213-628-5392
14655	CORNELL-DUBILIER ELECTRONICS	Div. of Federal Pacific Electric Co. Government Contracts Department 150 Avenue L Newark, NJ 07101

CODE	MANUFACTURER	ADDRESS
15542	MINI-CIRCUITS LABORATORY	Div. of Scientific Components Corp. 2625 East 14th Street Brooklyn, NY 11235
16428	BELDEN ELECTRONIC WIRE & CABLE	Sub of Cooper Industries, Inc. 2200 U.S. Highway 27 South P.O. Box 1980 Richmond, IN 47374 PHONE: 317-983-5200
18612	VISHAY INTERTECHNOLOGY, INC.	Vishay Resistor Products Division 63 Lincoln Highway Malvern, PA 19355
19209	GENERAL ELECTRIC COMPANY	Battery Business Department 441 Highway N P. O. Box 861 Gainesville, FL 32602 PHONE: 904-462-3911
23936	PAMOTOR DIVISION OF WILLIAM J. PURDY COMPANY	770 Airport Boulevard Burlingame, CA 94010
26805	OMNI SPECTRA, INC.	Microwave Connector Division Waltham, MA
26806	AMERICAN ZETTLER, INC.	16881 Hale Avenue Irvine, CA 92714
27014	NATIONAL SEMICONDUCTOR CORPORATION	2900 Semiconductor Drive Santa Clara, CA 95051
27264	MOLEX, INC.	2222 Wellington Court Lisle, IL 60532
32997	BOURNS, INC.	Trimpot Division 1200 Columbia Avenue Riverside, CA
33472	ARGOSYSTEMS, Inc.	884 Hermosa Court Sunnyvale, CA 94086
34649	INTEL CORPORATION	3585 SW 198th Avenue Aloha, OR 97005

CODE	MANUFACTURER	ADDRESS
50088	MOSTEK CORPORATION	Sub of United Technologies Corp. 1215 West Crosby Road P.O. Box 169 Carrollton, TX 75006
50434	HEWLETT-PACKARD COMPANY	Optoelectronics Division 640 Page Mill Road Palo Alto, CA 94304
51642	CENTRE ENGINEERING, INC.	2820 E. College Avenue State College, PA 16801
53387	MINNESOTA MINING AND MANUFACTURING COMPANY	Electronic Products Division 3M Center St. Paul, MN 55101
54893	HEWLETT-PACKARD COMPANY	Microwave Semiconductor Division 350 West Trimble Road San Jose, CA 95131
55154	PLESSEY PERIPHERAL SYSTEMS, INC.	17466 Daimler Avenue P. O. Box 19616 Irvine, CA 92714
55566	R A F ELECTRONIC HARDWARE, INC.	95 Silvermine Road Seymour, CT 06483 PHONE: 203-888-2133
56289	SPRAGUE ELECTRIC COMPANY	87 Marshall Street North Adams, MA 01247
58910	ABBOTT TRANSISTOR LABORATORIES, INC.	Transformer Division 639 South Glenwood Place Burbank, CA 91506
59660	TUSONIX, INC.	2155 North Forbes Boulevard Suite 107 Tucson, AZ 85745
59705	STANDEX INTERNATIONAL CORPORATION	United Service Equipment Co. Div. 1152 Park Avenue Murfreesboro, TN 37130

CODE	MANUFACTURER	ADDRESS
71279	MIDLAND-ROSS CORPORATION	Cambion Division One Alewife Place Cambridge, MA 02140 PHONE: 617-491-5400
71450	CTS CORPORATION	905 North West Boulevard Elkhart, IN 46514
71984	DOW CORNING CORPORATION	3901 South Saginaw Road Midland, MI 48640
73138	BECKMAN INSTRUMENTS, INC.	Helipot Division Sub of Smith Kline/Beckman Corp. 2500 Harbor Boulevard Fullerton, CA 92634
75915	TRACOR LITTLEFUSE, INC.	800 East Northwest Highway Des Plaines, IL 60016
77969	RUBBERCRAFT CORPORATION OF CALIFORNIA LTD.	1800 West 220th Street P.O. Box B Torrance, CA 90507 PHONE: 213-328-5402
78277	SIGMA INSTRUMENTS, INC.	170 Pearl Street South Braintree, MA 02184 PHONE: 617-853-5000
80009	TEKTRONIX, INC.	4900 Southwest Griffith Drive P. O. Box 500 Beaverton, OR 97077
81349	MILITARY SPECIFICATIONS	Promultgated by Military Departments/Agencies Under Authority of Defense Standard- ization Manual 4120 3-M
83330	SMITH HERMAN H. INC.	A North American Philips Company 1913 Atlantic Avenue Manasquan, NJ 08736
88245	WINCHESTER ELECTRONICS	Litton Systems-Useco Division 1536 Saticoy Street Van Nuys, CA 91409
90201	MALLORY CAPACITOR COMPANY	Sub of Emhart Industries, Inc. 4760 Kentucky Avenue P. O. Box 372 Indianapolis, IN 46206

CODE	MANUFACTURER	ADDRESS
91506	AUGAT, INC.	33 Perry Avenue P. O. Box 779 Attleboro, MA 02703
91637	DALE ELECTRONICS, INC.	2064 12th Avenue P.O. Box 609 Columbus, NE 68601 PHONE: 402-563-6301
91836	KINGS ELECTRONICS COMPANY, INC	40 Marbledale Road Tuckahoe, NY 10707 PHONE: 914-793-5000
92194	ALPHA WIRE CORPORATION	71 Lidgerwood Avenue Elizabeth, NJ 07207 PHONE: 201-925-8000
95146	ALCO ELECTRONIC PRODUCTS, INC.	1551 Osgood Street North Andover, MA 01845
95238	CONTINENTAL CONNECTOR CORPORATION	34-63 56th Street Woodside, NY 11377 PHONE: 212-899-4422
95987	WECKESSER COMPANY, INC.	Chicago, IL
98291	SEALECTRO CORPORATION	225 Hoyt Mamaroneck, NY 10544
99800	AMERICAN PRECISION INDUSTRIES, INC.	Delevan Division 270 Quaker Road East Aurora, NY 14052 PHONE: 716-652-3600

M84-0017

AS210-05
STANDBY BATTERY

Revised 8/84

ARGOSystems, Inc. / 884 Hermosa Court, Sunnyvale, California 94086
Telephone (Area Code 408) 737-2000 / Telex No. 352077

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

PREFACE

This manual contains installation, operation and maintenance instructions for the AS210-05 Standby Battery. The data contained herein is arranged as follows:

Reference Publications

AS210A-PM	Portable Mainframe Operation and Maintenance Manual
AS210RM,LM	Mainframe Operation and Maintenance Manual
AS210-01A	Module Controller Operation and Maintenance
AS210-02	Frequency Comparator Operation and Maintenance Manual
AS210-03	Frequency Generator Operation and Maintenance Manual
AS210-04	Digital Delay Generator Operation and Maintenance Manual
AS210-06	Microwave Generator Operation and Maintenance Manual
AS210-08	Distribution Amplifier Operation and Maintenance Manual
AS210-20	Time Clock Operation and Maintenance Manual

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

The AS210-05 Standby Battery module is designed for use with the AS210 Electronic Counter and Frequency Standard Calibration System Mainframe. The Standby Battery is illustrated in Figure 1.1. This module can be plugged into any one of the three locations on the AS210 Mainframe that is not being occupied by another module. The Standby Battery supplies power to the Rubidium Frequency Standard in the Mainframe during an A.C. power failure or when the AS210 is in transit from one location to another. The use of the Standby Battery during transit avoids the 10-minute warm-up necessary for achieving maximum frequency accuracy of 1 part in 10^{-10}. The standby battery is also needed to keep the power off time clock functional during power drops or transit conditions. The unit can be used to maintain ± 1 part in 10^{-9} accuracy for periods up to three (four typical) hours and have accuracy within $\pm 1 \times 10^{-10}$ in 30 seconds after power is resumed. This manual covers the installation, operation and maintenance of the standby battery.

1-2 PHYSICAL AND ELECTRICAL DESCRIPTION

The Standby Battery is constructed in a single width modular plug-in frame. Rechargeable lead-acid batteries are mounted on one side of an internal mounting plate. A printed circuit card assembly with the charging indicator and control circuits is mounted on the opposite side of this mounting plate. Mounted on the front panel is the STANDBY/OFF switch. In standby, the switch places the module in an automatic mode to supply power as soon as prime power is disconnected. Also found on the front panel is the TEST pushbutton switch which, when pressed, tests the condition of the battery. Four LED indicators provide a visual means of determining the charge condition of the batteries. A small knob in the lower left hand corner of the front panel is used for removal and retention of the module in the mainframe.

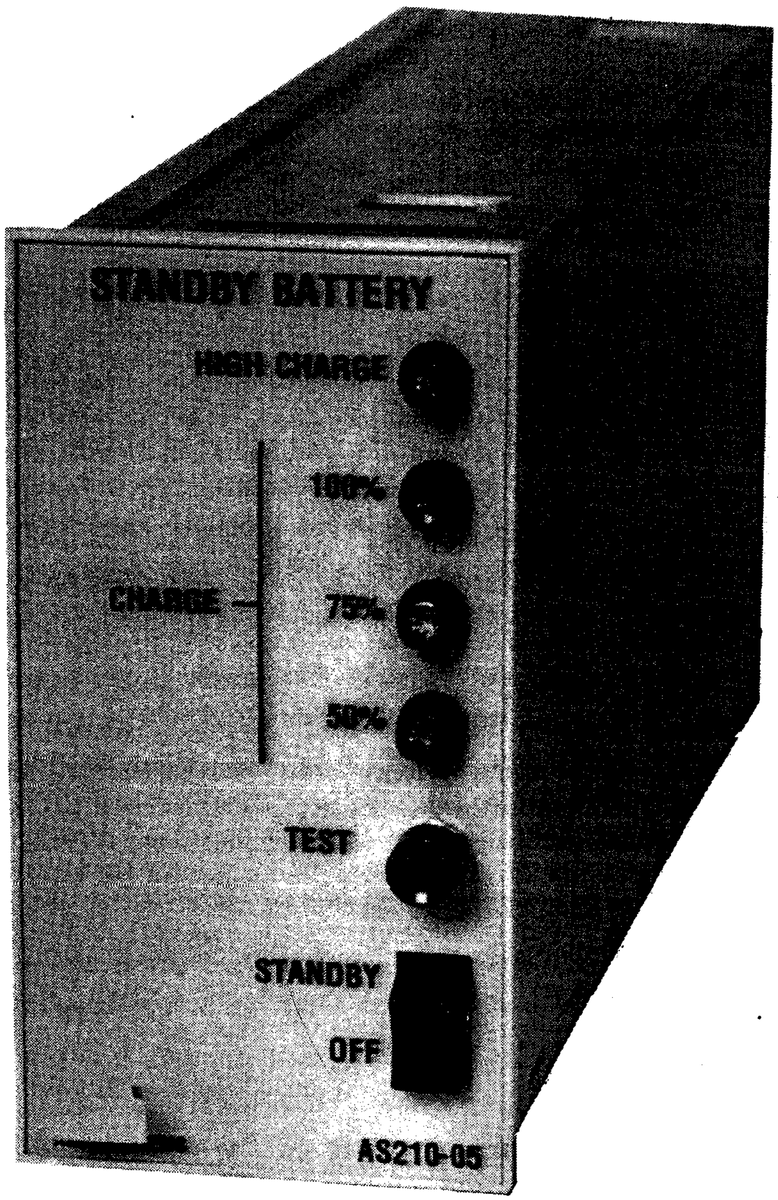


Figure 1.1 AS210-05 Standby Battery Module

CHAPTER 2
INSTALLATION

2-1 INTRODUCTION

The Standby Battery is a plug-in module of the Electronic Counter and Frequency Standard Calibration system. The module is retained by a removable locking bar on the mainframe. The Standby Battery requires no special power or handling. It will normally be installed during transit of the instrument or when prime power has been disconnected.

NOTE 1: This module cannot be installed in a Tektronix mainframe.

NOTE 2: Prior to shipment, the battery will be disconnected at the factory by removing the 5 amp fuse. Reinstall the 5 amp fuse carefully to avoid shorting the battery before operation.

NOTE 3: The Standby Battery Module should not be left in the standby position when the module is not plugged into the AS210 mainframe. When inserted into the mainframe, the module should not be left in the standby position for periods in excess of three hours, when mainframe power is off. If one of the above conditions occurs, damage could result to the internal battery pack which would require replacement of batteries.

CHAPTER 3
OPERATION

3-1 INTRODUCTION

This chapter describes the operation of the standby battery module. Figure 3.1 and Table 3-1 illustrate and describe the front panel controls and indicators. No operator interface is required other than observation of the charge condition and placing the unit in the standby or off mode.

Table 3-1

STANDBY BATTERY CONTROLS AND INDICATORS

INDEX NO. FIGURE 3.1	PANEL MARKING	FUNCTION
1	HIGH CHARGE	LED indicator illuminates when the module is in the high charge rate mode (250 mA).
2	100%	LED indicator is ON when battery is fully charged. Lights when TEST switch is pressed to check charge condition.
3	75%	LED indicator is ON when battery is above 75 percent of fully charged condition. Lights when switch is pressed to check charge condition.
4	50%	LED indicator is ON when battery is above 50 percent of fully charged condition. Lights when switch is pressed to check charge condition.
5	TEST	Momentary switch is pressed to check battery charge condition. See items 2, 3, and 4.
6	STANDBY/OFF	Switch for selecting the STANDBY or OFF mode of the module. In the STANDBY position the batteries are automatically inserted in the circuit when prime power is lost or disconnected.
7	None	Release mechanism used for plug-in, removal and retention of the module.

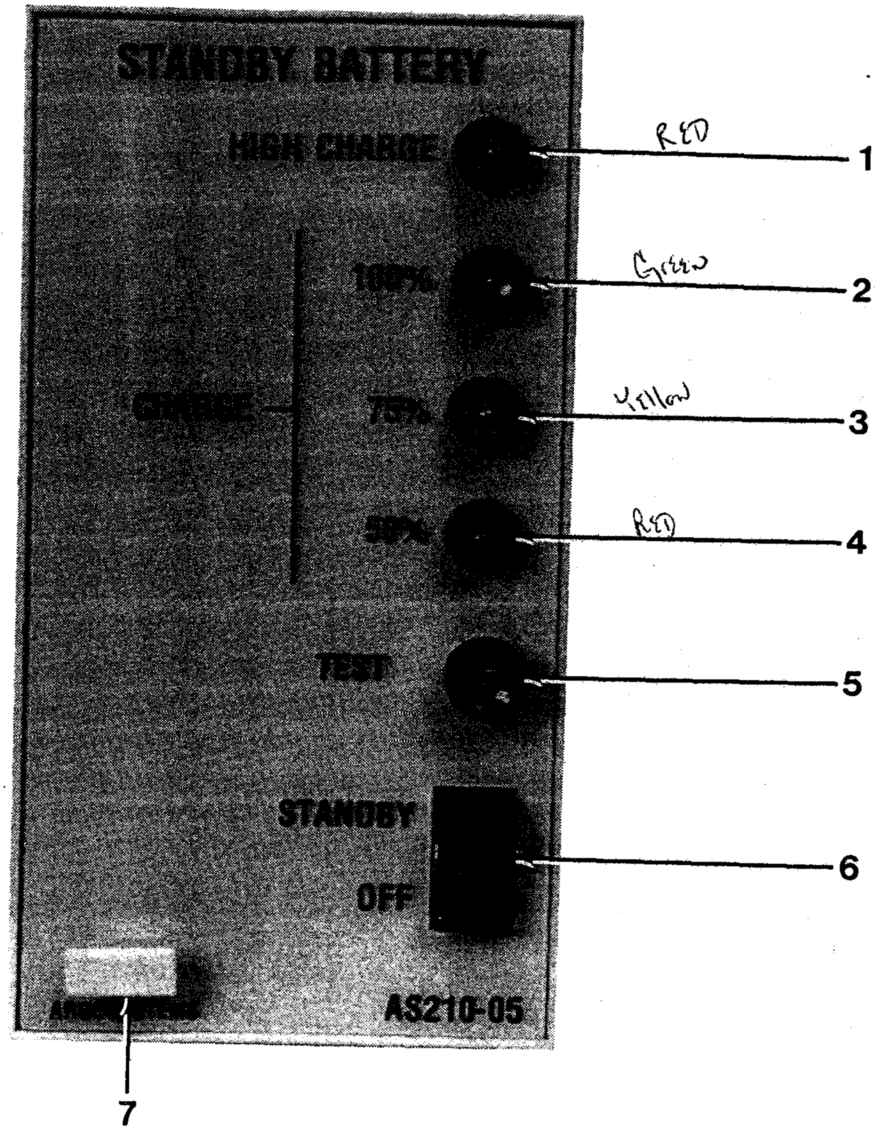


Figure 3.1 Standby Battery Controls and Indicators

CHAPTER 4
THEORY OF OPERATION

4-1 INTRODUCTION

This chapter contains a functional description of the Standby Battery. Figure 4.1 is a functional block diagram. Refer to the schematic diagram, Figure 5.1 for more circuit details.

The primary purpose of the Standby Battery Module is to supply +26V dc power to the Rubidum frequency standard when prime power is removed. The module also provides a regulated charging current for the batteries. The module is comprised of a switching circuit, charging circuit and display driver circuit. When prime power is lost from the mainframe, relay K1 in the switching circuit goes to the N.C. position, allowing current to flow from the battery through the standby switch to the Rubidium frequency standard in the mainframe. A low voltage dropout relay, K2, disconnects the battery from the standard when voltage falls below 20V dc, preventing the batteries from being destroyed. The dropout circuit is disabled when the battery voltage rises above 24V dc. While prime power is being maintained, 31V dc from the mainframe power supply is applied to the charging circuit. A 250 mA charging current is maintained through series pass transistor Q1. Variable resistor R7 forms a voltage divider with R9 and R10. This turns Q1 OFF when the battery voltage reaches 28.6V dc. The HIGH CHARGE lamp will remain OFF until the battery voltage drops below 27.5V dc. A trickle charge is applied to the battery through R16 when the high charge circuit is OFF. While the charger is in the high current mode the HIGH CHARGE LED indicator is lighted on the front panel. When the battery voltage equals 28.2V dc, a voltage limiter circuit consisting of Q4 shunts the trickle charging current to ground. The voltage limit is set with R11 which forms a voltage divider with zener CR2

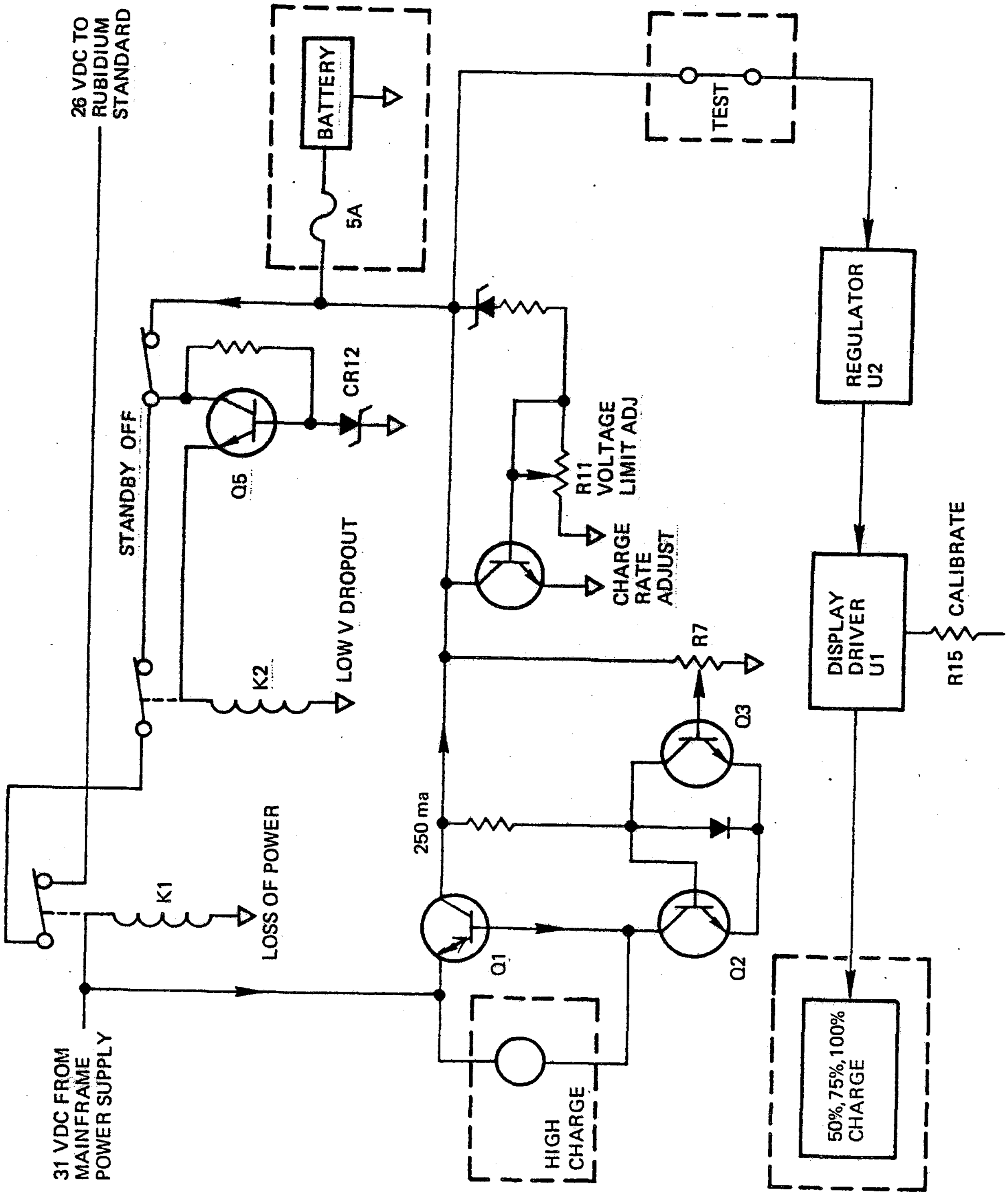


Figure 4.1 Standby Battery Functional Block Diagram

and R6. When the TEST button on the module's front panel is pressed, the battery voltage is applied to the display driver circuit. This circuit consists of a load resistor R5, regulator U2 and dot/bar display driver IC device U1. The display driver is calibrated by R15 to light three LED indicators on the module's front panel. At 25V dc the green 100 percent lamp is lit, at approximately 24V dc the yellow 75 percent lamp is lit. The red 50 percent lamp is illuminated at approximately 23V dc. When the battery's TEST switch is pressed, a 100 ohm load is maintained by R5 in order to test the battery under load condition when it is not connected to the Rubidium standard.

CHAPTER 5
MAINTENANCE AND CALIBRATION

5-1 INTRODUCTION

The purpose of this chapter is to provide maintenance and calibration data for the AS210-05 Standby Battery. Section I covers routine preventive maintenance procedures. Section II outlines performance tests for the Standby Battery. Section III contains the calibration/alignment procedures for the AS210-05 module and Section IV describes troubleshooting data. Please contact the factory for any assistance required in the maintenance or servicing of the AS210-05.

SECTION I

5-2 PREVENTIVE MAINTENANCE

Table 5-1 lists preventive maintenance checks and services which should be performed regularly.

Table 5-1

PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURES
CABLES	Visually inspect cables for strained, cut, frayed, or other damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfaces as follows: A. Remove the dust and loose dirt with a clean soft cloth. B. Remove dust or dirt from plugs and jacks with a brush. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle.
CORROSION	Make sure exterior surfaces of unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: A. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. B. Brush two coats of paint on base metal to protect it from further corrosion.

SECTION II

5-3 PERFORMANCE TESTS

Performance testing for the AS210-05 Standby Battery is limited to the front panel test button. Upon pressing the front panel test button, LEDs will light corresponding to the percent of charge the battery contains. To charge the AS210-05, simply run the AS210 system with the standby battery installed until the high charge LED goes out or cycles on and off.

SECTION III

5-4 CALIBRATION/ALIGNMENT PROCEDURES

WARNING

The following Calibration/Alignment Procedures (Chapter 5, Section III) and Troubleshooting Procedures (Chapter 5, Section IV) are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that of Routine Maintenance (Chapter 5, Section I) and Performance Testing (Chapter 5, Section II) unless you are qualified to do so.

5-5 ACCESS TO AS210-05 STANDBY BATTERY

Please reference the AS210 mainframe manual for the disassembly procedure of the AS210 system to allow access to the AS210-05 Standby Battery module. Access to the module circuitry itself is gained by removing the two metal side covers with a small straight-blade screwdriver. Place the module on one of its sides so that one cover is facing up. Starting with the end toward the edge connector, insert the screwdriver into one of the slots where the cover mates with the module chassis and pry the cover up. It will be necessary to move along the slot toward the front panel of the module and repeat the prying action to loosen the side of the cover from the module. Repeat this technique to free the other side of the cover from the chassis. Set the free cover clear of the module and flip the module over so that the second cover is now facing up. Repeat the above procedure to free this cover.

5-6 CHARGE INDICATOR ALIGNMENT PROCEDURE

User adjustment should not be required. Initial adjustments are preset at factory. If alignment is considered necessary, please contact the factory.

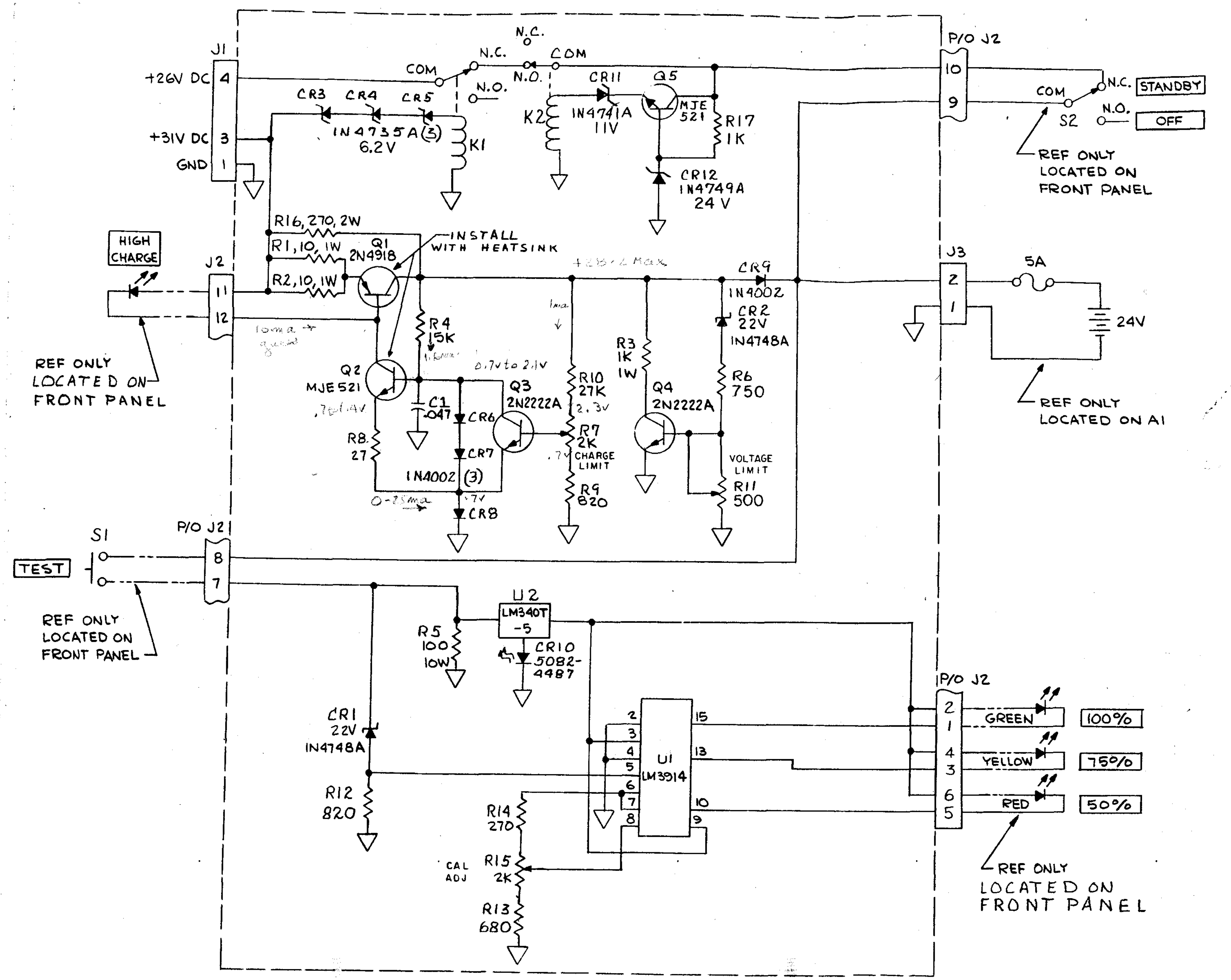
SECTION IV

5-7 TROUBLESHOOTING PROCEDURES

WARNING

Use extreme care when troubleshooting the module. The batteries can deliver a short circuit current of 250 amperes. If accidently shorted, severe burns could result. Never bypass the 5 ampere fuse or replace it with a larger value.

The charge indicators on the front panel of the module provide the operator with the primary troubleshooting data. The indicators are the 100 percent, 75 percent, 50 percent and HIGH CHARGE LEDs described in Chapter 3. The charge percentage indicators give an approximation of the amount of charge on the battery. After the battery has been fully charged, all of the charge percentage indicators should be illuminated. If they are not and it has been determined that the battery is fully charged, check U1, U2 or the LEDs. The determination of battery condition will have to be made with an external charge tester before these components can be declared defective. The HIGH CHARGE indicator should only be on when the battery is being initially charged; thereafter it cycles on and off. If the indicator does not go off (and start cycling on and off) after a maximum of 12 hours of charging, check the battery and charging circuit. If the indicator does not come on, check the 5 ampere fuse and the LED. The LED is part of the charging circuit, therefore the battery will not charge if defective. When the TEST button is pressed, LED CR10 on the circuit board should illuminate. If it does not,check the 5 ampere fuse, battery charge condition, test switch and U2.



NOTES: Unless otherwise specified

1. Interpret drawing in accordance with standard prescribed by MIL-STD-100.
2. All resistance values are in ohms, 1/4W, ± 5 percent.
3. All capacitance values are in µF.
4. ◁— denotes signal ground.
5. Relays shown in standby and mainframe power off.

Figure 5.1 AS210-05 Standby Battery Schematic Diagram

CHAPTER 6
ILLUSTRATED PARTS LIST

6-1 INTRODUCTION

This chapter contains an illustrated parts list for the AS210-05 Standby Battery. The assembly numbers and assembly title are listed at the top of the parts lists. The parts lists are divided into six columns and arranged in the following order:

Column 1 - Item Number

Column 2 - Quantity per assembly.

Column 3 - Manufacturer's Code

Column 4 - Part Number

Column 5 - Description

Column 6 - Reference Designation

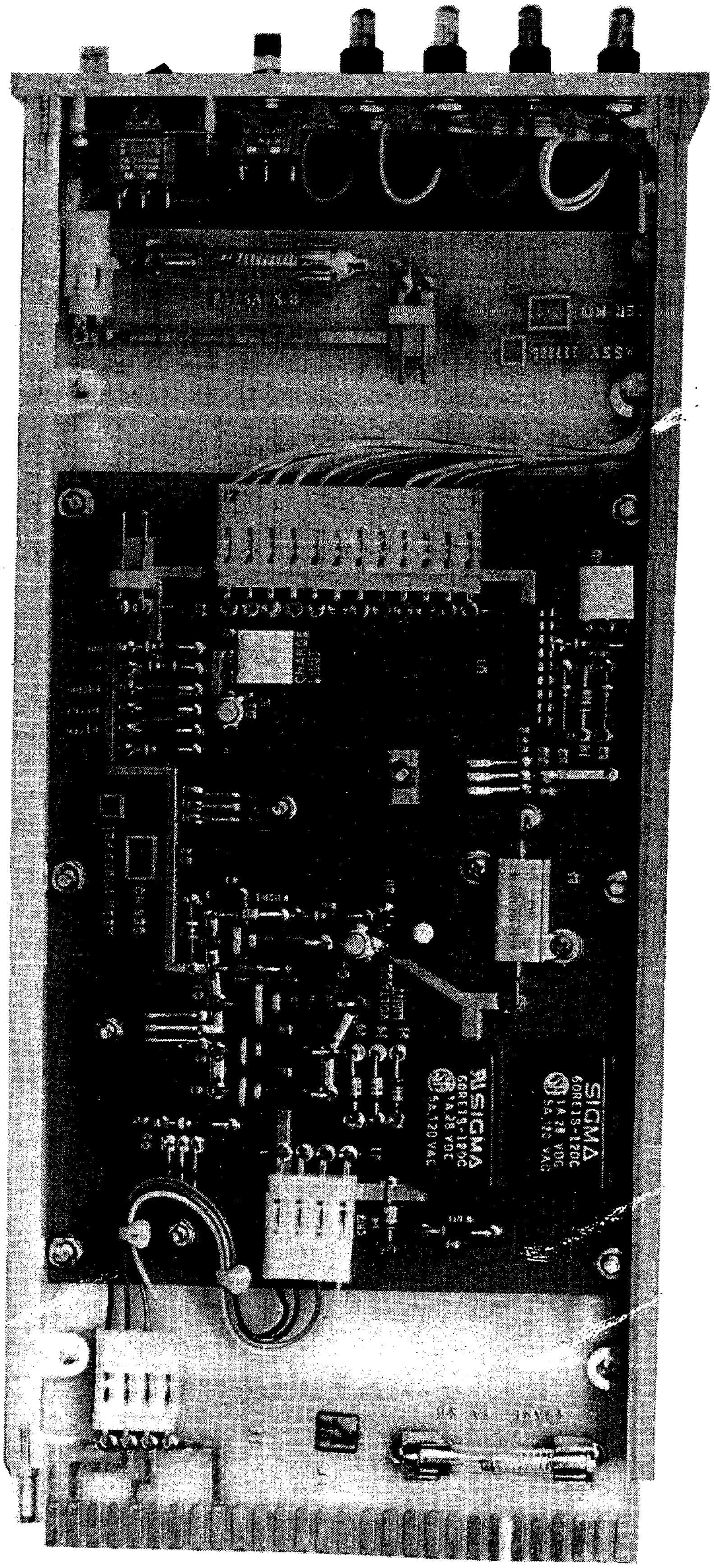


Figure 6.1 AS210-05 Standby Battery Module Assembly

ASSEMBLY NUMBER 117290-01 - STANDBY BATTERY MODULE AS-210-5

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117330-01	Battery Pack Assembly	
2	1	33472	117265-01	Battery Interconnect Assembly	A1
3	1	33472	117270-01	Battery Charger Assembly	A2
4	1	33472	117300-01	Plate, Battery Support	
5	0	06383	PBMS-H25C	Clamp	
6	4	06383	MLT4S-CP	Pan-Steel Ties	
7	6	81349	MS51957-30	Screw: PNH 6-32X1/2	
8	18	81349	NAS620-C6	Reduced OD Flat Washer #6	
9	12	81349	MS35338-136	Split Lock Washer #6	
10	12	81349	NAS671-C6	Small Pattern Hex Nut #6	
11	1	33472	117353-02	Cable Assembly 2 Wire	
12	1	33472	117326	Frame	
13	1	33472	117355-01	Cable Assembly 4 Wire	
14	1	33472	117291-01	Front, Panel, Lexan	
15	0	33472	117295	Wire List	
16	4	03797	0086-13D	Socket, LED	
17	1	50434	5082-4957	LED, Green	100%
18	1	50434	5082-4557	LED, Amber	75%
19	2	50434	5082-4657	LED, Red	50% and High Charge
20	1	09353	8121	Switch, Pushbutton	S1
21	1	09353	7089-2	Small Cap, Black	
22	1	09353	8121	Switch, Pushbutton	S1
23	1	09353	7089-2	Small Cap, Black	
24	1	98353	7101-J1-ZQE	Switch, Toggle, SPDT	S2
25	2	81349	NAS662-C2R8	Screw Flathead 2-56X1/2	
26	1	27264	09-50-7121	Connector, Plug, 12 Pin	

ASSEMBLY NUMBER 117290-01 - STANDBY BATTERY MODULE AS-210-5 (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
27	12	27264	08-50-0108	Pin, Crimp	
28	2	81349	MS35338-134	Split Lock Washer #2	
29	0	81349	ET 24 AWG	Wipe 24 AWG Stranded	
30	1	33472	117291-02	Subpanel, Plastic	
31	1	33472 *	117291-03	Panel, Rear	
32	1	80009	366-1690-01	Latch Pull	
33	1	33472	117291-02	Plastic Panel	
34	1	33472	117291-01	Lexan Panel	
35	1	80009	105-0718-01	Latch	
36	1	80009	105-0719-00	Latch Retainer	
37	1	80009	426-0724-00	Bottom	
38	2	80009	337-1399-00	Side Cover	
39	1	80009	214-1061-00	Tension Spring	
40	1	80009	426-0725-00	Top	
41	2	80009	386-3657-01	Guide Pin	
43	1	81349	0000	Screw FLH STL Sheetmetal	
42	4	81349	MS24693-C26	Scew FLH 6-32X3/8	
43	4	81349	0000	Screw PNH STL Sheetmetal #6X3/8	

ASSEMBLY NUMBER 117265-01 - BATTERY MODEL INTERCONNECT ASSEMBLY A1

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117268-01	PWB	
2	0	33472	1172667021	Schematic	
3	0	33472	117265	Assembly Drawing	
4	1	27264	09-88-2021	2 Pin Connector (Male)	
5	4	75915	102068	Fuse Clip	
6	2	75915	313005	Fuse, 5 Amp, 250V SLO BLO	

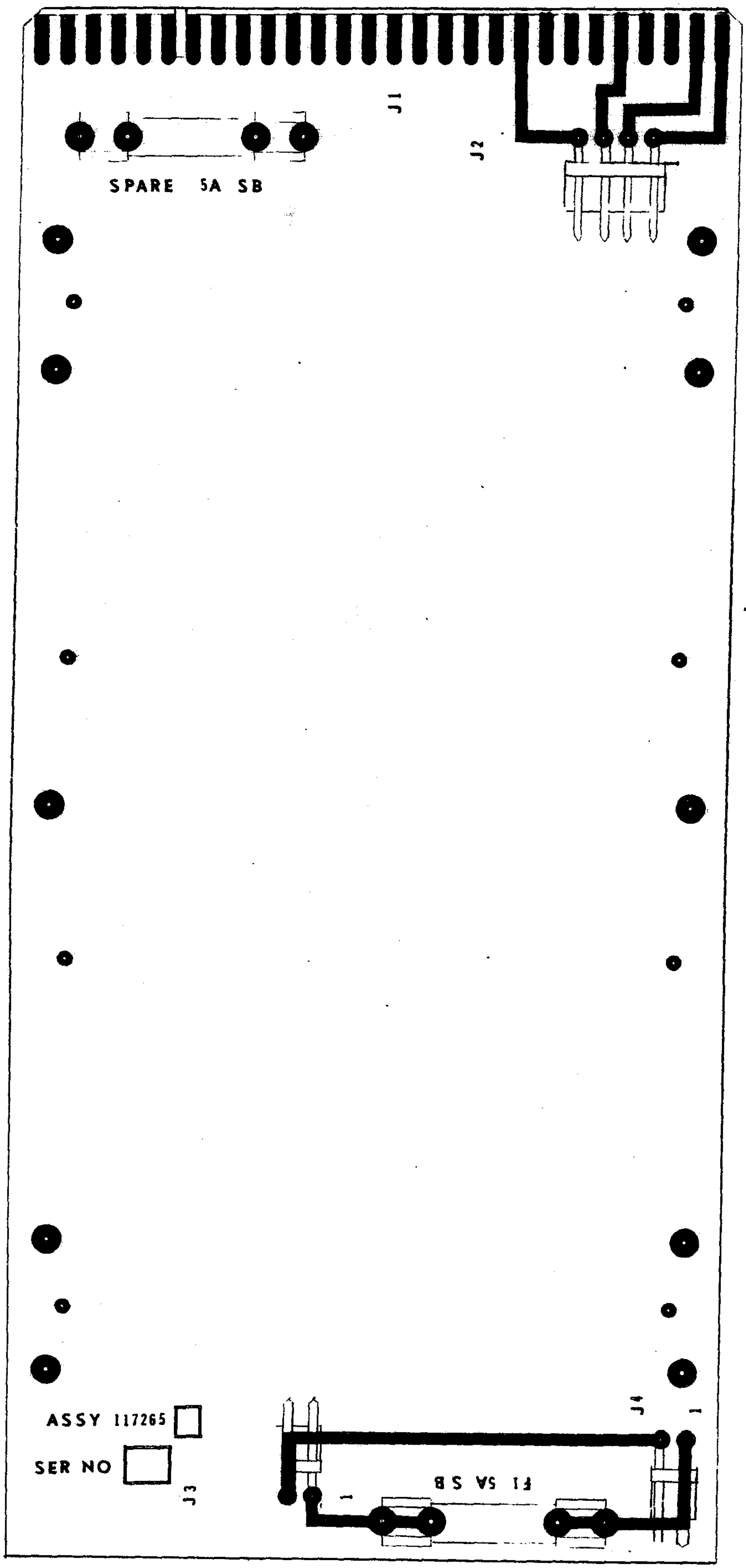


Figure 6.2 AS210-05 Standby Battery Interconnect Assembly

ASSEMBLY NUMBER 117270-01 - BATTERY CHARGER

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	117273	PWB	
2	0	33472	117271	Schematic	
3	0	33472	117270	Assembly Drawing	
4	1	81349	CK05BX473K	.047 UFD 10% Ceramic Cap	C1
5	1	04713	1N4741A	Zener Diode 18V	CR11
6	3	04713	1N4735A	Zener Diode 6.2V	CR3,CR4,CR5
7	1	50434	5082-4487	LED	CR10
8	2	04713	1N4748A	Diode, Zener 22V	CR1,CR2
9	4	27014	1N4002	Diode	CR6,CR7,CR8, CR9
10	1	27264	09-88-2041	4 Pin Wafer, RT Angle	J1
11	1	27264	09-88-2121	12 Pin Wafer, RT Angle	J2
12	2	78277	60RE1S-12DC	Relay	K1,K2
13	1	27264	09-88-2021	2 Pin Wafer, RT Angle	J3
14	1	04713	1N4749A	Zener Diode 24V	CR12
15	1	04713	2N4918	Transistor	Q1
16	2	04713	MJE521	Transistor	Q2,Q5
17	2	27014	2N2222A	Transistor	Q3,Q4
18	2	13103	6073B	Heat Sink	
19	2	81349	MS51957-16	Screw: PNH 4-40X7/16	
20	3	81349	MS51957-15	Screw: PNH 4-40X3/8	
21	1	81349	MS51957-14	Screw: PNH 4-40X5/16	
22	8	81349	NAS620-C4	Reduced OD Flat Washer #4	
23	8	81349	NAS620-C4	Reduced OD Flat Washer #4	
24	4	81349	MS35338-135	Split Lock Washer #4	
25	4	81349	NAS671-C4	Small Pattern Hex Nut #4	
26	2	81349	MS1957-4	Screw: PNH 2-56X5/16	
27	4	81349	NAS620-C2	Reduced OD Flat Washer #2	

ASSEMBLY NUMBER 117270-01 - BATTERY CHARGER (Continued)

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
28	2	81349	MS35338-134	Split Lock Washer #2	
29	2	81349	NAS671-C2	Small Pattern Hex Nut #2	
30	1	81349	RCR07G153JS	15K ohm 5% 1/4W Carbon Comp.	R4
31	1	81349	RCR07G270JS	27 ohm 5% 1/4W Carbon Comp	R8
32	1	81349	RCR07G271JS	270 ohm 5% 1/4W Carbon Comp	R14
33	1	81349	RCR07G681JS	680 ohm 5% 1/4W Carbon Comp	R13
34	2	81349	RCR07G821JS	820 ohm 5% 1/4W Carbon Comp	R9,R12
35	2	81349	RCR32G100JS	10 ohm 5% 1W Carbon Comp	R1,R2
36	1	81349	RCR32G102JS	1K ohm 5% 1W, Carbon Comp	R3
37	1	81349	RCR07G102JS	1K ohm 5%1/4W Carbon Comp	R17
38	1	81349	RCR07G751JS	750 ohm 5% 1/4W Carbon Comp	R6
39	1	81349	RCR07G273JS	27K ohm 5% 1/4W Carbon Comp	R10
40	1	81349	RCR42G271JS	270 ohm 5% 2W Carbon Comp	R16
41	1	91637	RE65G1000	100 ohm 1% 10W Resistor	R5
42	2	05712	72XWR2K	2K Potentiometer	R7,R15
43	1	05712	72XWR500	500 ohm Potentiometer	R11
44	1	27014	LM3914	Bar Graph Display Driver	U1
45	1	27014	LM340T-5	5V Regulator	U2
46	1	01295	C9318-02	18 Pin Socket	

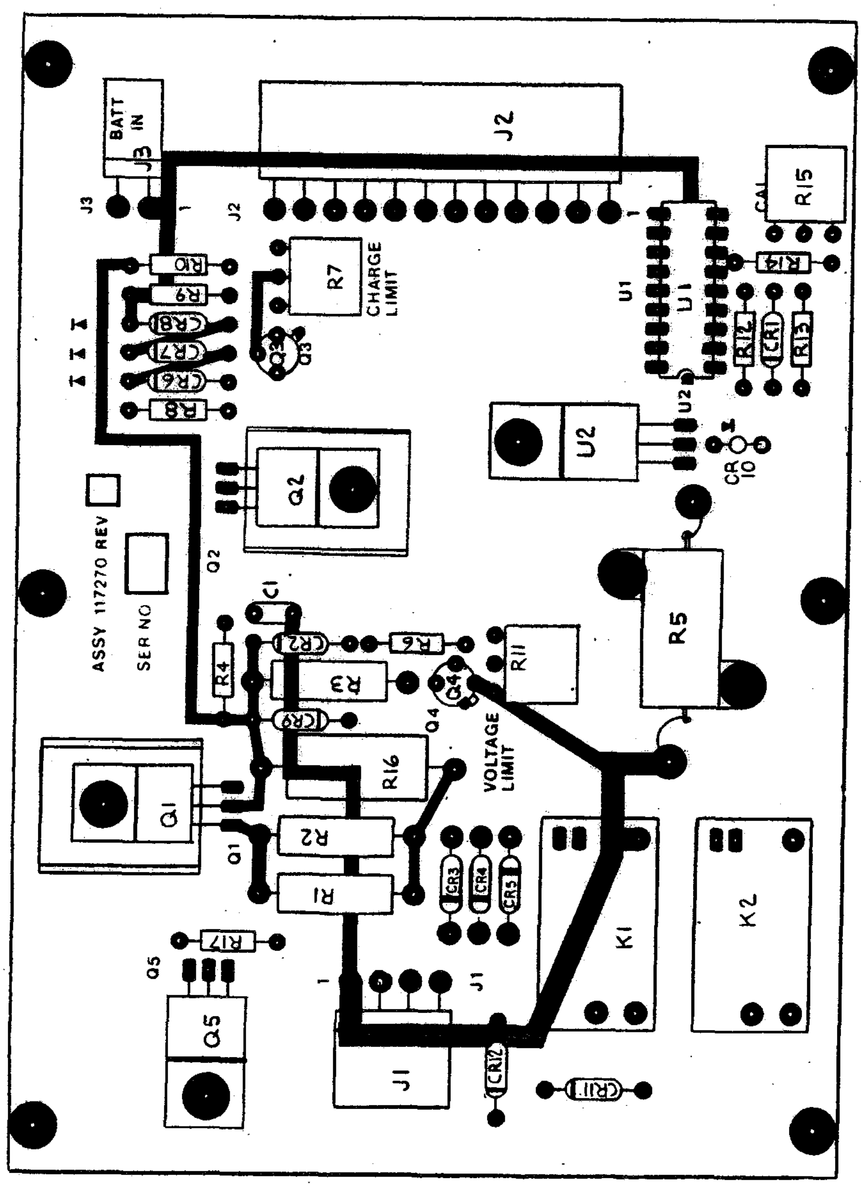


Figure 6.3 AS210-05 Standby Battery Charging Assembly

ASSEMBLY NUMBER 117353-02 - CABLE ASSEMBLY

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	27264	09-50-7021	Connector, 2 Pin	
2	2	27264	08-50-0108	Pin Crimp	
3	0	81349	ET 26 AWG	Wire Stranded Teflon Insulated	

ASSEMBLY NUMBER 117355-01 - CABLE ASSEMBLY

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	27264	09-50-7041	Connector, 4 Pin	
2	4	27264	08-50-0108	Pin Crimp	
3	0	81349	ET 26 AWG	Wire 26 Gauge Stranded	

6-2 MANUFACTURER'S LIST CODE TO NAME

This section contains all manufacturer's codes for materials used in the AS210 system. The codes are listed in numerical order by code.

MANUFACTURER'S LIST CODE TO NAME

CODE	MANUFACTURER	ADDRESS
00779	AMP, INC	P.O. Box 3608 Harrisburg, PA 17105
01121	ALLEN-BRADLEY COMPANY	1202 South 2nd Street Milwaukee, WI 53204
01139	GENERAL ELECTRIC COMPANY	Silicone Products Business Department Waterford, NY 12188 PHONE: 518-237-3330
01281	TRW, INC.	TRW Semiconductor Division 14520 Aviation Boulevard Lawndale, CA 90260
01295	TEXAS INSTRUMENTS, INC.	Semiconductor Group 13500 North Central Expressway P.O.Box 225012 M/S 49 Dallas, TX 75265
02114	AMPEREX ELECTRONIC CORPORATION	Ferroxcub Division 5083 Kings Highway Saugerties, NY 12477
02660	BUNKER RAMO-ELTRA CORPORATION	Amphenol Division 2801 South. 25th Avenue Broadview, IL 60153
02735	RCA CORPORPATION	Solid State Division Route 202 Somerville, NJ 08876
03797	GENISCO TECHNOLOGY CORPORATION	Electronics Division 18435 Susana Road Rancho Dominguez, CA 90221 PHONE: 213-537-4750
04426	ILLINOIS TOOL WORKS, INC.	Licon Division 6615 West Irving Park Road Chicago, IL 60634
04713	MOTOROLA, INC.	Semiconductor Products Sector 5005 East McDowell Road Phoenix, AZ 85008 PHONE: 602-244-7100

CODE	MANUFACTURER	ADDRESS
05245	CORCOM, INC.	1600 Wincheste Road Libertyville, IL 60048
06090	RAYCHEM CORPORATION	300 Constitution Drive Menlo Park, CA 94025
06383	PANDUIT CORPORATION	17301 Ridgeland Tinley Park, IL 60477
06540	MITE CORPORATION	Amatom Electronic Hardware Division 446 Blake Street New Haven, CT 06515
07263	FAIRCHILD CAMERA & INSTRUMENT CORPORATION	Sub of Schlumberger LTD North American Sales Mail Stop 14-1053 401 Ellis Street P. O. Drawer 7284 Mt. View, CA 94042
09353	C AND K COMPONENTS, INC.	15 Riverdale Avenue Newton, MA 02158 PHONE: 617-964-6400
11237	CTS KEENE, INC.	P.O. Box 1977 Paso Robles, CA 93446
12136	PHC INDUSTRIES, INC.	1643 Haddon Avenue Camden, NJ 08103
13103	THERMALLOY COMPANY, INC.	2021 West Valley View Lane P. O. Box 340839 Dallas, TX 75234
13556	TRW CINCH CONNECTORS	Nuline Facility Division of TRW, Inc. New Hope, MN
14099	SEMTECH CORPORATION	652 Mitchell Road Newbury Park, CA 91320 PHONE: 213-628-5392
14655	CORNELL-DUBILIER ELECTRONICS	Div. of Federal Pacific Electric Co. Government Contracts Department 150 Avenue L Newark, NJ 07101

CODE	MANUFACTURER	ADDRESS
15542	MINI-CIRCUITS LABORATORY	Div. of Scientific Components Corp. 2625 East 14th Street Brooklyn, NY 11235
16428	BELDEN ELECTRONIC WIRE & CABLE	Sub of Cooper Industries, Inc. 2200 U.S. Highway 27 South P.O. Box 1980 Richmond, IN 47374 PHONE: 317-983-5200
18612	VISHAY INTERTECHNOLOGY, INC.	Vishay Resistor Products Division 63 Lincoln Highway Malvern, PA 19355
19209	GENERAL ELECTRIC COMPANY	Battery Business Department 441 Highway N P. O. Box 861 Gainesville, FL 32602 PHONE: 904-462-3911
23936	PAMOTOR DIVISION OF WILLIAM J. PURDY COMPANY	770 Airport Boulevard Burlingame, CA 94010
26805	OMNI SPECTRA, INC.	Microwave Connector Division Waltham, MA
26806	AMERICAN ZETTLER, INC.	16881 Hale Avenue Irvine, CA 92714
27014	NATIONAL SEMICONDUCTOR CORPORATION	2900 Semiconductor Drive Santa Clara, CA 95051
27264	MOLEX, INC.	2222 Wellington Court Lisle, IL 60532
32997	BOURNS, INC.	Trimpot Division 1200 Columbia Avenue Riverside, CA
33472	ARGOSYSTEMS, Inc.	884 Hermosa Court Sunnyvale, CA 94086
34649	INTEL CORPORATION	3585 SW 198th Avenue Aloha, OR 97005

CODE	MANUFACTURER	ADDRESS
50088	MOSTEK CORPORATION	Sub of United Technologies Corp. 1215 West Crosby Road P.O. Box 169 Carrollton, TX 75006
50434	HEWLETT-PACKARD COMPANY	Optoelectronics Division 640 Page Mill Road Palo Alto, CA 94304
51642	CENTRE ENGINEERING, INC.	2820 E. College Avenue State College, PA 16801
53387	MINNESOTA MINING AND MANUFACTURING COMPANY	Electronic Products Division 3M Center St. Paul, MN 55101
54893	HEWLETT-PACKARD COMPANY	Microwave Semiconductor Division 350 West Trimble Road San Jose, CA 95131
55154	PLESSEY PERIPHERAL SYSTEMS, INC.	17466 Daimler Avenue P. O. Box 19616 Irvine, CA 92714
55566	R A F ELECTRONIC HARDWARE, INC.	95 Silvermine Road Seymour, CT 06483 PHONE: 203-888-2133
56289	SPRAGUE ELECTRIC COMPANY	87 Marshall Street North Adams, MA 01247
58910	ABBOTT TRANSISTOR LABORATORIES, INC.	Transformer Division 639 South Glenwood Place Burbank, CA 91506
59660	TUSONIX, INC.	2155 North Forbes Boulevard Suite 107 Tucson, AZ 85745
59705	STANDEX INTERNATIONAL CORPORATION	United Service Equipment Co. Div. 1152 Park Avenue Murfreesboro, TN 37130

CODE	MANUFACTURER	ADDRESS
71279	MIDLAND-ROSS CORPORATION	Cambion Division One Alewife Place Cambridge, MA 02140 PHONE: 617-491-5400
71450	CTS CORPORATION	905 North West Boulevard Elkhart, IN 46514
71984	DOW CORNING CORPORATION	3901 South Saginaw Road Midland, MI 48640
73138	BECKMAN INSTRUMENTS, INC.	Helipot Division Sub of Smith Kline/Beckman Corp. 2500 Harbor Boulevard Fullerton, CA 92634
75915	TRACOR LITTLEFUSE, INC.	800 East Northwest Highway Des Plaines, IL 60016
77969	RUBBERCRAFT CORPORATION OF CALIFORNIA LTD.	1800 West 220th Street P.O. Box B Torrance, CA 90507 PHONE: 213-328-5402
78277	SIGMA INSTRUMENTS, INC.	170 Pearl Street South Braintree, MA 02184 PHONE: 617-853-5000
80009	TEKTRONIX, INC.	4900 Southwest Griffith Drive P. O. Box 500 Beaverton, OR 97077
81349	MILITARY SPECIFICATIONS	Promultgated by Military Departments/Agencies Under Authority of Defense Standard- ization Manual 4120 3-M
83330	SMITH HERMAN H. INC.	A North American Philips Company 1913 Atlantic Avenue Manasquan, NJ 08736
88245	WINCHESTER ELECTRONICS	Litton Systems-Useco Division 1536 Saticoy Street Van Nuys, CA 91409
90201	MALLORY CAPACITOR COMPANY	Sub of Emhart Industries, Inc. 4760 Kentucky Avenue P. O. Box 372 Indianapolis, IN 46206

CODE	MANUFACTURER	ADDRESS
91506	AUGAT, INC.	33 Perry Avenue P. O. Box 779 Attleboro, MA 02703
91637	DALE ELECTRONICS, INC.	2064 12th Avenue P.O. Box 609 Columbus, NE 68601 PHONE: 402-563-6301
91836	KINGS ELECTRONICS COMPANY, INC	40 Marbledale Road Tuckahoe, NY 10707 PHONE: 914-793-5000
92194	ALPHA WIRE CORPORATION	71 Lidgerwood Avenue Elizabeth, NJ 07207 PHONE: 201-925-8000
95146	ALCO ELECTRONIC PRODUCTS, INC.	1551 Osgood Street North Andover, MA 01845
95238	CONTINENTAL CONNECTOR CORPORATION	34-63 56th Street Woodside, NY 11377 PHONE: 212-899-4422
95987	WECKESSER COMPANY, INC.	Chicago, IL
98291	SEALECTRO CORPORATION	225 Hoyt Mamaroneck, NY 10544
99800	AMERICAN PRECISION INDUSTRIES, INC.	Delevan Division 270 Quaker Road East Aurora, NY 14052 PHONE: 716-652-3600

M84-0008

AS210-06

MICROWAVE FREQUENCY GENERATOR MODULE

Revised 6 February 1985

M84-0008

ARGOSystems, Inc. / 310 N. Mary Ave., Sunnyvale, California 94086
Telephone (Area Code 408) 737-2000/Telex No. 352077

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LIST OF ILLUSTRATIONS

LIST OF TABLES

PREFACE

This manual contains the installation, operation, and maintenance instructions for the AS210-06 Microwave Frequency Generator Module . The data contained herein is arranged as follows:

Section 1 General Information
Section 2 Installation
Section 3 Operation
Section 4 Theory of Operation
Section 5 Maintenance and Calibration
Section 6 Illustrated Parts List

REFERENCE PUBLICATIONS

MODEL NO.	PUBLICATION TITLE
AS210-PM	Portable Mainframe Operation and Maintenance Manual
AS210-RM, LM	Mainframe Operation and Maintenance Manual
AS210-01A	Module Controller Operation and Maintenance Manual
AS210-02	Frequency Comparator Operation and Maintenance Manual
AS210-03	Frequency Generator Operation and Maintenance Manual
AS210-04	Digital Delay Generator Operation and Maintenance Manual
AS210-05	Standby Battery Operation and Maintenance Manual
AS210-08	Distribution Amplifier Operation and Maintenance Manual
AS210-20	Time Clock Operation and Maintenance Manual

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The AS210-06 Microwave Frequency Generator Module, illustrated in Figure 1-1, is a modular plug-in unit used in the ARGOSystems AS210 Electronic Counter and Frequency Standard Calibration System. This module is used for testing the amplitude and frequency specifications of microwave frequency counters. It provides output frequencies from 1 to 18 GHz in 1 GHz increments with selectable output power levels from -5 to -35 dBm in 5 dB steps. An internal ALC circuit combined with the leveling detector at the end of a low-loss flexible microwave cable provides an output power-level accuracy at the load of better than ±2 dB over a 30 dB dynamic range.

The AS210-06 is compatible with either the AS210A-PM Portable Mainframe, the AS210-RM Rackmount Mainframe, or the AS210-LM Laboratory Mainframe. The AS210-06 is programmable through the IEEE-488 interface in the AS210-01A Module Controller. Descriptions of other modules of the AS210 series are provided in separate publications referenced in the preface and available from ARGOSystems.

1.2 PHYSICAL AND ELECTRICAL DESCRIPTION

The AS210-06 Microwave Frequency Generator Module is modularly constructed for insertion into a compatible AS210 mainframe. The module's front panel contains a thumbwheel switch for selection of operating frequency, a rotary switch for selection of output level, a CAL LED, a precision N output signal connector, and a BNC leveling signal connector.

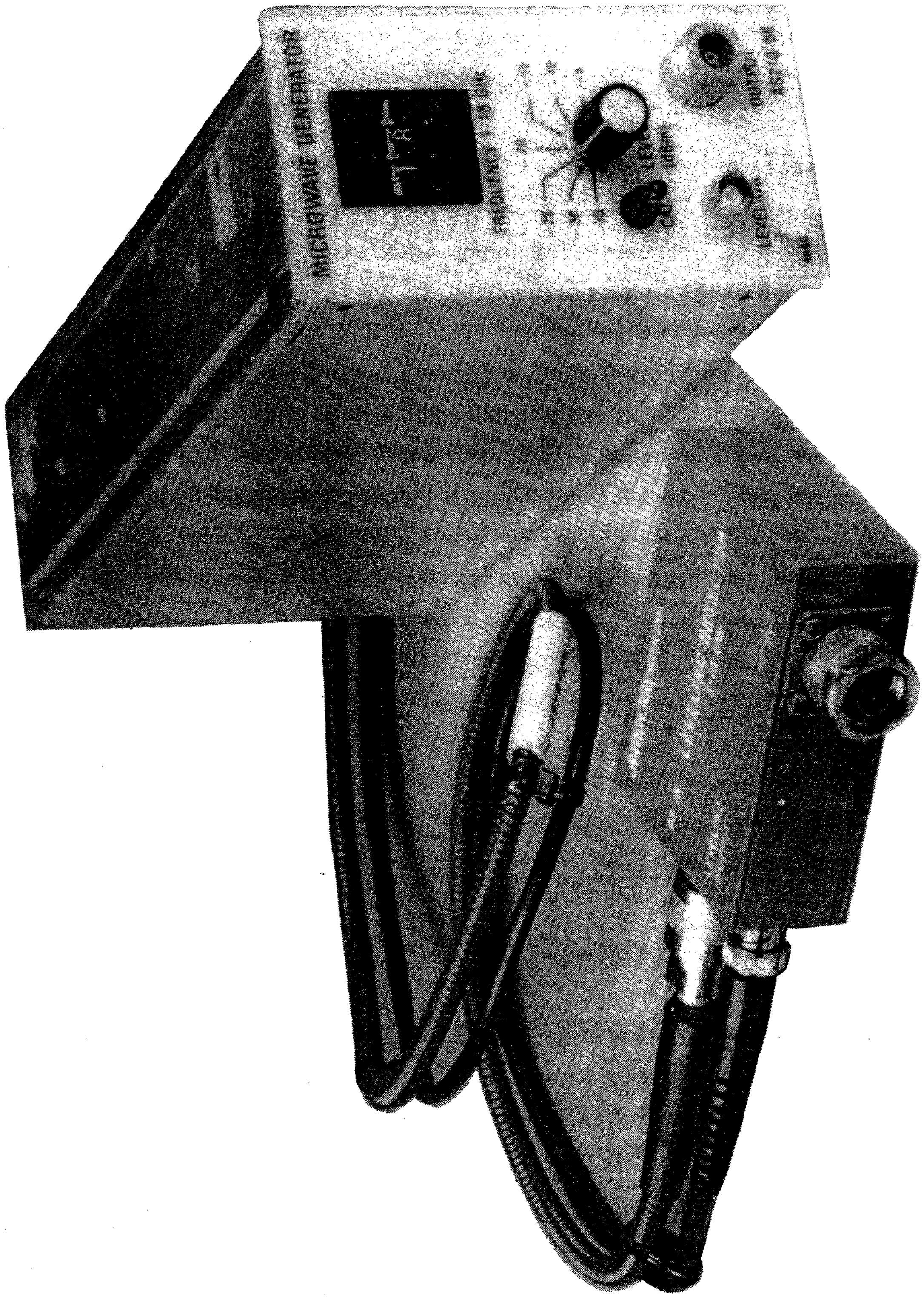


Figure 1-1 AS210-06 Microwave Frequency Generator Module

Internally, the module consists of one each of the following:

- 1 GHz phase-locked oscillator (PLO)
- 1 GHz, 1 watt amplifier
- YIG tuned multiplier
- YIG coil driver
- Microwave switch
- Printed circuit card for control circuitry.

The 1 GHz PLO is phase-locked directly to the 10 MHz output frequency from the Rubidium frequency standard provided by the AS210 mainframe. The 1 GHz PLO has two outputs. The first is the RF sample port, which the microwave switch and control circuitry switches directly to the output connector of the module. The second output is the RF output port, which is amplified and delivered to the input YIG tuned multiplier. Harmonics of the 1 GHz input signal from 2 to 18 GHz are available at the output of the YIG tuned multiplier. The YIG coil driver selects the desired harmonic, which the microwave switch directs to the output connector of the module. At the output connector of the module, all 18 output frequencies from 1 to 18 GHz are available.

A 3-foot flexible cable assembly comprised of a low-loss microwave cable and BNC leveling cable is attached to the AS210-06. At the end of the low-loss cable assembly is a leveling detector. The leveling detector contains a 3 dB power divider and a microwave detector for the precision ALC loop. The final leveled output of the microwave frequency generator is the RF OUT port of the leveling detector.

The frequency and level controls are scanned periodically by the microprocessor in the AS210-01A Module Controller. The data is returned to the AS210-06 Microwave Frequency Generator Module in the form of commands for selecting operating points for the ALC and YIG tuning circuits. Table 1-1 is an equipment specification for the AS210-06 installed in a compatible AS210 Mainframe with the AS210-01A Module Controller.

Table 1-1

AS210-06 EQUIPMENT SPECIFICATIONS

FEATURES	VALUES
OUTPUT FREQUENCIES	
RANGE	1 to 18 GHz
STEP SIZE	1 GHz
FREQUENCY ACCURACY	
VS TEMPERATURE	$\pm 6 \times 10^{11}$ maximum
VS TIME	$\pm 2 \times 10^{11}$ per month
SPURIOUS	
SECOND HARMONIC	20 dB minimum below desired frequency output
THIRD- AND HIGHER-ORDER HARMONICS	30 dB minimum below desired frequency output
NONHARMONIC	30 dB minimum below desired frequency output
OUTPUT LEVELS	
RANGE	- 5 to -35 dBm 1 to 8 GHz -10 to -35 dBm 8 to 12 GHz -15 to -35 dBm 12 to 18 GHz
STEP SIZE	5 dB
ACCURACY	±2 dB
OUTPUT CHARACTERISTICS	
IMPEDANCE	50 ohms
VSWR	Less than 2:1
CONNECTOR	Precision N, male, at leveling head (3-foot cable supplied to connect output to leveling head)
PHYSICAL CHARACTERISTICS	
OPERATING TEMPERATURE	+10 to 40°C
SIZE	Single width plug-in
WEIGHT	6 lb.

SECTION 2
INSTALLATION

2.1 INTRODUCTION

The AS210-06 Microwave Frequency Generator Module plugs into a compatible AS210 Mainframe. The module is electrically connected through a rear edge connector and mechanically retained with a front panel locking bar.

NOTE

Because of the high retention force of the rear card edge connector, the LEVEL switch knob may need to be pulled at the same time as the release mechanism is pulled, to remove the AS210-06 Microwave Frequency Generator Module from the mainframe (see Figure 3-1).

NOTE

The power in the AS210 Mainframe must be OFF when inserting or removing the AS210-06 Microwave Frequency Generator Module.

CAUTION

AS210 series plug-ins will not work in Tektronix TM-500 series mainframes. Severe damage will result if operation in this mode is attempted.

Power and signal interface is provided through the mainframe. The 3-foot, low-loss microwave cable assembly and leveling detector are connected as shown in Figure 2-1.

The flexible cable assembly and leveling head connect to the AS210-06 as shown in Figure 2-1.

NOTE

When installing the low-loss microwave cable assembly and ARGOSystems Leveling Detector, please observe the following:

1. The low-loss microwave cable has a minimum bend radius of 1.5 inches. If the cable is bent to less than the 1.5 inch minimum radius, the cable's electrical performance will be degraded, and failure could result.

2. The connector mating force for the Precision N connectors of the low-loss microwave cable should be 8 to 12 pounds.

3. Do not use the cable assembly as a handle.

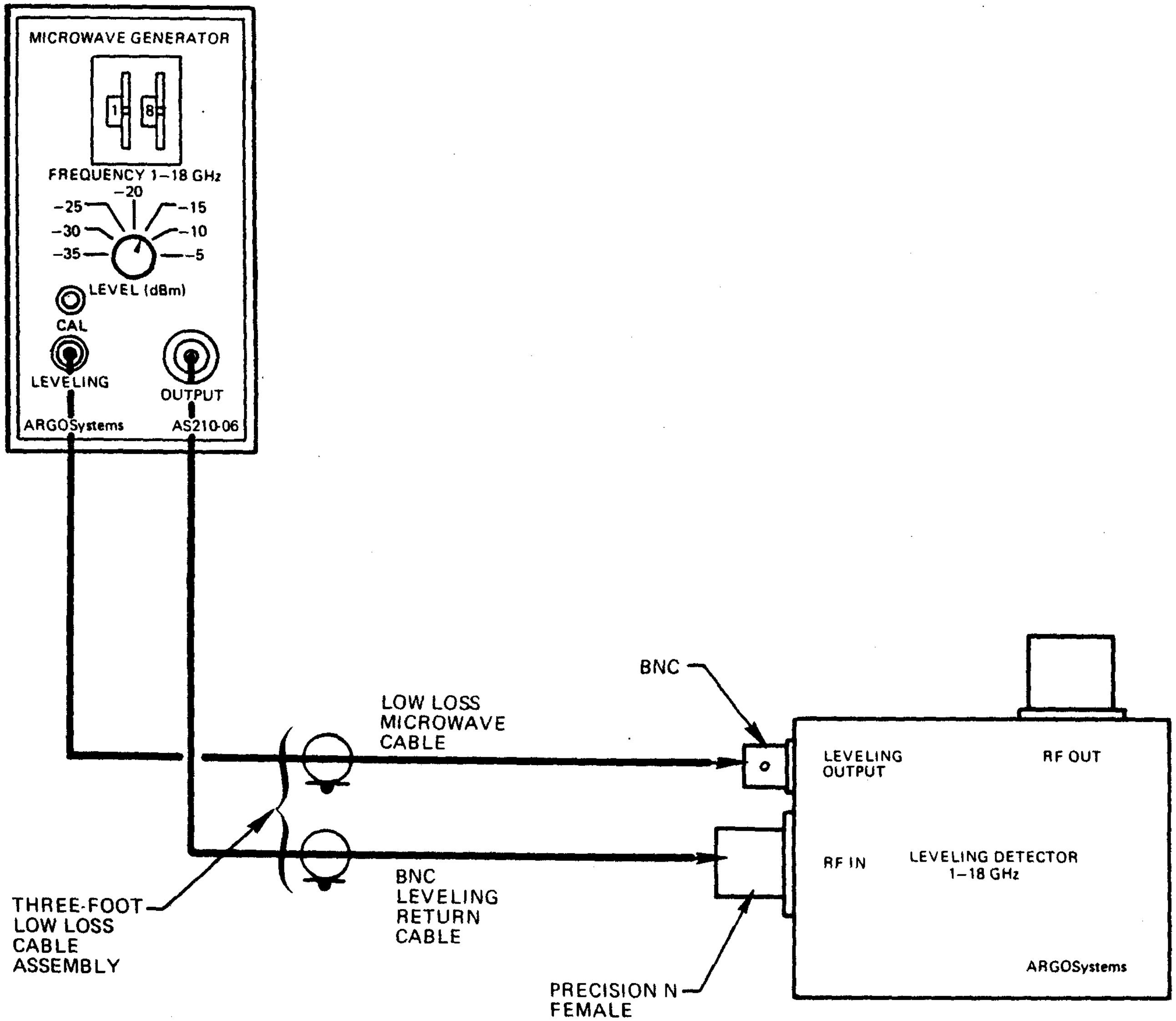


Figure 2-1 Connect Diagram for AS210-06 3-Foot Low-Loss Cable Assembly and for Leveling Detector

SECTION 3
OPERATION

3.1 INTRODUCTION

This section contains operation data and instructions for the AS210-06 Microwave Frequency Generator Module. Operator interface is provided through two controls, two connectors, and an LED on the front panel of the module. The AS210-06 is designed to be used with the AS210-01A Module Controller. However, this interface is transparent to the user of the AS210-06. The AS210-06 operating software, located in the AS210-01A, has a YIG filter calibration software routine that is executed upon detecting an unleveled output signal. This software routine will self-calibrate the YIG filter tuning in the AS210-06 during normal operating conditions. Section 5, Maintenance and Calibration, explains the self-diagnostic capability of the AS210-06 when used with the AS210-01A Module Controller.

3.2 CONTROLS AND CONNECTORS

Figure 3-1 is a front panel view of the AS210-06 Microwave Frequency Generator Module with indexed numbers keyed to Table 3-1. Figure 3-2 is a top view of the leveling detector showing connectors and indexed numbers keyed to Table 3-2.

3.3 OPERATING INSTRUCTIONS

The AS210-06 Microwave Frequency Generator Module is connected to the instrument under test via the RF OUT port located on the leveling detector assembly. The RF OUT port is a precision N male connector that will mate directly with the input connector found on most microwave counters used today. If the input connector of the instrument under test is not a type N female

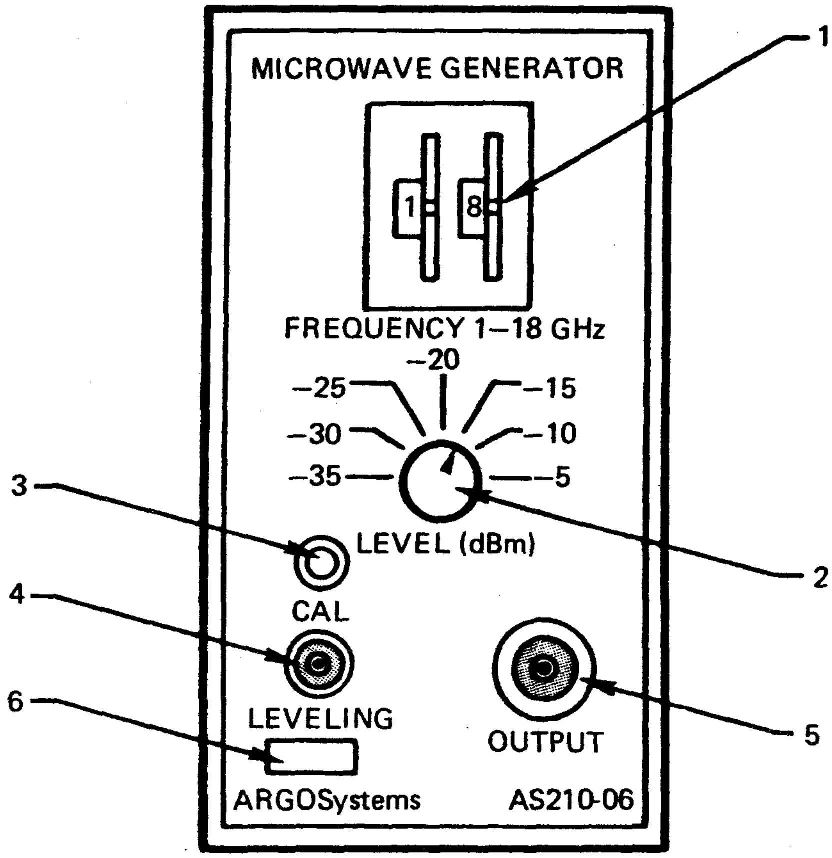


Figure 3-1 AS210-06 Module Front Panel Controls and Connectors

Table 3-1

AS210-06 MODULE FRONT PANEL CONTROLS AND CONNECTORS

INDEX NUMBER (Figure 3-1)	PANEL MARKING	FUNCTION
1	FREQUENCY 1 to 18 GHz	Selects one of 18 standard frequencies: 1 to 18 GHz in 1 GHz increments. NOTE: 00 and 19 are not valid operating frequencies and will result in an error condition.
2	LEVEL (dBm)	Selects one of nine output levels: -5 to -35 dBm in 5 dB increments.
3	CAL	Calibration mode LED.
4	LEVELING	ALC return signal input from leveling detector (BNC cable).
5	OUTPUT	Module output connector to RF IN port on leveling detector (low-loss microwave cable).
6	None	Release mechanism.

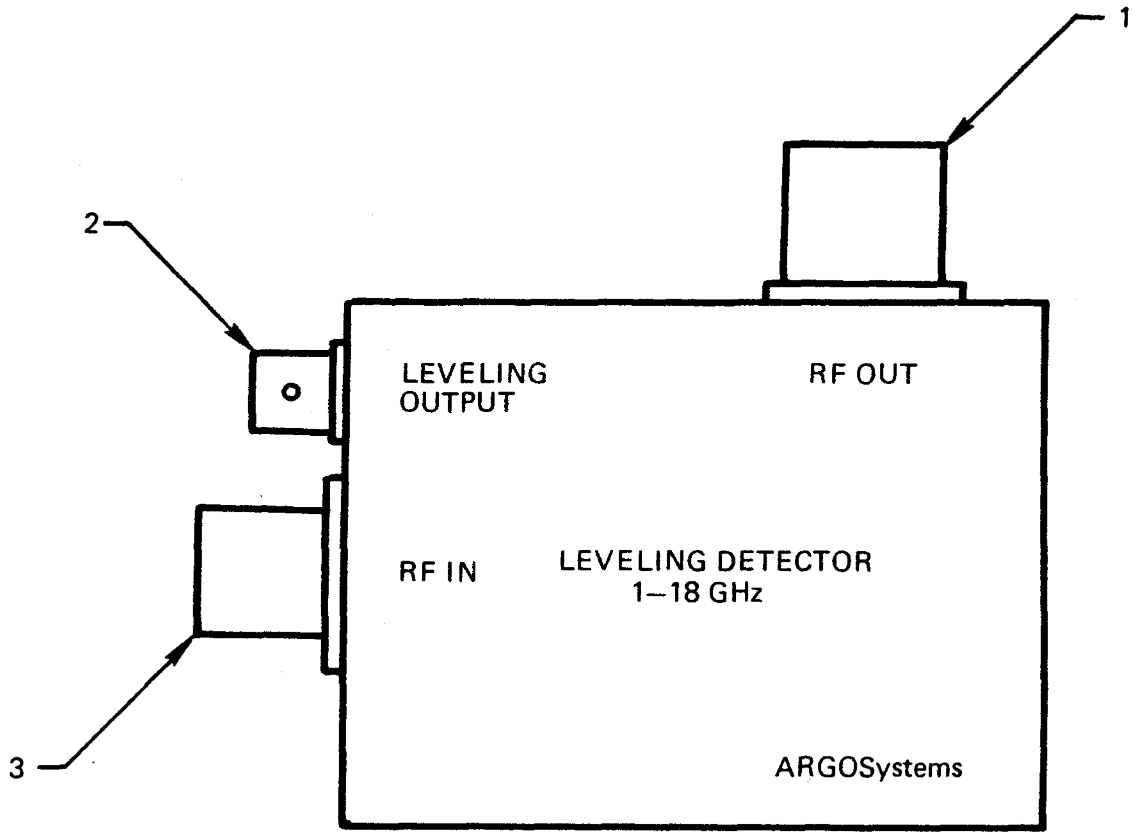


Figure 3-2 AS210-06 Leveling Detector Connectors

Table 3-2

AS210-06 LEVELING DETECTOR CONNECTORS

INDEX NUMBER (Figure 3-2)	PANEL MARKING	FUNCTION
1	RF OUT	Output connector (to instrument under test)
2	LEVELING OUTPUT	ALC return signal to LEVELING BNC on AS210-06 front panel (BNC cable)
3	RF IN	Input connector from module output connector (low-loss microwave cable).

or precision type N female, then an appropriate between-series adapter will have to be used. Select the desired output frequency with the thumbwheel switch, and choose the required output level with the rotary switch. The CAL LED will flash approximately once per second if the YIG filter calibration routine has been initiated. When the AS210-06 Microwave Frequency Generator Module has recalibrated the output signal, the CAL LED will stop flashing and will remain off. The AS210-06 is now ready to perform the desired test. If the AS210-06 is not able to generate the desired output signal level, the CAL LED will stop flashing and will remain lit. The AS210-01A Module Controller will sense this fault and will display an error code. If this condition occurs, consult Section 5, Maintenance and Calibration.

SECTION 4
THEORY OF OPERATION

4.1 INTRODUCTION

This section provides a description of the circuits used in the AS210-06 Microwave Frequency Generator Module. The circuit description is keyed to the functional block diagram (Figure 4-1) and the schematic diagrams included in Section 5. Details of common type circuits (such as power supplies) are not included in this description.

4.2 OVERALL DESCRIPTION

The AS210-06 Microwave Frequency Generator Module consists of the front panel controls and connectors (A4), a control circuit card assembly (A2), and a microwave subsystem (A1, A5, A6, A7). Figure 4-1 is a functional block diagram of the module, depicting how the generator produces standard frequency outputs of 1 to 18 GHz in 1 GHz increments over a 30 dB dynamic range.

The AS210-06 front panel controls select the desired frequency and output level. These front panel controls are interrogated by the AS210-01A Module Controller via the microprocessor interface circuitry located on the control circuit card assembly (A2). The AS210-01A then reads two 12-bit words from the AS210-06, corresponding to the level and frequency desired.

NOTE

The calibration EPROM is matched to the AS210-06 module and the leveling detector and should not be interchanged with other

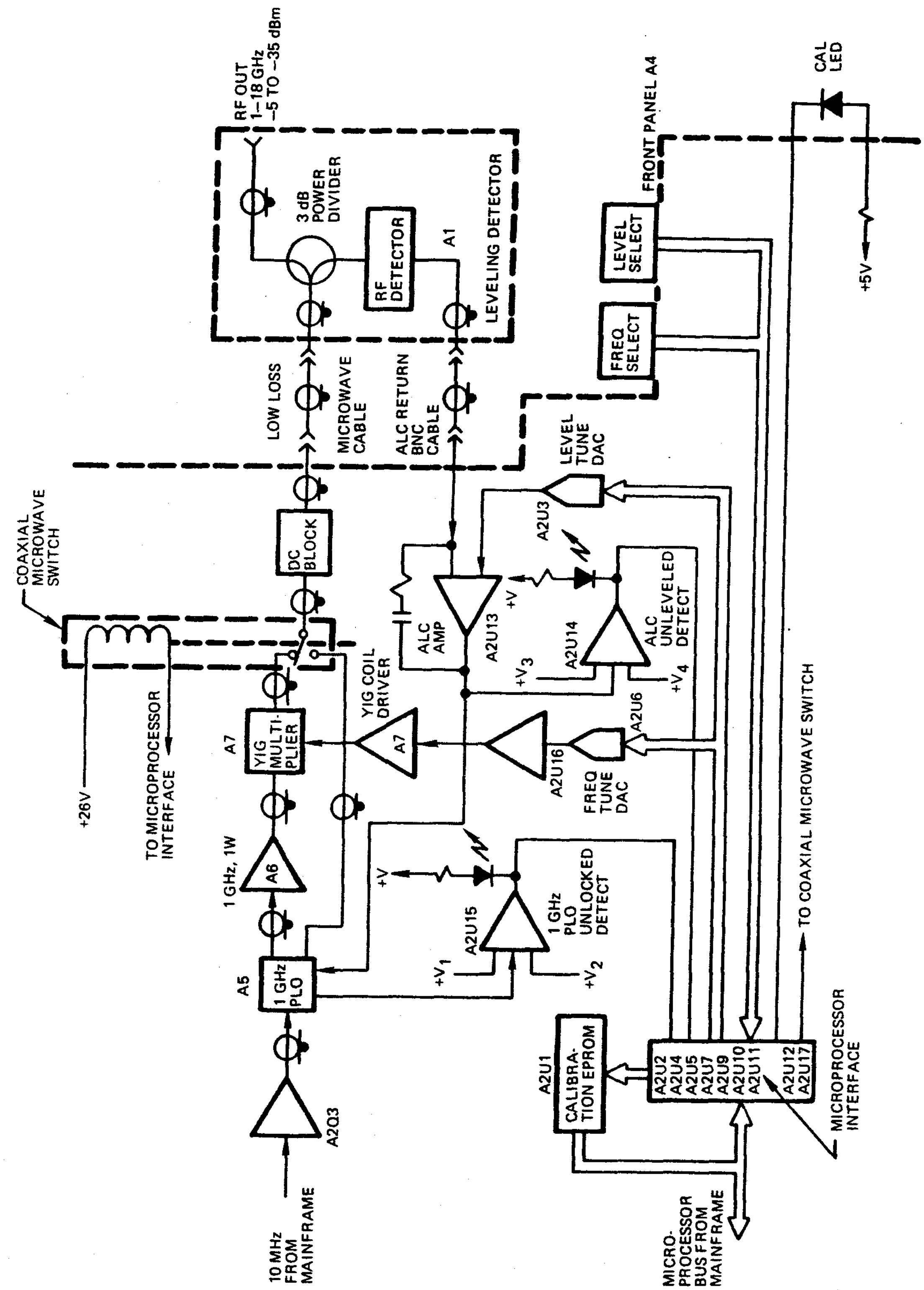


Figure 4-1 Microwave Frequency Generator Module Functional Block Diagram

calibration EPROMs. Automatic calibration software and test fixture are available from ARGOSystems to calibrate and load EPROMs. Consult the factory for additional information.

The AS210-01A then loads these two words back to the AS210-06 control circuitry. If the AS210-01A determines that the AS210-06 is operating in an unleveled condition, the YIG filter tuning calibration software routine will find the new operating words for the AS210-06 and will reload this information to the control circuitry.

The control circuit card assembly consists of the microprocessor interface (A2U2, A2U4, A2U5, A2U7, A2U9, A2U10, A2U11, A2U12, A2U17), a calibration EPROM (A2U1), a frequency tune digital-to-analog converter (DAC) (A2U6), a frequency tune driver amplifier (A2U16), a level tune DAC (A2U3), an ALC amplifier (A2U13), a 1 GHz PLO unlocked detect comparator (A2U15), an ALC unleveled detect comparator (A2U14), a 10 MHz (A2Q3) amplifier for the 1 GHz reference frequency, and power supply circuitry (A2U18, A2U19).

The microwave subsystem consists of the 1 GHz PLO (A5), the 1 GHz 1 watt amplifier (A6), the YIG tuned multiplier (A7), a coaxial microwave switch, a DC block, a low-loss flexible cable assembly, and an ARGOSystems level detector. The level detector contains a 3 dB power divider and RF detector.

4.3 FREQUENCY GENERATION CIRCUITRY

The output frequencies of the AS210-06 Microwave Frequency Generator Module are generated by the microwave subsystem (A1, A5 - A7) and selected by the control circuit card assembly (A2). The 10 MHz signal from the Rubidium frequency standard in the AS210 Mainframe is amplified on the control circuit card assembly (A2) and used as the reference frequency for the 1 GHz PLO (A5).

The 1 GHz PLO has two outputs. The first output is the RF sample port, which the microwave switch and control circuitry switches directly to the output connector of the module. The second output is the RF output port, which is amplified by the 1 GHz, 1 watt power amplifier (A6) and is used to drive the input port of the YIG tuned multiplier (A7).

The YIG tuned multiplier contains a step recovery diode (harmonic generator) matched to a YIG bandpass filter. Harmonics of the 1 GHz input signal from 2 to 18 GHz are available at the output of the YIG tuned multiplier, and the desired output signal is selected by the YIG coil driver. The frequency tune DAC (A2U6) located on the control circuit card assembly accepts the 12-bit frequency tuning word from the AS210-01A Module Controller and tunes the YIG coil driver to select the desired output harmonic. The 2 to 18 GHz band is switched to the module output connector by the microwave switch and control circuitry.

A DC block is included on the output of the microwave switch to prevent any low-level DC signals from feeding through to the output and offsetting the precision ALC circuitry.

The full 1 to 18 GHz output frequency range of the AS210-06 is available at the output connector of the module. The desired output signal is delivered to the level detector (A1) by a low-loss flexible cable. The level detector contains a 3 dB power divider and microwave detector. The output power is divided in half, with one portion being used as the output signal of the system and the other half being detected for the precision ALC circuitry.

4.4 LEVEL CONTROL CIRCUITRY

The precision ALC circuitry of the AS210-06 is located on the control circuit card assembly (A2). The level tune DAC (A2U3) accepts the 12-bit level tuning word from the module controller and creates a voltage reference for the ALC amplifier (A2U13). The ALC amplifier (A2U13) is a precision operational amplifier designed to be an integrator. This amplifier drives a voltage-controlled attenuator located in the 1 GHz PLO (A5) in such a way as to make the detected RF power (a dc voltage) the same value as the voltage reference created by the level tune DAC (A2U3). The detected RF power is fed back from the level detector through a BNC cable to the input of the ALC amplifier on the control circuit card assembly.

4.5 SELF-TEST CIRCUITRY

Two self-test signals are available to the AS210-01A Module Controller via the AS210 Mainframe motherboard. The first is a 1 GHz PLO unlocked detect signal, which will be indicated as an error message on the AS210-01A display. The second is an ALC unleveled detect signal, which, if the AS210-06 is in the 2 to 18 GHz band, will initially start the YIG filter tuning calibration software routine in the AS210-01A. If the YIG filter tuning calibration fails to level the output power, an error message will be shown on the AS210-01A display. If the AS210-06 is in the 1 GHz band, the ALC unleveled detect signal will result in an error message on the AS210-01A display. Refer to Section 5, Maintenance and Calibration, for information about clearing any error messages while operating the AS210-06 Microwave Frequency Generator Module.

NOTE

The AS210-06 leveling detector must be terminated into 50 ohms during self-test. If the unit is not terminated into 50 ohms, false error codes may result.

SECTION 5
MAINTENANCE AND CALIBRATION

5.1 INTRODUCTION

This section provides maintenance and calibration data for the AS210-06 Microwave Frequency Generator Module. Part I covers routine preventive maintenance procedures. Part II outlines performance tests. Part III contains the calibration/ alignment procedures for the AS210-06, and Part IV describes troubleshooting data. Figures 5-4 and 5-5 are the schematic diagrams of the AS210-06. Please contact the factory for any assistance required in the maintenance or servicing of the AS210-06.

PART I
PREVENTATIVE MAINTENANCE

5.2 PREVENTIVE MAINTENANCE CHECKS AND SERVICES

Table 5-1 lists preventive maintenance checks and services that should be performed regularly.

Table 5-1
PREVENTIVE MAINTENANCE CHECKS AND SERVICES

ITEM	PROCEDURE
CABLES	Visually inspect cables for strained, cut, frayed, or otherwise damaged insulation.
CLEANLINESS	Make sure the exterior surfaces of the unit are clean. If necessary, clean exterior surfaces as follows: a. Using a clean, soft cloth, remove the dust and loose dirt. b. Using a brush, remove dust or dirt from plugs and jacks. WARNING Use only warm soapy water for cleaning all plastic parts. Many solvents will cause the plastic to become brittle.
CORROSION	Make sure exterior surfaces of the unit are free of rust and corrosion.
PRESERVATION	Inspect exterior surfaces of the unit for chipped paint or corrosion. If necessary, spot-paint surfaces as follows: a. Remove rust and corrosion from metal surfaces by lightly sanding them with sandpaper. b. Brush two coats of paint on base metal to protect it from further corrosion.

PART II
PERFORMANCE TESTING

5.3 OVERVIEW

Part II describes the procedure to test the AS210-06 Microwave Frequency Generator Module to ensure proper performance of the instrument. The AS210-06 must be used in conjunction with the AS210-01A Module Controller because the CPU in the AS210-01A monitors the controls and output of the AS210-06. The AS210-06 will not operate without the AS210-01A installed. If the AS210-06 fails any of these performance tests, please see Part III, Calibration/Alignment Procedures, or Part IV, Troubleshooting Procedures.

5.4 RF OUTPUT FREQUENCY PERFORMANCE TEST

The following is a procedure for testing the 18 selectable output frequencies of the AS210-06 Microwave Frequency Generator Module. Table 5-2 contains the required equipment to perform this test.

Table 5-2

REQUIRED TEST EQUIPMENT FOR THE
INTERNAL FREQUENCY STANDARD ACCURACY TEST

ITEM	RECOMMENDED TEST EQUIPMENT
MICROWAVE ELECTRONIC FREQUENCY COUNTER	EIP 548 or Hewlett-Packard 5342A or 5343A
COAXIAL CABLE	3 ft long, 50 ohm, BNC

5.5 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system before beginning this procedure.

B. Connect the equipment as indicated in Figure 5-1, and apply power to the AS210. The Rubidium frequency standard in the AS210 system will require 20 minutes warm-up time to reach the specified frequency accuracy.

C. Select the -15 dBm output power level on the AS210-06 front panel. Starting with 1 GHz dialed into the thumbwheel switch for the output frequency, compare the frequency displayed by the microwave counter to Table 5-3 to verify that the output frequency is within the acceptable frequency range for 1 GHz. Continue this process through the remaining 17 output frequencies available from the AS210-06. If any of the frequencies fall out of the limits for acceptable performance, please see Part III, Calibration/Alignment Procedures, or Part IV, Troubleshooting Procedures.

D. Disconnect the microwave frequency counter from the AS210-06.

5.6 RF OUTPUT LEVEL PERFORMANCE TEST

The following is a procedure for testing the seven RF output levels for each of the 18 selectable output frequencies of the AS210-06. The footnotes to Table 5-4 give the required equipment for this performance test.

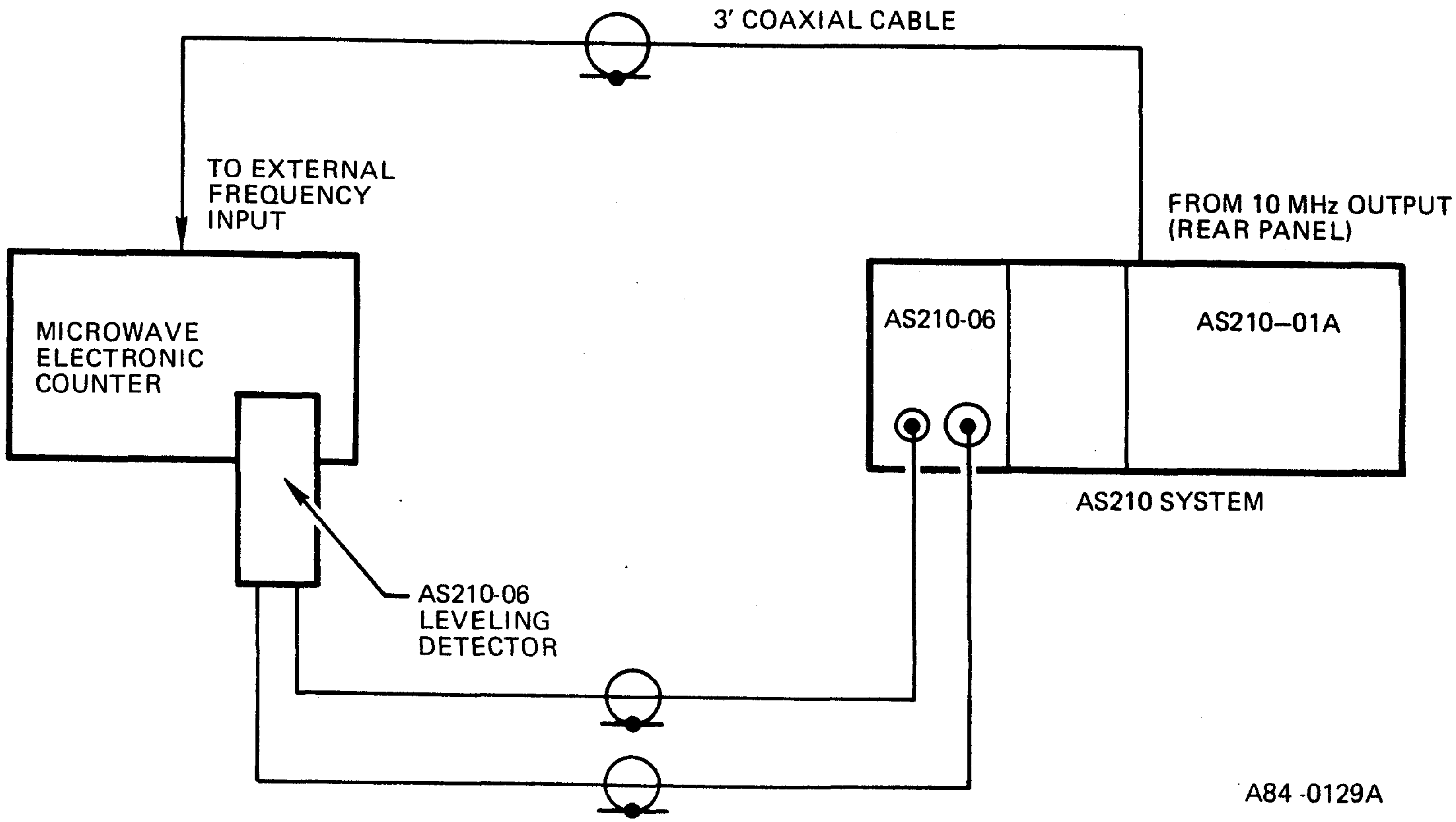


Figure 5-1 AS210-06 Microwave Frequency Generator Module RF Output Frequency Test Configuration

Table 5-3

MINIMUM PERFORMANCE LIMITS FOR
RF OUTPUT FREQUENCIES OF THE AS210-06

FREQUENCY (GHz)	ACCEPTABLE FREQUENCY RANGE
1	1,000,000,000 Hz ±1 Hz
2	2,000,000,000 Hz ±1 Hz
3	3,000,000,000 Hz ±1 Hz
4	4,000,000,000 Hz ±1 Hz
5	5,000,000,000 Hz ±1 Hz
6	6,000,000,000 Hz ±1 Hz
7	7,000,000,000 Hz ±1 Hz
8	8,000,000,000 Hz ±1 Hz
9	9,000,000,000 Hz ±1 Hz
10	10,000,000,000 Hz ±1 Hz
11	11,000,000,000 Hz ±1 Hz
12	12,000,000,000 Hz ±1 Hz
13	13,000,000,000 Hz ±1 Hz
14	14,000,000,000 Hz ±1 Hz
15	15,000,000,000 Hz ±1 Hz
16	16,000,000,000 Hz ±1 Hz
17	17,000,000,000 Hz ±1 Hz
18	18,000,000,000 Hz ±1 Hz

5.7 TEST PROCEDURE

A. Ensure that power is disconnected from the AS210 system and the HP power meter before beginning this procedure.

B. Connect the equipment as indicated in Figure 5-2. Use an HP8481A Power Sensor as the power head. Turn power on to the AS210 system and the HP power meter. Wait for the AS210-01A Module Controller to display SEL?. If the AS210-01A responds with an error message, consult Part III, Calibration/ Alignment Procedures, or Part IV, Troubleshooting Procedures. Note that ERR 0-00 indicates that the Rubidium frequency standard in the AS210 system is not phase locked and will require a maximum of 20 minutes warm-up time to achieve phase lock.

C. Starting with 1 GHz as the selected output frequency of the AS210-06 and -5 dBm as the desired output level, the microwave power meter should read between -3 and -7 dBm for acceptable performance. Next, change the output frequency to 2 GHz and repeat the measurement. Continue this process through 8 GHz.

D. Return the output frequency to 1 GHz. Change the output level to -10 dBm. The microwave power meter should read between -8 and -12 dBm. Repeat this procedure through 12 GHz.

E. Return the output frequency to 1 GHz. Change the output level to -15 dBm. The microwave power meter should read between -13 and -17 dBm. Repeat this procedure through 18 GHz.

F. Turn power off to both the HP power meter and the AS210 system.

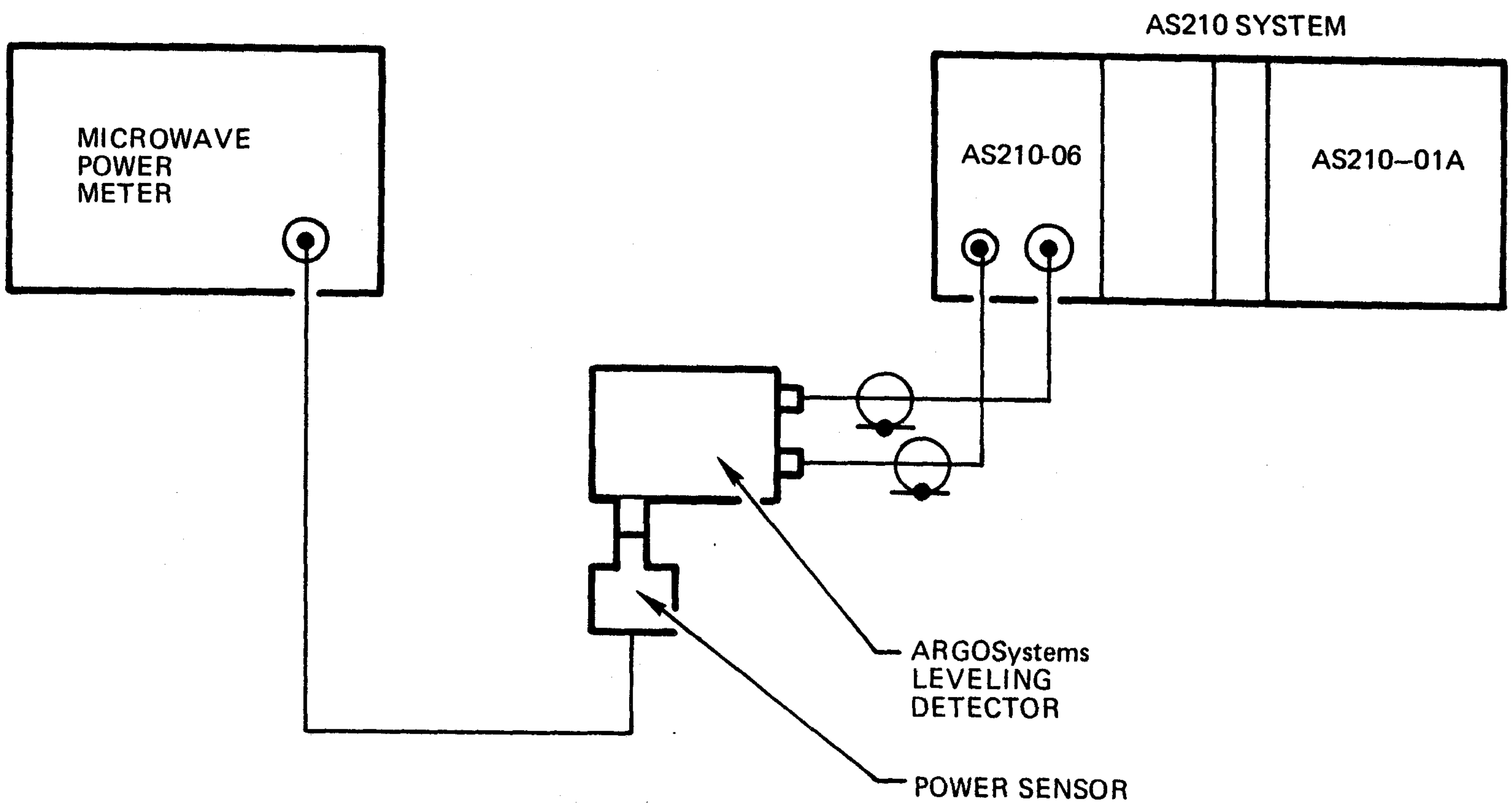


Figure 5-2 AS210-06 Microwave Frequency Generator Module RF Output Level Test Configuration

G. Connect the equipment as indicated in Figure 5-2. Use an HP8484A Power Sensor as the power head. Turn power on to the AS210 system and the HP power meter. Wait for the AS210-01A Module Controller to display SEL?. If the AS210-01A responds with an error message, consult Part III, Calibration/Alignment Procedures, or Part IV, Troubleshooting Procedures. Note that ERR 0-00 indicates that the Rubidium frequency standard in the AS210 system is not phase locked and will require a maximum of 20 minutes warm-up time to achieve phase lock.

H. Turn the output frequency to 1 GHz. Change the output level to -20 dBm. The microwave power meter should read between -18 and -22 dBm. Repeat this procedure through 18 GHz.

I. Return the output frequency to 1 GHz. Change the output level to -25 dBm. The microwave power meter should read between -23 and -17 dBm. Repeat this procedure through 18 GHz.

J. Return the output frequency to 1 GHz. Change the output level to -30 dBm. The microwave power meter should read between -28 and -32 dBm. Repeat this procedure through 18 GHz.

K. Return the output frequency to 1 GHz. Change the output level to -35 dBm. The microwave power meter should read between -33 and -37 dBm. Repeat this procedure through 18 GHz.

L. Table 5-4 is a listing of the minimum performance limits for the RF output level measurements of the AS210-06. If any of the levels fall out of the range for acceptable performance, see Part III, Calibration/Alignment Procedures or Part IV, Troubleshooting Procedures.

M. Disconnect the microwave power meter from the AS210-06.

Table 5-4

MINIMUM PERFORMANCE LIMITS FOR RF OUTPUT LEVEL OF THE AS210-06

OUTPUT FREQUENCY (GHz)	-5 dBm*		-10 dBm*		-15 dBm*		-20 dBm†		-25 dBm†		-30 dBm†		-35 dBm†	
	MIN (dB)	MAX (dB)	MIN (dB)	MAX (dB)	MIN (dB)	MAX (dB)	MIN (dB)	MAX (dB)	MIN (dB)	MAX (dB)	MIN (dB)	MAX (dB)	MIN (dB)	MAX (dB)
1	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
2	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
3	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
4	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
5	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
6	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
7	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
8	-7	-3	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
9	-	-	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
10	-	-	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
11	-	-	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
12	-	-	-12	-8	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
13	-	-	-	-	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
14	-	-	-	-	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
15	-	-	-	-	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
16	-	-	-	-	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
17	-	-	-	-	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33
18	-	-	-	-	-17	-13	-22	-18	-27	-23	-32	-28	-37	-33

*USE HP 8481A POWER SENSOR

†USE HP 8484A POWER SENSOR

PART III
CALIBRATION/ALIGNMENT PROCEDURES

5.8 OVERVIEW

WARNING

The following calibration/alignment procedures (Section 5, Part III) and Troubleshooting Procedures (Section 5, Part IV) are for use by qualified personnel only. To avoid personal injury, do not perform any servicing other than that of routine maintenance (Section 5, Part I) and performance testing (Section 5, Part II) unless you are qualified to do so.

Figure 5-3 is a flow diagram of the Calibration/Alignment Procedure for the AS210-06 Microwave Frequency Generator Module. Use this flow diagram with the theory of operation in Section 4, the text in this section, and the illustrated parts lists in Section 6. The AS210 internal frequency standard calibration data, contained in the AS210 mainframe operation and maintenance manual, is also referenced in this flow diagram. Note that the AS210 system need not be disassembled to determine if calibration/alignment is necessary. For any assistance needed in performing this calibration/alignment procedure, please contact the factory.

5.9 ACCESS TO AS210-06 MICROWAVE FREQUENCY GENERATOR MODULE

Please refer to the AS210 mainframe manual for the AS210 system disassembly procedure allowing access to the AS210-06 Microwave Frequency Generator Module. Access to the module circuitry itself is gained by using a small straight-blade screwdriver to remove the two metal sidecovers. Place the module on one of its sides so that one cover is facing up.

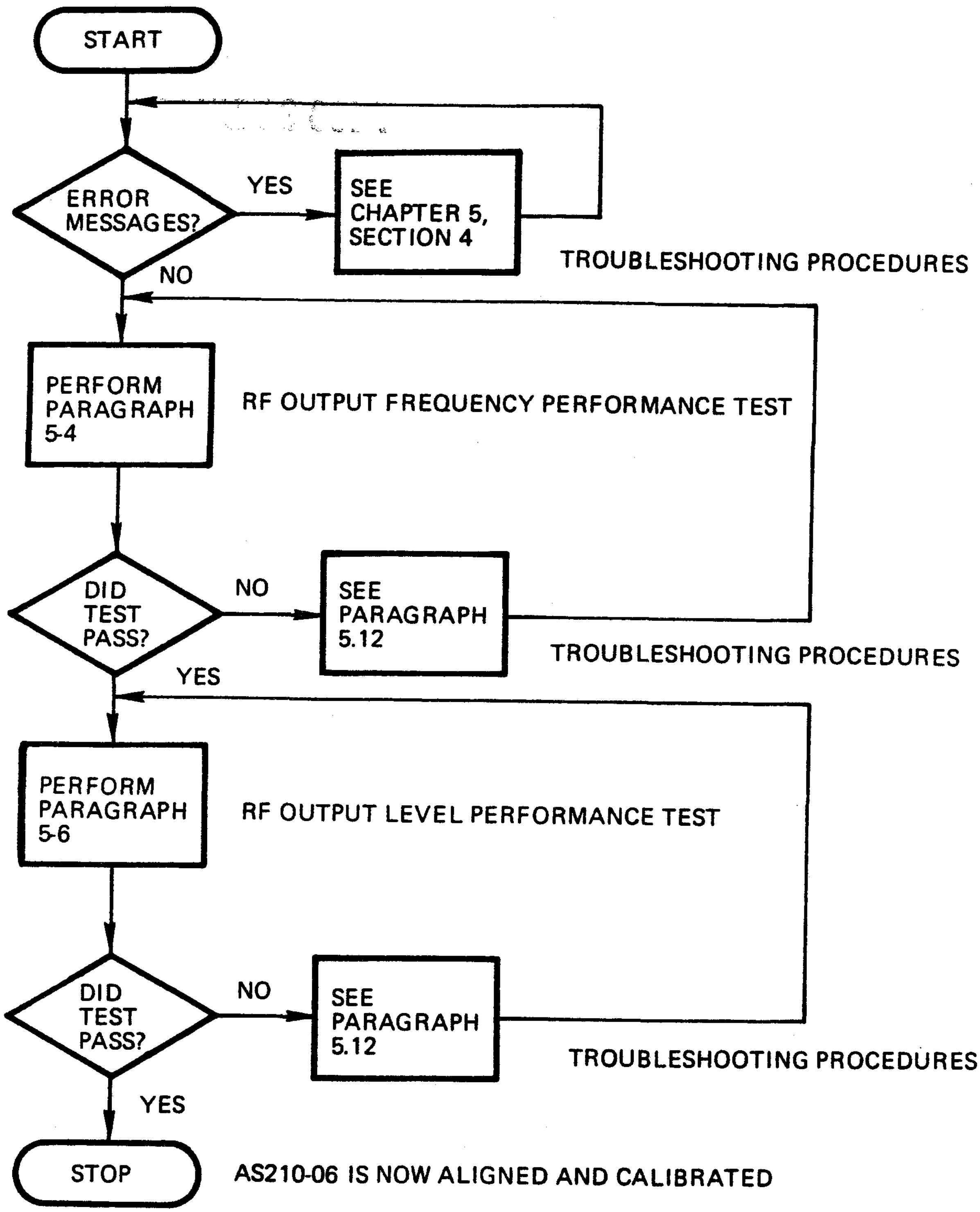


Figure 5-3 Flow Diagram of the Calibration/Alignment Procedure for the AS210-06 Microwave Frequency Generator Module

Starting with the end toward the edge connector, insert the screwdriver into one of the slots where the cover mates with the module chassis, and pry the cover up. You must move along the slot toward the front panel of the module and repeat the prying action to loosen the side of the cover from the module. Repeat this technique to free the other side cover from the chassis. Set the free cover clear of the module, and flip the module over so that the second cover is now facing up. Repeat the above procedure to free this cover.

5.10 ±15V POWER SUPPLY ALIGNMENT

The AS210-06 has two adjustable voltage supplies on the control circuit card. Table 5-5 lists the test equipment recommended to align the ±15 volt supplies. To align the voltages' supplies, use the following procedure:

A. Obtain access to the AS210-06 by using the procedure described in Section 5-9.
B. Monitor the +15 volt supply with the digital voltmeter (DVM) at test point 15V on A2.
C. Adjust A2R28 until the DVM reads +15 ±0.25 volt.
D. Monitor the -15 volt supply with the DVM at test point 15V on A2.
E. Adjust A2R31 until the DVM reads -15 ±0.25 volt.
F. Remove the DVM, and reassemble the AS210-06.

Table 5-5

REQUIRED TEST EQUIPMENT FOR
±15 VOLT POWER SUPPLY ALIGNMENT

ITEM	RECOMMENDED TEST EQUIPMENT
DIGITAL VOLTMETER	Hewlett-Packard 3455A

PART IV
TROUBLESHOOTING PROCEDURES

5.15 OVERVIEW

Troubleshooting the AS210-06 Microwave Frequency Generator Module is facilitated by a combination of error codes displayed on the module controller display and by LED indicators on the control circuit card assembly, A2. The control circuit card is illustrated in Figure 6-3. Table 5-6 correlates the error code, displayed on the module controller when a fault occurs, to the malfunction. An explanation of the problem is provided with possible solutions. Table 5-7 is a list of visual indicators on Circuit Card A2 and of the indicators' meaning. Figures 5-4 and 5-5 are the schematic diagrams of the AS210-06. For further assistance, contact the factory.

NOTE

The AS210-06 leveling detector must be terminated into 50 ohms during self-test. If the unit is not terminated into 50 ohms, false error codes may result.

Table 5-6

ERROR CODE LISTING

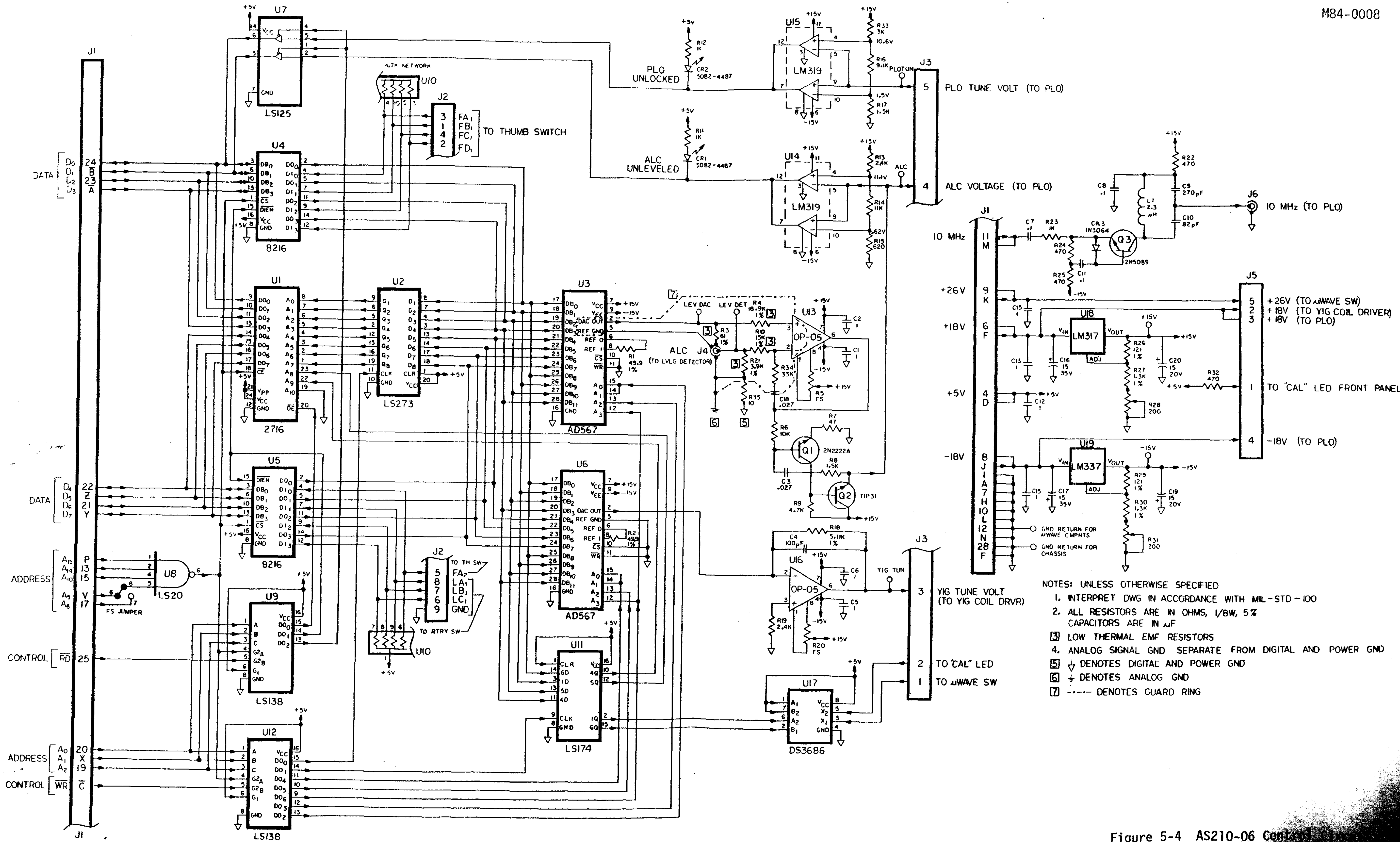
ERROR CODE	PROBLEM	RECOMMENDED SOLUTION
ERR 6-00	Frequency not available	Select proper output frequency.
ERR 6-0X	No leveling loop indication at frequency X X = 1 1 GHz X = 2 2 GHz X = 3 3 GHz . . . . . . X = 9 9 GHz	The AS210-06 may require 10 minutes warm-up time to stabilize the YIG multiplier and associated circuitry. After 10 minutes warm-up, initiate self-test from the front panel of the AS210-01A Module Controller. If the same error condition occurs during or after self-test, or both, then check the ALC circuitry A2U3, A2U13, A2U14, A2Q1, and A2Q2. Also check the microwave switch control circuitry A2U11 and A2U17.
ERR 6-1X	No leveling loop indication at frequency X X = 0 10 GHz X = 1 11 GHz X = 2 12 GHz . . . . . . X = 8 18 GHz	Same as ERR 6-0X.
ERR 6-30	1 GHz source not locked	Check 10 MHz amplifier A2Q3; output should be approximately 0 dBm.
ERR 6-40	Calibration in progress	None. Let calibration routine finish.
ERR 6-50	Unable to level, and level chosen is greater than guaranteed by performance specifications	Select proper output power level.

Table 5-7

VISUAL INDICATIONS

INDICATOR	PROBLEM	RECOMMENDED SOLUTION
A2CR1	ALC Unleveled	Check A2U3, A2U13, A2Q1, A2Q2, A2U14, and A2U16.
A2CR2	PLO Unlocked	Check A2Q3 and A2U15.
CAL LED (Front Panel)	Calibration Program Initiated	Normal operation; see Section 3 for description.

M84-0008



NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DWG IN ACCORDANCE WITH MIL-STD-100
2. ALL RESISTORS ARE IN OHMS, 1/8W, 5%
   CAPACITORS ARE IN µF
3. LOW THERMAL EMF RESISTORS
4. ANALOG SIGNAL GND SEPARATE FROM DIGITAL AND POWER GND
5. DENOTES DIGITAL AND POWER GND
6. DENOTES ANALOG GND
7. -·-·- DENOTES GUARD RING

Figure 5-4 AS210-06 Control Circuit Card Schematic

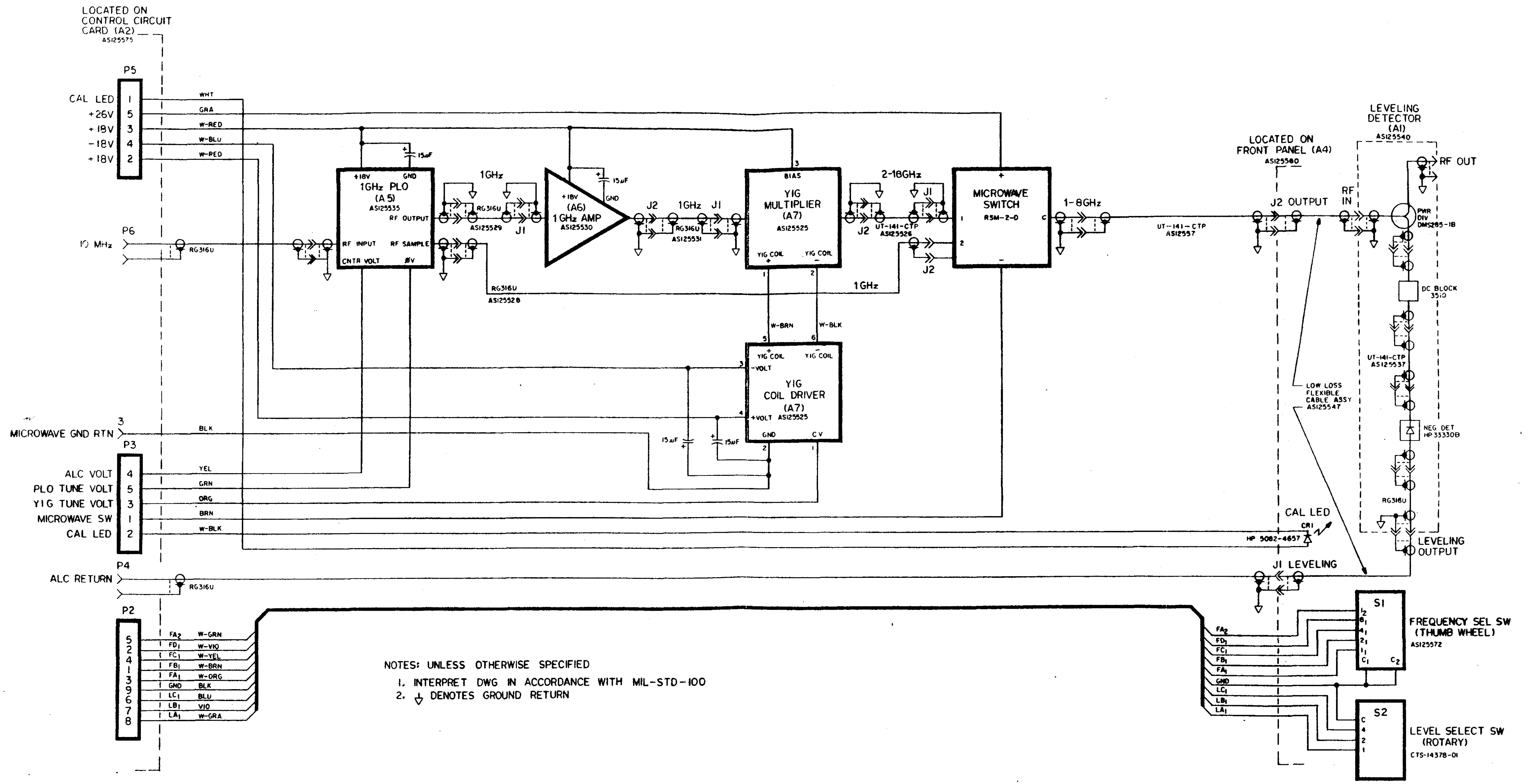


Figure 5-5 AS210-06 Chassis Interconnect Diagram

SECTION 6
ILLUSTRATED PARTS LISTS

6.1 INTRODUCTION

This section contains illustrated parts lists for the AS210-06 Microwave Frequency Generator Module. The assembly number and assembly title are listed at the top of each parts list. The parts lists are divided into six columns and arranged in the following order:

Column 1 - Item Number
Column 2 - Quantity per Assembly.
Column 3 - Manufacturer's Code
Column 4 - Part Number
Column 5 - Description
Column 6 - Reference Designation

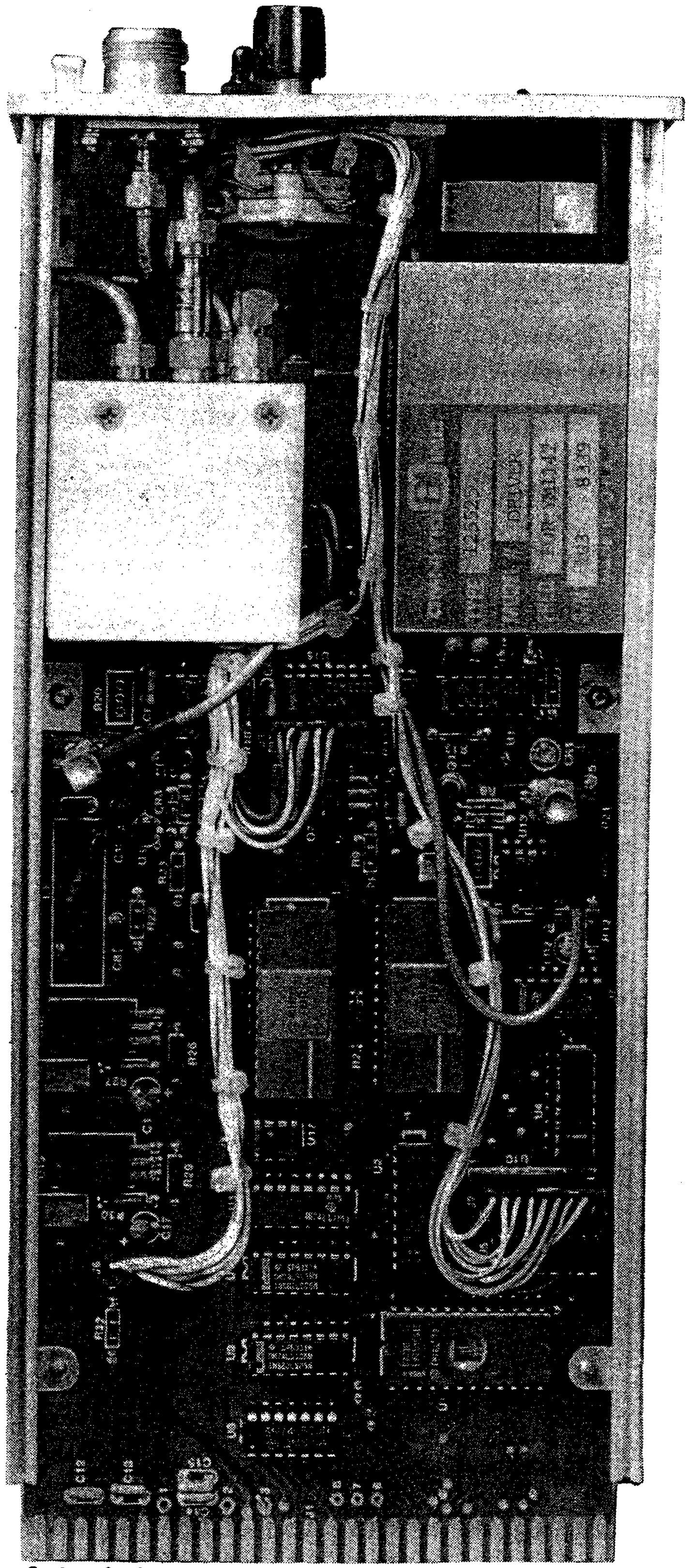


Figure 6-1 AS210-06 Module Showing Control Circuit and Assembly

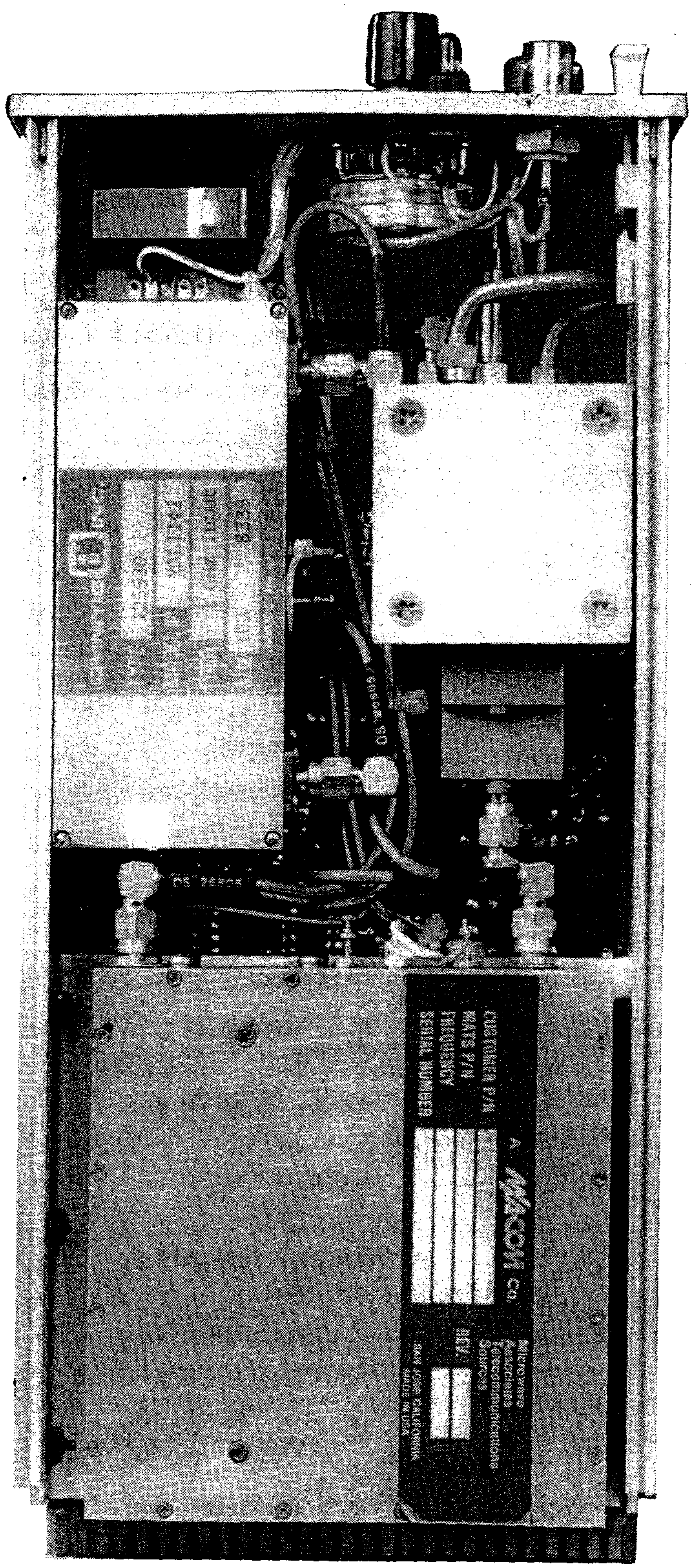


Figure 6-2 AS210-06 Module Showing Microwave Subsystem

PARTS LIST NUMBER 125520 - AS210-06 MICROWAVE FREQUENCY GENERATOR MODULE

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	-	33472	125521	Module Schematic	
2	-	33472	125522	Drawing Tree	
3	1	33472	125525	YIG Tuned Multiplier	A7, A8
4	1	33472	125530	Power Amplifier, 1 GHz	A6
5	1	33472	125538	BNC Cable, 36 in.	
6	1	33472	125535	Oscillator, Phase-Locked, 1 GHz	A5
7	1	-----	104A/91/44CM/11N/11N	Cable, Flex, Low-Loss, 3 ft.	
8	1	33472	125526	Cable Assy., Microwave	
9	1	33472	125527	Cable Assy., Microwave	
10	1	33472	125528	Cable Assy., Microwave	
11	1	33472	125529	Cable Assy., Microwave	
12	1	33472	125531	Cable Assy., Microwave	
13	1	33472	125536	Cable Assy., 10 MHz	
14	1	33472	117200-01, Rev. A	Plate, Mounting	
15	1	54487	RSM-2-D	Switch, SPDT, Microwave	Failsafe A9
16	1	33472	125532	Spacer, Mounting, YIG MULT/RF Switch	
17	1	33472	125533	Bracket, Mounting, YIG MULT/RF Switch	
18	1	33472	125534	Spacer, Mounting, 1 GHz Amp/YIG MULT/Driver	

PARTS LIST NUMBER 125520 - AS210-06 MICROWAVE FREQUENCY GENERATOR MODULE
(Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
19	1	33472	125540	Leveling Head Assy.	A1
20	1	33472	125575	Circuit Card Assy., Control	A2
21	1	33472	125584	Wire Assy., Chassis	A3
22	1	33472	125580	Front Panel Assy.	A4
23	8	06383	SSB25-CO	Sta-Strap Bow-Ty	
24	1	33472	125585	Frame Section, Top	
25	1	33472	125586	Frame Section, Bottom	
26	2	81349	M535338-135	Washer, Lock, #4	
27	2	81349	NAS620-C4	Washer, Flat, Red. O/D, #4	
28	2	33472	125583	Spacer Mounts for Board	
29	4	81349	MS24693-C25	Screw, Fhd., #6-32 x 5/16 in.	
30	2	81349	MS24693-C1	Screw, Fhd., #4-40 x 3/16 in.	
31	14	81349	MS24693-C23	Screw, Fhd., #6-32 x 3/16 in.	
32	2	81349	MS51957-13	Screw, Phd., #4-40 x 1/4 in.	
33	1	80009	214-1061-00	Spring, Tension	
34	2	80009	386-3657-01	Pin, Guide	

PARTS LIST NUMBER 125526 - AS210-06 MICROWAVE CABLE ASSY.

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	16733	527-001	Connector, 0.141, Semi-Rigid SMA	
2	3 in.	93306	UT-141-CTP	Cable, Coaxial, 0.141, Semi-Rigid	

PARTS LIST NUMBER 125527 - AS210-06 MICROWAVE CABLE ASSY.

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	16733	527-001	Connector, 0.141, Semi-Rigid SMA	
2	3 in.	93306	UT-141-CTP	Cable, Coaxial, 0.141, Semi-Rigid	

PARTS LIST NUMBER 125528 - AS210-06 MICROWAVE CABLE ASSY.

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	98291	55-628-9188-31	Connector, SMA, Right Angle	
2	6 in.	81349	RG316/U	Cable, Coaxial, 50 ohm	
3	1	26805	2031-5003-00	Connector, SMA, Straight	

PARTS LIST NUMBER 125529 - AS210-06 MICROWAVE CABLE ASSY.

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	98291	55-628-9188-31	Connector, SMA, Right Angle	
2	6 in.	81349	RG316/U	Cable, Coaxial, 50 ohm	
3	1	26805	2031-5003-00	Connector, SMA, Straight	

PARTS LIST NUMBER 125531 - AS210-06 MICROWAVE CABLE ASSY.

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	98291	55-628-9188-31	Connector, SMA, Right Angle	
2	6 in.	81349	RG316/U	Cable, Coaxial, 50 ohm	

PARTS LIST NUMBER 125536 - AS210-06 10 MHz CABLE ASSY.

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	98291	50-628-9188-31	Connector, SMA, Right Angle	
2	1	98291	51-328-3188	Connector, SMA, Right Angle	
3	6 in.	81349	RG316/U	Cable, Coaxial, 50 ohm	

PARTS LIST NUMBER 125540 - AS210-06 LEVELING DETECTOR ASSY., A1

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	-	33472	125541	Schematic Diagram, A1	
2	-	33472	125542	Silkscreen, A1	
3	1	33472	125545	Case, Leveling Head	
4	2	33472	125546	Cover, Leveling Head	
5	1	10017	DMS285-18	3 dB Power Divider, 1 to 18 GHz	
6	1	54893	33330B	Detector (Neg.), 0.01 to 18 GHz	
7	1	98291	50-675-6701-89	Panel Mount, PN/F to SMA/F	
8	1	98291	50-677-6700-89	Panel Mount, PN/M to SMA/F	
9	2	26805	2081-0000-00	Barrel, SMA/M to SMA/M	
10	1	95077	2994-6002	Swept Right Angle, SMA/M to SMA/F	
11	1	89709	74868-UG-1094AU	BNC, Jack, Panel	
12	1	83330	1497	Solder Lug	
13	4 in.	81349	RG178B/U	Cable, DC Return	
14	1	98291	50-311-3196	Connector, Conhex RF, DC Return	
15	16	81349	- - - -	Screw, Fhd., Cover, #0-80 x 3/16 in.	
16	8	81349	MS51957-16	Screw, Phd., #4-40 x 7/16 in.	
17	8	81349	NAS620-C4	Washer, Flat, Red. O/D, #4	
18	8	81349	MS35338-135	Washer, Split-Lock, #4	
19	8	81349	NAS671-C4	Nut, Hex, Sm. Pat., #4	

PARTS LIST NUMBER 125540 - AS210-06 LEVELING DETECTOR ASSY., A1 (Continued)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
20	2	02114	56-590-65/3B	Ferrite Beads	
21	1	26805	2001-5032-00	Connector, Straight, OSM	
22	1	26805	2007-5055-00	Connector, Right Angle, OSM	
23	A/R	81349	UT-141-CPT	Cable, 0.141, Semi-Rigid	
24	1	26805	2080-0000-00	Connector, Barrel, SMA/F to SMA/F	
25	1	34078	3510	Block, DC	

PARTS LIST NUMBER 125538 - AS210-06 BNC CABLE

ITEM	QTY	MANUFACTURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	-	33472	125338	Fabrication Drawing	
2	2	91836	KC-59-123	Connector, BNC, Male	
3	A/R	16428	RG-58C/4	Cable, 50 ohm	
4	2	05276	5155-0	Boot, Strain Relief	

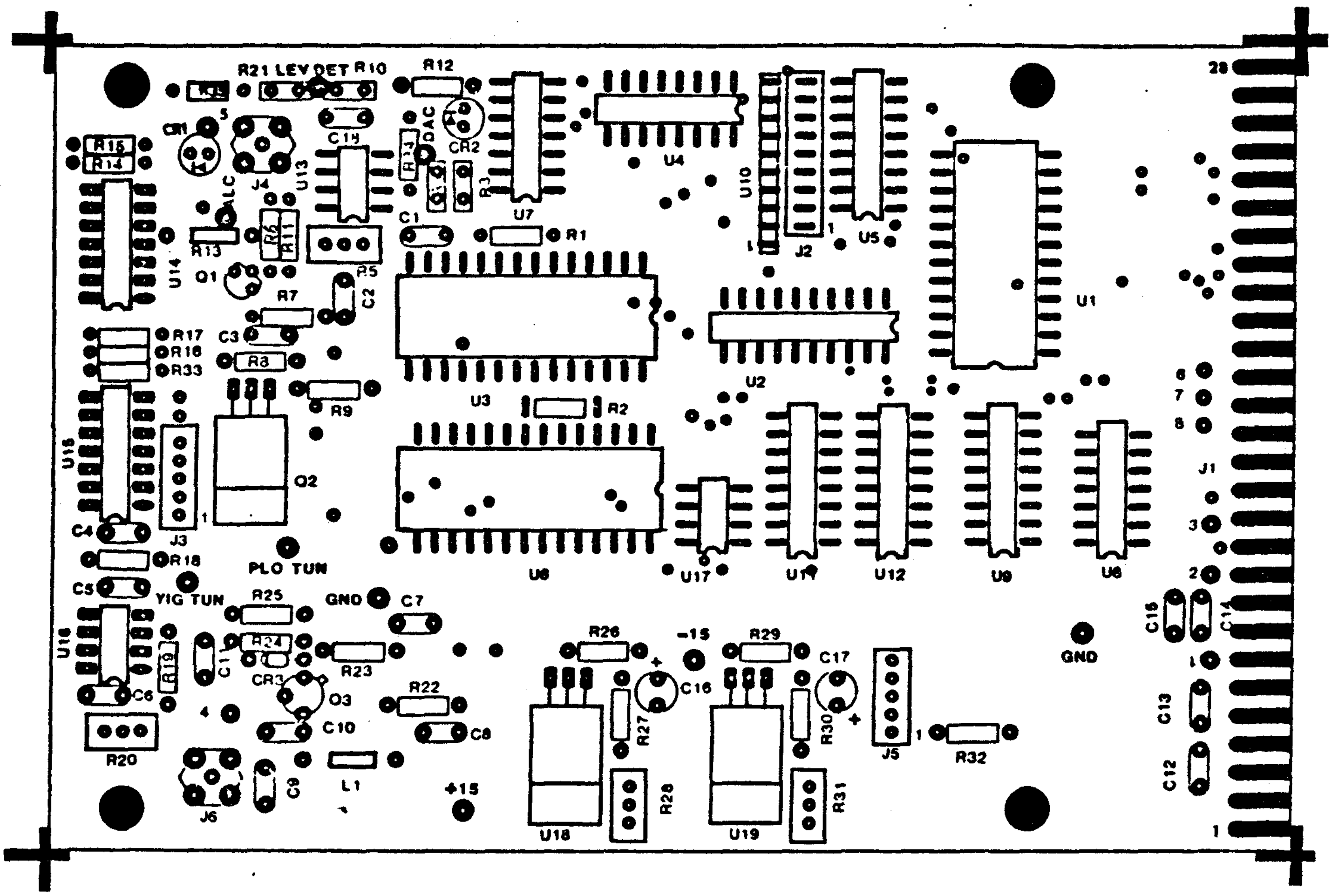


Figure 6-3 AS210-06 Control Circuit Card (A2) Assembly Diagram

PARTS LIST NUMBER 125575 - AS210-06 CONTROL CIRCUIT CARD ASSY., A2
(SEE FIGURE 6-3 FOR ASSEMBLY DIAGRAM)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	-	33472	125576	Schematic Diagram, A2	
2	-	33472	125577	Master Pattern, A2	
3	-	33472	125578	Fabrication Drawing PWB, A2	
4	-	33472	125579	Silk Screen, A2	
5	1	33472	125578	PWB, A2	
7	8	56289	300-50-601-105M	Capacitor, 1.0 microfd., 20%, Ceramic	C1, C2 - C4, C6, C12 - C15
8	1	81349	CK05BX101K	Capacitor, 100 picofd., 10%, Ceramic	C5
9	3	81349	CK05BX104K	Capacitor, 0.1 microfd., 10%, Ceramic	C7, C8, C11
10	1	81349	CK05BX271K	Capacitor, 270 picofd., 10%, Ceramic	C9
11	1	81349	CM04F0820J03	Capacitor, 82 picofd., Dipped Silver Mica	C10
12	2	56289	196D156X9020KA1	Capacitor, 15 microfd., 20V, Tant.	C19, C20
13	2	56289	196D156X9035PE4	Capacitor, 15 microfd., 35V, Tant.	C16, C17
14	2	54893	5082-4487	LED, Clear	CR1, CR2
15	1	81349	1N3064	Diode	CR3
16	1	27264	22-03-2091	Connector, 9-Pin	J2
17	2	27264	22-03-2051	Connector, 5-Pin	J3, J4
18	2	98291	51-051-0000	Connector, RF, Conhex, Snap-On	J4, J6
19	1	00213	35F1863	Inductor, Fixed, 3.3 microhenry,	L1
20	2	81349	RNC55H49R9FS	Resistor, Metal Film, 49.9 ohm, 1%, 1/8W	R1, R2
21	1	18612	S102K,61	Resistor, Precision, 61 ohm, 1%	R3

PARTS LIST NUMBER 125575 - AS210-06 CONTROL CIRCUIT CARD ASSY., A2 (Continued)
(SEE FIGURE 6-3 FOR ASSEMBLY DIAGRAM)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
22	1	18612	S102K,18.9K	Resistor, Precision, 18.9k, 1%	R4
23	2	73138	66WR20K	Resistor, Variable, 20k ohm	R5, R20
24	1	81349	RCR05G103JS	Resistor, Carbon Comp., 10k ohm, 5%, 1/8W	R6
25	1	81349	RCR05G113JS	Resistor, Carbon Comp., 11k ohm, 5%, 1/8W	R14
26	1	81349	RCR05G470JS	Resistor, Carbon Comp., 47 ohm, 5%, 1/8W	R7
27	1	81349	RCR05G152JS	Resistor, Carbon Comp., 1.5k ohm, 5%, 1/8W	R8
28	1	81349	RCR05G333JS	Resistor, Carbon Comp., 33k ohm, 5%, 1/8W	R34
29	1	81349	RCR05G472JS	Resistor, Carbon Comp., 4.7k ohm, 5%, 1/8W	R9
30	1	18612	S102K,15K	Resistor, Precision, 15k ohm, 1%	R10
31	3	81349	RCR05G102JS	Resistor, Carbon Comp., 1k ohm, 5%, 1/8W	R11, R12, R23
32	1	81349	RCR05G620JS	Resistor, Carbon Comp., 62 ohm, 5%, 1/8W	R15
33	1	81349	RCR05G912JS	Resistor, Carbon Comp., 9.1k ohm, 5%, 1/8W	R16
34	1	81349	RNC55H111FC	Resistor, Metal Film, 5.11k ohm, 1%, 1/8W	R18
35	1	81349	RCR05G392JS	Resistor, Carbon Comp., 3.9k ohm, 5%, 1/8W	R13
36	1	81349	RCR05G242JS	Resistor, Carbon Comp., 2.4k ohm, 5%, 1/8W	R19
37	1	18612	S102K,3.9K	Resistor, Precision, 3.9k ohm, 1%, 1/8W	R21

PARTS LIST NUMBER 125575 - AS210-06 CONTROL CIRCUIT CARD ASSY., A2 (Continued)
(SEE FIGURE 6-3 FOR ASSEMBLY DIAGRAM)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
38	4	81349	RCR05G471JS	Resistor, Carbon Comp., 470 ohm, 5%, 1/8W	R22, R24, R25, R32
39	2	81349	RNC55H1210FS	Resistor, Metal Film, 121 ohm, 1%, 1/8W	R26, R29
40	2	81349	RNC55H1301FS	Resistor, Metal Film, 1.30k ohm, 1%, 1/8W	R27, R30
41	2	32997	3386T-01-201	Resistor, 200 ohm, Pot., Side Adjust	R28, R31
42	2	81349	RCR05G302JS	Resistor, Carbon Comp., 3k ohm, 5%, 1/8W	R17, R33
43	1	81349	RCR05G100JS	Resistor, Carbon Comp., 10 ohm, 5%, 1/8W	R35
44	1	34649	D2716	IC, EPROM, 2k x 8	U1
45	1	01295	74LS273	IC, Octal "D", Flip-Flop	U1
46	2	24355	AD567KD	IC, D/A Converter, 12-Bit	U3, U6
47	2	34694	P8216	IC, Bidirectional Bus Driver	U4, U5
48	1	01295	74LS125	IC, Quad Bus Buffer	U7
49	1	01295	74LS20	IC, NAND, Quad 4-Input	U8
50	2	01295	74LS138	IC, 3 to 8 Decoder	U9, U12
51	1	01121	110A473	Resistor Network, 4.7k ohm	U10
52	1	01295	74LS175	IC, Hex "D", Flip-Flop	U11
53	2	31148	OP-05-EP	IC, Op. Amp., Precision	U13, U16
54	2	27014	LM319N	IC, Dual Comparator	U14, U15
55	1	27014	DS3686N	IC, Dual Relay Driver	U17
56	1	27014	LM317T	IC, Voltage Regulator, Adj. Positive	U18
57	1	27014	LM337T	IC, Voltage Regulator, Adj. Positive	U19

PARTS LIST NUMBER 125575 - AS210-06 CONTROL CIRCUIT CARD ASSY., A2 (Continued)
(SEE FIGURE 6-3 FOR ASSEMBLY DIAGRAM)

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
58	1	81349	2N2222A	Transistor, NPN	Q1
59	1	81349	TIP31	Transistor, NPN	Q2
60	1	81349	2N5089	Transistor, NPN	Q3
61	3	01295	C9308-02	Socket, IC, 8-Pin	
62	4	01295	C9314-02	Socket, IC, 14-Pin	
63	5	01295	C9316-02	Socket, IC, 16-Pin	
64	1	01295	C9320-02	Socket, IC, 20-Pin	
65	1	01295	C9324-02	Socket, IC, 24-Pin	
66	2	01295	C9328-02	Socket, IC, 28-Pin	

PARTS LIST NUMBER 125580 - AS210-06 FRONT PANEL ASSY., A4

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	1	33472	125572	Switch, Rotary Thumbwheel	S1
2	1	98291	50-675-6701-89	Panel Mount, PN/F to SMA/F	
3	1	89709	31-10	Connector, Bulkhead, Insulated, BNC to Solder Pot	
4	A/R	16428	24AWG	Wire, 24-AWG	
5	1	11237	14738-01	Switch, Rotary	
6	1	33472	125582-01	Panel, Lexan	
7	1	33472	125582-02	Front Panel, Plastic	
8	1	33472	125582-03	Subpanel, Metal	
9	1	03797	Q086-13D	Socket, LED	
10	1	54893	5082-4657	LED, Red	
11	1	80009	366-1690-01	Latch, Pull	
12	1	80009	105-0718-01	Latch	
13	1	80009	105-0719-00	Latch, Retainer	
14	1	81349	NAS662-C2R4	Screw, Fhd., #2-56 x 1/4 in.	
15	4	81349	MS24693-C26	Screw, Fhd., #6-32 x 3/8 in.	
16	2	81349	MS24693-C2	Screw, Fhd., #4-40 x 1/4 in.	
17	1	81349	PKG-50B1/4	Knob	
18	4	81349	NAS620-C4	Washer, Flat, Red. O/D, #4	
19	4	81349	MS35338-135	Washer, Split-Lock, #4	
20	4	81349	NAS671-C4	Nut, Hex, Sm. Pat., #4	
21	4	81349	MS24693-C4	Screw, Fhd., #4-40 x 3/8 in.	

PARTS LIST NUMBER 125584 - AS210-06 MICROWAVE FREQUENCY GENERATOR CHASSIS WIRE ASSY.

ITEM	QTY	MANUFAC-TURER'S CODE	PART NUMBER	DESCRIPTION	REF. DESIG.
1	2	27264	22-012051	Connector, 5-Pin	P3, P5
2	1	27264	22-01-2091	Connector, 9-Pin	P2
3	A/R	16428	ET-24	Wire, 24-AWG	
4	19	27264	08-50-0114	Pin Crimp	
5	-	33472	125588	Wire List	

6.2 MANUFACTURER'S LIST -- CODE TO NAME

This section contains all manufacturer's codes for materials used in the AS210 system. The codes are listed in ascending numberical order.

CODE	MANUFACTURER	ADDRESS
00213	NYTRONICS COMPONENTS GROUP, INC.	Subsidiary of Nytronics, Inc. Orange Street Darlington, SC 29532
00779	AMP, INC.	P.O. Box 3608 Harrisburg, PA 17105
01121	ALLEN-BRADLEY COMPANY	1202 South 2nd Street Milwaukee, WI 53204
01139	GENERAL ELECTRIC COMPANY	Silicone Products Business Department Waterford, NY 12188 PHONE: 518-237-3330
01281	TRW, INC.	TRW Semiconductor Division 14520 Aviation Boulevard Lawndale, CA 90260
01295	TEXAS INSTRUMENTS, INC.	Semiconductor Group 13500 North Central Expressway P.O. Box 225012 M/S 49 Dallas, TX 75265
02114	AMPEREX ELECTRONIC CORPORATION	Ferroxcub Division 5083 Kings Highway Saugerties, NY 12477
02660	BUNKER RAMO-ELTRA CORPORATION	Amphenol Division 2801 South 25th Avenue Broadview, IL 60153
02735	RCA CORPORATION	Solid State Division Route 202 Somerville, NJ 08876
03797	GENISCO TECHNOLOGY CORPORATION	Electronics Division 18435 Susana Road Rancho Dominguez, CA 90221 PHONE: 213-537-4750
04426	ILLINOIS TOOL WORKS, INC.	Licon Division 6615 West Irving Park Road Chicago, IL 60634

CODE	MANUFACTURER	ADDRESS
14655	MOTOROLA, INC.	Semiconductor Products Sector 5005 East McDowell Road Phoenix, AZ 85008 PHONE: 602-244-7100
05245	CORCOM, INC.	1600 Winchester Road Libertyville, IL 60048
06090	RAYCHEM CORPORATION	300 Constitution Drive Menlo Park, CA 94025
06383	PANDUIT CORPORATION	17301 Ridgeland Tinley Park, IL 60477
06540	MITE CORPORATION	Amatom Electronic Hardware Division 446 Blake Street New Haven, CT 06515
07263	FAIRCHILD CAMERA AND INSTRUMENT CORPORATION	Sub of Schlumberger LTD North American Sales Mail Stop 14-1053 401 Ellis Street P.O. Drawer 7284 Mt. View, CA 94042
09353	C AND K COMPONENTS, INC.	15 Riverdale Avenue Newton, MA 02158 PHONE: 617-964-6400
11237	CTS KEENE, INC.	P.O. Box 1977 Paso Robles, CA 93446
12136	PHC INDUSTRIES, INC.	1643 Haddon Avenue Camden, NJ 08103
13103	THERMALLOY COMPANY, INC.	2021 West Valley View Lane P.O. Box 340839 Dallas, TX 75234
13327	SOLITRON DEVICES	256 Oak Tree Road Tappan, NY 10983
13556	TRW CINCH CONNECTORS	Nuline Facility Division of TRW, Inc. New Hope, MN
14099	SEMTECH CORPORATION	652 Mitchell Road Newbury Park, CA 91320 PHONE: 213-628-5392
14655	CORNELL-DUBILIER ELECTRONICS	Div. of Federal Pacific Electric Co. Government Contracts Department 150 Avenue L Newark, NJ 07101

CODE	MANUFACTURER	ADDRESS
15542	MINI-CIRCUITS LABORATORY	Div. of Scientific Components Corp. 2625 East 14th Street Brooklyn, NY 11235
16428	BELDEN ELECTRONIC WIRE & CABLE	Sub of Cooper Industries, Inc. 2200 U.S. Highway 27 South P.O. Box 1980 Richmond, IN 47374 PHONE: 317-983-5200
16733	CABLEWAVE	60 Dodge Avenue New Haven, CT 06473 PHONE: 203-239-3311
18612	VISHAY INTERTECHNOLOGY, INC.	Vishay Resistor Products Division 63 Lincoln Highway Malvern, PA 19355
19209	GENERAL ELECTRIC COMPANY	Battery Business Department 441 Highway N P.O. Box 861 Gainesville, FL 32602 PHONE: 904-462-3911
23936	PAMOTOR DIVISION OF WILLIAM J. PURDY COMPANY	770 Airport Boulevard Burlingame, CA 94010
24355	ANALOG DEVICES	2 Technology Way P.O. Box 280 Norwood, MA 02062 PHONE: 617-329-4700
26805	OMNI SPECTRA, INC.	Microwave Connector Division Waltham, MA
26806	AMERICAN ZETTLER, INC.	16881 Hale Avenue Irvine, CA 92714
27014	NATIONAL SEMICONDUCTOR CORPORATION	2900 Semiconductor Drive Santa Clara, CA 95051
27264	MOLEX, INC.	2222 Wellington Court Lisle, IL 60532
31148	PMI	P.O. Box 15264 Sacramento, CA 95813
32997	BOURNS, INC.	Trimpot Division 1200 Columbia Avenue Riverside, CA
33472	ARGOSYSTEMS, INC.	310 North Mary Avenue Sunnyvale, CA 94086

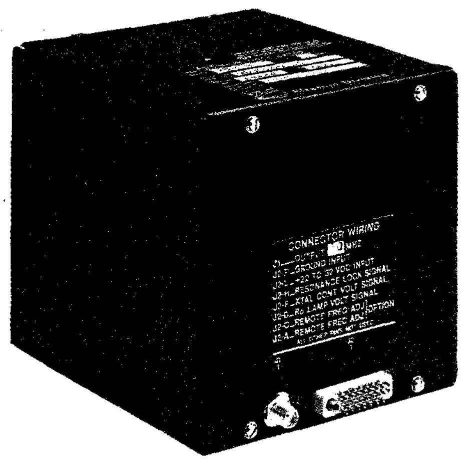
CODE	MANUFACTURER	ADDRESS
34649	INTEL CORPORATION	3585 Southwest 198th Avenue Aloha, OR 97005
50021	TECHNICAL RESEARCH & MANUFACTURING, INC.	Kelley Avenue Grenier Field, RFD #3 Manchester, NH 03103 PHONE: 603-668-0120
50088	MOSTEK CORPORATION	Sub. of United Technologies Corp. 1215 West Crosby Road P.O. Box 169 Carrollton, TX 75006
50434	HEWLETT-PACKARD COMPANY	Optoelectronics Division 640 Page Mill Road Palo Alto, CA 94304
51642	CENTRE ENGINEERING, INC.	2820 E. College Avenue State College, PA 16801
53387	MINNESOTA MINING AND MANUFACTURING COMPANY	Electronic Products Division 3M Center St. Paul, MN 55101
54487	MICRONETICS	36 Oak Street Norwood, NJ 07648 PHONE: 201-767-1320
54893	HEWLETT-PACKARD COMPANY	Microwave Semiconductor Division 350 West Trimble Road San Jose, CA 95131
55154	PLESSEY PERIPHERAL SYSTEMS, INC.	17466 Daimler Avenue P.O. Box 19616 Irvine, CA 92714
55566	R A F ELECTRONIC HARDWARE, INC.	95 Silvermine Road Seymour, CT 06483 PHONE: 203-888-2133
56289	SPRAGUE ELECTRIC COMPANY	87 Marshall Street North Adams, MA 01247
58910	ABBOTT TRANSISTOR LABORATORIES, INC.	Transformer Division 639 South Glenwood Place Burbank, CA 91506
59660	TUSONIX, INC.	2155 North Forbes Boulevard Suite 107 Tucson, AZ 85745

CODE	MANUFACTURER	ADDRESS
59705	STANDEX INTERNATIONAL CORPORATION	United Service Equipment Co. Div. 1152 Park Avenue Murfreesboro, TN 37130
59730	THOMAS AND BETTS CORPORATION	Highway 218, South Iowa City, IA 52240
71279	MIDLAND-ROSS CORPORATION	Cambion Division One Alewife Place Cambridge, MA 02140 PHONE: 617-491-5400
71450	CTS CORPORATION	905 North West Boulevard Elkhart, IN 46514
71984	DOW CORNING CORPORATION	3901 South Saginaw Road Midland, MI 48640
73138	BECKMAN INSTRUMENTS, INC.	Helipot Division Sub of Smith Kline/Beckman Corp. 2500 Harbor Boulevard Fullerton, CA 92634
75915	TRACOR LITTLEFUSE, INC.	800 East Northwest Highway Des Plaines, IL 60016
77969	RUBBERCRAFT CORPORATION OF CALIFORNIA LTD.	1800 West 220th Street P.O. Box B Torrance, CA 90507 PHONE: 213-328-5402
78277	SIGMA INSTRUMENTS, INC.	170 Pearl Street South Braintree, MA 02184 PHONE: 617-853-5000
80009	TEKTRONIX, INC.	4900 Southwest Griffith Drive P.O. Box 500 Beaverton, OR 97077
81349	MILITARY SPECIFICATIONS	Promulgated by Military Departments/Agencies Under Authority of Defense Standardization Manual 4120 3-M
83330	HERMAN H. SMITH, INC.	A North American Philips Company 1913 Atlantic Avenue Manasquan, NJ 08736
88245	WINCHESTER ELECTRONICS	Litton Systems-Useco Division 1536 Saticoy Street Van Nuys, CA 91409

CODE	MANUFACTURER	ADDRESS
90201	MALLORY CAPACITOR COMPANY	Sub of Emhart Industries, Inc. 4760 Kentucky Avenue P.O. Box 372 Indianapolis, IN 46206
91506	AUGAT, INC.	33 Perry Avenue P.O. Box 779 Attleboro, MA 02703
91637	DALE ELECTRONICS, INC.	2064 12th Avenue P.O. Box 609 Columbus, NE 68601 PHONE: 402-563-6301
91836	KINGS ELECTRONICS COMPANY, INC.	40 Marbledale Road Tuckahoe, NY 10707 PHONE: 914-793-5000
92194	ALPHA WIRE CORPORATION	71 Lidgerwood Avenue Elizabeth, NJ 07207 PHONE: 201-92508000
93306	UNIFORM TUBES	MicroDelay Division 200 West 7th Avenue Collegetown, PA 19426 PHONE: 215-539-0700
95146	ALCO ELECTRONIC PRODUCTS, INC.	1551 Osgood Street North Andover, MA 01845
95238	CONTINENTAL CONNECTOR CORPORATION	34-63 56th Street Woodside, NY 11377 PHONE: 212-899-4422
95987	WECKESSER COMPANY, INC.	Chicago, IL
98291	SEALECTRO CORPORATION	225 Hoyt Mamaroneck, NY 10544
99800	AMERICAN PRECISION INDUSTRIES, INC.	Delevan Division 270 Quaker Road East Aurora, NY 14052 PHONE: 716-652-3600

Efratom Division

OPERATION AND MAINTENANCE MANUAL



MODEL

FRK (H OR L) LN

LOW NOISE RUBIDIUM FREQUENCY STANDARD

71/10

LIMITED WARRANTY

"The seller warrants that each article of goods sold by it will at the time of shipment be free from defects in materials furnished and workmanship performed by the seller. This warranty and seller's liability are limited either to granting credit or repairing or replacing, at seller's option, with reasonable promptness after return to seller of any article which is disclosed to seller's satisfaction to be defective, and only if said article is returned to the seller promptly after discovery of such defect and in no event later than ***12 months*** (or such other time period as may be specified in writing as a warranty period for a particular article) from the date of delivery thereof. Normal transportation charges in connection with an article returned shall be at the seller's expense, but only if the seller is responsible under the terms of this warranty. This warranty does not extend to any article which has been subject to misuse, neglect or accident, nor does it extend to any article which has been repaired or altered by other than the seller. **THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. THE RIGHTS AND REMEDIES PROVIDED HEREIN ARE EXCLUSIVE AND IN LIEU OF ANY OTHER RIGHTS OR REMEDIES. IN NO EVENT SHALL SELLER BE LIABLE FOR CONSEQUENTIAL DAMAGES".**

Ball Corporation, Efratom Division, will be happy to answer any application or usage questions which will enhance your use of this unit. Please address your requests or correspondence to: **Ball Corporation., Efratom Division,** 3 Parker, Irvine, California 92718-1605, Attention: Sales Department, or call (714) 770-5000, Fax: (714) 770-2463.

European customers may contact: **Ball Efratom Elektronik GmbH,** Fichtenstrasse 25, 8011 Hofolding, West Germany, Telephone: 49-81-049040, Fax: 49-81-049918.

CONTENTS

SECTION I

INTRODUCTION AND SPECIFICATION

1.1 INTRODUCTION.

The Efratom Model FRK-(H or L)LN Rubidium Frequency Standard (RFS) is a compact, atomic resonance-controlled oscillator which provides an extremely pure and stable sinusoidal signal of 5 or 10 MHz, at 1 Vrms into a 50 ohm load (refer to Section 1.5 for other available options). The unit is designed for use in high-performance communication systems, frequency standard equipment, advanced navigation equipment, and all other equipment and systems which require extremelyprecise frequencies/time intervals. With the proper input power provided and suitable cooling provisions, the FRK-( )LN can be operated as a free-standing frequency standard for laboratory and testing purposes.

NOTE

Throughout this manual the models FRK-HLN & FRK-LLN will be referred to as model FRK-( )LN, indicating that the text or diagram references both models. If only one model is to be referenced, the full model designation will be printed out.

1.2 MANUAL CONTENT.

This manual contains information regarding the operation and field maintenance of the Model FRK -( ) LN, 5 MHz Rubidium Frequency Standard (RFS), with a Final Assembly No. 703-200-8. A Model FRK-( ) LN with a Final Assembly No. other than 703-200-8 is a modified unit producing a 10 MHz output, or has some other feature not standard to model 703-200-8. If a modified unit differs operationally from the standard unit an addendum will be included with this manual describing the differences. Note the information in the addendum prior to reading the manual to determine what special specification or operation aspects may exist. If an addendum has not been included for a modified unit, it can be assumed that the modification does not affect the unit's operation.

Sections I and II contain general information concerning the unit. It is recommended that these sections be read completely prior to attempting operation. Section III provides the general theory of operation for the technician or engineer who requires a more thorough understanding of the unit's operation. Section IV provides the required information for performing field maintenance on the unit. An Outline Drawing, Schematic Diagrams, Assembly Drawings and Parts Lists are provided in the Appendix.

1.3 CONNECTORS.

All necessary connectors for inputs, output and monitor signals are easily accessible from the outer cover of the unit. The unit is manufactured using either a Winchester connector, P/N SRE-20PJ, which mates with SRE-20SJ and a SMA-type coaxial connector. For other connector configurations, refer to unit label for pin out information. (Other optional connectors are available; contact the Efratom sales department).

1.4 ELECTRICAL PROTECTION.

The unit is protected against reverse polarity input power by both an internal fuse and diode. The output and monitor signals are short-circuit protected.

1.5 AVAILABLE OPTIONS

(a) External (remote) Frequency Adjustment Option.

(b) Additional Magnetic Shielding.

(c) Low Operating Temperature Option:

FRK-HLN $\leq$ 4E-10 from -55°C to +65°C
FRK-LLN $\leq$ 6E-10 from -55°C to +65°C

1.6 SPECIFICATIONS.

Pertinent performance specifications for the Models FRK-LLN and FRK-HLN are listed in Table 1.1.

Table 1.1. Specifications

CHARACTERISTICS	MODEL FRK-L (LN)	MODEL FRK-H (LN)
Output	5 or 10 MHz sine wave 1.0 Vrms into 50 ohms, floating ground (not floating with filter connector).	
Accuracy	Factory set to 5.0 MHz ±5E-11 at shipment.	
Signal to Noise (SSB 1 Hz BW)	125 dB at 10 Hz and 155 dB at 100 Hz from carrier. (5 MHz) 120 dB at 10 Hz and 147 dB at 100 Hz from carrier. (10 MHz)	
Input Power	13W at 24 Vdc, 25°C ambient; 22 to 32 Vdc; peak during warm-up, 1.8A.	
Warm-up Characteristics	≤ 10 minutes to reach 2E-10 at 25°C ambient.	
Retrace	±2E-11	
Long-term Stability	<4E-11/month	<1E-11/month
Short-Term Stability	3E-11 $\tau = 1$ sec 1E-11 $\tau = 10$ sec 3E-12 $\tau = 100$ sec	1E-11 $\tau = 1$ sec 4E-12 $\tau = 1$ 0sec 1E-12 $\tau = 100$ sec
Trim Range	≥ 2E-9	
Voltage Variation	< 1E-11/10% change (within input power limit noted above)	
*Operating Temperature	< 3E-10 from -25°C to +65°C	<1E-10 from -25°C to +65°C
Storage Temperature	-55°C to +75°C	
Magnetic Field	< 4E-13/AM^{-1} (3E-11/0.1 millitesla)	
Altitude	< 1E-13/mbar (sea level to 21,000m)	
Humidity	95% MIL-T-5422F	
Shock	MIL-STD-810C, Method 516.2, Procedure 1	
Vibration	MIL-STD-810C, Method 514.2, Procedure 1	
Size	100mm x 99 mm x 112 mm (3.9 in. x 3.9 in. by 4.4 in.)	
Weight	1.3 Kg (2.9 lbs); 1.55 Kg (3.5 lbs.), with optional heat sink	

*Highest operating temperature as measured at the baseplate. The highest ambient temperature the unit may be operated in is dependent on the heat transfer between the unit's baseplate and the ambient.

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SECTION II

INSTALLATION AND OPERATION

2.1 INTRODUCTION.

This section of the manual contains information regarding the installation and operation of the Efratom FRK-( )LN. It is recommended that this section be read carefully prior to attempting operation of the unit.

2.2 SHIPPING AND RECEIVING INFORMATION.

The Model FRK-( )LN is packaged and shipped in a foam-packed container. The unit was inspected mechanically and electrically prior to shipment. Upon receipt of the unit, a thorough inspection should be made to ensure that no damage has occurred during shipping. If any damage is discovered, contact Ball Corporation, Efratom Division, 3 Parker, Irvine, CA. 92718-1605. Telephone (714) 770-5000; Telex 685-635. European customers should contact Ball Efratom Elektronik GmbH, Fichtenstrasse 25, 8011 Hofolding, West Germany, Telephone 08104/90 40. If reshipment of the unit is necessary, the original container and packing should be used. If the original container is not available, a suitable container with foam-packing is recommended.

2.3 MOUNTING.

The unit's baseplate has been drilled and tapped to accommodate installation. The unit should be mounted with the aluminum thermal baseplate in contact with a flat metal surface. Mounting screws must not be allowed to penetrate the baseplate more than 0.2 inches (5mm). It is recommended that the mounting surface be designed to permit free access to the unit's frequency adjust potentiometer. Refer to outline drawing 703-203-1 in the appendix for mounting dimensions.

The heat transfer characteristics of the mounting surface must be adequate to limit the rise of the unit's baseplate to $< +65^{\circ}C$. The maximum allowable environmental temperature (Ta), for this mounting is:

$$Ta = 65^{\circ}C - (V_s \times I_s \times R_k)$$

Where: V_s = Supply Voltage in volts

I_s = Supply Current in amperes

R_k = Thermal Resistance between unit and ambient, ($^{\circ}C$/watt).

NOTE
An add-on heat sink is an available option from Efratom; order Model 70223, Air Cooled Heat Sink.

2.4 POWER REQUIREMENTS.

The Model FRK-( )LN requires an external power source capable of providing between +22 and +32 Vdc, with a minimum of 1.8 ampere output. The positive input voltage for the unit is to pin L with the negative return voltage on pin P of the connector.

In order to obtain the cleanest output signal close to the carrier, the maxmum ac ripple on the supply voltage must be less than 1 mV peak-to-peak. If it is acceptable for the output frequency to contain spurious multiples of the powerline frequency (50, 60, or 400 Hz), the ripple can be higher, but in no case should the supply voltage AC +/- peak exceed the upper or lower input power limit of the unit.

2.5 INSTALLATION CONSIDERATIONS.

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

CAUTION
CARE MUST BE TAKEN TO ENSURE THAT THE MAXIMUM OPERATING TEMPERATURE IS NOT EXCEEDED, (+65°C AS MEASURED AT THE UNIT'S BASEPLATE). IN ADDITION, THE UNIT'S OUTER COVER IS A SPECIALLY DESIGNED MAGNETIC SHIELD; DAMAGE TO THE OUTER COVER COULD CHANGE ITS SHIELDING CHARACTERISTICS.

2.6 FREQUENCY AND MONITORING SIGNAL OUTPUTS.

Figure 2.1 illustrates the standard Model FRK-( )LN coaxial connector J1 with Winchester connector J2, and presents a brief functional description of the pin connections. Figure 2.2 presents the same information for the optional 8-pin, wirewrap or press-fit connector with coaxial connector.

J1 5 or 10 MHz OUTPUT
J2 A. Optional remote frequency adjust
C. Optional remote frequency adjust
D. Rb LAMP VOLTAGE SIGNAL
F. XTAL CONT VOLTAGE SIGNAL
H. RESONANCE LOCK SIGNAL
L. +22 TO +32 VDC INPUT
P. GROUND (connected to enclosure)

(Viewed rotated 180° so pin callouts are readable)

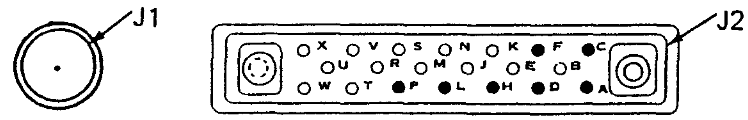


FIGURE 2.1. Winchester Connector and Pin Arrangement

AS210 WIRING

COAX 1. 5 or 10 MHz OUTPUT
NC 2. 5 or 10 MHz GROUND (isolated from enclosure)
BLACK 3. GROUND (connected to enclosure)
WHT/YEL 4. +22 TO +32 VDC INPUT
GREEN 5. RESONANCE LOCK SIGNAL
NC 6. XTAL CONT VOLTAGE SIGNAL
NC 7. Rb LAMP VOLTAGE SIGNAL
YELLOW 8. Optional remote frequency adjust
RED 9. Optional remote frequency adjust

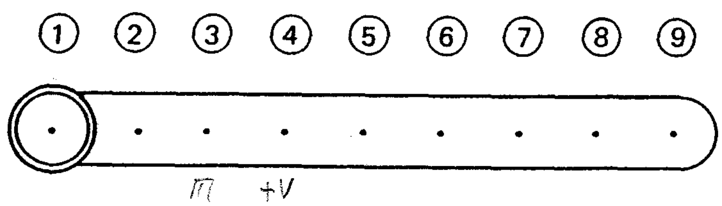


FIGURE 2.2. Optional 8-Pin, Connector with Coaxial Connector and Pin Arrangement

NOTE

Although Figure 2.1 illustrates the output signal (10 MHz) from the coaxial connector J1, the unit can be wired to provide the output signal to the Winchester connector, thus eliminating the need for the coaxial connector. For that configuration the output signal is to pin W, and the shield to pin T.

2.7 NORMAL OPERATION.

When the unit's output is terminated with a 50 ohm resistive load, and 28 Vdc is applied to J2 pins L (+) and P (-), the unit will immediately begin producing a 10 MHz signal from the crystal oscillator. Within approximately 10 minutes after application of input power, the unit will "lock". At that time the crystal is stabilized by the atomic resonant frequency.

2.8 FUNCTIONAL OPERATION TEST EQUIPMENT.

The test equipment required to functionally test the unit is listed in Table 2.1. Test equipment other than those items listed may be used provided that the performance equals or exceeds the MINIMUM USE CHARACTERISTICS as stated in Table 2.1.

TABLE 2.1. Functional Operation Test Equipment

PARA #	ITEM	MINIMUM USE CHARACTERISTICS	TEST EQUIPMENT
2.1	DC Power Supply	Output Voltage: 22 to 30Vdc Output Current: 2.0 Amps Min.	Hewlett-Packard 6433B or 6296A
2.2	DMM (Digital Multimeter)	Voltage Range : 0 to 30 Vdc Accuracy: ± 1.25% Resistance Range: 0 to 150 ohm.	Fluke 8020A or 8000A
2.3	Freq. & Time Interval Analyzer	Internal Ref. Freq: 10 MHz Accuracy: ± 1E-12 Stability: parts in 10^{12}	Hewlett-Packard 5371A Frequency & Time Interval Analyzer and HP5371A Software Kit

NOTE

Throughout the test procedures in this manual the Model FRK-( )LN will be referred to as the Unit Under Test, (UUT). All connections described or illustrated pertain to the standard Winchester connector; if the UUT has a different connector arrangement, make the described connections to the appropriate pins as described in 2.6 or the pin diagram accompaning the UUT.

2.9 OPERATIONAL FREQUENCY ACCURACY TEST.

2.9.1 Connect the equipment as shown in Figure 2.3.

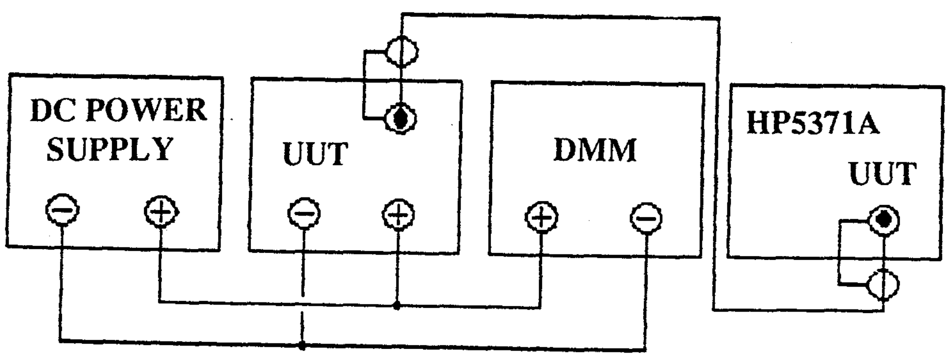


Figure 2.3. Operational Frequency Accuracy Test Setup.

2.9.2 Adjust the DC power supply controls to obtain a 28 ± 1.4 Vdc indication on the DMM.

2.9.3 Allow sufficient time for equipment to stabilize.

NOTE

The UUT requires 10 minutes stabilization to obtain the following frequency accuracy: ± 2E-10 of the final frequency (calibrated frequency), or the frequency before turn off, (if turn off was within 24 hours and at the same environmental temperature). If the UUT was in storage, the worse case error = ± 2E-10 warm-up + ± last calibration accuracy or ± 5E-10 factory setting at shipment, whichever is applicable + *aging specification.

The UUT requires 1 hour stabilization time to obtain the following accuracy: ± 2E-11 of final frequency or frequency at turn off (if turn off was within 24 hours and at the same environmental temperature). If UUT was in storage, the worse case error = ± 2E-11 warm-up +/- last calibration accuracy or ± 5E-11 factory setting at shipment, whichever is applicable + *aging specification.

* Aging Specification: FRK-HLN $\leq 1X10^{-11}$ /month
FRK-LLN $\leq 4X10^{-11}$ /month

2.9.4 Follow the instructions in the HP5371A Frequency and Time Interval Analyzer Operation Manual to begin the test.

2.9.5 Allow sufficient time for the HP5371A to indicate the UUT OFFSET for the data you require. Verify that the UUT frequency offset is within the tolerance stated in the NOTE following Step 2.9.3.

NOTE

If the UUT is not within the stated tolerance limits, perform the Frequency Adjustment procedure, paragraph 4.6.5.1 through 4.6.5.2.

2.10 SHORT-TERM STABILITY TEST (ALLAN VARIANCE)

NOTE
If you have just completed 2.9 through 2.9.5, and the Allan Variance indications (as displayed by the HP5371A) are of the required averaging times, the test results as indicated are valid. If 2.9 was not performed continue with 2.10.1

2.10.1 With the equipment connected as shown in Figure 2.3, and the required stabilization time allowed, (refer to NOTE following 2.9.3), begin the test.

2.10.2 Allow sufficient time for the HP5371A to display the required data for the averaging times, and verify that UUT Allan Variance is within tolerances listed in Table 1.1 SPECIFICATIONS.

SECTION III

THEORY OF OPERATION

3.1 INTRODUCTION.

This section of the manual contains a general theory of operation and circuit analysis of the Model FRK-( )LN Rubidium Frequency Standard. A block diagram, (Figure 3.2) has been included to help clarify the text. Schematic diagrams are included in the Appendix.

3.2 GENERAL THEORY OF OPERATION.

The unit's highly frequency-stable 5 or 10 MHz output signal is obtained from a 5 or 10 MHz Voltage Controlled Crystal Oscillator (VCXO), whose frequency is referenced and locked to the atomic ''Resonance Frequency'' of Rubidium (f_{Rb}).

3.2.1 ATOMIC REFERENCE FREQUENCY.

The atomic reference frequency is provided by the 6.834 GHz ground-state hyperfine transition of the Rb^{87} (rubidium). The VCXO is locked to the f_{Rb} at approximately 6.834 GHz, by synthesizing a microwave signal, from the 10 MHz VCXO output, having a frequency in the vicinity of f_{Rb}. The microwave signal is used to excite the rubidium atoms that are contained within a microwave cavity (resonance cell). The frequency synthesis scheme is designed so that the VCXO frequency is exactly 10 MHz when the microwave frequency is equal to f_{Rb}. The frequency of the signal applied to the microwave cavity can be maintained equal to f by generating an error signal to servo the VCXO through its control voltage.

3.2.2 RUBIDIUM LAMP.

Light from a rubidium lamp is generated by an rf excited plasma discharge. The light passes through the resonance cell, where it interacts with the rubidium atoms contained therein. Some of the light is incident upon a silicon photo detector photocell within the resonance cell. When the applied microwave frequency is equal to the f_{Rb}, the rubidium atoms resonate within the microwave field in the cavity; this causes the light reaching the photo detector to decrease. This behavior is illustrated by the left, uppermost curve in Figure 3.1.

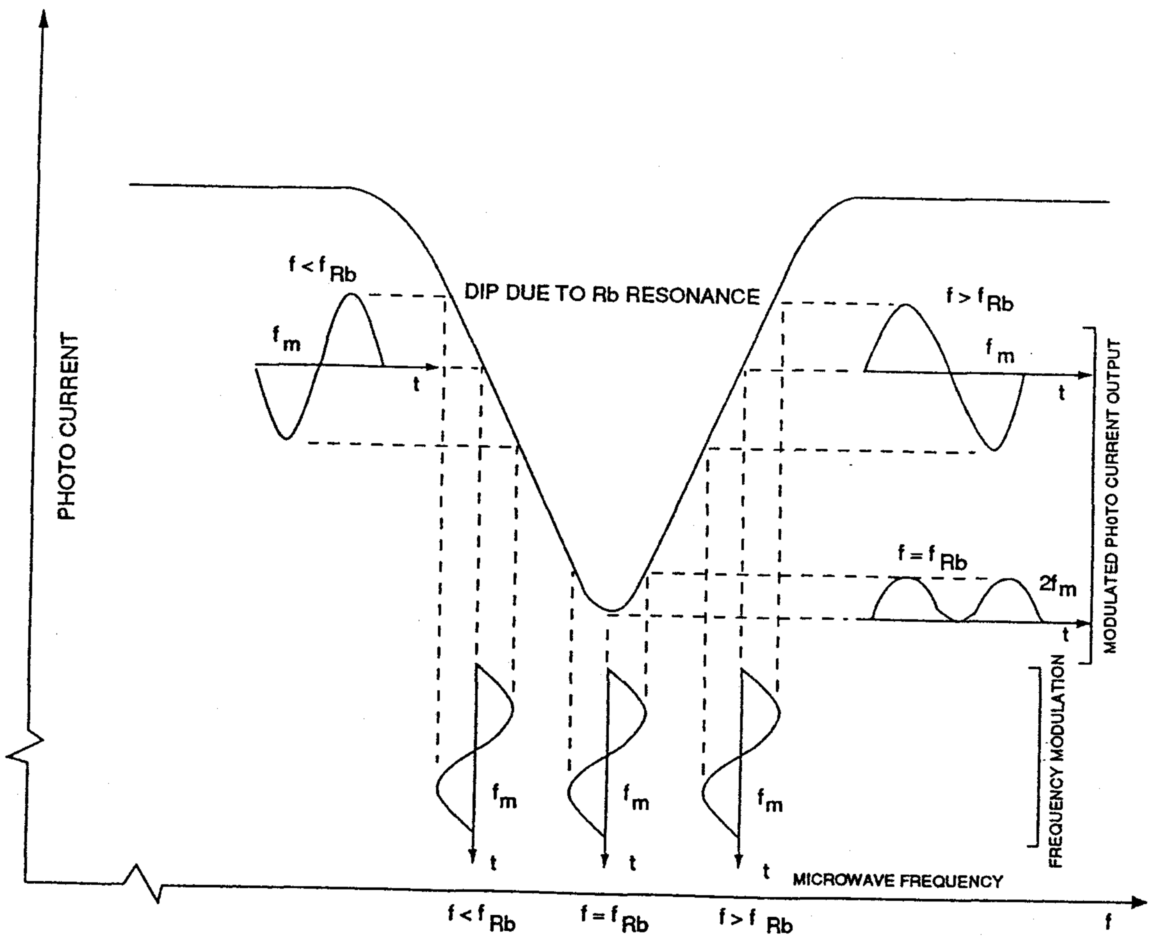


Figure 3.1. Derivation of Modulation Signal

3.2.3 OPTICAL PUMPING. The rubidium oscillator is a passive device, meaning that the atoms themselves do not produce a self-sustaining oscillation. Nevertheless, the atoms can be viewed in their simplest form as a high-Q, (Q ~10^7) series-resonant tank curcuit that is resonant at the hyperfine frequency (~6.8 GHz for rubidium atoms). The voltage source driving the tank is the microwave input coming from the Modulator/Synthesizer, and the LCR components are the rubidium atoms contained in the optical package. The atomic resonance is detected by optical means and involves a process known as Optical Pumping, by which atoms are raised to a higher state through the absorption of light energy.

The two lower levels, A and B, are the ground state hyperfine levels. Statistically speaking, the rubidium atoms will be equally divided between these two levels. If the atoms are irradiated with microwave energy at the hyperfine frequency, then those atoms in level A will make a transition to level B and vice- versa, without changing the overall distribution between the two levels (statistically). [The hyperfine frequency (f_{Rb}) is related to the hyperfine energy level separation E (joules) = h • f_{Rb} (Hz) where h = Plank's Constant = 6.6226 x 10^{-34} joule/Hz]. A third and higher energy state exists which is referred to as level C.

Level C is an optically excited state of the atom which is normally vacant; (for rubidium, this C level state can be excited by infrared light energy at the proper wavelength). Transitions to level C are known as "optical transitions" and can occur from either of the two hyperfine energy levels A or B. If only the spectral wavelength corresponding to one of the hyperfine levels is introduced, only the atoms at that hyperfine level will make the transition to level C. This condition can be generated by filtering out the spectral wavelength corresponding to one of the hyperfine levels.

If the light energy injected into the resonance cell corresponds to the wavelength required for level A to C transitions, the rubidium atoms at the A level will absorb some of the light. The absorption of light raises those atoms to the C level energy state. After a short time the atoms which were raised to the C level will emit a photon of the same wavelength that caused the energy level to increase; they then return to the ground state hyperfine level, redistributing themselves (statistically) equally between level A and B. The atoms which return to level A will again absorb the light and be raised to level C, where they will remain for the short time before emitting the photon and again redistributing themselves between the two hyperfine energy levels A and B. By this means, Optical Pumping can be used to produce a population difference between the two hyperfine levels, whereby all of the atoms are pumped into one hyperfine level (for the preceeding situation, level B). Once this condition exists, there are no atoms left in level A to be excited to level C and the light is not the proper wavelength to excite the atoms in level B to level C, therefore the light is unattenuated after passing through the resonance cell.

As discussed earlier, if a microwave field corresponding to the hyperfine frequency were applied, the atoms at level B would make a transition to level A and be available for excitation to level C by the light beam. Since each excitation of an atom in level A is accomplished by the absorption of a light photon, the net effect of applying the microwave field is to cause attenuation of the light beam. Figure 3.3 pictorially illustrates the Optical Pumping process.

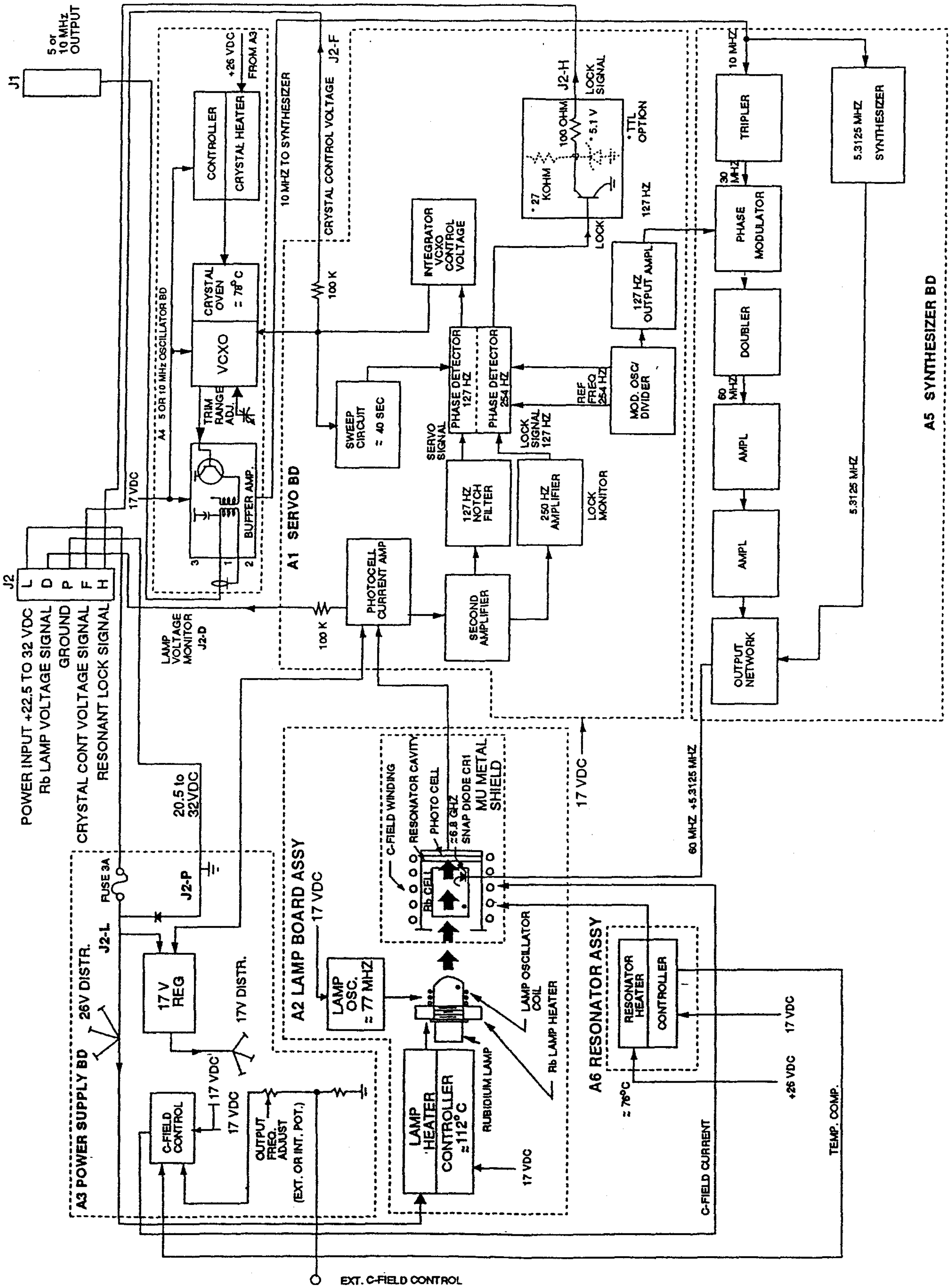


Figure 3.2. FRK Block Diagram

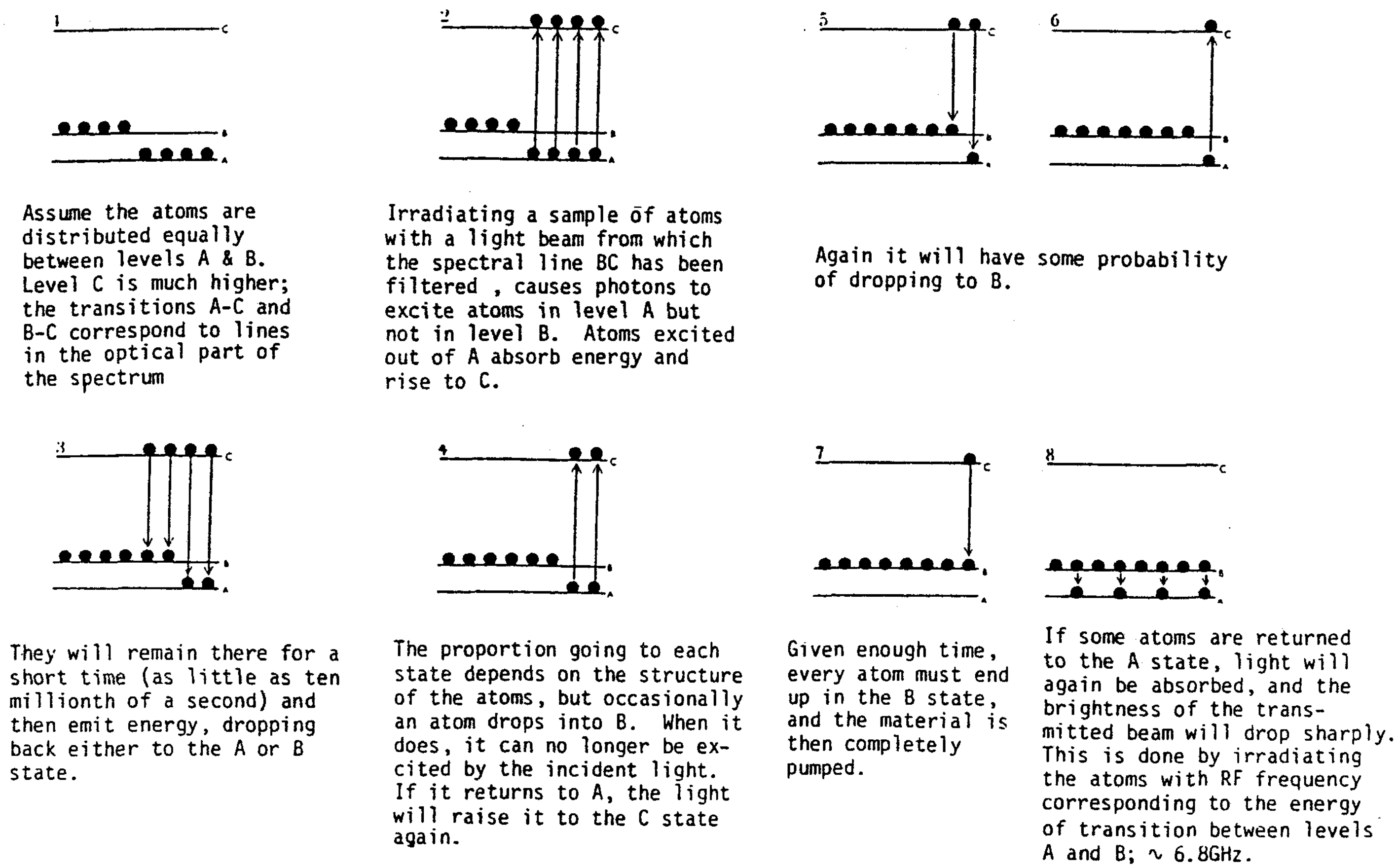


Figure 3.3. Optical Pumping Process Illustrated

If the overall energy level were to remain constant, there would be no way to generate an error signal for VCXO frequency correction. By frequency modulating the microwave signal, the light from the rubidium lamp appears to vary in intensity at the same modulation rate. This variation in the light intensity is effective at < 0.1% of the overall intensity of the light. The photocell, within the cavity, detects the variation in light intensity; the Servo Board uses this signal to indicate atomic lock and to generate the correction signal for the VCXO if the VCXO should drift off frequency.

3.2.4 RESONANT SIGNAL/LOCK SIGNAL LOGIC.

When light from the Rubidium lamp strikes the photocell contained within the resonator, the photocell generates a current proportional to the intensity of the light. By modulating the rf signal injected into resonator, (at 127 Hz), the light striking the photocell will vary at the modulation rate, (127 Hz), and the photocell output current will vary at the same modulation rate, (127 Hz).

When the rf being injected into the resonator is exactly equal to f_{Rb}, the 127 Hz modulation varies the light signal around the null point of the photocell current. (minimum light = minimum photocell current.) When the light signal varies around the photo current null point, the photocell output varies at twice the fundamental frequency, or 254 Hz. It is this 254 Hz signal which is used to generate the lock indicator signal. The lock indicator signal is the primary indicator that the unit is operating normally. If the rf signal, (which is synthesized from the 10 MHz VCXO), drifts off frequency (rf <> f_{Rb}), the photocell output reverts to the fundamental 127 Hz rate. The phase of the 127 Hz indicates if the rf is < f_{Rb} or > f_{Rb} and this phase information is used to servo the VCXO in the proper direction so that rf = f_{Rb}. This principle is illustrated in the lower three sine waves labeled MODULATION (127Hz), in Figure 3.1.

3.3 RESONATOR (Schematic Drawing No.703-221)

The function of the Resonator is to provide the correct signal to the Servo board in order to control the frequency of the crystal oscillator.

3.3.1 STEP RECOVERY DIODE.

The 60 MHz and 5.3125 MHz signals from the Synthesizer board are applied to a Step Recovery Diode, CR1. When CR1 conducts, it produces the harmonics of the 60 MHz and 5.3125 MHz signals (mixed). The fundamental frequency and the harmonic frequencies are input to the resonant cell via a resonant loop. The resonant cell and loop are tuned to select the 114th harmonic which corresponds to the resonant frequency of rubidium. The ''Response of the Atoms'' is detected by the photocell CR2 which supplies the correcting signal to the servo board.

3.3.2 RESONATOR COIL.

The resonator coil provides a magnetic field around the resonator cavity. This magnetic field is called the ''C-Field''. The strength of the C-Field is controlled by the voltage divider network on the power supply board comprised of R19 through R22. The adjustment of the C-Field is used for fine tuning of the FRK's output frequency.

3.3.3 RESONATOR CAVITY.

The resonator cavity temperature is elevated and maintained between 75°C and 78°C depending upon actual requirements of the particular FRK.

3.3.4 RESONATOR THERMOSTAT.

The operation of the resonator thermostat is typical of the heater control circuitry used in the unit. The resonator thermostat circuit consists of Q1 and U1 along with associated circuitry mounted on board 6, part of the resonator assembly, in conjuction with the resonator heater transistors, Q2 and Q3 and resonator thermistor mounted on the resonator assembly, and select resistor R15 mounted on the power supply board.

U1 is an op amp with a resistive bridge network on its inputs. The elements of the bridge network are R1, R5, and the thermistor. In one leg of the bridge is the thermistor sensing the temperature of the resonator; in the other leg of the bridge is select resistor R15.

For a given resistance value of R15, the Op Amp will drive the resonator heaters until the desired temperature is achieved. When the desired temperature is achieved, the bridge network will obtain a balanced condition. With the bridge in balanced condition, the op amp begins to regulate the power to the heater transistors, effectively maintaining the resonator at the proper temperature. In order to control the temperature overshoot, a portion of the output from U1, pin 1 is fed back to the input, this slows down the rate of change sensed at the input by the changing resistance of the thermistor. Transistor Q1 functions as a current limiter for the heater circuit. Q1 senses the current through the heater by detecting the voltage drop across R13. If the heater current becomes too high, Q1 begins to conduct which causes the bias to the heater to decrease. R11 limits the heater current when higher input voltage are present so that the maximum heater power is approximately constant.

3.4 SIMPLIFIED BLOCK DIAGRAM.

As illustrated by the simplified block diagram Figure 3.2, the Model FRK contains a servo board assembly, the lamp board assembly, a power supply assembly, a crystal oscillator assembly, the synthesizer board assembly, and the physics package (resonator assembly, Rb lamp, etc.).

3.5 SERVO BOARD, ASSEMBLY A1. (Schematic Drawing No. 100120).

The primary function of the servo circuit is to provide the crystal control voltage at E8 for the 10 MHz VCXO. The control voltage is derived by comparing the phase of the 127 Hz modulation signal with the phase of the photocell signal at E1 and E5. The secondary function is to provide the monitoring signal for the Rb lamp operation at E4, the atomic resonant lock circuit at E7 and the VCXO monitor control voltage at E9.

3.5.1 127 AND 254 Hz REFERENCE SIGNALS.

CMOS oscillator/divider U3 on the servo board, provides the 127 and 254 Hz reference signals and the 127Hz modulation signal for the rf introduced into the resonator. The oscillator frequency of 8.128 KHz is determined by C17, R19 and Select-in-test resistor R20. The divider portion of U3 divides the oscillator frequency into the required 127 and 254 Hz signals. The 127Hz reference signal is routed from U3, pin 4 to pin 11 of synchronous demodulator U4; and to the input of U6, pin 2 through the RC network R37-C24. The RC network R37-C24 plus the feedback network R38-C25 and the output RC filters (R39, C26, R40 on the servo board, and C2 and C12 on the synthesizer board) serve to waveshape the 127 Hz signal into the sinewave which is coupled to the synthesizer to modulate the rf.

The 254 Hz reference signal is routed from U3, pin 5 to pin 9 of synchronous demodulator U4. It is the 254 Hz reference signal and the 127 Hz reference signal which control the timing of the synchronous switch U4.

3.5.2 PHOTOCELL OUTPUT SIGNAL.

The photocell output, (DC bias together with 254 Hz when the unit is in the normal locked mode of operation, or 127 Hz while the unit is obtaining a lock), is routed to E1 and E5 on the servo board A1. E1 and E5 tie to the input of dual stage amplifier Ul at pins 5 and 6 respectively. The output of the first stage of amplification is capacitively coupled to the input of the second stage of amplification U1, pin 8 and routed to E4. E4 provides the Rb Lamp Monitor signal to the front panel connector.

The output of the second stage of amplification is capacitively coupled to the input of the lock-monitor circuit, pin 12 of U6; to the input of the 127 Hz Filter, pin 3 of U2. U2, pins 5, 6, and 7 set the conditions for the power supply to switch from +22 Vdc to +17 Vdc after the Rb Lamp obtains ''correct mode ignition''. When the unit is operating in its normal, locked condition the output of pin 1 of the 127 Hz filter is a 254 Hz sinewave. This output is coupled to pin 12 of the synchronous demodulator U4.

3.5.3 SYNCHRONOUS DEMODULATOR, U4.

U4 is a triple two-channel CMOS analog switch which functions as a synchronous demodulator. The 127 and 254Hz reference signal at pins 11 and 9 respectively, control the synchronous switching of two of the switches, while the third switch is controlled by the level of signal at U4, pin 10, from the lock monitor circuit, U6. In addition to the reference signals at U4, pins 9 and 11, the filter output at U4 pin 12, and the output of the lock monitor amplified at U4 pin 5, the synchronous demodulator also has a 6.8 volt reference level applied to pins 5 and 13 from the dividing/regulating network on the +17Vdc line at E2, E3.

3.5.4 INTEGRATOR U5.

U5 functions as an integrator. It's output voltage changes at a rate determined by the differential input voltage. For example, an input differential of -200 mV causes an output voltage change of +200 mV/sec. The change will continue until the differential input is nullified, (crystal returns to center frequency), or until the Op amp reaches it's maximum output voltage. The output of the integrator U5 is the crystal control voltage used to control the frequency of the VCXO via varactor A4-CR3. Part of the integrator output is also routed to the sweep control circuit at U6, pin 5.

3.5.5 SWEEP CONTROL CIRCUIT, U6.

U6 pins 5, 6, and 7 function as a comparator which controls the up/down sweep. When the unit is not locked to the atomic resonance, the output of U6 at pin 7 is fed back to the input of U5 via the synchronous demodulator U4, pin 2. This feed back signal causes the integrator U5 output to sweep the entire voltage range about once every forty seconds; this sweeps the VCXO frequency until atomic resonance lock is achieved.

3.5.6 LOCK MONITOR CIRCUITS.

As stated in 3.4.2, a portion of the photocell signal is applied to an input of the Lock Monitor circuit at U6, pin 12. U6 pins 12, 13 and 14, with associated circuitry, form a second harmonic amplifier to provide a 254 Hz signal at pin 3 of the Synchronous demodulator U4. The 254 Hz at pin 3 is chopped at the 6.8 volt reference level from U4, pin 13, at the 254 Hz rate, controlled by the 254 Hz reference signal at U4, pin 9. The resultant signal at U4 pin 4 is coupled to U6, pin 9. With the unit locked to f_{Rb} the signal at U6, pin 9 will cause the output at U6 pin 8 to increase. This increase provides the positive signal at U4 pin 10 which removes the sweep control signal from the Integrator U5; and also biases Q1 into a conduct mode which provides the Lock Monitor signal at the front panel connector.

3.6 LAMP BOARD A2. (Schematic Drawing No. 703-209)

The lamp board contains the lamp exciter circuits and lamp-housing heater circuits. The function of the lamp board is to ignite and maintain ignition of the Rb lamp, and to provide the required heating necessary to maintain the lamp housing at approximately 115°C.

3.6.1 The Rb lamp excitation circuit consists of an adjustable 79 MHz oscillator. Transistor Q2 is the active element, and the tank circuit L4, C11 maintain optimum lamp ignition.

3.6.2 The Rb lamp is mounted in a temperature-controlled housing. Q3 is mounted on the housing and acts as the heating element. Thermistor RT1 is the temperature sensor and forms part of the feedback network for the thermal control circuit U1 and Q1. Refer to paragraph 3.3.4 RESONATOR THERMOSTAT for a more complete analysis of the Heater Controller operation.

3.7 POWER SUPPLY A3 (Schematic Drawing No. 703-254).

The internal power supply provides the unregulated, filtered voltages for the Rb lamp heaters, Oscillator heater and Resonator heaters; in addition to providing the filtered and regulated voltage for the units operation. The input voltage line is fuse and diode protected against reverse polarity inputs.

The Power Supply board accepts the +22 to +32 Vdc input voltage at E2, and provides +22 Vdc, until the Rb lamp ignites, at which time the power supply is switched to +17 Vdc. The switching occurs when U2-B, on the Servo board, senses that the Rb lamp is ignited, in the correct mode, by the positive increase at pin 5. The output of U2-B is routed to the power supply board at E29. The positive voltage increase provides reverse bias for CR6, effectively removing R24 from the circuit and setting the condition for the power supply output to be lowered to the +17 Vdc required for the internal circuits of the unit.

3.7.1 +17 Vdc REGULATED POWER SUPPLY. The +17 Vdc power supply consists of Q1 and U1 along with the components in their respective circuitry mounted on the Power Supply board and pass transistor Q1 mounted on the baseplate.

The +22 to +32 Vdc input is routed across the 3 amp fuse F1 to the voltage divider circuit consisting of R5, R7. The input voltage is dropped to approximately 3 Vdc which is coupled through CR3 to U1 pin 2. Before power is applied, U1 pins 2, 3, and 6 were at ground potential. With 3 volts at U1, pin 2 and U1, pin 3 still at ground potential, the resultant offset causes U1, pin 6 to go low, turning on the power transistor Q1. The +17 volt line is fed back through CR4 and R9 to the reference zener diode, CR5. CR5 develops approximately 6.3Vdc at U1, pin 2. In addition, the 17 volt line is fed back to the voltage divider consisting of R6, R8 and R10 to apply a voltage to U1, pin 3. The voltage divider determines the voltage ratio of the 17 volt line to the voltage reference diode CR5, thus setting the voltage level of the 17 volt line.

Transistor Q1 on the power supply board functions as a current limiter by sensing the voltage drop across R14. If the current through the pass transistor becomes excessive, Q1 begins to conduct decreasing the emitter-base bias on the pass transistor, thus limiting the current flow.

3.8 **OSCILLATOR BD, A4** (Schematic Drawing No.703-103).

The purpose of the Oscillator board is to provide a stable 5 or 10 MHz signal (depending on configuration) to the output connector, and a 10 MHz signal to the synthesizer board. The Oscillator board consists of the 5 MHz or 10 MHz Voltage Controlled Crystal Oscillator (VCXO), the crystal oven and thermal control circuitry, and a buffer amplifier.

3.8.1 VCXO HEATER. The 5 or 10 MHz VCXO crystals are mounted in a temperature controlled oven. The oven is heated by the heater transistor Q9. The crystal heater controller operation is basically the same as discussed in 3.3.4, with RT1 acting as the temperature sensor, balancing out R37 and Select Resistor R42. Transistor Q8 is a current limiter which senses the current through the heater by detecting the voltage drop across R49.

3.8.2 5 MHz or 10 MHz VCXO. The oscillator consists of the 5 or 10 MHz SC-Cut crystal Y1, and transistors Q1 and Q2 with associated circuitry. Q2 is the actual oscillator circuit, with Q1 setting the gain of the oscillator by controlling the bias at the base of Q2. The frequency of oscillation is determined by the capacitive tuning network consisting of C5, C6, C7 and varactor CR1. The 5 MHz signal from the VCXO is the driving signal for the Field Effect Transistor (FET) Q3. FET Q3 provides the feedback for the oscillator circuit and is used as a low-noise linear amplifier to drive the output buffer (Q4,5).

3.8.3 Buffers

3.8.3.1 5 MHz LN Oscillator (5 MHz buffer and 10 MHz doubler). The 5 MHz LN Oscillator drives the Cascade Buffer made up of Q4 and Q5. Its output is transformer coupled (through T1) to the output connector (J1). Phase complimentary signals of equal amplitude are picked off the collector and emitter of Q5 and fed to the frequency doubler (Q6, Q7). This stage feeds 10 MHz to the Synthesizer PCB.

3.8.3.2 10 MHz LN Oscillator. The 10 MHz LN Oscillator drives the Cascade Buffer, which is made up of Q4 and Q5. Its output is transformer coupled (through T1) to the output connector (J1). The signal at the emitter of Q5 drives the internal buffer Q7, which in turn feeds 10 MHz to the

Synthesizer PCB.

3.8.4 VCXO Control Voltage (electronic tuning)

3.8.4.1 10 MHz LN Oscillator

The control voltage from the Servo PCB is routed to the Oscillator PCB terminal E9. From here the voltage is fed to CR1 via the resistor network made up of R50, 51, and 52. CR2 is a reversed bias varicap, capable of electronically tuning the frequency of the crystal (Y1). The trim range of the crystal is designed to compensate for crystal aging over a period of several years, as well as temperature compensation of the Oscillator over its entire temperature range.

C7 and C8 match the Crystal Tuning Sensitivity to the varicap (CR1). C6 mechanically tunes the crystal center frequency and can be used to compensate for crystal aging during maintenance.

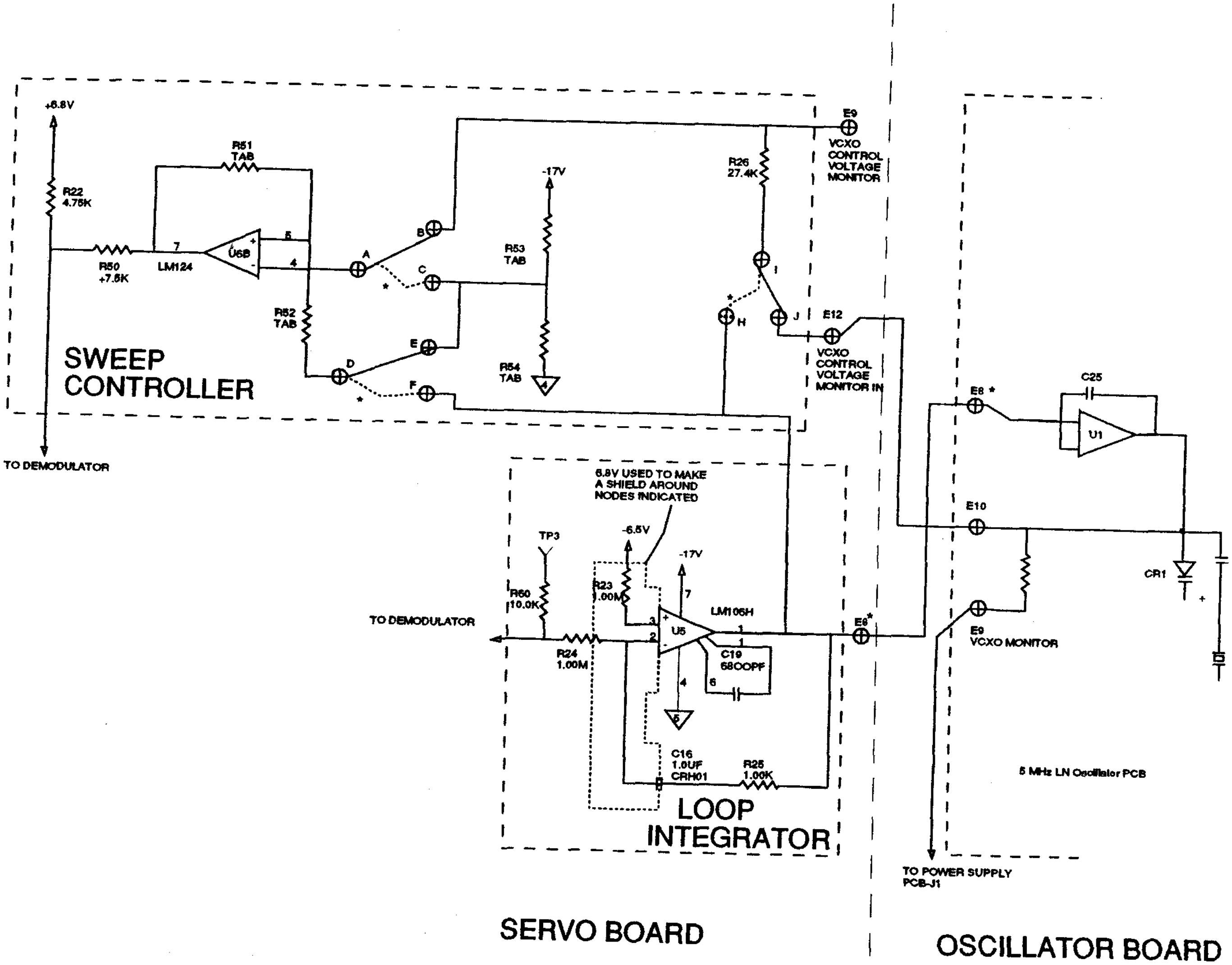
3.8.4.2 5 MHz LN Oscillator

The circuit functions very similar to the 10 MHz unit, the major difference is that an integrator stage (U1) has been added, resulting in a slower loop time constant. This feature takes full advantage of the crystal's outstanding reduced phase noise close to the carrier frequency. The interconnection of the Servo PCB, as well asthe Servo modification, and the 5 MHz LN Oscillator are shown in Figure 3-4.

3.9 **SYNTHESIZER A5.** (Schematic Drawing No. 703-218).

The 10 MHz signal from the crystal oscillator is applied to the input of a frequency tripler consisting of Q3, Q4 and associated circuitry. The 30 MHz signal is capacitively coupled through C13 to transformer T1. The 127 Hz from the Servo assembly is injected into the rf signal via varactor CR6. The interaction of CR6 with the tuned tank circuit on the primary of T1 serves to phase modulate the rf at a 127 Hz rate. The secondary of T1 is center tapped to provide a split phase signal that drives the bases of Q5 and Q6. The result is a 60 MHz signal that is amplified by Q7, Q8 which are class A inverting amplifiers.

A portion of the 10 MHz signal from the crystal oscillator is applied to the base of Q2. Q2 converts the sinewave to a TTL compatible trigger signal. Power for the TTL circuits is provided by the voltage regulator VR1. VR1 is a 3 pin, +5V regulating IC. The 10 MHz TTL signal is divided down in U2 and U3, and recombined in U1. The final TTL signal from U1 is a 5.3125 MHz signal. This 5.3125 MHz signal is mixed with the 60 MHz output of Q8, and routed to the Step Recovery diode in the Resonator circuit.



* SERVO JUMPERS
... 10 MHz FRK

** E8=VCXO CONTROL VOLTAGE
(ENTER 2X AT TERMINALS)

Figure 3-4. Interconnection of Servo PCB, Servo modification, and 5 MHz LN Oscillator

SECTION IV

MAINTENANCE, TROUBLESHOOTING, AND REPAIR

4.1 INTRODUCTION

This portion of the manual provides procedures for performing maintenance on the FRK-( )LN (5 & 10 MHz).

NOTE
If the unit should require service within the warranty period, contact Ball Corporation, Efratom Division for repairs. Refer to warranty page (i) for addresses and phone numbers of the repair center closest to you.

4.2 TEST EQUIPMENT

The required test equipment to ensure normal operation is listed in Table 4.1. Test equipment other than those items listed may be used, providing that the substitute equipment meets or exceeds the "Minimum Use Specifications" as listed in Table 4.1. If the required test equipment or its equivalent is not available, it is recommended that the unit be sent back to the Efratom factory whenever service is required.

Table 4-1: Required Test Equipment - Performance Tests & Trouble-shooting (TS)

INSTRUMENT	REQUIRED CHARACTERISTICS	USE	MODEL (or equivalent)
DC Power Supply	Output Voltage: 0 to 30 Vdc. Output Voltage: 2.0 Amps Min.	Perf. Test	Hewlett-Packard 6433B or 6296A
Oscilloscope	10 MHz	Perf. Test	Tektronix 465
DMM (Digital multimeter)	Voltage Range: 0 to 30 Vdc Accuracy: ±1.25% Iv, Resistance Range: 0 to 150 Ohms	Perf. Test/TS	Fluke 8000A or 8020A
RF Voltmeter	10 MHz, true rms	Perf. Test/TS	Racal Dana 9300B
Freq. and Time Interval Analyzer	Internal Ref. Frequency: 10 MHz, ±1E-12, Stability: parts in 10^{12}	Perf. Test	Hewlett-Packard 5371A or 5372A (App. Note 358-12)
Phase Comparator	Analog voltage output	Perf. Test	Hewlett-Packard K34-59991A
Precision Potentiometer	500K	Perf. Test	
Resistive Load	Feed-thru type, 50 ohms	Perf. Test	Hewlett-Packard 10100C
Timer	Capable of indicating 1 to 15 mins.	Perf. Test/TS	Any timepiece
Ref. Freq. Standard	Output: 10 MHz, ±2E-12 Accuracy	Perf. Test	Must be traceable to NIST (1)
Linear Recorder	0-10 Vdc Full Scale, 1-10 cm/hr	Perf. Test	Tracor 888
Temp. probe	Capable of measuring -50°C to 150°C	Perf. Test	Fluke 80T-150
Frequency Counter	5 MHz . 125 MHz	Perf. Test/TS	Fluke 1910A
Decade Resistance	0 > 9.999999 Mohm	Perf. Test/TS	I.E.T. Model RS200
Mixer/IF Amp.	Low noise, wideband limiting amplifier	Perf. Test	HP K79-59992A

(1) Efratom Modular Frequency System with interface to a GPS receiver recommended.

4.3 PERFORMANCE VERIFICATION TESTS

4.3.1 Output Level Test

(1) Connect the UUT as shown in Figure 4-1.

(2) Apply dc power and allow the UUT to stabilize (> 10 minutes).

(3) Measure output level with a rf voltmeter, using a 50 ohm resistive termination. Record the voltage level of output.

(4) Observed voltage level must be 1 Vrms. ±10%.

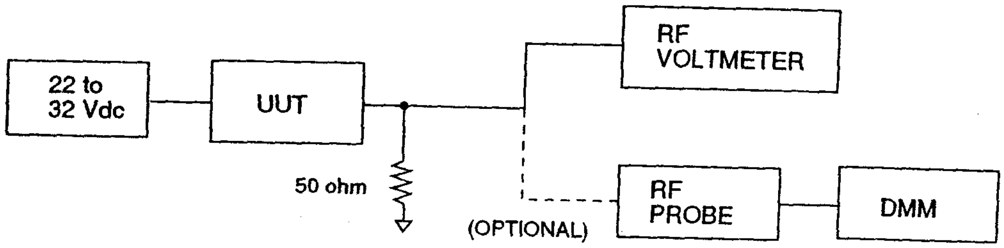


Figure 4-1. Output Level Test Configuration

4.3.2 Frequency Offset Test

(1) Connect the Unit (UUT) and the test equipment as illustrated in Figure 4-2. (As an alternative, the HP5371A may be used to measure frequency offset. Contact a HP field engineer for details.)

(2) Adjust chart recorder pen position to center scale for 0 volts input.

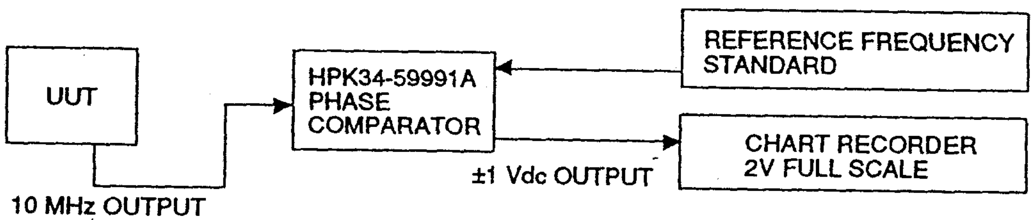


Figure 4-2. Frequency Offset Test & Long-term Stability Test Configuration

(3) Ensure that the equipment has had sufficient time to warm-up. (The UUT requires 1 hour to stabilize.)

NOTE

The maximum temperature fluctuation must not exceed 2° C.

(4) Monitor phase comparator output voltage on the chart recorder for 15 minutes. Calculate the the fractional frequency offset ($\Delta f/f$) from the phase comparator output voltage change over time ($\Delta V/\Delta t$) according to the equation:

$$\text{Fractional Frequency Offset} = \frac{\Delta V}{\Delta t} \cdot \frac{1}{10\ \text{MHz} \cdot V_{p-p}}$$

Where: $\Delta V/\Delta t$ = Slope of phase comparator output in volts/sec over a 15 min. interval (t in sec.).
V_{p-p} = Output voltage swing of phase comparator for 360° phase shift.

For the HP K34-59991A, the fractional frequency offset = $\frac{\Delta V}{\Delta t}$ X 5E-8 sec/volt.

(5) Verify that the fractional frequency offset is within the required limit.

4.3.3 Frequency Retrace Test

(1) Connect the UUT as shown in Figure 4-2.

(2) Apply dc input power to the UUT.

(3) Allow at least 1 hour for the UUT to stabilize. Measure and record the output frequency offset per Section 4.3.2, Step 4.

(4) Disconnect input power to the UUT for 24 ± 2 hours.

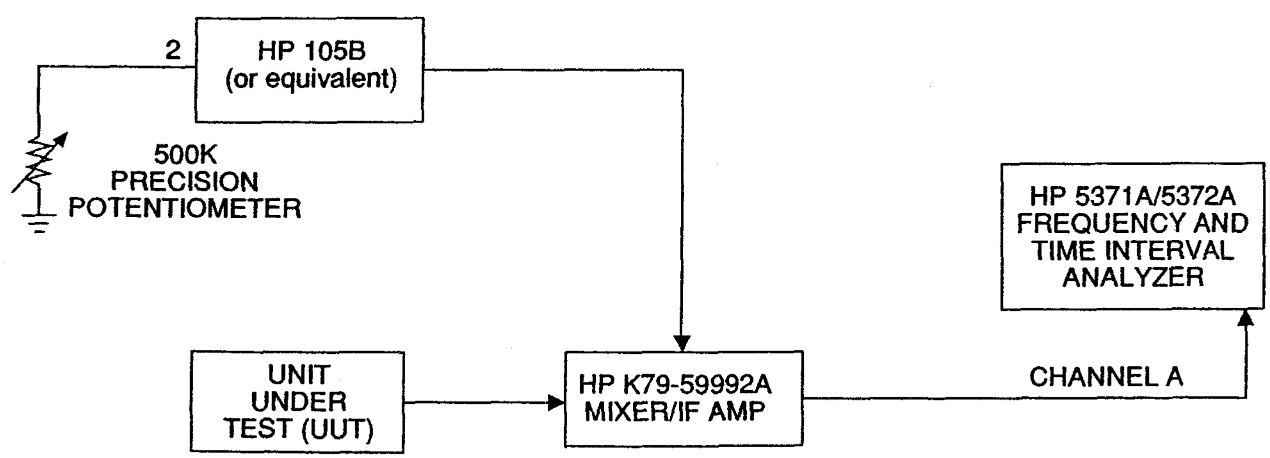
(5) Apply dc input power to the UUT.

(6) After one hour of operation, measure and record the output frequency offset per Section 4.3.2, Step 4.

(7) Determine the absolute value of the difference between the offsets marked in Step 3 and Step 6. The difference must be ±2E-11.

4.3.4 Short-term Stability (Root Allan Variance) Test

(1) Connect the UUT as shown in Figure 4-3.



NOTE:
The 1 sec. Allan Variance of the Adjustable Frequency Standard must be much better than the 1 sec. Allan Variance of the UUT.

Figure 4-3. Short Term Stability and Signal Output Tests.

(2) Apply dc input power. Allow UUT to stabilize (about 1 hour).

(3) Refer to the HP 5371A/5372A manual and Application Note 358-12, for specific details regarding measurement of Root Allan Variance using the HP5371A/5372A. If necessary, contact local HP field engineer for assistance. Tune HP 105B to produce 10 Hz IF frequency. Measure the root Allan Variance (A.V.) at 1.0 second using 100 data samples. The measured A.V. must be $\leq$ 3 x 1E-11 (for FRK-H. Since the dominant source of frequency instability at 1 sec. through 100 sec. is white FM noise, root Allan Variance at 10 sec. and 100 sec. can be calculated using the expressions:

$$A.V._{(t=10\,sec.)} = A.V._{(t=1\,sec.)} / \sqrt{10}$$

$$(A.V._{(t=100\,sec.)} = A.V._{(t=1\,sec.)} / \sqrt{100})$$

The calculated A.V. for 10 sec. must be $\leq$ 1E-11 (4E-12 for FRK-H). The calculated A.V. for 100 sec must be $\leq$ 3E-12 (1E-12 for FRK-H).

4.3.5 Long-term Stability Test

Long-term stability refers to slow changes in the average frequency, with time due to secular changes in UUT physics and or electrical circuitry. Long-term stability is usually expressed as fractional frequency offset ($\Delta f/f$), for a given period of time. The daily fractional frequency offsets can be plotted to show the long-term stability.

NOTE

The long-term stability test should be performed only after the UUT has been operating continuously a minimum of 48 hours. The frequency of the UUT should be measured and recorded each day to establish the drift rate.

(1) Connect the equipment as shown in Figure 4-2.

(2) Per Section 4.3.2, Step 4, compute and record the fractional frequency offset every 24 hours over a period of 15 days.

NOTE

It is recommended to plot the daily offset graphically and use this plot to estimate long-term aging (drift rate).

(3) After completion of 1 month of aging, compute the drift rate of the UUT over the 1 month period.

(4) If the drift rate over 1 month is $\leq$ 4E-11 (1E-11 for FRK-H), the UUT has passed.

(5) If the drift rate is $\geq$ 4E-11 (1E-11 for FRK-H) , the UUT has failed and must be retested (repeat step 2).

(6) Depending on the off-time since the last operation, the environmental exposure, and the repairs performed, the unit may need to repeat this test a second time before meeting the original manufacturer's specifications.

4.4 FIELD MAINTENANCE, TROUBLESHOOTING, AND REPAIR

4.4.1 FIELD MAINTENANCE

Field maintenance consists of compensating for crystal aging and frequency adjustment. These are routine adjustments that may be made periodically to compensate for aging effects.

4.4.1.1 Crystal Aging Compensation

NOTE

The effects of crystal aging can be seen on a voltmeter. Attach a voltmeter probe to the crystal volts output monitor line of the FRK. A meter indication of <+4 Vdc or >+12 Vdc, indicates an adjustment of the crystal oscillator base frequency is required.

(1) Ensure that the UUT has been operating continuously for at least 1 hour.

(2) Locate the crystal trim adjustment on the FRK.

(3) Unscrew the Philips head screw plug that acts as the adjustment access cover. The trimmer capacitor adjustment screw will now be visible.

NOTE

For the **5 MHz LN** unit COUNTERCLOCKWISE rotation of the adjustment will INCREASE the control voltage, while CLOCKWISE rotation will DECREASE the control voltage.
For the **10 MHz LN** unit CLOCKWISE rotation of the adjustment will INCREASE the control voltage, while COUNTERCLOCKWISE rotation will DECREASE the control voltage.

(4) Using a non-metallic alignment tool, SLOWLY adjust the trimmer capacitor as necessary to obtain a +8 Vdc indication on a meter.

4.4.1.2 Frequency Adjustment

(1) Monitor the fractional frequency offset per section 4.3.2.

(2) Adjust POT (R21) on power supply board (accessed through baseplate) to obtain a fractional frequency offset that is within the required limits.

4.4.2 TROUBLESHOOTING AND REPAIR

Troubleshooting and repair consists of testing and repair of the FRK. This section contains information on fault identification and removal, repair, replacement, and calibration of the assemblies of the FRK.

NOTE:

THESE PROCEDURES ARE NOT ROUTINE ADJUSTMENTS AND PERFORMING THEM SHOULD BE CONSIDERED ONLY IN THE EVENT OF UNIT FAILURE.

a. Troubleshooting Flowcharts

A series of flow charts is provided to aid in the isolation of faults. Flowcharts are presented in logical fault isolation order and must be performed in the proper sequence given. The troubleshooting/repair procedures for the various subassemblies of the FRK are presented after each flowchart and are designed to permit the repair technician to identify the fault and replace and/or repair the subassembly.

b. FRK Disassembly

CAUTION

All FRK disassembly operations must be performed with power removed from the unit. Disassemble assemblies only as needed to make repairs.

(1) Detach the cover from the FRK assembly by removing ~~two~~ six 2mm screws on the connector face of the unit, then remove four 2mm screws that hold the bottom of the cover to the baseplate (see Figure 4-4). Once all six retaining screws are removed, hold the baseplate while gently pulling on the cover (it may be necessary to move the cover slightly from side to side as the FRK internal assembly is removed from the case).

(2) Remove any of the outside PCB assemblies by removing the M2x6 screws that fasten the boards to the FRK frame at each corner (the servo and synthesizer boards have additional screws that must also be unfastened).

(3) Once the mounting screws are removed, label all wires and coax (shielded wire) connections, and then remove each one (a soldering iron is required).

(4) Disassemble the baseplate of the FRK by removing the lamp inspection cover and all other screws on the outside face of the baseplate. This frees the baseplate from the frame.

NOTE

The Q1 Pass Transistor will still be connected. Pulling the baseplate away from the frame rapidly may unintentionally break the wire connection of the transistor.

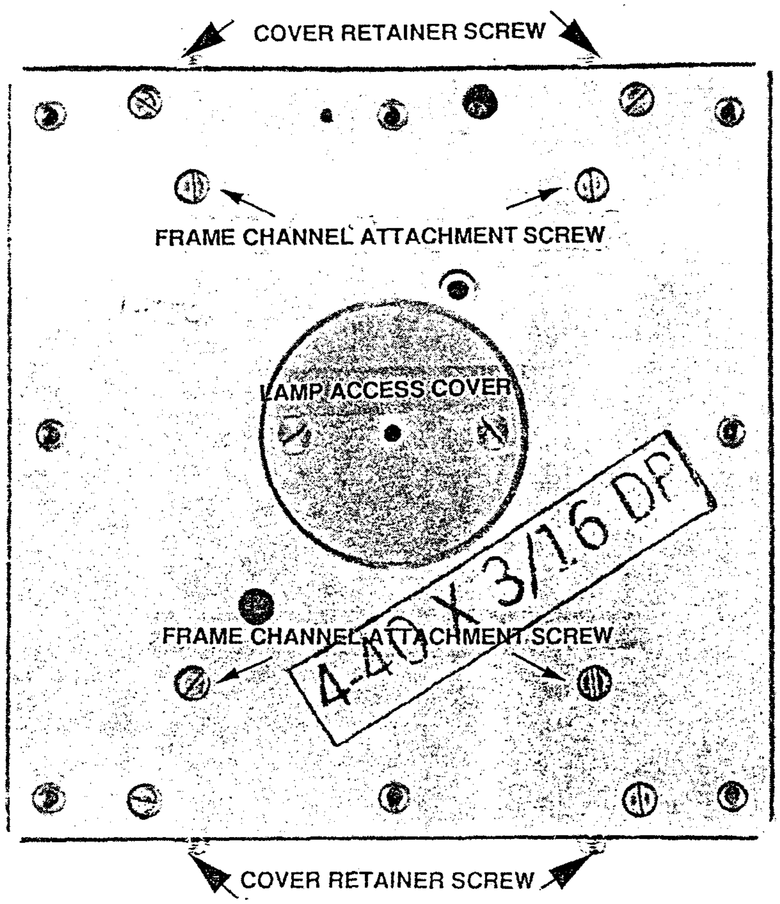


Figure 4-4. FRK Baseplate

(5) The lamp board assembly and the metal container that is the exterior of the resonator assembly are located inside the frame channel. These two assemblies are accessed by removing four M2x6 screws from the four nut blocks that are located inside the frame channel. The resonator board is located inside the mu-metal canister of the resonator assembly. Figure 4-5 is a wiring diagram that illustrates how the FRK boards and the physics package are connected together.

(6) Before the lamp assembly can be removed from the baseplate end of the FRK unit, all wires must be disconnected from each end of C1 and C2. These feedthrough capacitors (which are frame mounted) must be removed completely from the frame. Once this has been accomplished, removal of the two M2x6 screws at the opposite corners of the lamp PCB allows it to be lifted away from the interior frame channel.

(7) Remove the resonator assembly from the connector end of the unit by unsoldering the 10 wires that connect the resonator to the other board assemblies of the unit. Disconnect the wires from the locations shown in Table 4-2.

Table 4-2. Resonator Disconnect Points

Servo Bd.	Power Supply Bd.	Synthesizer Bd.
A1E1	A3E21	A5E6
A1E5	A3E22	A5E7
	A3E23	
	A3E24	
	A3E25	
	A3E26	
	A3E27	
	A3E28	

(8) Remove the M2x6 screws at each corner of the resonator assembly PCB, allowing the entire resonator assembly to be removed from the interior frame channel.

(9) The inner shield lid of the resonator can is assembled to the can with a tight mechanical fit. The lid is removed by gently tapping around the circumferance of the lid's exposed lip.

(10) Separate the resonator assembly's PCB from the inner shield can by removing the three M2 nuts spaced around the light entry hole in the PCB.

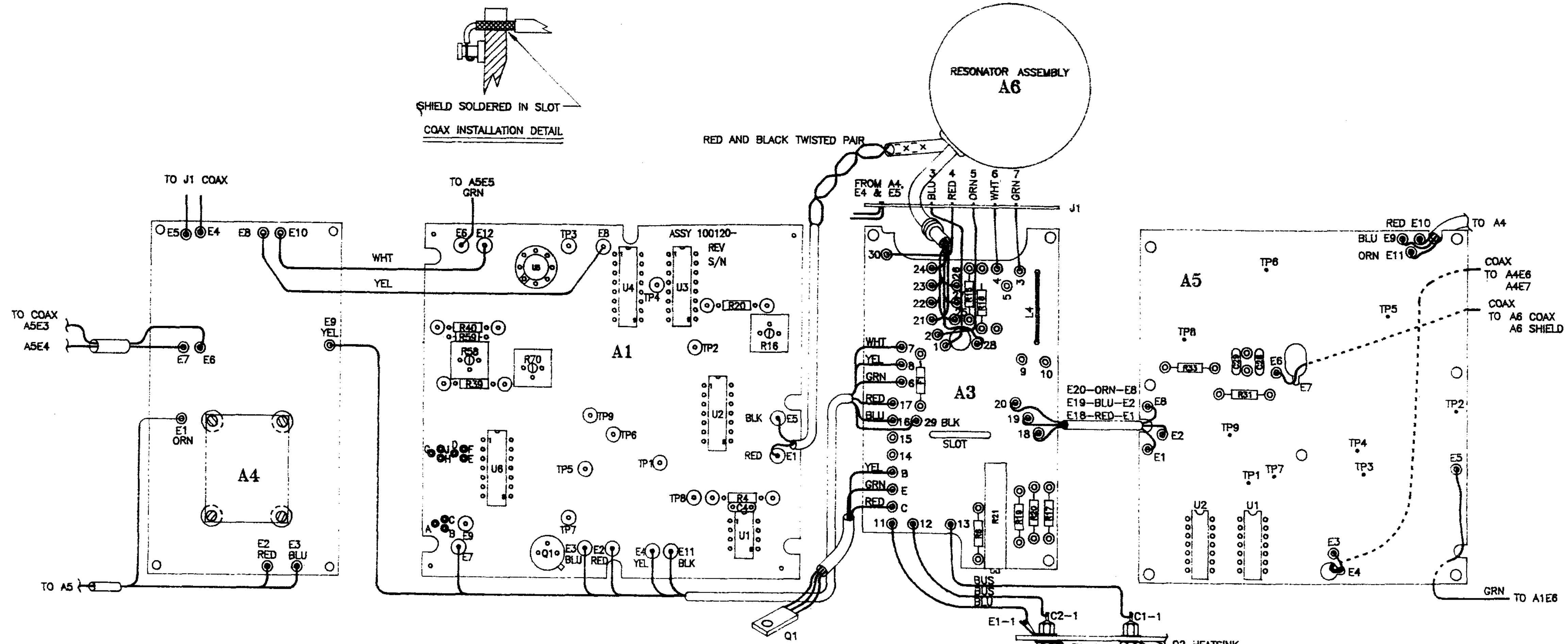
(11) Having completed these steps, the resonator housing, with the heater control PCB attached, can be removed from the inner shield can for service.

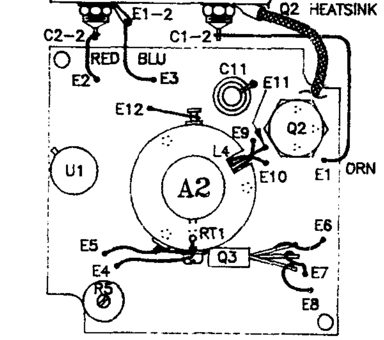
The FRK can now be visually inspected for burned components or broken connections. Placed on a test bench and powered up, signal traces can also be obtained from the test points on the various board assemblies (refer to Section 4.4.2.5, Detailed FRK Circuit Descriptions).

NOTE

Disassembly of the FRK should be performed only to to the level necessary to identify a fault (or faults). Excessive disassembly may introduce other problems into the unit, making it impossible to repair.

After repairs have been completed, and the FRK reassembled, refer to Section 4.3 for Performance Verification Tests that must be performed before the FRK is returned to service. Refer to Section 4.4.2.6 is alignment is required for any of the repaired or replaced assemblies.





WIRE LIST				
No.	FROM	TO	COLOR (AWG)	FUNCTION
1	A1E1	A6E9	RED (28)	PHOTOCELL
2	A1E2	A3E17	RED (24)	+17 VDC
3	A1E3	A3E16	BLU (24)	GND
4	A1E4	A3E8	YEL (24)	Rb LAMP MONITOR
5	A1E5	A6E8	BLK (28)	PHOTOCELL
6	A1E6	A5E5	GRN (24)	127 Hz SIGNAL
7	A1E7	A3E7	WHT (24)	RES LOCK SIGNAL
8	A1E8	A4E8	YEL (24)	XTAL CONT VOLTAGE
9	—	—	—	—
10	—	—	—	—
11	A1E11	A3E29	BLK (24)	
12	A1E12	A4E10	WHT (24)	
13	A2E1	C1-2	ORN (24)	+28 VDC
14	A2E2	C2-2	RED (24)	+17 VDC
15	A2E3	E1-2	BLU (24)	GND
16	—	—	—	—
17	A4E1	A5E11	ORN (24)	+28VDC (VIA A3E20)
18	A4E2	A5E10	RED (24)	+17 VDC (VIA A3E18)
19	A4E3	A5E9	BLU (24)	GND (VIA A3E19)
20	A4E4	J1-1	COAX	5MHz OUTPUT
21	A4E5	J1-1	SHIELD	
22	—	—	—	—
23	A4E6	A5E3	COAX	5MHz
24	A4E7	A5E4	SHIELD	
25	A4E9	A3E6	GRN (24)	
26	A5E1	A3E18	RED (24)	+17 VDC
27	A5E2	A3E19	BLU (24)	GND
28	A5E6	A6	COAX	RESONATOR
29	A5E7	A6	SHIELD	
30	A5E8	A3E20	ORN (24)	+28 VDC
31	—	—	—	—
32	A3E1	J1-3	BLU (24)	GND INPUT

WIRE LIST				
No.	FROM	TO	COLOR (AWG)	FUNCTION
33	A3E2	J1-5	ORN (24)	+28 VDC INPUT
34	A3E11	E1-1	BLU (24)	GND
35	A3E12	C2-1	BUS (24)	+17 VDC
36	A3E13	C1-1	BUS (24)	+28 VDC
37	—	—	—	—
38	A6E1	A3E21	ORN (26)	
39	A6E2	A3E24	BLU (26)	TWISTED PAIR
40	A6E4	A3E22	RED (26)	
41	A6E3	A3E23	YEL (26)	
42	A6E5	A3E25	WHT (28)	
43	A6E6	A3E26	BLK (26)	
44	A6E7	A3E28	GRN (26)	
45	A6E10	A3E27	BRN (28)	
46	—	—	—	—
47	—	—	—	—
48	—	—	—	—
49	—	—	—	—
50	A3E4	J1-6	WHT (24)	RES LOCK SIGNAL
51	A3E3	J1-7	GRN (24)	XTAL OSC MONITOR
52	A3E30	J1-4	RED (24)	HTR POWER INPUT

Figure 4-5. 5 MHz FRK-( )LN Wiring Diagram

c. FRK Assembly Repair

If troubleshooting has indicated that the FRK assembly has failed and the assembly must be repaired instead of being replaced, the following sections provide repair guidelines.

SN6WRMAP3 SOLDER, per QQ-S-571, and a 35 to 40 watt soldering iron should be used to accomplish the soldering that might need to be done on the FRK.

> **CAUTION**
> Excessive heat can cause the etched circuit wiring to separate from the board material.

If it becomes necessary to solder in the general area of any of the high frequency contacts in the unit (terminal points), clean the contacts immediately upon completion of the soldering.

The adjustments, repair, or alignments required by the fault isolation flowcharts should be followed by the retesting of the procedure that led to the fault isolation to ensure the unit is functioning as required.

d. Overall FRK Troubleshooting (Fault Isolation Flowchart)

Figure 4-6 is the overall troubleshooting flowchart that should be followed to locate a fault in the FRK unit. For additional information, refer to the assembly drawings and schematics presented in Appendix B, and to the text in the following sections that describes the operation of the major FRK boards and circuits.

(1) Rubidium Lamp Replacement

Although this is seldom a cause for failure in the FRK (refer to 4.4.2.5 (2) for symptoms), the Rubidium lamp is replaceable. The Rubidium lamp is accessed by removing the two screws holding the Lamp Cover Plate to the baseplate (refer to Figure 4-8). A slotted access plate is beneath the cover plate. Once the access plate has been removed, the base of the lamp housing is visible.

> **CAUTION**
> The lamp housing is at the electrical potential of the unit (28 Vdc) and a short will occur if an attempt to remove the lamp is made with power applied to the unit. The lamp housing is extremely hot, as well. Extreme care must be exercised when removing the lamp to avoid burns.

Once all power to the unit is off, carefully unscrew the rubidium lamp and lift it from the housing (use a pair of needle nose pliers for this task). Make sure the replacement lamp is clean and that its surface is free of any oils or grease and screw the bulb into the housing. Once the bulb is firmly seated in the housing, replace the access plate and the Lamp Cover Plate, and replace the two screws previously removed.

Apply power to the FRK and, after allowing sufficient warm-up time, run a performance test to ensure that the unit is fully functional.

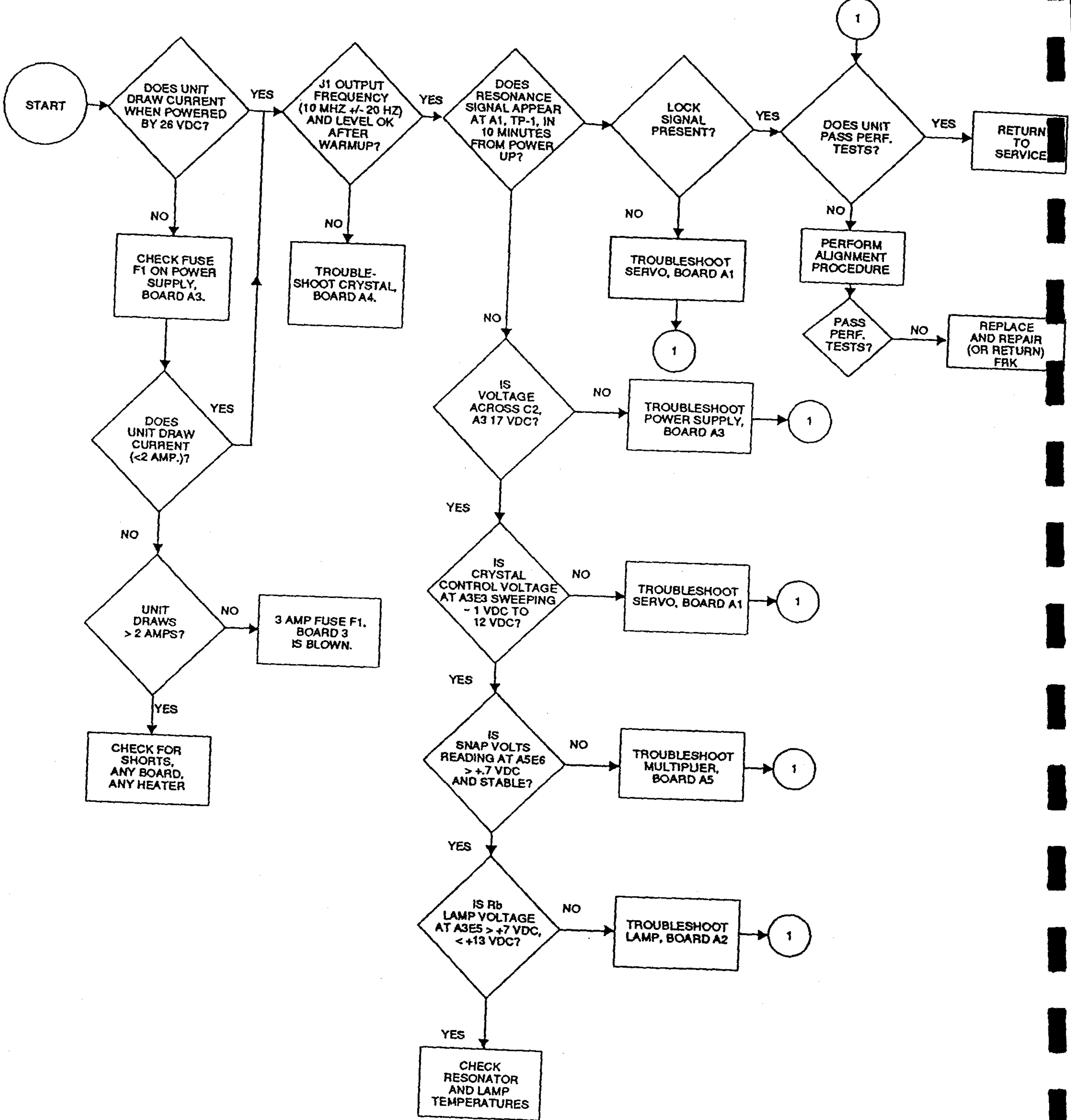


Figure 4-6. FRK Troubleshooting Overview

4.4.2.1 Detailed FRK Circuit Descriptions

a. Resonator Assembly (schematic 703-221)

The function of the resonator assembly is to compare the multiplied and synthesized output frequency of the crystal oscillator to the ground-state hyperfine transition frequency of ^{87}Rb. It provides a 127 Hz error signal to the servo board to lock the crystal frequency to the atomic transition.

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

(2.) Step Recovery Diode - The 60 MHz and 5.3125 MHz from the multiplier are summed at the output of the multiplier/synthesizer board and then applied to the step recovery diode. This diode, CR1, produces electromagnetic radiation having frequencies given by the expression (60 n + 5.3125 m) MHz, where n = a positive integer and m = an integer. The diode is part of a tuned coupling loop, tuned to the 114th harmonic of 60 MHz (n = 114); the coupling loop is inside a microwave cavity that is tuned to the same frequency. The bandwidth of the microwave cavity assembly is wide in comparison with the bandwidth of the atomic transition (< 1 kHz), so that the atoms function as a narrow-band filter for the microwave signal. The diode can be replaced by gaining access to the light entry end of the resonator assembly PCB. An access hole in the PCB provides clearance to remove first the diode retaining screw and then the diode itself (refer to Figure 4-7).

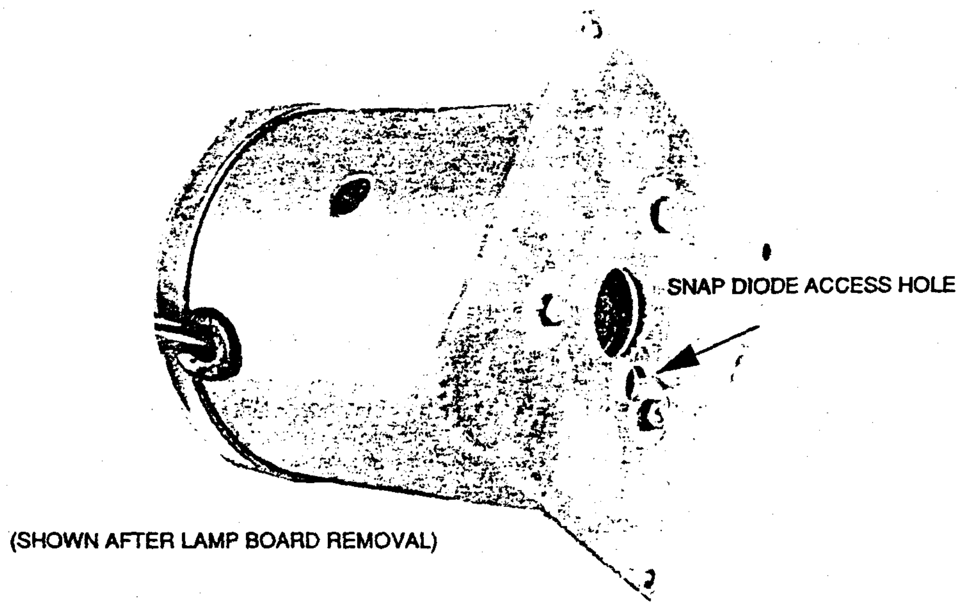


Figure 4-7. Snap Diode Access Hole on Resonator Assembly

(3.) Photocell - The photocell current is proportional to the total light incident on the photocell CR2. Minimum current results when a microwave field corresponding to the Rb hyperfine frequency is applied simultaneously with pumping light. Photocell problems are unlikely (always check the lamp assembly and power supply first), but manifest themselves as instable lamp monitor dc voltages, or as sporadic noise on the servo board's TP1 resonance signal. The photocell is replaced as part of the complete resonator assembly.

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

R17 on the power supply board supplies a fixed current to the coil.

R21, the 24 turn potentiometer, on the power supply PCB, provides a variable current for frequency adjustment.

The temperature compensation circuit formed by Q2, Q3, R13 and R16 provides a current that varies with temperature. The power to heat the microwave cavity increases approximately 40 mW for every degree centigrade decrease of the ambient temperature. This results in a current change through resonator heater transistors Q2 and Q3, and through R13 on the resonator thermostat assembly. The voltage across R13 is routed to R16 on the power supply board and back to the C-field coil. Decreases in ambient air temperature causes the voltage across R13 to rise, providing more C-field current, and raising the output frequency.

The most common C-field problem is an open winding. An ohmeter is used to check for this situation by removing power to the FRK and measuring from A3E27 to A3E19. A good C-field coil will give a reading of approximately 30 ohms.

(5.) Resonator Thermostat (part of resonator board assembly, refer to schematic 703-221) - the resonator thermostat consists of U1, Q1, and associated circuitry on the resonator PCB, and Q2, Q3, and RT1 mounted on the resonator cavity housing. U1 is the temperature control element, Q1 is a current limiting element, and Q2 and Q3 are the heat source.

U1 and the resistive bridge network on its inputs form the temperature control section. E1 receives +12 Vdc from the power supply board to power this section. R5 and R7 form a fixed voltage divider that references U1, pin 3. Thermistor RT1 and the series combination of R1 and the temperature select resistor form a voltage divider on the other op-amp input, U1, pin 2. The feedback network of R8 and C4 serves to control U1's output response when the inputs reach equilibrium.

During the high power dissipation period of the warm-up cycle, the current through Q2 and Q3 must be limited to a safe level of ~1 amp. This is done by sensing the current draw of Q2 and Q3 at R13. An increase in heater current causes an increase in voltage at the base of Q1. As Q1 turns on, it shunts a portion of Q2's base drive current to ground, allowing only the preset maximum current to flow. R11 and R12 form a voltage divider network that provides for the preset maximum current to be automatically shifted up or down, depending on the heater supply voltage. This is done to maintain a reasonably constant power dissipation during warm-up over the range of input voltage to the FRK.

As the thermostat circuit reaches equilibrium, the voltage output of U1 drops to a level that operates Q2 in a vernier control mode. The current through Q2 and Q3 folds back to a nominal 100 mA. The current foldback reduces the voltage drop across R13 to the point where Q1 does not conduct and effectively drops out of the circuit.

The resonator assembly is protected from a runaway heater control problem by thermal fuse F1, mounted on the resonator cavity housing.

b. Lamp, Assembly A2, (Schematic 703-209)

The lamp assembly consists of the lamp oscillator circuit, the lamp housing assembly, the lamp thermostat circuit, and the rubidium lamp. The function of the lamp assembly is to ignite and maintain the electrodeless plasma gas discharge of the rubidium lamp, and to maintain the temperature of the lamp housing at approximately 115°C.

The most common fault condition involving the lamp assembly is the generation of spurious noise on the unit output. This condition can be detected at TP1 of the servo board, where the lamp noise will cause severe disturbances to the resonance signal. If the disturbances are too severe, the unit may fail to lock. The spurious noise problem is very difficult to isolate due to the electro-mechanical aspects of the circuit and is typically remedied by replacing the entire lamp assembly. Occasionally, noise from the lamp can be eliminated by changing the oscillator frequency to a lower frequency, or by changing the rubidium lamp. The two most likely lamp failure modes are the loss of vacuum due to glass failure and Rb depletion. Glass failure will prevent lamp ignition (make sure the lamp oscillator circuit is not the cause of failure before lamp removal), whereas Rb depletion results in a whitish tint to the lamp light (another cause of this symptom is an improper lamp thermostat temperature). In case of Rb depletion and/or lamp thermostat failure, the FRK will not develop a resonance signal (refer to section 4.4.2.6, subsection h, Resonance Search).

NOTE

The loss of Rb cannot be detected by the decay of lamp voltage.

Lamp replacement is covered is Section 4.4.1.7 (1), FRK Lamp Replacement.

(1.) Lamp Oscillator - The lamp oscillator circuit is a modified Colpitts design consisting of Q2 as the active element, tank circuit L4 and C11 as the power transfer and primary resonant network, L3 as a secondary frequency control element, and associated bias circuitry.

Mechanical capacitor C11 provides for current/frequency adjustment of the oscillator and is accessible from outside the unit. Figure 4-8 illustrates the location of the adjustment port.

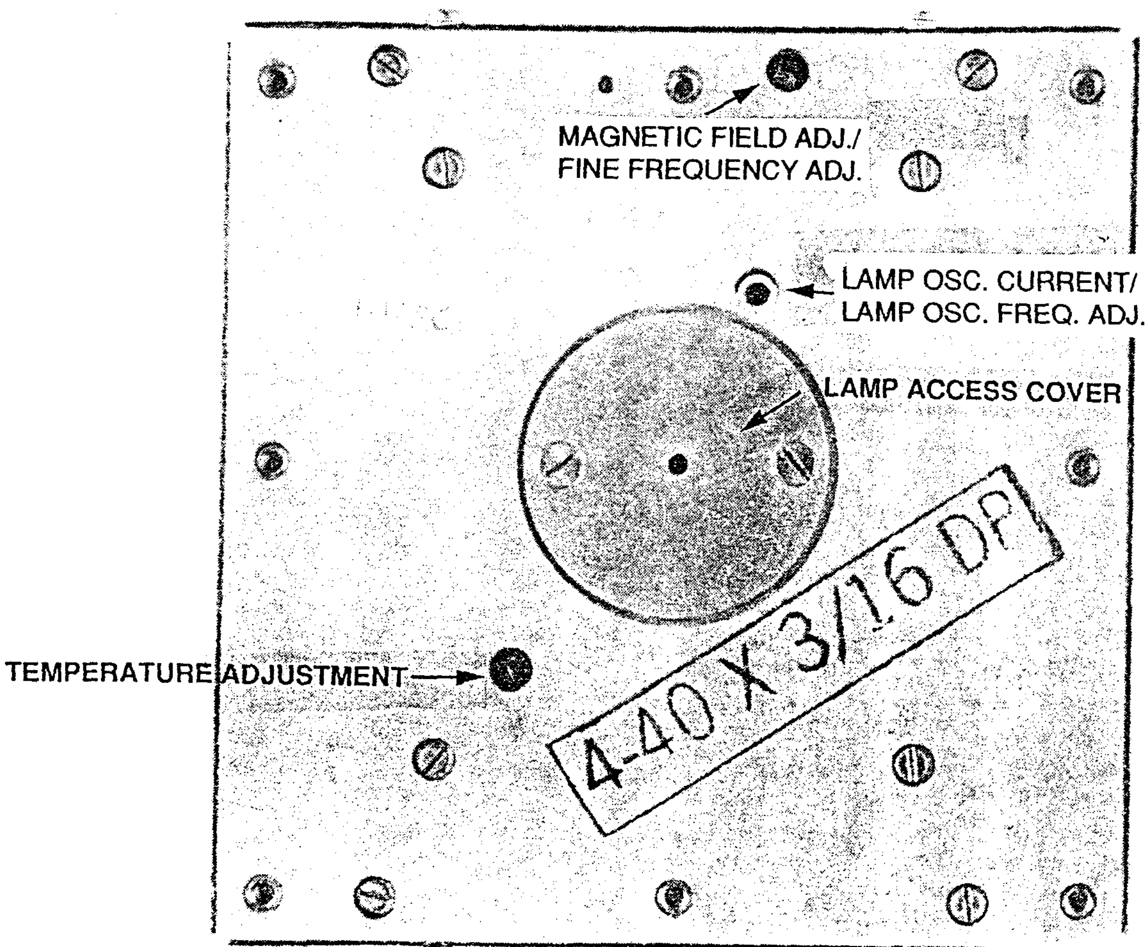


Figure 4-8. Lamp Adjustment Ports

Adjusting C11 tunes the oscillator's frequency over a range of approximately 70 MHz to 90 MHz. Within this range of adjustment there are specific optimum frequencies that should be used (refer to Section 4.4.1.7.2, Lamp Oscillator Tuning, part b, FRK Alignment Procedures). The operational frequency that is chosen is determined by finding the highest frequency setting that produces optimum ignition characteristics and noise free operation. In normal stabilized operation, the oscillator current draw from the regulated supply (E2) is a nominal 120 mA.

(2.) Lamp Thermostat - the lamp thermostat consists of U1, Q1, R5 and associated circuitry on the PCB, and Q3 and RT1 mounted on the lamp housing. U1 is the temperature control element, RT1 is part of the resistive bridge network at U1's inputs, Q1 is a current limiting element, and Q3 is the heat source element.

Op-Amp U1 is controlled by a balanced bridge circuit on its inputs. R3 and R6 form a fixed voltage divider that biases U1, pin 3. Thermistor RT1 and the series combination of R4 and R5 form the dynamic leg of the bridge. RT1 senses the temperature on the lamp housing and potentiometer R5 selects the stabilized temperature. The R5 potentiometer is accessible from outside the unit. Figure 4-14 illustrates the location of the adjustment port.

The operation of current limiter Q1 and heater transistor Q3 is essentially the same as the resonator thermostat circuit, which is discussed in detail in Section 4.4.2.5, part e.

c. Servo Board, Assembly A1 (schematic 10017)

The primary function of the servo circuit is to amplify and demodulate the photocell output to generate the crystal control voltage at E8 for the 10 MHz VCXO. The control voltage is derived by comparing the phase of the 127 Hz modulation signal with the phase of the photocell signal at E1 and E5. Secondary functions are to provide the monitoring signal for the Rb lamp operation at E4, the atomic resonant lock circuit at E7 and the VCXO control voltage monitor at E9.

(1.) Preamplifier - The photocell output, (dc bias together with the 254 Hz error signal when the unit is in the normal locked mode of operation, or 127 Hz error signal while the unit is obtaining a lock), is routed to E1 and E5 on the servo board A1. E1 and E5 tie to the input of dual stage amplifier U1 at pins 5 and 6 respectively. The output of the first stage of amplification is capacitively coupled to the input of the second stage of amplification (U1, pin 8) and directly coupled to E4 and U2-B, pin 5. E4 provides the Rb Lamp Monitor signal to the front panel connector.

U2-B senses the voltage at E4 and determines if the Rb lamp has ignited and if it is in "Correct Mode Ignition". Proper lamp ignition (<3 minutes after turn-on) will cause U2-B output, E11, to switch from <1 Vdc to >15 Vdc. The E11 voltage is fed to the power supply (Board 3, E29), where it switches the regulated unit power from 22 Vdc to 17 Vdc.

The output of the second amplifier (U1, Pin 13) is connected to Test Point (TP) 1, the primary oscilloscope monitoring point of the FRK. U1, pin 13, is also capacitively coupled to U2-A, the 127 Hz active bandpass filter, and to U6, the 254 Hz active bandpass filter.

(2.) Reference Signal Generation - 127 and 254 Hz Reference Signals - CMOS oscillator/divider U3 on the servo board, provides the 127 and 254 Hz reference signals and the 127 Hz signal which modulates the rf injected into the resonator. The primary oscillator frequency of 8.128 Khz is determined by C17, R19 and select-in-test resistor R20. The divider portion of U3 divides the primary oscillator frequency into the required 127 and 254 Hz signals. The 127 Hz reference signal is routed from U3, pin 4 to pin 11 of synchronous demodulator U4 and to pin 2, of U6, through the RC network R37/C24. The RC network R37/C24, the feedback network R38/C25, and the output RC filters (R39, C26, R40 on the servo board, and C2, R3, and C12 on the synthesizer board) serve to waveshape the 127 Hz signal into the sinewave that is coupled to the synthesizer to modulate the rf. R40 of the output RC filter is also used to adjust the modulation level to the multiplier and the phase of the correction signal at TP3.

The 254 Hz reference signal is routed from U3, pin 5 to pin 9 of synchronous demodulator U4. The 254 Hz reference signal is correlated with the photocell output to detect unit lock.

The dc voltage of approximately 6.8 Vdc generated by CR2 is also a reference signal. This DC level is used to bias the ac signals that are processed by U4 and U5, and to bias op-amps U6 and U5.

(3.) 127 Hz Signal Processing - As explained in the "pre-amplifier" section, the 127 Hz signal processing starts at the photocell inputs E1 and E5. U1-A and U1-B provide two stages of high gain amplification. The output of U1-B, pin 13, feeds both active bandpass filters, U2-A, the 127 Hz, and U6, the 254 Hz.

NOTE

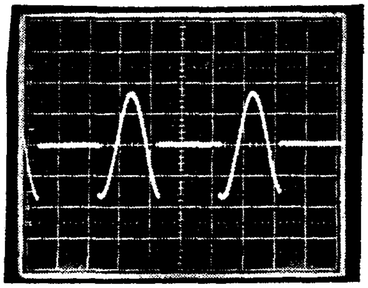
For troubleshooting purposes it is usually best to control the rubidium loop manually. Connect a potentiometer of 10 Kohms, or more, across C22 on the servo board. Disconnect the wire soldered to E8 and connect this wire to the wiper of the potentiometer. This technique provides for manual control of the VCXO's output frequency and critical servo functions.

The servo correction signal is amplitude modulated onto a 127 Hz subcarrier that passes through the 127 Hz filter, U2-A. When the system is locked, this signal (TP-2) appears as a 254 Hz sine wave, with a noticeable 127 Hz component. From TP2, the signal is routed to the synchronous demodulator U4, pin 12.

U4 is a triple two-channel CMOS analog switch that functions as a synchronous amplitude demodulator. The 127 and 254 Hz reference signals at pins 11 and 9 respectively, control the synchronous switching of two of the switches. A third switch is controlled by the level of the signal at U4, pin 10, from the lock detector circuit, U6, pin 8. U4, pins 5 and 13, receive the 6.8 Vdc reference level from CR2. When the unit sweeps near atomic lock, U4, pin 10 receives a "high" signal (>12 Vdc) that switches the output of the 127 Hz filter U2-A to the output of the demodulator, U4, pin 15, for dynamic tracking. The demodulator output is monitored at TP3 and appears as shown in Figure 4-15.

The signal from U4, pin 15 is direct coupled to U5, pin 2. U5 functions as the servo loop integrator. Its output voltage changes at a rate determined by the differential input voltage. For example, an input differential of -200 mV causes an output voltage change of +200 mV/sec. The change will continue until the differential input is nullified, (the crystal returns to center frequency), or until the Op amp reaches its maximum output voltage.

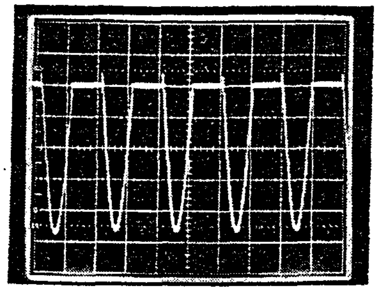
The output of the integrator, E8, is the crystal-control voltage that steers the frequency of the VCXO by means of a varactor diode in the oscillator tuning circuit. A portion of the integrator output is routed to the sweep control circuit at U6, pin 5.



TP-3 Normal Signal 1 volt/div., 50 ms./div.

Figure 4-9. Demodulator Output (Servo Board)

(4.) Lock Circuit - A portion of the photocell signal is applied to an input of the Lock Monitor circuit at U6, pin 12. U6-D, with its associated circuitry, forms a 254 Hz active bandpass filter that connects to pin 3 of the synchronous demodulator U4. The output signal at U4, pin 4 is coupled to U6, pin 9, and is monitored at TP6 (refer to Figure 4-10). With the unit locked, the negative offset at U6, pin 9 will cause the output at U6, pin 8 to go high. This provides the positive signal at U4, pin 10 that removes the sweep signal from the integrator, U5. It also biases Q1 into a conduct mode that provides the Lock Monitor signal at the front panel connector (pin H for the Winchestor connector, pin 5 for the 8-pin connector with coax). When the unit is locked, the Lock Monitor line as a resistance of 150 ohms to ground. Otherwise the Lock Monitor is an open circuit.



Normal Signal 1 volt/div., 1 volt/div, 2 ms./div

Figure 4-10. Signal Waveform at TP6

(5.) Sweep Circuit - To allow the FRK to compensate for several years of crystal aging, in addition to frequency offsets of the crystal caused by environmental changes (e.g., temperature changes), the trim range of the oscillator is very wide compared to the width of the atomic resonance. To aid servo acquisition, the crystal frequency is swept over the entire trim range until atomic resonance can be detected.

This is accomplished by switching the integrator input (U5, pin 2) to U6, pin 7 via U4 (the unit is unlocked when U6, pin 14 is low). U6-B functions as a high hysteresis voltage comparator. The trigger points are controlled by R51 and R52 and the voltage reference. The lower trigger point is approximately 1.5 Vdc, the higher trigger point is approximately 16 Vdc. If the output of U5 is equal to or lower than the lower trigger point, the output of U6 becomes 0 Vdc, resulting in about a -.7 Vdc differential to the integrator. With R24 = 1 M and C18 = 1 µF its output will rise .7 V/s until the upper trigger point of 16 Vdc is reached. At this point, the output of U6 will go high, resulting in about a +.7 Vdc differential at the integrator input. This will decrease U5's output by .7 V/s. The result is a sweep time of about 40 s. Due to the fast sweep, atomic resonance can be detected for only 100 ms at a time during each sweep cycle. Reliable transition from sweep to locked operation is facilitated by CR3.

d. Power Supply, board assembly A3 (schematic 703-254) - the internal power supply provides the unregulated, filtered voltages for the Rb lamp heaters, the crystal heater, and the resonator heaters, in addition to providing the filtered and regulated voltage to the unit's electronics. The input voltage line is fuse and diode protected against reverse polarity inputs.

The power supply board accepts the +22 to +32 Vdc input voltage at E2, and provides regulated +22 Vdc at E12, E17, and E18, until the Rb lamp ignites, at which time the power supply is switched to +17 Vdc. The switching occurs when U2-B, on the servo board, senses that the Rb lamp is ignited, in the correct mode, by the positive increase at U2-B, pin 5. The output of U2-B is routed to the power supply board at E29. The positive voltage increase provides reverse bias for CR6, effectively removing R24 from the circuit and setting the condition for the power supply output to be lowered to the +17 Vdc required for the internal circuits of the unit.

(1.) Regulated Power Supply - The +17 Vdc power supply consists of Q1 and U1 along with the components in their respective circuitry mounted on the power supply board and pass transitor Q1, which is mounted on the baseplate of the FRK.

The +22 to +32 Vdc input is routed across the 3 amp fuse (F1) to the voltage divider circuit that consists of R5 and R7. The input voltage is dropped to approximately 3 Vdc, which is coupled through CR3 to U1, pin 2. Before power is applied, U1, pins 2, 3 and 6, were at ground potential. With 3 volts at U1, pin 2, and U1, pin 3 still at ground potential, the resultant offset causes U1, pin 6 to go low, turning on the power transistor Q1. The +17 volt line is fed back through CR4 and R9 to the reference zener diode, CR5. CR5 develops approximately 6.3 Vdc at U1, pin 2. In addition, the 17 volt line is fed back to the voltage divider consisting of R6, R8 and R10 to apply a voltage to U1, pin 3. The voltage divider determines the voltage ratio of the 17 volt line to the voltage reference diode CR5, thus setting the voltage level of the 17 volt line.

Transistor Q1 on the power supply board functions as a current limiter by sensing the voltage drop across R14. If the current through the pass transistor becomes excessive, Q1 begins to conduct, decreasing the emitter-base bias on the pass transisitor, thus limiting the current flow.

e. Crystal Oscillator (VCXO) Assembly (schematic 703-103-5) - the purpose of the 5 or 10 MHz oscillator is to provide a clean and stable output frequency to the output connector, and a 10 MHz signal to the synthesizer. To optimize the reduction of phase noise the crystal is selected to match the output frequency. The oscillator board contains the Voltage Controlled Crystal Oscillator (VCXO), the crystal oven andthermal control, and a buffer amplifier. The output signals are transformer coupled to the output connector J1 and to the synthesizer circuit. In the case of the 5 MHz Ln Oscillator a doubler circuit is used to generate the 10 MHz signal to the Synthesizer.

(1.) Crystal Oscillator - the oscillator incorporates an AT Cut 3rd-overtone crystal, with an operating temperature of about 80°C. The crystal is mounted in the crystal housing assembly, which is heater controlled to the operating temperature of the crystal. The frequency adjustment is via L2, C6, 7 and 8. L2 is used for coarse adjustment and C7/8 for fine adjustment of the sweep range and center frequency. Roughly a 1E-6 adjustment is expected for a crystal control voltage range of 1.0 to 14 volts. These voltages correspond to the sweep mode of the crystal control voltage, which is approximately 1.0 to 14 volts.

The gain stage of the oscillator is formed by Q2, with C4 and L1 selected to provide a resonant frequency of about 70 - 80% of the nominal crystal frequency. The output buffer stage has Q3 as a source follower to buffer the crystal network from the loading of the following buffer stages.

The AGC stage utilizes Q1 to form an AGC circuit, which controls the output voltage of the oscillator at the source of Q3 to approximately 1.2 Vpp. C5 is used to adjust the AGC voltage at the collector of Q1 to 0.5 Vdc for nominal conditions. This provides the capability of decreasing or increasing the oscillator loop gain by adjusting the bias condition of Q1.

(2.) Crystal Buffer Section - the output buffer amplifier section consists of Q5 and Q4.

Q6 is a FET device used as a high input impedance decoupling stage between the oscillator circuit and the output drivers. The 10 MHz signal at the gate of Q6 is a nominal 1.4 v.p.p.

The cascade arrangement guarantees maximum decoupling between input and output. T1 is tuned to 5 or 10 MHz by C16, 17 and matches the output impedance of Q4 to the nominal 50 ohm load on J1.

The 10 MHz signal for the Synthesizer is generated by either the frequency doubler Q6, 7 (driven by complimentary signals of Q5), or by the buffer formed by Q7, depending on the configuration. T2 is tuned to 10 MHz via C22.

(3.) Crystal Thermostat - the crystal oven thermostat circuit consists of U2, Q8, and associated circuitry on the P.C.B, and Q9 and RT1 mounted on the oven assembly. U2 is the temperature control element, Q8 is a current limiting element, and Q9 is the heat source.

U2 and the resistive bridge network on its inputs form the temperature control section. Thermistor RT1, mounted on the crystal oven, is the sensing element in the input network, R40 and R43 set the reference voltage. R42 functions as the temperature select component. During warmup, the oven heater transistor Q1 would be destroyed by runaway current if not for Q8, which serves as a current limiter. In the current limit mode, Q8 senses the voltage across R49 to determine Q1's emitter current. As the R49 voltage approaches ~.4 Vdc, Q5 starts conducting, reducing the voltage at Q9's base to the level required to throttle Q9's current to a nominal 400 mA. The power delivered to the oven in the warm-up mode is kept constant over the range of supply voltages by the R46, R48 network. The higher the supply voltage, the less maximum current is allowed in Q9.

f. Synthesizer - Board Assembly A5 (schematic 703-285-1)

The synthesizer assembly contains a frequency multiplier circuit and a frequency synthesis section. Q3 through Q8 make up the multiplier section and Q2, U1, and U2 perform the synthesis.

(1.) Multiplier - the 10 MHz signal from the crystal oscillator is applied to the input of a frequency tripler consisting of Q3, Q4, and associated circuitry. C9 and L3 are tuned to 30 MHz. R12 limits the Q of the tank to about 30. The 30 MHz signal is capacitively coupled through C13 to transformer T1. At this point, the 127 Hz modulation signal, biased at a nominal 6.5 Vdc, comes into E5 and modulates the rf signal via varactor CR6. The interaction of CR6 with the tuned tank circuit on the primary of T1 serves to phase modulate the rf at a 127 Hz rate. The secondary of T1 is center tapped to provide a split phase signal that drives the doubler circuit of Q5 and Q6. The result is a 60 MHz signal that is amplified by Q7 and Q8. C17/L5, C21/L8, and C27/L10 are tuned to 60 MHz. Q7 and Q8 are Class A inverting amplifiers. The 60 MHz signal at E6 drives the snap diode in the physics package through a coax cable. C29 matches the coax-cable to the driver stage. R31 and R34 provide the bias voltage for the snap diode.

Refer to Figure 4-11 for waveform and amplitude illustrations for the multiplier circuit's test points (T.P. 2, 3, 4, 5, 6, 8).

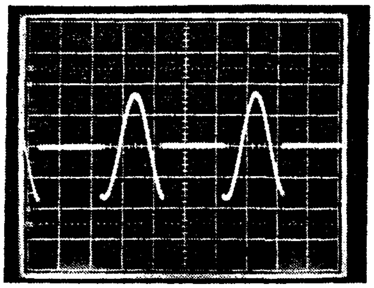
The adjustable parameters of the multiplier circuit include L3, T1, L5, L8, L11, C29, and R34. Adjustments of these component values should not be necessary except if other components are replaced during repairs. In this event, see section 4.4.2.6, subsection f., which covers the alignment procedures for the synthesizer, board A5.

(2.) Synthesizer Circuitry - the 10 MHz input signal from the crystal oscillator is applied to the base of Q2. Q2 converts the sine wave input to a TTL compatible trigger signal. This signal is coupled into U2-A, Pin 1. U2-A functions as a divide by "2" block, with a 5 MHz TTL signal coming out on pin 3. One branch of the 5 MHz signal goes to U2-B, pin 13. U2 functions as a divide by "16" block, producing a 312.5 KHz TTL signal output from pin 8 and passing to U1. U1-C is an "exclusive OR" gate which mixes the 5 MHz and 312.5 KHz input signals to produce an output at pin 8 that contains the upper and lower mixing products, 4.6875 MHz and 5.3125 MHz. The signals are then routed across tuned tank L11/C30. This tank is tuned at 5.3175 MHz and selects this frequency from the two that are injected. The capacitive coupling of C26 and the filtering action of L11/C30 converts the TTL signal at TP7 into a sine wave signal referenced to ground at TP-9. Finally, the signal leaves TP-9 and is summed with the 60 MHz at E6, from which both frequencies are routed to the step recovery diode.

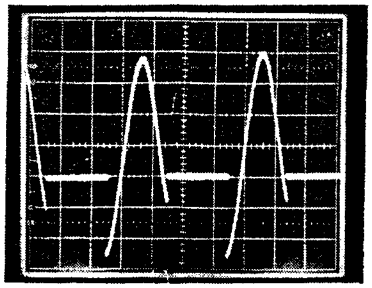
Refer to Figure 4-11 for waveform and amplitude illustrations for TP1, TP7, and TP9 of the synthesizer circuit.

NOTE: all signals monitored with X10 oscilloscope probe.

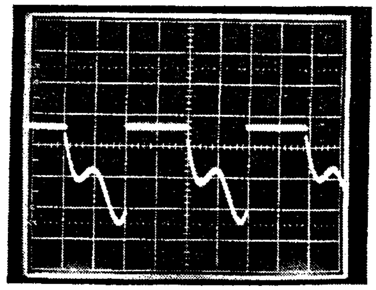
SERVO BOARD



TP-3: normal correction signal
500 mV/div., 2 ms/div

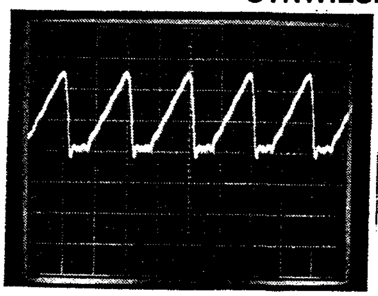


TP-3: 20 Mohm resistor
from C18 to Ground
500 mV/div, 2 ms/div

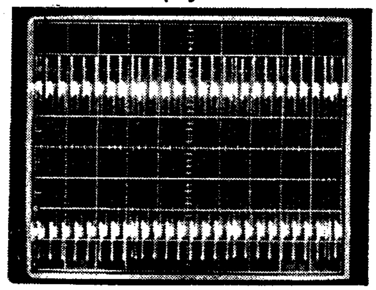


TP-3: 20 Mohm resistor
from C18 to +17 Vdc
500 mV/div., 2 ms/div.

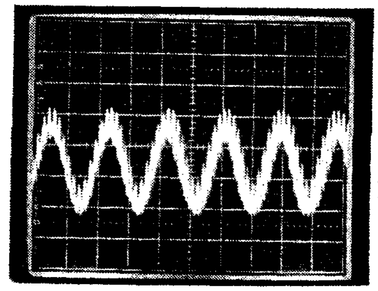
SYNTHESIZER BOARD (Synthesizer Section)



TP-1 dc coupled, 0 Vdc
at center scale, 1 V/div.,
50 ns/div.

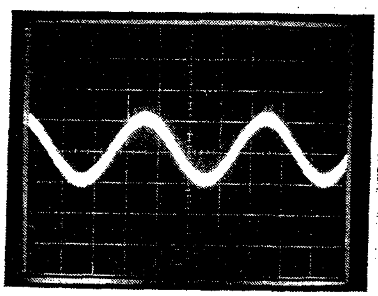


TP-7 dc coupled, 3.0 Vdc
at center scale, 1V/div.,
500 ns/div.

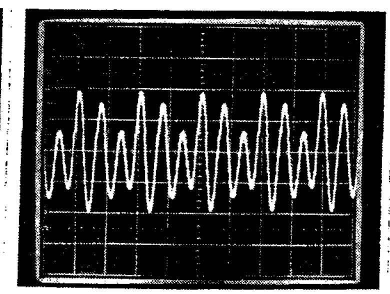


TP-9 normal signal
500 mv/div., 100 ns/div.

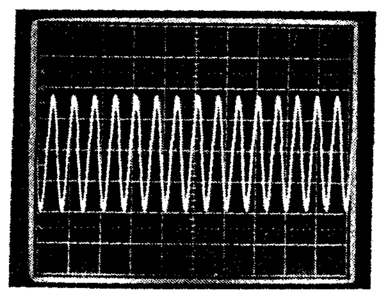
SYNTHESIZER BOARD (Multiplier Section)



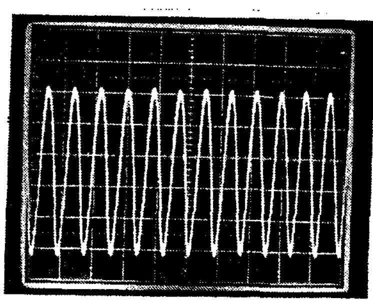
TP-2 Normal signal, 6.5 Vdc center
scale, 50 mV/div., 2 ms/div.,
20 MHz B.W. limit,



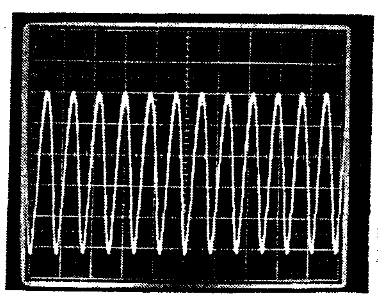
TP-3 normal signal
1 V./div., 50 ns/div.



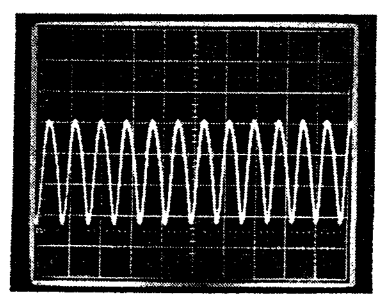
TP-4 normal signal
500 mV./div., 50 ms/div.



TP-5 normal signal
500 mV/div., 20 ns./div.



TP-6 normal signal
1V/div., 20 ns/div.



TP-8 normal signal
5V/div., 20 ns/div.

Figure 4-11. Waveform and Amplitude Traces for Servo and Synthesizer Boards.

4.4.2.2 FRK Alignment Procedures

NOTE

It is not necessary to perform all alignment procedures each time the FRK is repaired. Perform only those alignments that pertain to the board, or assembly, that has been repaired or replaced.

a. Regulated Voltage Supply:

(1) Before power is applied to the FRK, connect a voltmeter across C2 of the Power Supply, Assembly A3. Observe the meter while applying power. At the instant of turn-on the voltmeter should read ~ 23 Vdc. Within 3 minutes the lamp should ignite, switching the regulated voltage to a lower level. If the unit has been warmed up previously to this test, the lamp will ignite instantly upon applying power and no voltage transition will be seen. The regulator output voltage at C2 should be 17.3 Vdc ± .3 V. after lamp ignition.

+17.34v

(2) If the measured voltage falls outside the range of 17.3 Vdc ± .3V, an adjustment will be necessary. Locate R6 on the power supply board, assembly A3. Increasing the value of R6 will increase the regulator output voltage.

b. Lamp Temperature Setting:

(1) Apply power to the FRK and allow at least 15 minutes for temperature stabilization.

(2) Remove the lamp access cover from the base plate.

(3) Measure the temperature of the lamp housing by placing a temperature probe next to the rubidium lamp. Allow time for the temperature probe readings to stabilize. Turn off the power to the unit momentarily and record the probe reading. Remove the probe and reapply power. The temperature measured should be a nominal 113°C ± 2°C. If the recorded temperature is out of specification, an adjustment is necessary. Locate the temperature access hole in the baseplate and adjust A2R5. Repeat the temperature measurement and adjustment step until the proper lamp housing temperature is obtained.

c. Lamp Oscillator Tuning

(1) Tuning the lamp oscillator requires that the regulated voltage supply to the lamp board (C2-1) be interrupted and a 0 to 500 milliamp meter be installed in series.

(2) Locate the frequency access hole in the baseplate and insert an isolated tip driver until mechanical capacitor C11 is engaged.

(3) The oscillator frequency can be monitored using a scope probe as an antenna. By holding the probe in close proximity to the rubidium lamp the probe signal can drive a frequency counter directly or after amplification from an oscilloscope buffer amplifier.

(4) Apply power to the unit and allow at least 15 minutes for stabilization. Adjusting C11 will change the oscillator current and frequency.

(a) Set the lamp oscillator current to the low side of 125 to 145 mA, to a point that gives an oscillator frequency of 91.5, 87.0, 84.5, 79.0, 78.5, 77.5, 76.5, 71.0 or 69.5 MHz. After setting the frequency, remove power to the unit for 5 minutes. Then re-apply power and verify normal ignition and operation.

(b) If parasitic oscillations (i.e. spurs) appear at A1TP1 (see 4.4.1.7.1 (2)), set the lamp oscillator frequency as far away from the parasitic point as practical.

d. Resonator Temperature Setting:

(1) Apply power to the FRK and allow at least 15 minutes for temperature stabilization.

(2) Locate the resonator temperature probe hole in the power supply board, assembly A3 (see Figure 4-19). Remove any foam or other material that prevents clear vision of the glass resonator cell through the probe hole. Install the temperature probe and read the temperature. The resonator temperature should be +74°C ± 3°C.

(3) If the temperature reading does not conform to the specified range, an adjustment is necessary. Locate R15 on the power supply board, assembly A3. Decreasing the value of R15 will increase the temperature of the resonator. Allow 5 minutes of stabilization time between temperature readings and adjustment steps.

e. Crystal Oscillator, Board Assembly 4

CRYSTAL OVEN TEMPERATURE SETTINGS

(1) Apply power to the FRK and allow at least 15 minutes for temperature stabilization.

(2) Locate the crystal oven assembly on the crystal oscillator board, assembly A4. There is a label on the top of each oven assembly and a slotted crystal inspection window. The label and the crystal are marked with a turning point temperature in °C. The oven temperature, as monitored with a temperature probe, should be set at or slightly above the temperature marked on the crystal to optimize unit temperature coefficient. In the event no temperature reference can be found on the crystal, set the oven within +75°C and +82°C.

(3) If the reading obtained with the temperature probe does not correspond with the parameters described in Section 2., an adjustment is required.

(4) Locate R42 on the crystal oscillator board, assembly A4. Increasing the value of R8 will lower the oven temperature. Allow 5 minutes of temperature stabilization after changing the setting of R8/R42 before monitoring the result.

TRANSFORMER TUNING

I think they mean T1

(1) Connect an oscilloscope probe to J1 (rf connector). Slowly turn the slug for T3 until the 10 MHz signal at J1 reaches a minimum.

(2) Connect an oscilloscope probe at E6. Adjust T2 for a maximum signal.

TRIM RANGE SETTINGS

Before correcting the trim range, the crystal oven needs to be set to the correct temperature (see above). Allow >1 hour of warm-up at the correct crystal temperature setting before correcting the trim range. Disconnect the yellow wire that is terminated at E9 and fold it back out of the way.

NOTE

Do not allow the bare end of the wire to touch the chassis or other circuitry.

(1) Adjust C6 in 3 or 4 turns from flush. Install a 27pF capacitor in C8. Tack in a select inductor into L2. (Start with a 25 windings inductor.)

(2) Check for unit oscillation by measuring AGC voltage at the collector of Q1. (.3V to .7V).

(3) Run the output of the board (from E4 and E5) into a frequency counter. (Function: frequency; resolution: .1 Hz - house standard, or 10 MHz unit run into back.)

Run a jumper from E8 to ground. (This will establish the low end of the frequency range.)

Run the same jumper from E8 to a 20 volts line. (This will establish the high end of the frequency range.)

Satisfactory tuning requires a range greater than or equal to 2.5 Hz for a 5 MHz unit, 5 Hz for a 10 MHz unit.

(4) C8 sets the range. (Increasing C8 increases the frequency sweep range. It also decreases the board oscillation frequency).

L2 sets the center frequency. (Increasing L2 windings decreases the board oscillation frequency.)

The frequency must be set so that the center of the frequency range is 5.000000 MHz, or 10.000000 MHz.

(5) Peak transformer T1 so that the output from E6 is greater than 2.5V peak-to-peak.

(6) Peak transformer T2 and select resistor R19 (100 ohms) so that the output from E4 into a 50 ohm load is about equal to 3.0 volts peak-to-peak.

The final step is to reconnect the yellow wire to terminal E9.

f. Synthesizer Board Alignment, Assembly A5

TRANSFORMER TUNING

(1) Connect a dc voltmeter to E6 through a 10 Kohm isolation resistor. Apply power to the FRK. Adjust potentiometer R34 for the maximum dc voltage. Tune inductors L3, T1, L5 and L8 in sequence for the maximum dc voltage at E6.

(2) Attach an oscilloscope probe to TP9. Tune L11 for a maximum signal of 5.312 MHz.

OUTPUT COAX MATCHING

(1) If the synthesizer has been replaced, transfer the C29 value from the old board.

(2) If the Resonator assembly has been replaced, select C29.

(3) Connect a dc voltmeter to E6 through a 10 Kohm isolation resistor. Apply power to the FRK. Adjust potentiometer R34 for the maximum dc voltage.

(4) Select C29 for the maximum dc voltage at E6.

RESISTANCE TUNING

Refer to the Synthesizer board alignment procedure under "Resonance Search."

g. Servo Board Alignment, Assembly A1

LAMP VOLTS SETTING

(1) Monitor E4 with a dc voltmeter. Apply power to the FRK and allow at least 15 minutes for temperature stabilization.

(2) Locate R4 on the servo board. Adjust R4 for a nominal 11 Vdc ±2 at E4.

127 HZ REFERENCE ADJUSTMENT

(1) Monitor TP4 with a X10 oscilloscope probe. The probe will drive a frequency counter directly, or an oscilloscope with a buffered output to the counter.
(2) Locate R20 and adjust for a frequency counter reading of 127 Hz ± 1 Hz.

MODULATION AMPLITUDE

(1) Monitor E6 with an oscilloscope.

(2) Adjust R58 for a signal amplitude of 400 mV ± 50 mV peak to peak.

h. Resonance Search

BANDPASS FILTERS (This procedure is recommended only for replacement boards)

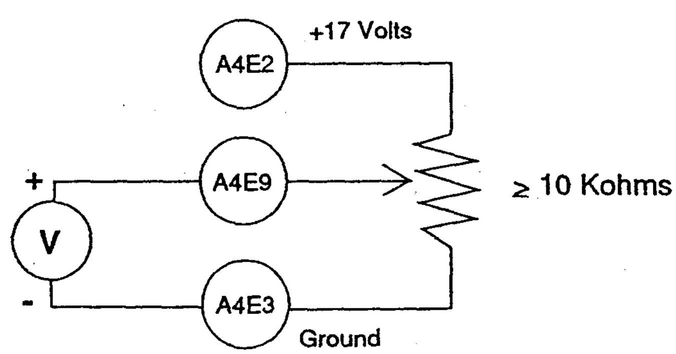
(1) Disconnect power to the unit.

(2) Locate R16 and R70 potentiometers on the servo board, assembly A1.

(3) Adjust both potentiometers to a point approximately midway in their adjustment range. Lock should be obtained. If lock does not occur, move on to Bandpass Filter Tuning section and adjust the filters.

CRYSTAL CONTROL VOLTAGE (10 MHz Unit)

(1) Disconnect the yellow wire terminated at A1E8 on the servo board assembly. Connect this yellow wire to a potentiometer as shown below:



(2) Monitor the 10 MHz output of the unit with a frequency counter.

(3) Apply power to the unit and allow at least 15 minutes for thermal stabilization.

(4) Monitor A1TP1 on the servo board with an oscilloscope.

(5) Adjust the output frequency with the test potentiometer to 1 Hz above or below 10 MHz.

(6) Monitor the dc voltage at A5E6 through a 10 Kohm isolation resistor using a voltmeter.

(7) Adjust potentiometer R34 on the synthesizer board, assembly A5, for maximum voltage, then decrease the voltage slowly, watching the oscilloscope for an ac waveform of 127 Hz.

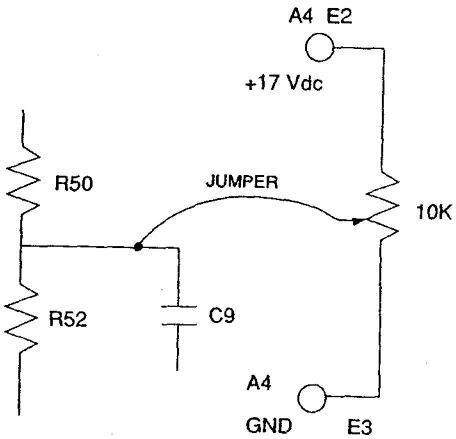
(8) At the first sign of a signal at A1TP1, adjust the output frequency for a maximum 127 Hz signal. Adjust R34 for the maximum signal amplitude.

(9) Disconnect power to the FRK. Remove the test potentiometer and reconnect the yellow wire to A1E8. Apply power to the FRK. Atomic lock should be acquired automatically, resulting in a 254 Hz signal at A1TP1.

CRYSTAL CONTROL VOLTAGE (5 MHz Unit)

(1) Disconnect the yellow wire terminated at A1E8 on the servo board assembly.

(2) Connect a 10 k potentiometer as follows:



(3) Monitor the 5 MHz output of the unit with a frequency counter.

(4) Apply power to the unit and allow at least 15 minutes for thermal stabilization.

(5) Monitor A1TP1 on the servo board with an oscilloscope.

(6) Adjust the output frequency with the test potentiometer to .5 Hz above or below 5 MHz.

(7) Monitor the dc voltage at A5E6 through a 10 Kohm isolation resistor using a voltmeter.

(8) Adjust potentiometer R34 on the synthesizer board, assembly A5, for maximum voltage, then decrease the voltage slowly, watching the oscilloscope for an ac waveform of 127 Hz.

(9) At the first sign of a signal at A1TP1, adjust the output frequency for a maximum 127 Hz signal. Adjust R34 for the maximum signal amplitude.

(10) Disconnect power to the FRK. Remove the test potentiometer and reconnect the yellow wire to A1E8. Apply power to the FRK. Atomic lock should be acquired automatically, resulting in a 254 Hz signal at A1TP1.

i. Bandpass Filter Tuning: Servo Board, Assembly A1

127 HZ ACTIVE BANDPASS FILTER (U2-A) ADJUSTMENT (SERVO LOOP)

(1) Verify that the FRK is stabilized and locked.

(2) Monitor A1TP3 with an oscilloscope.

(3) Connect a 20 megohm resistance jumper between U5, pin 2 and E2.

(4) Adjust potentiometer R16 to obtain a waveform as shown in Figure 4-12.

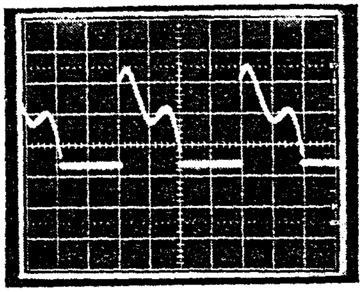


Figure 4-12. Waveform, Servo Board (TP-3)

254 HZ ACTIVE BANDPASS FILTER (U6) ADJUSTMENT (LOCK MONITOR)

(1) Monitor A1TP6 with an oscilloscope.

(2) Verify that the unit is stabilized and locked.

(3) Adjust potentiometer R70 to obtain the most symmetrical negative cycle waveform possible (see Figure 4-13).

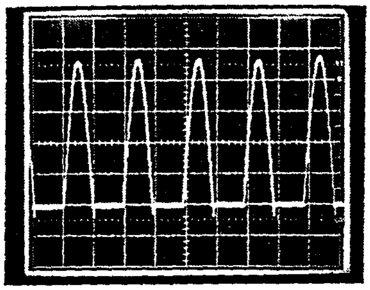


Figure 4-13. Waveform, Servo Board (TP-6)

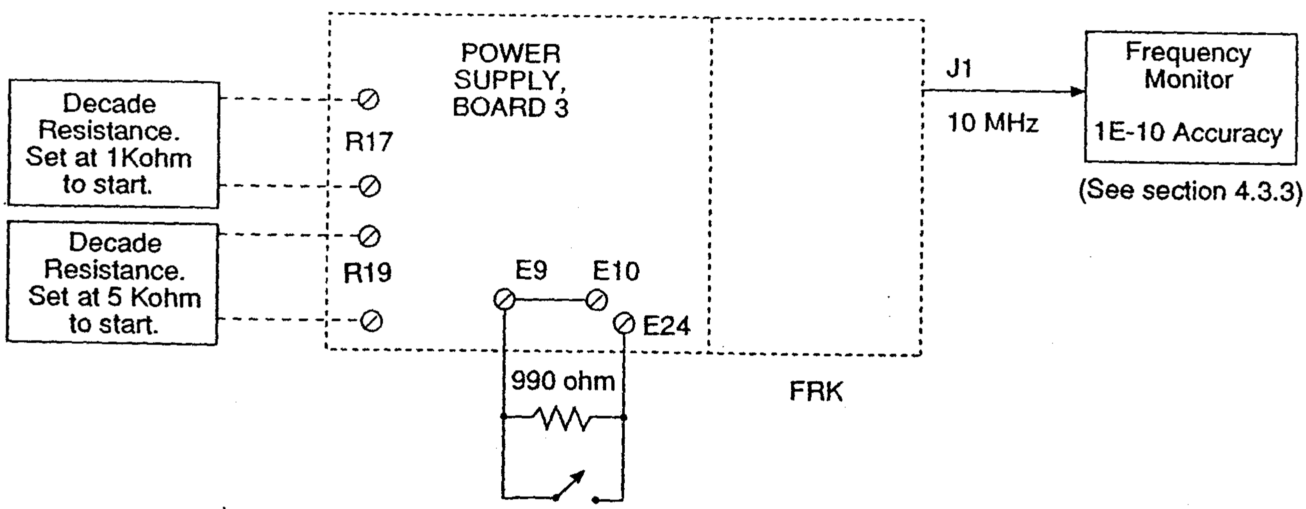
j. C-Field Adjustments: Power Supply Board, Assembly A3

(1) Set the magnetic field trim range and centering. R17 and R19 are the selected components. R17 functions as the primary frequency centering control. R19 works in conjunction with potentiometer R21 to provide a means of manually adjusting the 10 MHz output frequency. R17 and R19 are slightly interactive during their adjustments, therefore the use of two decade boxes for this alignment is suggested (refer to schematic 703-254).

(2) Start the adjustment by setting R17 to ~ 1.2 Kohm and R19 to ~ 120 Kohm. Lower values of R17 shift the frequency higher, while lower values of R19 allow R21 to adjust over a wider range.

(3) Select R17 and R19 so that R21 can adjust the output frequency >1E-9 above and below 10 MHz (or 5 MHz, if this is a 5 MHz FRK).

(4) Connect the unit in the test configuration as shown below.



(5) Apply power to the FRK and allow at least 1 hour stabilization time.

4.4.2.3 FRK Temperature Testing Procedure

FRK Temperature Testing Procedure - this test requires the UUT be placed in an environmental testing chamber. Connect the test equipment as shown in Figure 4-14.

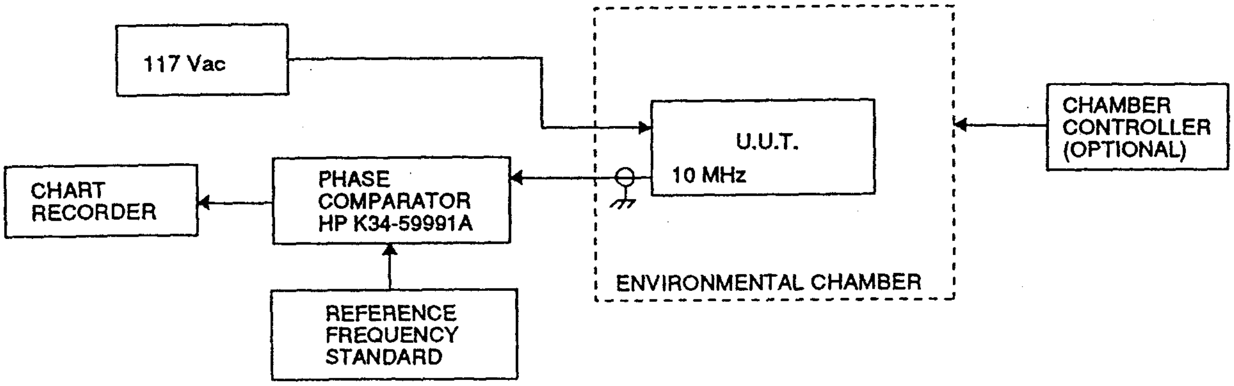


Figure 4-14. Environmental Test Chamber Set-up

(1) Adjust the chamber controls so that the air temperature is maintained at +30° C ambient

(2) Apply ac input power to the UUT. Allow sufficient warm-up time to allow the unit's output frequency to stabilize (> 60 min.). If the UUT was operated continuously for greater than 60 minutes prior to this test, no additonal operation time is required.

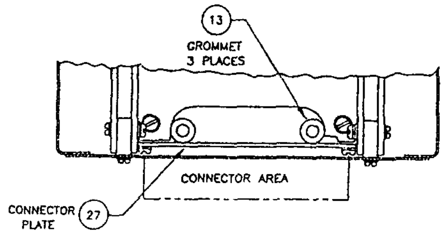
(3) Start frequency recording. This monitoring should continue throughout the test. The frequency resolution of the chart recorder must be $\Delta f/f$ = 1 x 10E-11/division.

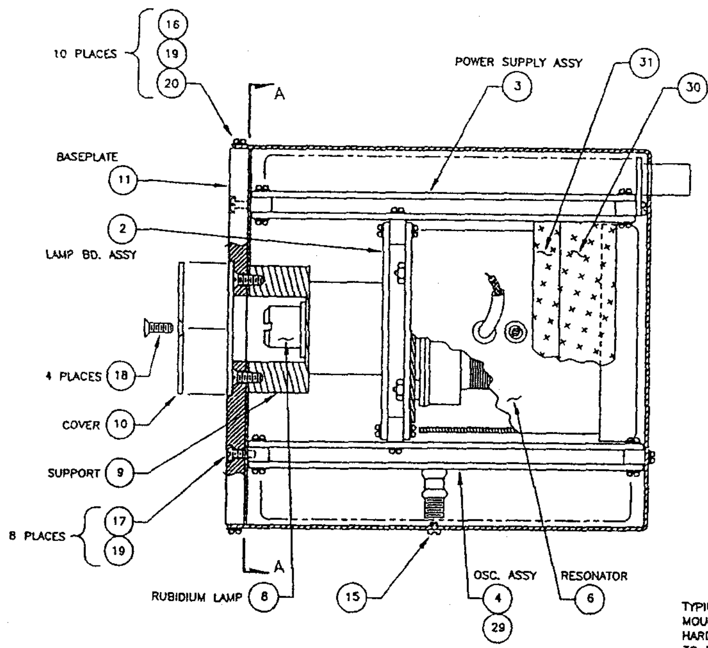
(4) The temperature chamber can be controlled manually or automatically. Set the temperature cycles for the chamber as shown in the "Required" column. Use the left column to document the actual test run conditions so they can be used for future reference.

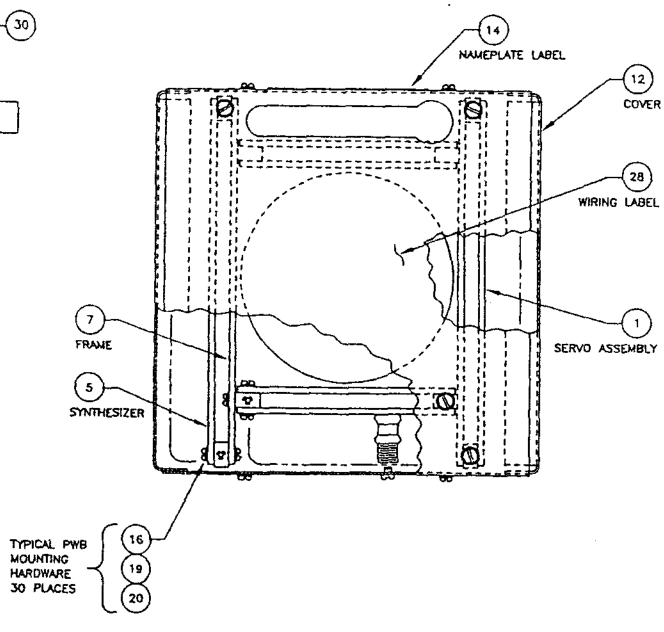
	Required
A. Ambient _______° C	(+30 ± 2° C)
Cycle Time ________ hrs	(≥ 1.5 hr.)
B. Low Temperature _____ ° C	(+15 ± 2° C)
Cycle Time ________ hrs	(≥ 1.5 hr.)
C. High Temperature ______ ° C	(+65 ± 2° C)
Cycle Time ________ hrs	(≥ 1.5 hr.)

APPENDIX

LIST OF DRAWINGS







FINAL ASSEMBLY, FRK (203-200-001)

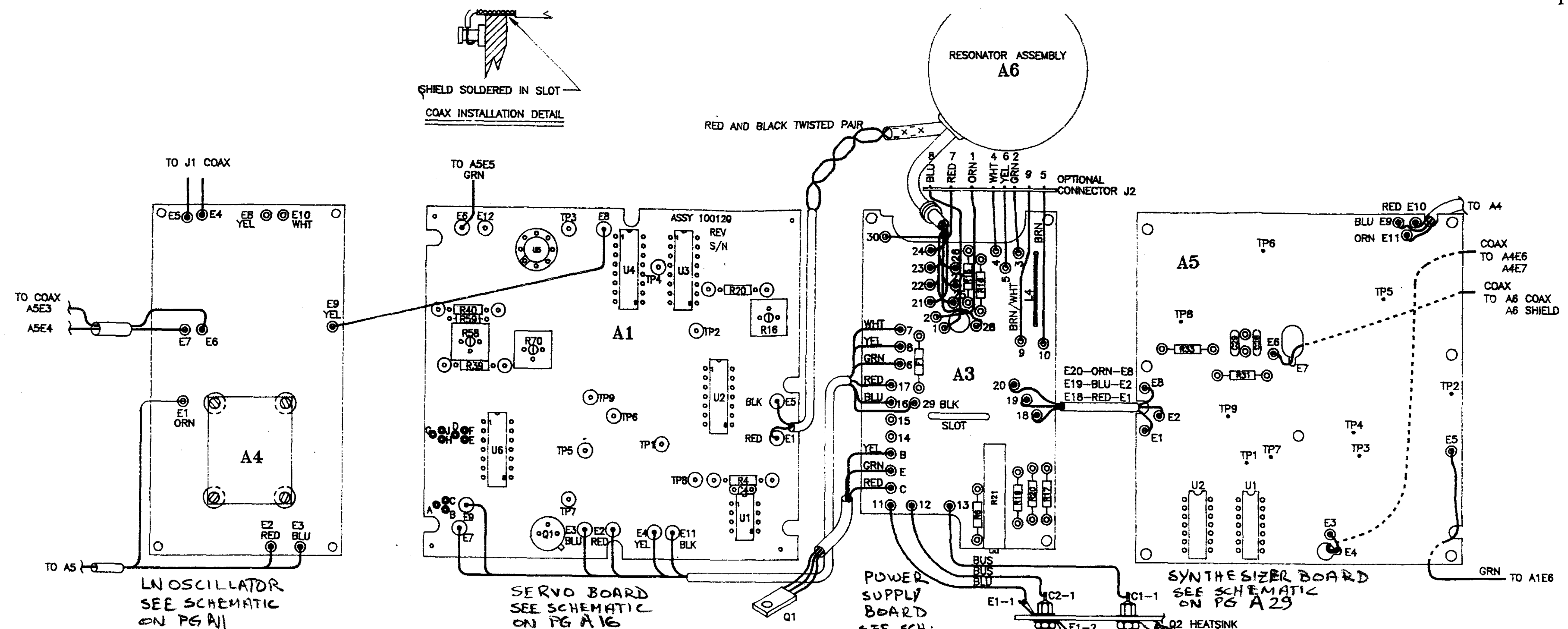
BALL, EFRATOM DIVISION   CONTRACT No.   CAGE CODE 55761   PL 703-200-1   REVISION LTR.
REVISION DATE 91-04-25

TITLE: PARTS LIST, FRK

SHEET 2

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
1	1	100120-001		SERVO BOARD	A1	
2	1	703-208-1		LAMP BOARD ASSEMBLY	A2	
3	1	703-253-1		POWER SUPPLY ASSEMBLY	A3	
4	1	703-214-1		OSCILLATOR ASSEMBLY	A4	
5	1	703-283-1		SYNTHESIZER ASSEMBLY	A5	
6	1	703-223-1		RESONATOR ASSEMBLY	A6	
7	1	703-226-1		FRAME ASSEMBLY		
8	1	250-165-1		RUBIDIUM LAMP ASSEMBLY		
9	1	703-239		LAMP SUPPORT		
10	1	703-242		COVER PLATE		
11	1	703-245-3		BASEPLATE ASSEMBLY (4-40)		
12	1	250-091		MU-METAL COVER		
13	3	MS35489-4		GROMMET		2801398
14	1	705-150		NAMEPLATE, LABEL		
15	1	MS51957-39		SCREW, PAN HD, 8-32 x 1 /8		2821433
16	38	85ST-M2x4		SCREW, M2 x 4		70425-1
17	8	85ST-M2x6		SCREW, M2 x 6		70425-3
18	4	963ST-M2.5x10		SCREW, FLAT HD M2.5 x 10		2820500
19	54	6798ST-IN2.2		WASHER, LOCK 2.mm (I.T.)		
20	46	MW-400		WASHER, FLAT 2mm		2821475
21				NOT USED		
22	A/R	704-232-1		ADHESIVE SEALANT (PURPLE)		
23	A/R	SN63WRMAP3		SOLDER		2102572
24	A/R	M17/93-RG178		CABLE, COAX		6001032
25	A/R	70422-1		TUBING, SHRINK		
26	A/R	MIL-W-16878, TYPE E		WIRE, 22 AWG INSULATED, TEFLON		
27	1	703-246-1		CONNECTOR PLATE ASSEMBLY (PIN & COAX)		
28	1	703-238-5		LABEL, CONNECTOR WIRING		
29	1	703-248		INSULATOR, OSCILLATOR BOARD		
30	A/R	70424-3		FOAM POLYURETHANE (ECCOFOAM FPH)		
31	1	100298-001		INSULATOR FOAM		

PARTS LIST, FRK FINAL ASSEMBLY (PL 703-200-1)

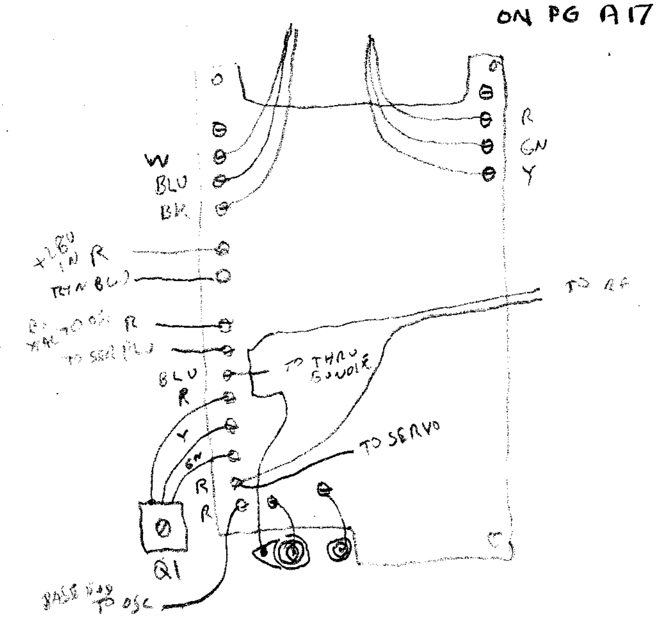


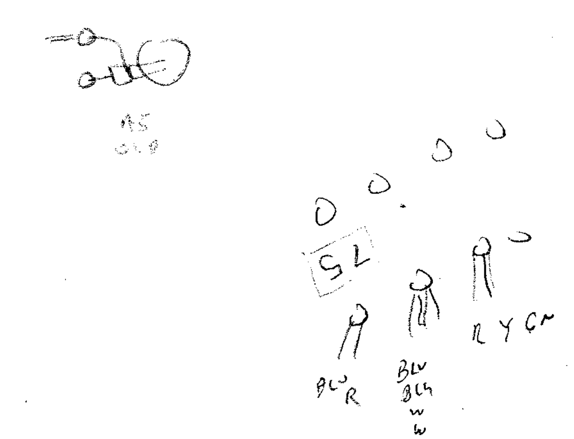
WIRE LIST

No.	FROM	TO	COLOR (AWG)	FUNCTION
1	A1E1	A6E9	RED (28)	PHOTOCELL
2	A1E2	A3E17	RED (24)	+17 VDC
3	A1E3	A3E16	BLU (24)	GND
4	A1E4	A3E8	YEL (24)	Rb LAMP MONITOR
5	A1E5	A6E8	BLK (28)	PHOTOCELL
6	A1E6	A5E5	GRN (24)	127 Hz SIGNAL
7	A1E7	A3E7	WHT (24)	RES LOCK SIGNAL
8	A1E8	A4E9	YEL (24)	XTAL CONT VOLTAGE
9	A1E9	A3E6	GRN (24)	
10	—	—	—	—
11	A1E11	A3E29	BLK (24)	
12	—	—	—	—
13	A2E1	C1–2	ORN (24)	+28 VDC
14	A2E2	C2–2	RED (24)	+17 VDC
15	A2E3	E1–2	BLU (24)	GND
16	—	—	—	—
17	A4E1	A5E11	ORN (24)	+28VDC (VIA A3E20)
18	A4E2	A5E10	RED (24)	+17 VDC (VIA A3E18)
19	A4E3	A5E9	BLU (24)	GND (VIA A3E19)
20	A4E4	J1–1	COAX	10MHz OUTPUT
21	A4E5	J1–1	SHIELD	
22	—	—	—	—
23	A4E6	A5E3	COAX	10MHz
24	A4E7	A5E4	SHIELD	
25	—	—	—	—
26	A5E1	A3E18	RED (24)	+17 VDC
27	A5E2	A3E19	BLU (24)	GND
28	A5E6	A6	COAX	RESONATOR
29	A5E7	A6	SHIELD	
30	A5E8	A3E20	ORN (24)	+28 VDC
31	—	—	—	—
32	A3E1	J2–8	BLU (24)	GND INPUT

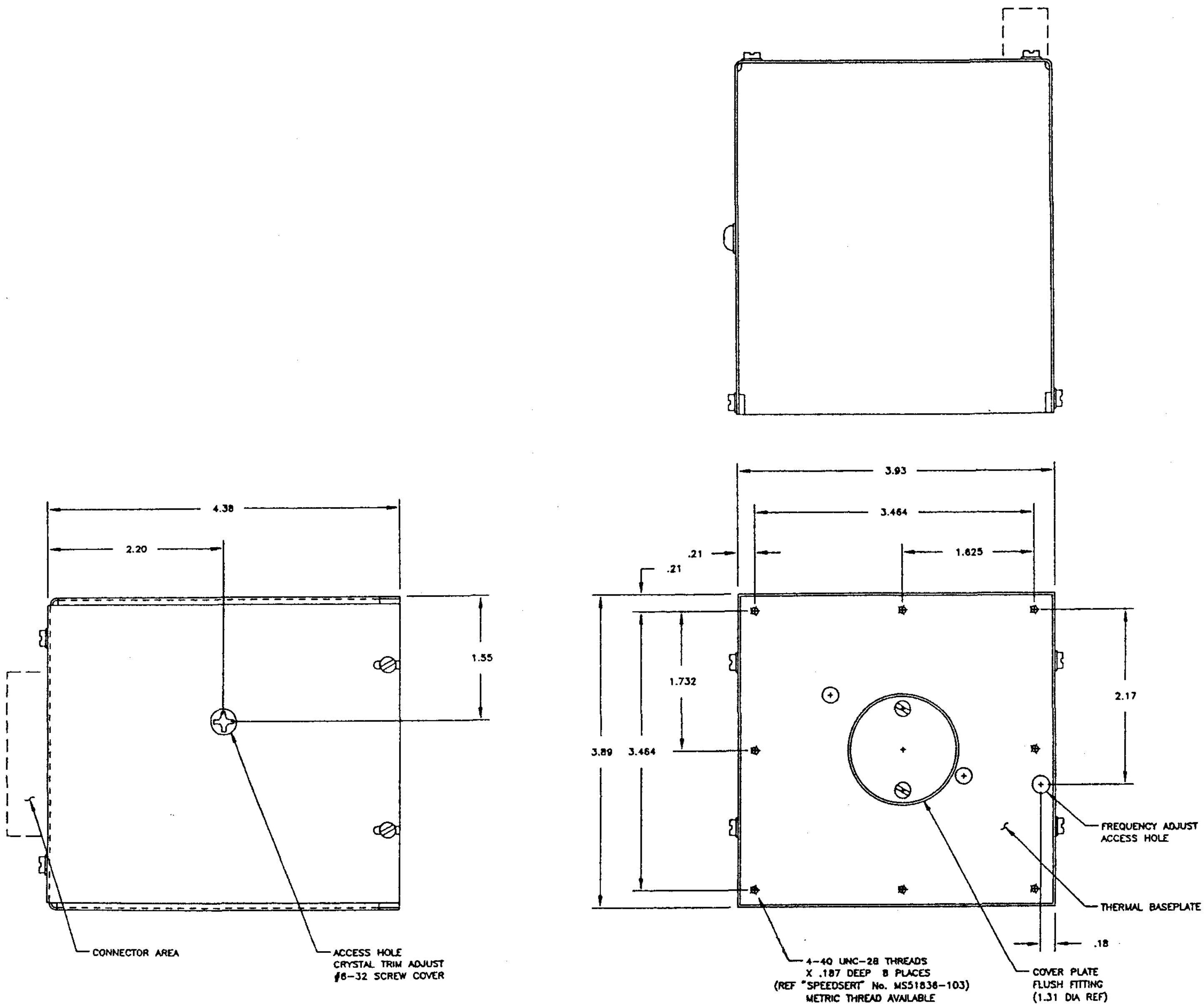
WIRE LIST

No.	FROM	TO	COLOR (AWG)	FUNCTION
33	A3E2	J2–1	ORN (24)	+28 VDC INPUT
34	A3E11	E1–1	BLU (24)	GND
35	A3E12	C2–1	BUS (24)	+17 VDC
36	A3E13	C1–1	BUS (24)	+28 VDC
37	—	—	—	—
38	A6E1	A3E21	ORN (26)	
39	A6E2	A3E24	BLU (26)	TWISTED PAIR
40	A6E4	A3E22	RED (26)	
41	A6E3	A3E23	YEL (26)	
42	A6E5	A3E25	WHT (28)	
43	A6E6	A3E26	BLK (26)	
44	A6E7	A3E28	GRN (26)	
45	A6E10	A3E27	BRN (28)	
46	—	—	—	—
47	A3E9	J2–9	BRN/WHT (24)	REMOTE FREQ ADJ
48	A3E10	J2–5	BRN (24)	+17 V OUT
49	A3E5	J2–6	YEL (24)	Rb LAMP MONITOR
50	A3E4	J2–4	WHT (24)	RES LOCK SIGNAL
51	A3E3	J2–2	GRN (24)	XTAL OSC MONITOR
52	A3E30	J2–7	RED (24)	HTR POWER

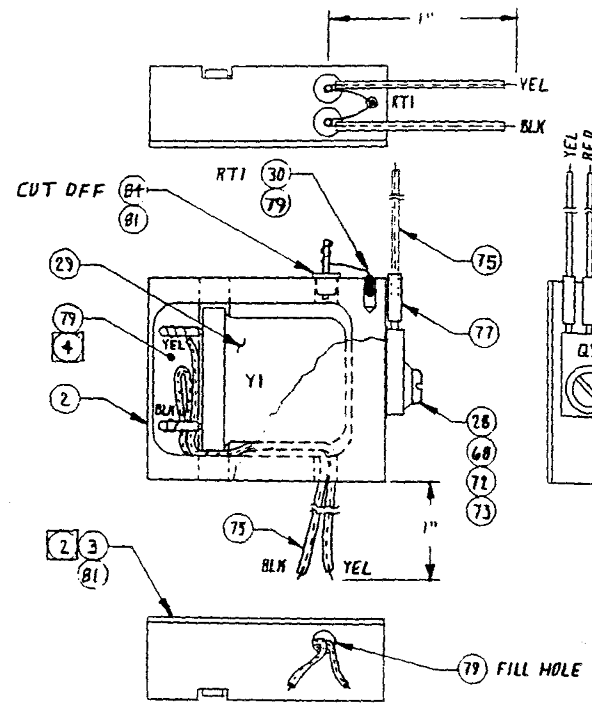


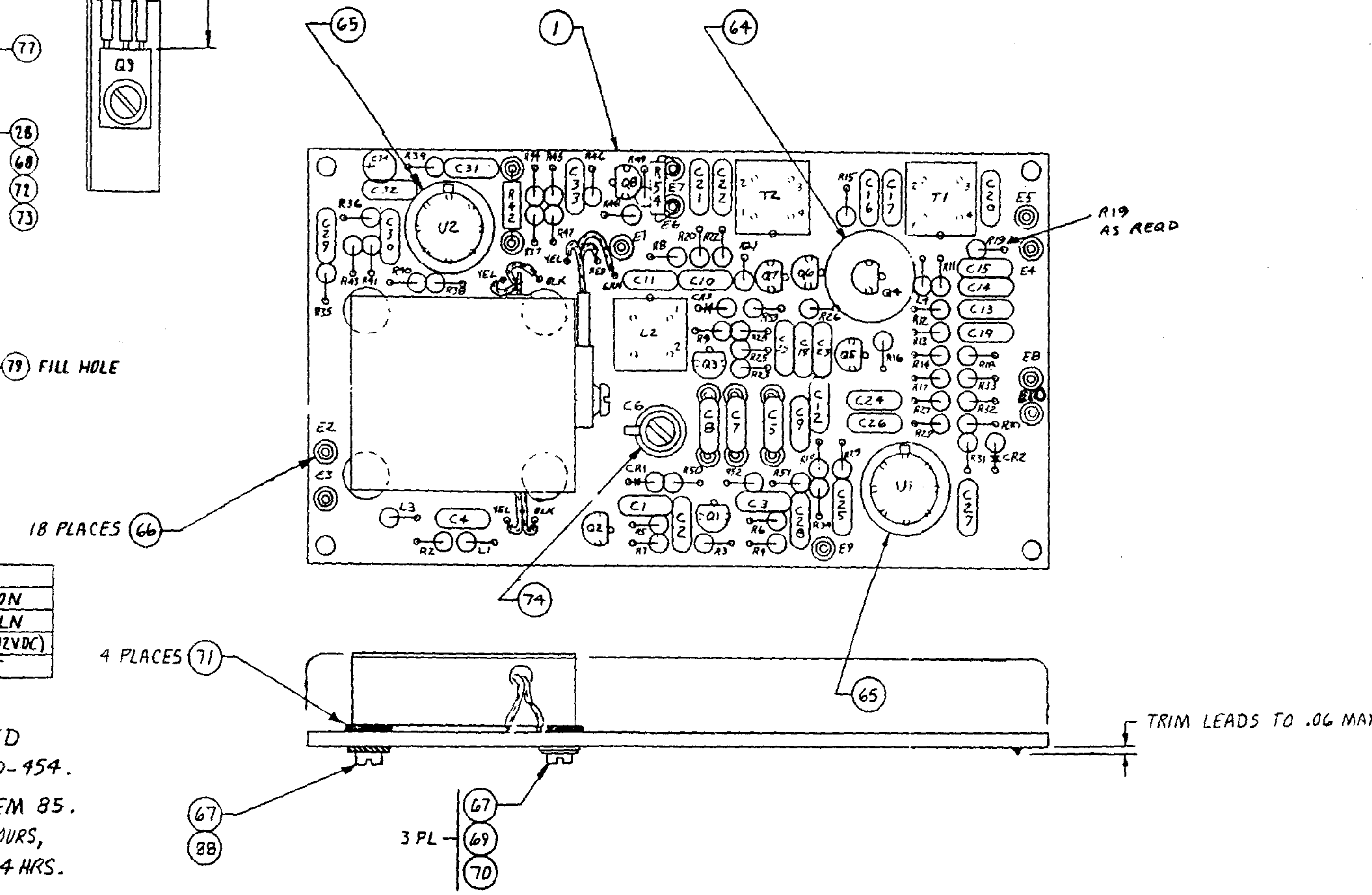


WIRING DIAGRAM, (10 MHz Unit)



OUTLINE DRAWING, FRK (703-203-1)





TABULATION					
PART NO.	R44	R45	R46	R49	USED ON
703-102-1	6.81K	1.00K	10K	1.10Ω	FRK-HLN
703-102-2	3.09K	2.00K	4.3K	.806Ω	FRK-HLN (12VDC)
703-102-3	SEE SEPARATE DWG				MNT

NOTES – UNLESS OTHERWISE SPECIFIED

1. SOLDER PER REQT 5 OF MIL-STD-454.
2. BOND LID TO HOUSING USING ITEM 85. CURE AT +60°C TO +70°C FOR 2 HOURS, OR CURE AT ROOM TEMP FOR 24 HRS.
3. MARK PART NO. ON ASSEMBLY.
4. APPLY APPROX 1/2" BEAD RTV ITEM-79 TO HOUSING. THEN PRESS CRYSTAL DOWN INTO PLACE. TACK WIRES ALSO WITH RTV.

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 PL 703-102-1 REVISION LTR.
REVISION DATE 91-04-25

TITLE: PARTS LIST, LN OSCILLATOR

SHEET 2

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
1	1	703-104		PRINTED WIRING BOARD		
2	1	70583-2		HOUSING, CRYSTAL		
3	1	70584		COVER, CRYSTAL		
4	1	EDPT 12 PF NPO		CAPACITOR 12 PF NPO	C18	1500738
5	1	EDPT 27 PF NPO		CAPACITOR 27 PF NPO	C11	1500763
6	1	EDPT 33 PF NPO		CAPACITOR 33 PF NPO	C16	1500747
7	1	EDPT 68 PF NPO		CAPACITOR 68 PF NPO	C22	1500758
8	3	EDPT 100PF NPO		CAPACITOR 100PF NPO	C26,30,32	1500764
9	1	EDPT 270PF NPO		CAPACITOR 270PF NPO	C17	1500776
10	1	EDPT SELECT NPO		CAPACITOR 10 PF NOMINAL	C7	
11	1	EDPT SELECT NPO		CAPACITOR 27 PF NOMINAL	C8	
12	1	C320C122J2GSCA		CAPACITOR 1200 PF +/-5% COG	C4	
13	1	C320C SELECT		CAPACITOR 600PF NOMINAL	C5	
14	3	CKR05BX104KSV		CAPACITOR 0.1 UF	C3,10,27	1500688
15	1	CKR06BX474KSV		CAPACITOR 0.47UF	C31	1500700
16	16	CKR05BX682KS		CAPACITOR 6800PF +/-10%	C1,2,9,12-15,19-21,23,28,24,29,33,35	1500695
17	1	CKR06BX105KSV		CAPACITOR 1 UF	C25	
18	1	ETPW 2C 10/6.3		CAPACITOR 10UF, TANTALUM	C34	
19	1	PC26T140		CAPACITOR, VARIABLE, 1-14PF	C6	1501499
20	1	MV1646		DIODE, VARACTOR	CR1	
21	1	1N5235B		DIODE, ZENER	CR2	
22	1	1N4151		DIODE	CR3	
23	1	MS75084-4		INDUCTOR 2.2UH	L1	
24	2	MS75085-10		INDUCTOR 180UH	L3,L4	
25	1	70277-SELECT		INDUCTOR 10-25UH	L2	
26	7	2N3904		TRANSISTOR	Q1,2,4-8	
27	1	JANTX2N4857		TRANSISTOR	Q3	
28	1	MJE802		TRANSISTOR	Q9	
29	1	704-286		CRYSTAL 5MHZ	Y1	
30	1	B43KB273K		THERMISTOR 27K+/-10% @25'C	RT1	
31	1	70277-1		TRANSFORMER 13:3	T2	
32	1	MK2 33.2 OHM		RESISTOR 33.2 OHM	R15	4701245
33	2	MK2 56.2 OHM		RESISTOR 56.2 OHM	R18,22	4701286

BALL, EFRATOM DIVISION   CONTRACT No.   CAGE CODE 55761   PL 703-102-1   REVISION LTR.
REVISION DATE 91-04-25

TITLE: PARTS LIST, LN OSCILLATOR

SHEET 3

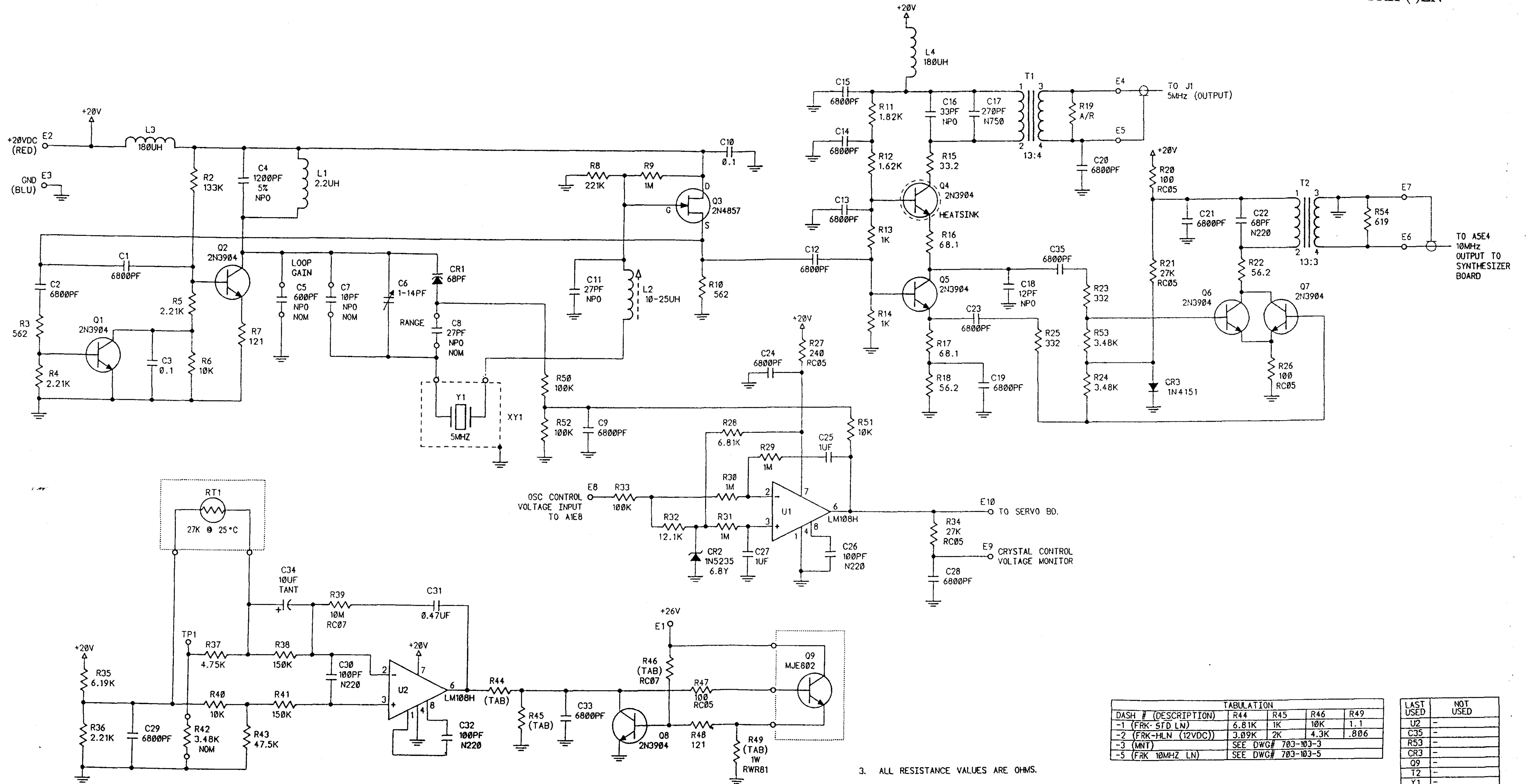
FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
34	2	MK2 68.1 OHM		RESISTOR 68.1 OHM	R16,17	4701296
35	2	MK2 121 OHM		RESISTOR 121 OHM	R7,48	4701178
36	2	MK2 332 OHM		RESISTOR 332 OHM	R23,25	4701248
37	2	MK2 562 OHM		RESISTOR 562 OHM	R3,10	4701287
38	3	MK2 1.00K		RESISTOR 1.00K	R45,13,14	4701153
39	1	MK2 619 OHM		RESISTOR 619 OHM	R54	4701292
40						
41	1	MK2 1.62K		RESISTOR 1.62K	R12	4701163
42	1	MK2 1.82K		RESISTOR 1.82K	R11	4701166
43	3	MK2 2.21K		RESISTOR 2.21K	R4,5,36	4701196
44	2	MK2 3.48K		RESISTOR 3.48K	R24,53	4701235
45	1	MK2 4.75K		RESISTOR 4.75K	R37	4701260
46	1	MK2 6.19K		RESISTOR 6.19K	R35	4701288
47	2	MK2 6.81K		RESISTOR 6.81K	R28,44	4701290
48	3	MK2 10.0K		RESISTOR 10.0K	R6,40,51	4701167
49	1	MK2 12.1K		RESISTOR 12.1K	R32	
50	1	MK2 47.5K		RESISTOR 47.5K	R43	4701267
51	3	MK2 100K		RESISTOR 100K	R33,50,52	4701170
52	1	MK2 133K		RESISTOR 133K	R2	4701180
53	2	MK2 150K		RESISTOR 150K	R38,41	4701185
54	1	MK2 221K		RESISTOR 221K	R8	4701212
55	4	MK2 1MEG		RESISTOR 1MEG	R9,29,30,31	
56	1	MK2 SELECT		RESISTOR (3.48K SELECT NOMINAL)	R42	
57	1	RCR05G241JS		RESISTOR 240 OHM 1/8W	R27	
58	3	RCR05G101JS		RESISTOR 100 OHM 1/8W	R20,26,47	
59	2	RCR05G273JS		RESISTOR 27 OHM 1/8W	R21,34	
60	1	RCR05G103JS		RESISTOR 10K	R46	
61	1	RCR05G106JS		RESISTOR 10 MEG 1/4W	R39	
62	1	RWR81S1R10FR		RESISTOR 1.10 OHM 1W	R49	
63	2	UA108HMQB		INTEGRATED CIRCUIT	U1,U2	
64	1	TXC20B		HEAT SINK	XQ	
65	2	7717-107N		TRANSISTOR PAD (8-PIN)	XU1,XU2	
66	18	70416-2		SOLDER TERMINAL		
67	4	70425-3		SCREW, M2x6		

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 PL 703-102-1 REVISION LTR.
REVISION DATE 91-04-25

TITLE: PARTS LIST, LN OSCILLATOR

SHEET 4

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
68	1	70425-15		SCREW, M3x6		
69	4	70414-18		WASHER, SPRING M2		
70	4	70414-4		WASHER, FLAT M2		
71	4	2191		WASHER, FIBER		
72	1	B52200F006		WASHER, BELLEVILLE		
73	1	61B586		WASHER, MICA	XQ9	
74	1	5622-1-007		WASHER, MYLAR	UNDER C6	
75	A/R	MIL-W-16878 TYPE E		WIRE, 28AWG, TEFLON (YEL,BLK,RED,GRN)		
76				NOT USED		
77	A/R	70422-1		SHRINK FIT SLEEVING 3/32		
78				NOT USED		
79	A/R	3145 RTV		SILICONE RUBBER, GRAY		
80				NOT USED		
81	A/R	LOCKTITE 00241		ADHESIVE, THERMAL "OUTPUT"		
82	A/R	MIL-I-46058 TYPE UR		CONFORMAL COAT, POLYURETHANE		
83	A/R	SN63WRMAP3		SOLDER		
84	2	70276		TERMINAL, HERMETIC		
85				NOT USED		
86				NOT USED		
87	1	70277-11		TRANSFORMER 13:4	T1	
88	1	6798ST-A2		WASHER, EXTERNAL TOOTH M2		



TABULATION				
DASH # (DESCRIPTION)	R44	R45	R46	R49
-1 (FRK-STD LN)	6.81K	1K	10K	1.1
-2 (FRK-HLN (12VDC))	3.09K	2K	4.3K	.806
-3 (MNT)	SEE DWG# 703-103-3			
-5 (FRK 10MHZ LN)	SEE DWG# 703-103-5			

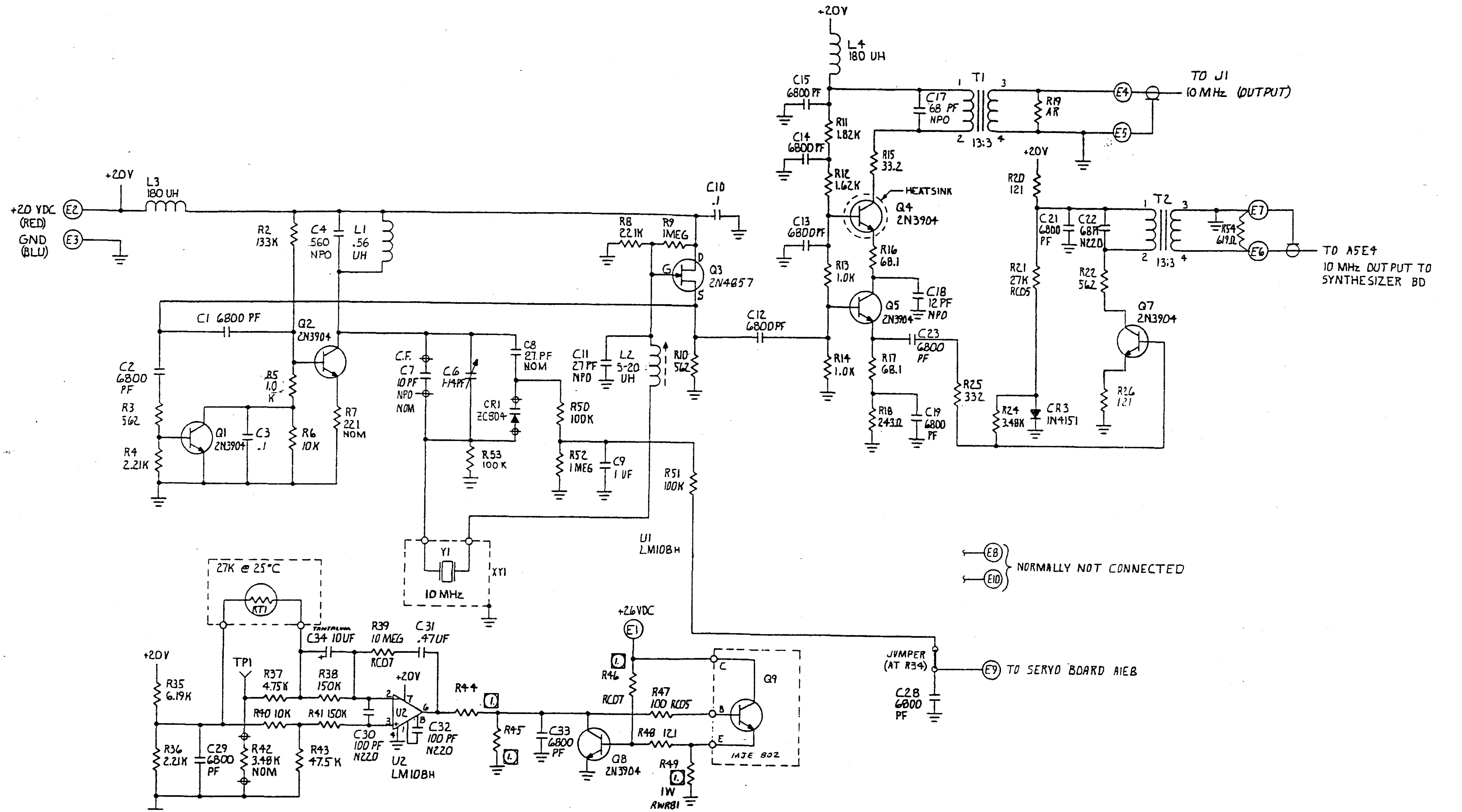
LAST USED	NOT USED
U2	-
C35	-
R53	-
CR3	-
Q9	-
T2	-
Y1	-
L4	-
RT1	-
E10	-

NOTES: UNLESS OTHERWISE SPECIFIED.

1. FOR ASSEMBLY SEE DWG# 703-102.
2. ALL CAPACITANCE VALUES ARE MICROFARADS.
3. ALL RESISTANCE VALUES ARE OHMS.

Mine is 10MHz - NEXT PAGE →

SCHEMATIC, 5 MHz LN OSCILLATOR (703-103-TAB)

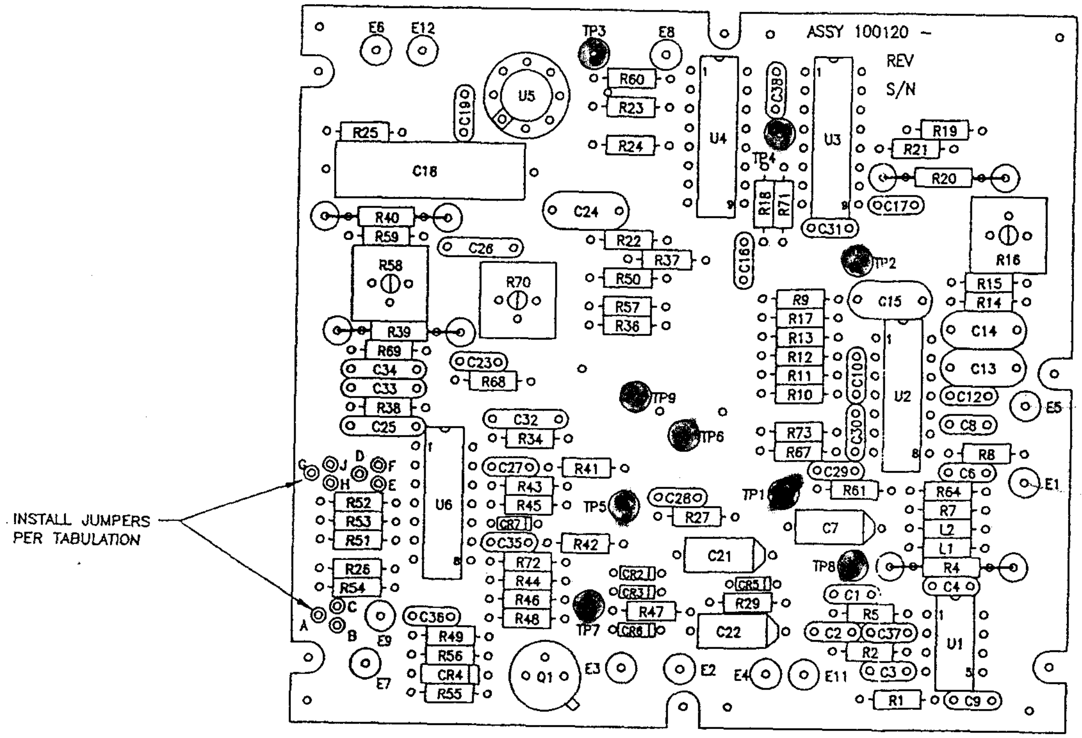


NOTES- UNLESS OTHERWISE SPECIFIED

1. SEE TABULATION BLOCK FOR COMPONENT VALUE.
2. FOR ASSEMBLY DRAWING SEE NO. 703-102-5
3. USE WITH NORMAL (NON-LN) SERVO BOARD.

BOARD A4

SCHEMATIC, 10 MHz LN OSCILLATOR (703-103)



LEGEND

ARTWORK 100119

REV A

NOTES: UNLESS OTHERWISE SPECIFIED.

1. PART ATTACHMENT, WIRING, SOLDERING, CLEANING AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH IPC-S-815 CLASS 111.
2. CONFORMAL COAT BOTH SIDES OF BOARD IN ACCORDANCE WITH MIL-STD-275 USING MATERIAL CONFORMING TO MIL-I-46058. MASK TEST POINTS, TERMINALS, MOUNTING SURFACES AND COMPONENT ADJUSTMENT SCREWS PRIOR TO-APPLICATION.
3. IDENTIFY ASSEMBLY WITH ASSEMBLY NUMBER, REVISION LETTER, AND SERIAL NUMBER PER MIL-STD-130.
4. FOR SCHEMATIC SEE DRAWING NUMBER 100117.
5. ALL COMPONENTS SHOWN ON DRAWING MAY NOT BE USED ON ALL ASSEMBLIES SEE TABULATION AND PARTS LIST FOR EACH ASSEMBLY.

TABULATION CHART

ASSEMBLY No.	DESCRIPTION	INSTALL JUMPERS
100120-000	BASIC ASSEMBLY	NONE
100120-001	STANDARD VERSION	A-C, D-F, G-H
100120-002	TTL VERSION	A-C, D-F, G-H
100120-003	LOW NOISE 5 MHz VERSION	A-B, D-E, G-J
100120-004	LOW NOISE TTL VERSION	A-B, D-E, G-J
100120-005	SPECIAL FOR GLOBAL	A-C, D-F, G-H
100120-006	LOW NOISE 10 MHz VERSION	A-B, D-E, G-J

ASSEMBLY, SERVO BOARD (100120)

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 DRAWING No. 100120-1 REVISION LTR.

REVISION DATE 91-04-25

PARTS LIST, SERVO BD FILENAME:100120 .DBF SHEET 2

FIND No.	-001	-002	-003	-004	-005	-006	-007	-008	-009	-010	CAGE CODE	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION		HCI CODE	REFERENCE DESIGNATOR	UNIS No.
1	1	1	1	1	1	1						100118-001	EFRATOM	P.C.B. FABRICATION SERVO BOARD				
2	2	2	2	2	2	2						EDPT100PFNPO	STETTNER	CAP, NPO	100PF		C17,37	1500764
3	1	1	1	1	1	1						CKR05BX102KS	MIL-C-39014	CAP, CER, 200V, 10%,	1000PF		C8	1500704
4	5	5	5	5	5	5						CKR05BX682KS	MIL-C-39014	CAP, CER, 100V, 10%	6800PF		C1-3,19,31	1500965
5	9	9	9	9	9	9						CKR05BX104KS	MIL-C-39014	CAP, CER, 50V, 10%,	0.1UF		C9,10,12,16,23,27,29,35,38	1500688
6	2	2	2	2	2	2						CKR06BX105KS	MIL-C-39014	CAP, CER, 50V, 10%,	1.0UF		C6,28	1500697
7	3	3	3	3	3	3						T322D106M035AS	KEMET	CAP, TANT, 35V, 20%	10UF		C7,21,22	1502105
8	1	1	1	1	1	1						22NA103K	S&EI	CAP, POLY, 50V, 10%,	.01UF		C25	1500142
9	4	4	4	4	4	4						22NA473J	S&EI	CAP, POLY, 50V, 5%,	.047UF		C26,C32-34	1500148
10	4	4	4	4	4	4						22NA104J	S&EI	CAP, POLY, 50V, 5%,	0.1UF		C13-15,24	1500144
11	1	1	1	1	1	1						M83421/01-1252S	MIL-C-83421	CAP, MF CRH01,30V,10%	1.0UF		C18	1501109
12	3	3	3	3	3	3						1N4151		DIODE,			CR3,CR6,CR7	4800084
13	1	1	1	1	1	1						1N5235B		DIODE, 6.8V ZENER			CR2	4800092
14	1	1	1	1	1	1						1N5245		DIODE, 15V ZENER			CR5	4800094
15														NOT USED				
16	2	2	2	2	2	2						MS75084-4	MIL-C-15305	INDUCTOR	2.2UH		L1,L2	1801448
17	1	1	1	1	1	1						OP27BZ		I.C., OPAMP			U1	3132958
18														NOT USED				
19	1	1	1	1	1	1						CD4060BF		I.C.,			U3	3130670
20	1	1	1	1	1	1						CD4053BF		I.C.,			U4	3130688
21	1	1	1	1	1	1						LM108H/883B		I.C., OPAMP			U5	
22	2	2	2	2	2	2						LM124J		I.C., OPAMP			U2,U6	3130984
23	1	1	1	1	1	1						7717-4N		SPACER, TO-5 (3 LEAD)			Q1	70418-1
24	1	1	1	1	1	1						7717-107N		SPACER, TO-5 (8 LEAD)			U5	2102217
25	A/R	A/R	A/R	A/R	A/R	A/R						SN63WRMAP3		SOLDER				2102572
26	20	20	20	20	20	20						70416-2		TERMINAL			TP1-TP9, E1-E9,E11,12	
27														NOT USED				
28	1	1	1	1	1	1						MK2 100		RES, MF, 1/4W, 1%,	100		R55	4701170
29	1	1	1	1	1	1						MK2 464		RES, MF, 1/4W, 1%,	464		R29	4701260
30	4	4	4	4	4	4						MK2 1.00K		RES, MF, 1/4W, 1%,	1.00K		R7,25,42,46	4701153
31	1	1	1	1	1	1						MK2 2.21K		RES, MF, 1/4W, 1%,	2.21K		R27	4701196
32	1	1	1	1	1	1						MK2 3.48K		RES, MF, 1/4W, 1%,	3.48K		R2	4701235
33	1	1	1	1	1	1						MK2 3.57K		RES, MF, 1/4W, 1%, NOM	3.57K		R68	4701236

PARTS LIST, SERVO BOARD (PL 100120) PAGE 1 OF 3

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 DRAWING No. 100120-1 REVISION LTR.

REVISION DATE 91-04-25

PARTS LIST, SERVO BD FILENAME:100120 .DBF SHEET 3

FIND No.	QTY REQ PER ASSY No. 100120-XXX -001	-002	-003	-004	-005	-006	-007	-008	-009	-010	CAGE CODE	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION		HCI CODE	REFERENCE DESIGNATOR	UNIS No.
34	1	1	1	1	1	1						MK2 4.75K		RES, MF, 1/4W, 1%,	4.75K		R22	4701260
35	1	1	1	1	1	1						MK2 5.76K		RES, MF, 1/4W, 1%	5.76K		R9	4701280
36														NOT USED				
37	2	2	2	2	2	2						MK2 9.09K	STETTNER	RES, MF, 1/4W, 1%,	9.09K		R15,69	4701317
38	4	4	4	4	4	4						MK2 10.0K	STETTNER	RES, MF, 1/4W, 1%,	10.0K		R4,17,60,61	4701167
39	1	1	1	1	1	1						MK2 22.1K	STETTNER	RES, MF, 1/4W, 1%,	22.1K		R43	4701210
40	3	3	3	3	3	3						MK2 27.4K	STETTNER	RES, MF, 1/4W, 1%,	27.4K		R1,26,73	4701220
41														NOT USED				
42														NOT USED				
43	2	2	2	2	2	2						MK2 47.5K	STETTNER	RES, MF, 1/4W, 1%,	47.5K		R50,57	4701267
44	1	1	1	1	1	1						MK2 56.2K	STETTNER	RES, MF, 1/4W, 1%,	56.2K		R13	4701285
45	6	6	6	6	6	6						MK2 82.5K	STETTNER	RES, MF, 1/4W, 1%,	82.5K		R10,11,34,39,59,67	4701311
46	4	4	4	4	4	4						MK2 100K	STETTNER	RES, MF, 1/4W, 1%,	100K		R18,36,64,71	4701171
47	1	1	1	1	1	1						MK2 332K	STETTNER	RES, MF, 1/4W, 1%,	332K		R37	4701247
48	1	1	1	1	1	1						MK2 309K	STETTNER	RES, MF, 1/4W, 1%,	309K		R19	4701241
49	2	2	2	2	2	2						MK2 475K	STETTNER	RES, MF, 1/4W, 1%,	475K		R41,72	4701270
50	1	1	1	1	1	1						MK2 SELECT	STETTNER	RES, MF, 1/4W, 1%	SELECT		R20	
51	6	6	6	6	6	6						MK2 1.00M	STETTNER	RES, MF, 1/4W, 1%,	1.00M		R8,23,24,38,44,45	4701153
52	1	1	1	1	1	1						RCR07G915JS	MIL-R-39008	RES, FC, 1/4W, 5%,	9.1M		R47	4701744
53	2	2	2	2	2	2						3386P-1-502	BOURNS	RES, VARIABLE	5.0K		R16,70	4750257
54														NOT USED				
55	1	1	1	1	1	1						3386P-1-503	BOURNS	RES, VARIABLE,	50K		R58	4750258
56	1	1	1	1	1	1						RCR07G205JS	MIL-R-39008	RES, FC, 1/4W, 5%	2.0M		R21	4701572
57	1	1	1	1	1	1						CKR05BX332KR	MIL-C-39014	CAP, CER, 100V, 10%,	3300PF		C4	1500705
58	1	1	1	1	1	1						MK2 511	STETTNER	RES, MF, 1/4W, 1%,	511		R5	4701282
59	1	1	1	1	1	1						CCR05CG202JR	MIL-C-20	CAP, NPO, 50V, 5%	2000PF		C30	1500622
60	A/R	A/R	A/R	A/R	A/R	A/R						QQW343S26S1T	QQ-W-343	WIRE, UNINSULATED 26AWG			JUMPERS A-C, D-F, G-H	
61	1	1	1	1	1	1						MK2 22.1K	STETTNER	RES, MF, 1/4W, 1%,	22.1K		R12	4701210
62	1	1	1	1	1	1						MK2 3.48K	STETTNER	RES, MF, 1/4W, 1%,	3.48K		R14	4701235
63	1	1	1	1	1	1						MK2 100K	STETTNER	RES, MF, 1/4W, 1%,	100K		R51	4701171
64	1	1	1	1	1	1						MK2 82.5K	STETTNER	RES, MF, 1/4W, 1%,	82.5K		R52	4701311
65	1	1	1	1	1	1						MK2 39.2K	STETTNER	RES, MF, 1/4W, 1%,	39.2K		R53	4701250
66	1	1	1	1	1	1						MK2 33.2K	STETTNER	RES, MF, 1/4W, 1%,	33.2K		R54	4701245

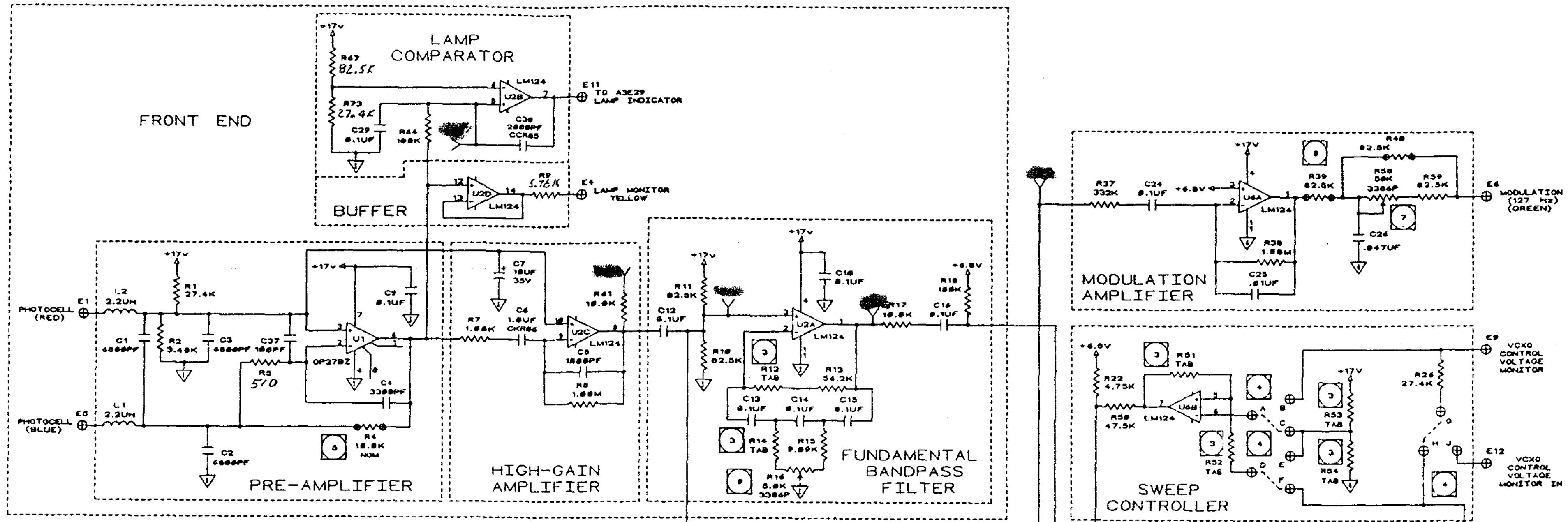
PARTS LIST, SERVO BOARD (PL 100120) PAGE 2 OF 3

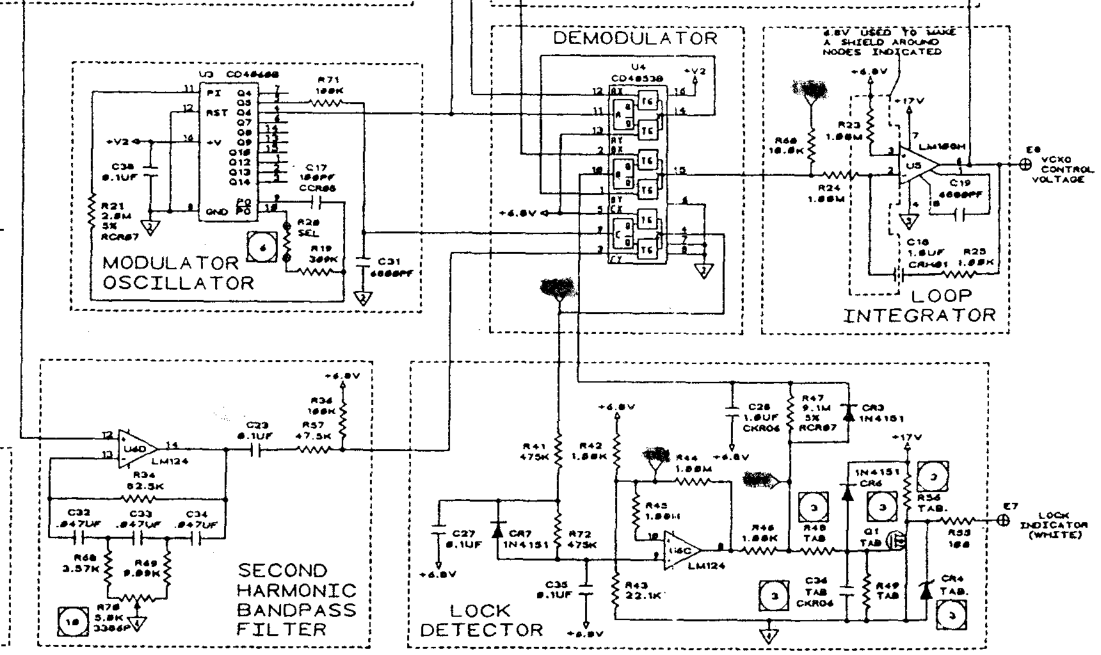
BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 DRAWING No. 100120-1 REVISION LTR.

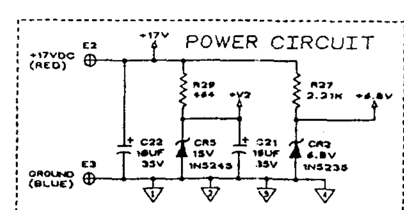
PARTS LIST, SERVO BD FILENAME:100120 .DBF REVISION DATE 91-04-25 SHEET 4

FIND No.	QTY REQ PER ASSY No. 100120-XXX -001	-002	-003	-004	-005	-006	-007	-008	-009	-010	CAGE CODE	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION		HCI CODE	REFERENCE DESIGNATOR	UNIS No.
67	0	1	0	1	0	0						MK2 10.0K	STETTNER	RES, MF, 1/4W, 1%,	10.0K		R56	4701167
68	1	1	1	1	1	1						MK2 1.00M	STETTNER	RES, MF, 1/4W, 1%,	1.00M		R48	4701153
69	0	0	0	0	1	0						MK2 464	STETTNER	RES, MF, 1/4W, 1%,	464		R49	4701260
70	1	1	1	1	0	1						CKR06BX105KS	MIL-C-39014	CAP, CER, 50V, 10%,	1.0UF		C36	1500697
71	1	1	1	1	1	1						VN0109N2	SUPER-TEX	TRANSISTOR, MOS FET			Q1	
72	1	1	1	1	0	1						1N5264B		DIODE, 60V ZENER			CR4	4800096

PARTS LIST, SERVO BOARD (PL 100120) PAGE 3 OF 3







TABULATION CHART

R12	R14	R51	R52	R53	R54	JUMPER	R56	FUNCTION
22.1K	3.48K	100K	82.5K	39.2K	33.2K	4	NOT USED	SERVO
22.1K	3.48K	100K	82.5K	39.2K	33.2K		10.0K	SERVO "TTL"
22.1K	3.48K	47.5K	221K	22.1K	15.8K		NOT USED	LN SERVO (5 MHz)
22.1K	3.48K	47.5K	221K	22.1K	15.8K		10.0K	LN SERVO "TTL"
11.0K	4.99K	100K	82.5K	39.2K	33.2K		NOT USED	LN SERVO (10 MHz)
22.1K	3.48K	100K	82.5K	39.2K	33.2K		NOT USED	SPECIAL (GLOBAL)

TABULATION CHART

R48	R49	C34	Q1	CR4	FUNCTION
1.00M	NOT USED	1.0UF	VN0109N2	1N5264 (60V)	SERVO
1.00M	NOT USED	1.0UF	VN0109N2	1N5231B (5.1V)	SERVO "TTL"
1.00M	NOT USED	1.0UF	VN0109N2	1N5264 (60V)	LN SERVO (5 MHz)
1.00M	NOT USED	1.0UF	VN0109N2	1N5231B (5.1V)	LN SERVO "TTL"
1.00M	NOT USED	1.0UF	VN0109N2	1N5264 (60V)	LN SERVO (10 MHz)
3.48K	464	NOT USED	2N1893 (NPN) 11	NOT USED	SPECIAL (GLOBAL)

LAST USED	NOT USED
C38	C5 C11 C28
CR7	CR1
E12	E10
L2	
Q1	
R73	R3 R6 R28
TP 9	R35 R30-33
U6	R62 R63 R65 R66
JUMPER J	

11 SEE ASSEMBLY DRAWING FOR Q1 INSTALLATION INSTRUCTIONS.

10 2nd HARMONIC BPF CENTER FREQUENCY ADJUST

9 FUNDAMENTAL BPF CENTER FREQUENCY ADJUST

8 MODULATION AMPLITUDE ADJUST

7 MODULATION PHASE ADJUST

6 MODULATION OSCILLATOR FREQUENCY ADJUST FOR 127 Hz

5 LAMP VOLTS ADJUST

4 INSTALL JUMPERS A-C, D-F, G-H.
FOR LOW NOISE UNITS ONLY: INSTALL JUMPERS A-B, D-E, G-J.

3 SEE TABULATION CHART FOR COMPONENT VALUES.

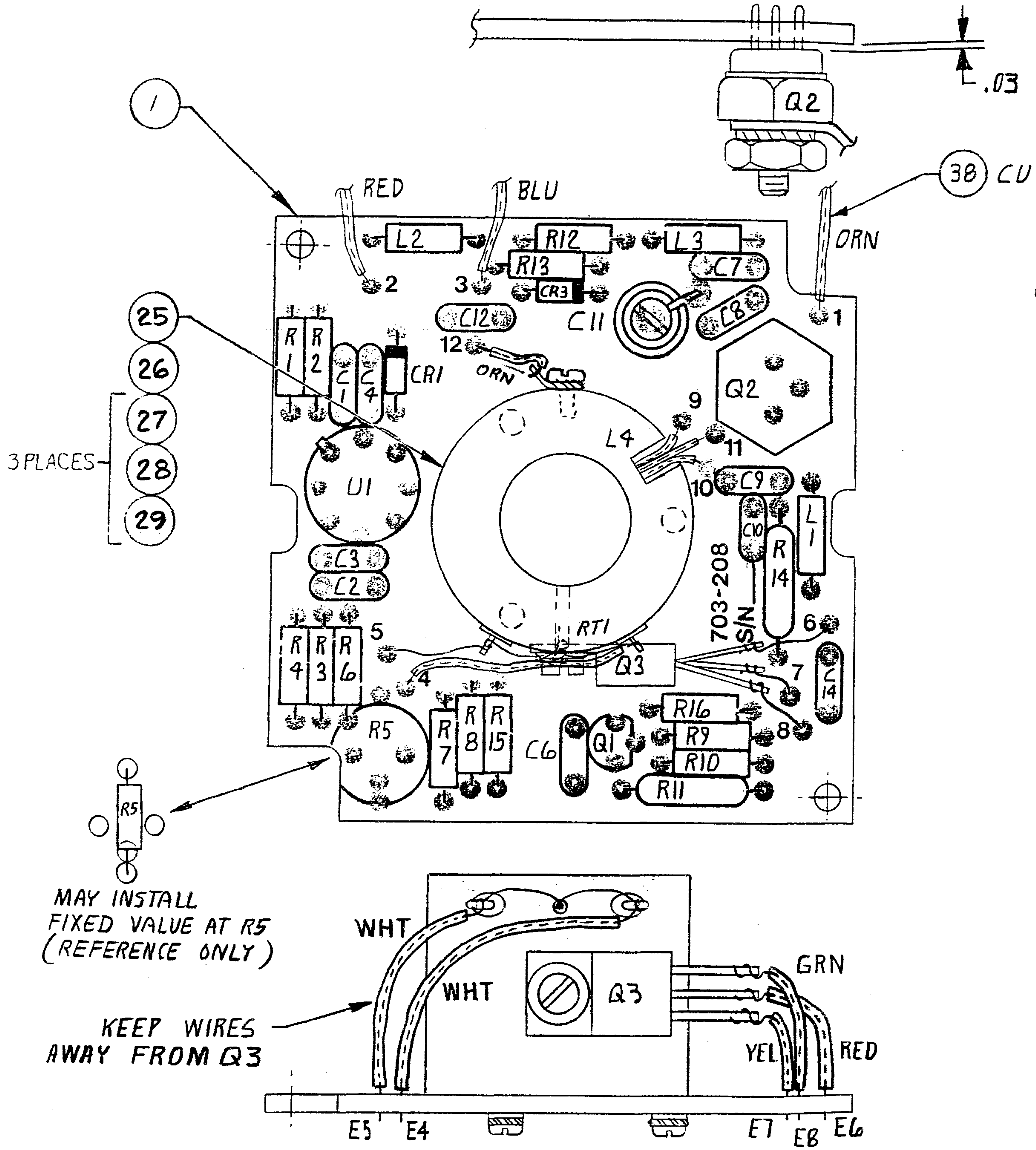
2. CAPACITORS ARE 50V MIN. OR CERAMIC. (CKR05BX----KS)

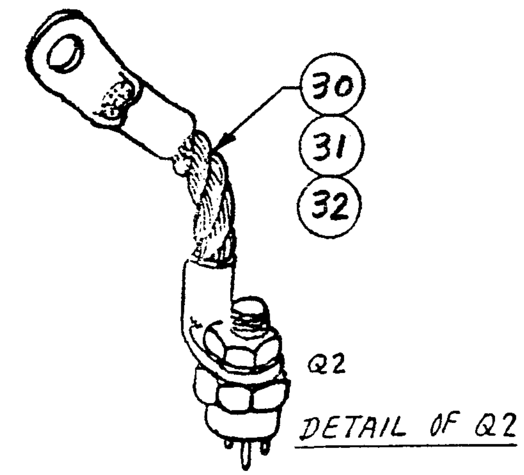
1. RESISTORS ARE 1/4W, 1% FIXED FILM. (MK2 ----)

NOTES: UNLESS OTHERWISE SPECIFIED.

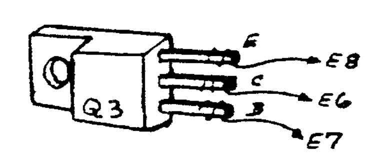
BOARD A1

SCHEMATIC, SERVO BOARD (100117)

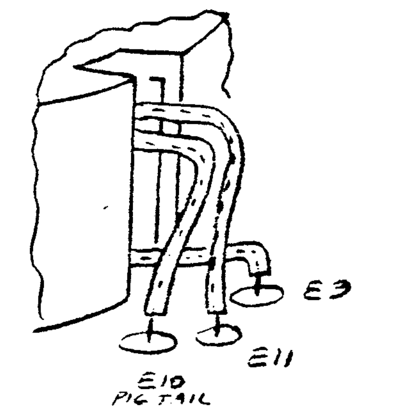




DETAIL OF Q2



DETAIL OF Q3



PICTORIAL VIEW
COIL WINDING

TABULATION					
ASSEMBLY NO	R7	R8	R11	R16	USED ON
703-208-1	8.25K	332Ω	1.00Ω	39.2K	FRK-H
703-208-2	12.1K	681Ω	.619Ω	4.32K	FRK-HLN (12VDC)

BOARD A2
ASSEMBLY, LAMP BOARD (703-208-1, 2)

BALL, EFRATOM DIVISION   CONTRACT No.   CAGE CODE 55761   PL 703-208-1   REVISION LTR. U
REVISION DATE 6-6-90

TITLE: PARTS LIST LAMP BOARD ASSY FRK

SHEET 2

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
1	1	703-210-1		PRINTED WIRING BOARD		
2	1	EDPT 10PF NPO	S-T	CAPACITOR 10PF	C10	1500734
3	7	C322C332K1G5CA	KEMET	CAPACITOR 3300PF	C1-4,7-9	1500579
4	1	PC32T140	JOHNSON	CAPACITOR, VARIABLE 1.5-14PF	C11	1501515
5	1	1N5232B	MOT	DIODE, ZENER	CR1	4800091
6	1	1N4151	F	DIODE, SWITCHING	CR3	4800084
7	1	MS75083-3	DELEVAN	INDUCTOR 0.15UH	L3	1801443
8	2	MS75084-4	DELEVAN	INDUCTOR 2.2UH	L1,L2	1801448
9	1	2N3904	MOTOROLA	TRANSISTOR	Q1	4800197
10	1	2N3375	MOTOROLA	TRANSISTOR	Q2	4800194
11	1	LM741HMQB	F	INTEGRATED CIRCUIT	U1	3131016
12	2	MK2 100 OHM	S-T	RESISTOR 100 OHM	R2,9	4701171
13	1	MK2 681 OHM	S-T	RESISTOR 681 OHM	R15	4701297
14	1	MK2 1K	S-T	RESISTOR 1K	R3	4701153
15	1	MK2 1.5K	S-T	RESISTOR 1.5K	R4	4701161
16	1	MK2 4.75K	S-T	RESISTOR 4.75K	R6	4701267
17	1	MK2 5.76K	S-T	RESISTOR 5.76K	R1	4701280
18	1	MK2 8.25K	S-T	RESISTOR 8.25K	R7	4701309
19	1	MK2 39.2K	S-T	RESISTOR 39.2K 1/4W	R16	4701250
20	1	RWR80520R0FR		RESISTOR 20 OHM 2W	R14	4701967
21	1	RWR81S1R00FR		RESISTOR 1.00 OHM 1W	R11	4702010
22	1	3339P-1-502	BOURNS	RESISTOR VARIABLE 5K	R5	4750249
23	1	MK2 332 OHM	S-T	RESISTOR 332 OHM	R8	4701248
24	2	CKR05BX682KSV	KEMET	CAPACITOR 6800PF	C12,14	1500695
25	1	70331-1		THERMOSTAT ASSEMBLY		
26	1	250-169		MICA WINDOW		
27	3	70425-3		SCREW, M2 x 6		
28	3	70414-4		WASHER, FLAT, M2		
29	3	6798ST-1N2.2		WASHER, LOCK, M2		
30	1	70334		HEATSINK CABLE		
31	1	MS35650-304		NUT, HEX, 10-32		2821407
32	1	MS35333-73		WASHER, IT LOCK, No. 10		2821386
33	1	MK2 140 OHM	S-T	RESISTOR 140 OHM 1/4W	R13	4701181
34	1	CKR05BX104KSV		CAPACITOR 0.1UF	C6	1500688

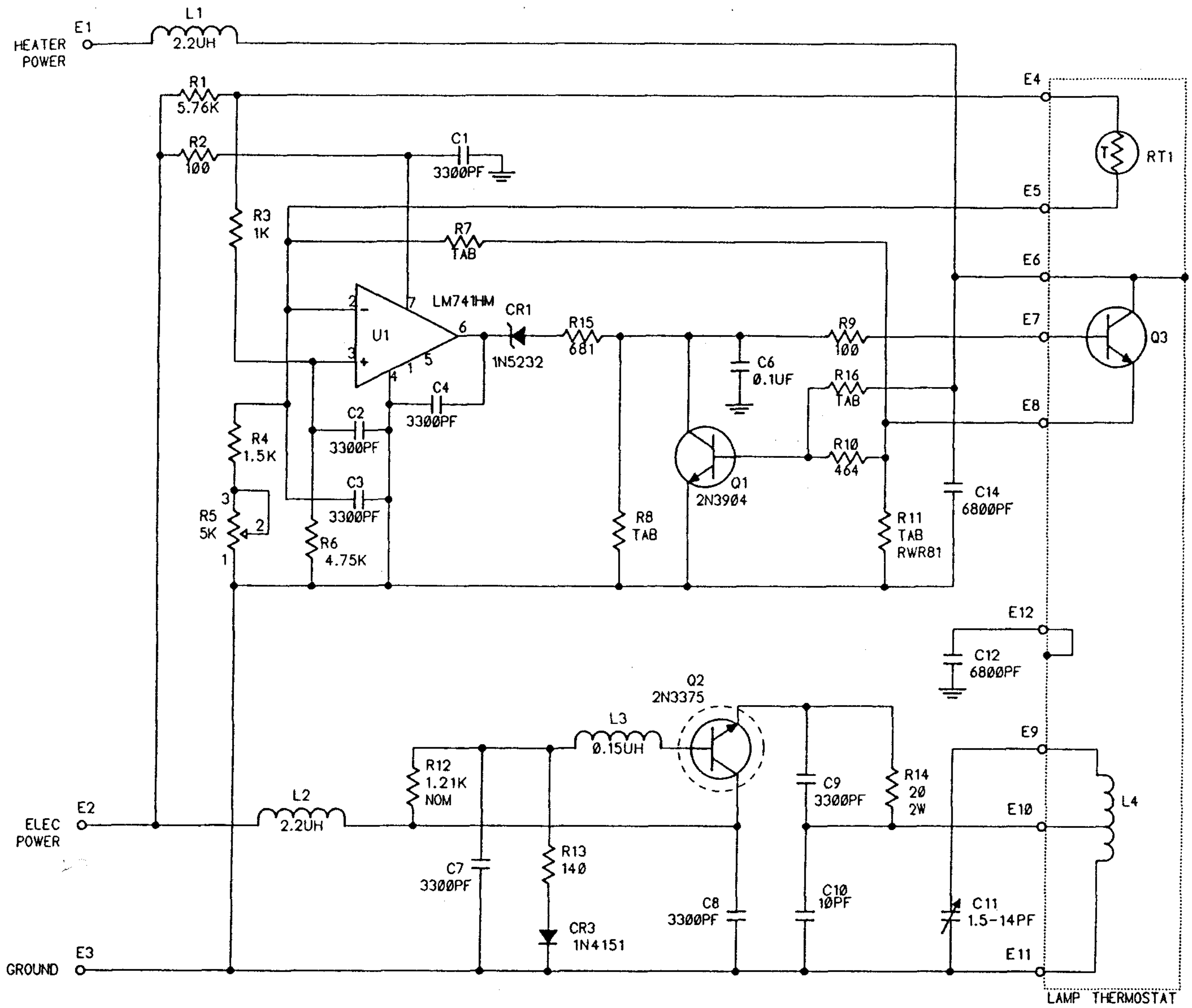
BALL, EFRATOM DIVISION   CONTRACT No.   CAGE CODE 55761   PL 703-208-1   REVISION LTR. U
REVISION DATE 6-6-90

TITLE: PARTS LIST LAMP BOARD ASSY FRK

SHEET 3

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
35	1	7717-107N		TRANSISTOR PAD (8 PIN)	XU1	2102217
36	1	MK2 464 OHM	S-T	RESISTOR 464 OHM 1/4W	R10	4701266
37	1	MK2 1.21K NOM	S-T	RESISTOR 1.21K NOMINAL	R12	4701158
38	A/R	MIL-W-16878, E.T.		WIRE, 24AWG, TEFLON, RED-BLU-ORN		

PARTS LIST, LAMP BOARD (PL 703-208-1) PAGE 2 OF 2



2. RESISTANCE VALUES ARE OHMS.

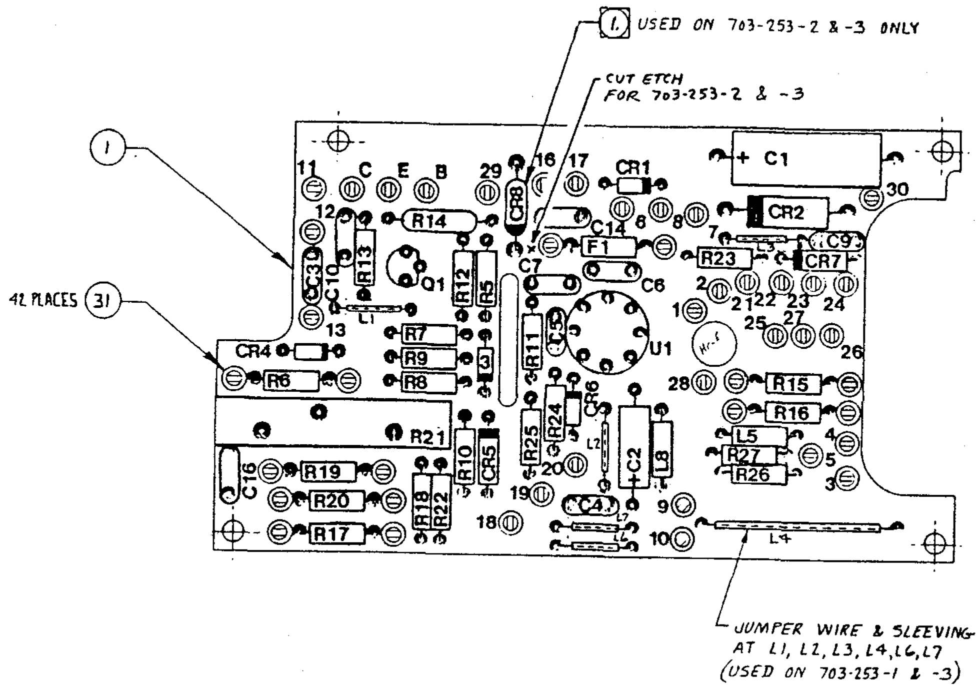
1. FOR ASSEMBLY SEE DWG# 703-208.

NOTES: UNLESS OTHERWISE SPECIFIED.

TABULATION					
ASSEMBLY	R7	R8	R11	R16	USED ON
703-208-1	8.25K	332	1	39.2K	FRK-H
703-208-2	12.1K	681	0.619	4.32K	FRK-HLN(12VDC)

LAST USED	NOT USED
U1	-
C14	C5,13
R16	R15
CR3	CR2
Q3	-
E12	-
RT1	-
L4	-

SCHEMATIC, LAMP BOARD (703-209)



NOTES-UNLESS OTHERWISE SPECIFIED

1. SEE SCHEMATIC- NO. 703-254.

TABULATION		
PART NO.	DESCRIPTION	
703-253-1	CR8 NOT USED, INSTALL JUMPER L1, L2, L3, L4, L6, L7	STANDARD P.S.
703-253-2	INSTALL CR8 & CUT ETCH BETWEEN CR8-C AND FUSE F1	USED WITH FILTER CONN & SEPARATE HEATER PWR
703-253-3	INSTALL CR8 & CUT ETCH BETWEEN CR8-C & FUSE F1. DO NOT INSTALL L1, L2, L3, L4, L6, L7 INSTALL JUMPER AT L1, L2, L3, L4, L6, L7	USED WITH SEPARATE HEATER POWER

ASSEMBLY, POWER SUPPLY BOARD (703-253-TAB)

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 PL 703-253-1 REVISION LTR.
REVISION DATE 91-04-25

TITLE: PARTS LIST, POWER SUPPLY (A3)

SHEET 2

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
1	1	703-255		PRINTED WIRING BOARD		
2	1	EDPT 3x4 3.3PF NPO		CAPACITOR 3.3PF	C5	1500777
3	1	EDPT 5x6 47PF NPO		CAPACITOR 47PF	C7	1500752
4	5	CKR05BX682K	AVX	CAPACITOR 6800PF	C3,4,6,9,10	1500695
5	2	CKR95BX104KS		CAPACITOR 0.1UF	C14,16	1500688
6	1	T322D106M035AS	KEMET	CAPACITOR 10UF	C2	1502105
7	1	600D176G060KD4	SPRAGUE	CAPACITOR 17UF 60V	C1	1500420
8	1	1.5KE43A	G.S.	DIODE	CR2	4800019
9	1	1N4578		DIODE	CR5	4800086
10	4	1N4151		DIODE	CR1,3,4,6	4800084
11	1	1N5242		DIODE	CR7	4800093
12	1	251003	LITTLE FUSE	FUSE 3 AMP	F1	
13	1	MK2 100 OHM		RESISTOR 100 OHM	R13	4701171
14	1	MK2 392 OHM		RESISTOR 392 OHM	R23	4701253
15	1	MK2 2.21K		RESISTOR 2.21K	R7(NOMINAL)	4701196
16	1	MK2 3.83K		RESISTOR 3.83K	R25	4701237
17	1	MK2 4.75K		RESISTOR 4.75K	R22	4701260
18	1	MK2 6.81K		RESISTOR 6.81K	R10	4701291
19	3	MK2 10K		RESISTOR 10K	R12,24,8	4701167
20	1	MK2 12.1K		RESISTOR 12.1K	R5	4701175
21	1	MK2 5.62K		RESISTOR 5.62K	R9	4701279
22	1	MK2 200K		RESISTOR 200K	R11	4701205
23	6	MK2 XXX		RESISTOR SELECT	R15-17,19,20	
24	1	RW80U1R10F	D	RESISTOR 1.1 OHM 2W WIREWOUND	R14	
25	1	3059Y-1-503		POTENTIOMETER 50K	R21	4750227
26	1	2N3906		TRANSISTOR	Q1	4800198
27	1	MS75084-1		INDUCTOR 1.2UH	L8	1801444
28	1	LM748H		INTEGRATED CIRCUIT	U1	
29				NOT USED		
30	1	7717-107N		PAD - 8 PIN SOLDER	XU1	2102217
31	42	70416-3		SOLDER TERMINAL		
32				NOT USED		
33	1	MK2 1K		RESISTOR 1K	R26	4701153
34	1	MK2 1K		RESISTOR 1K	R27	4701153

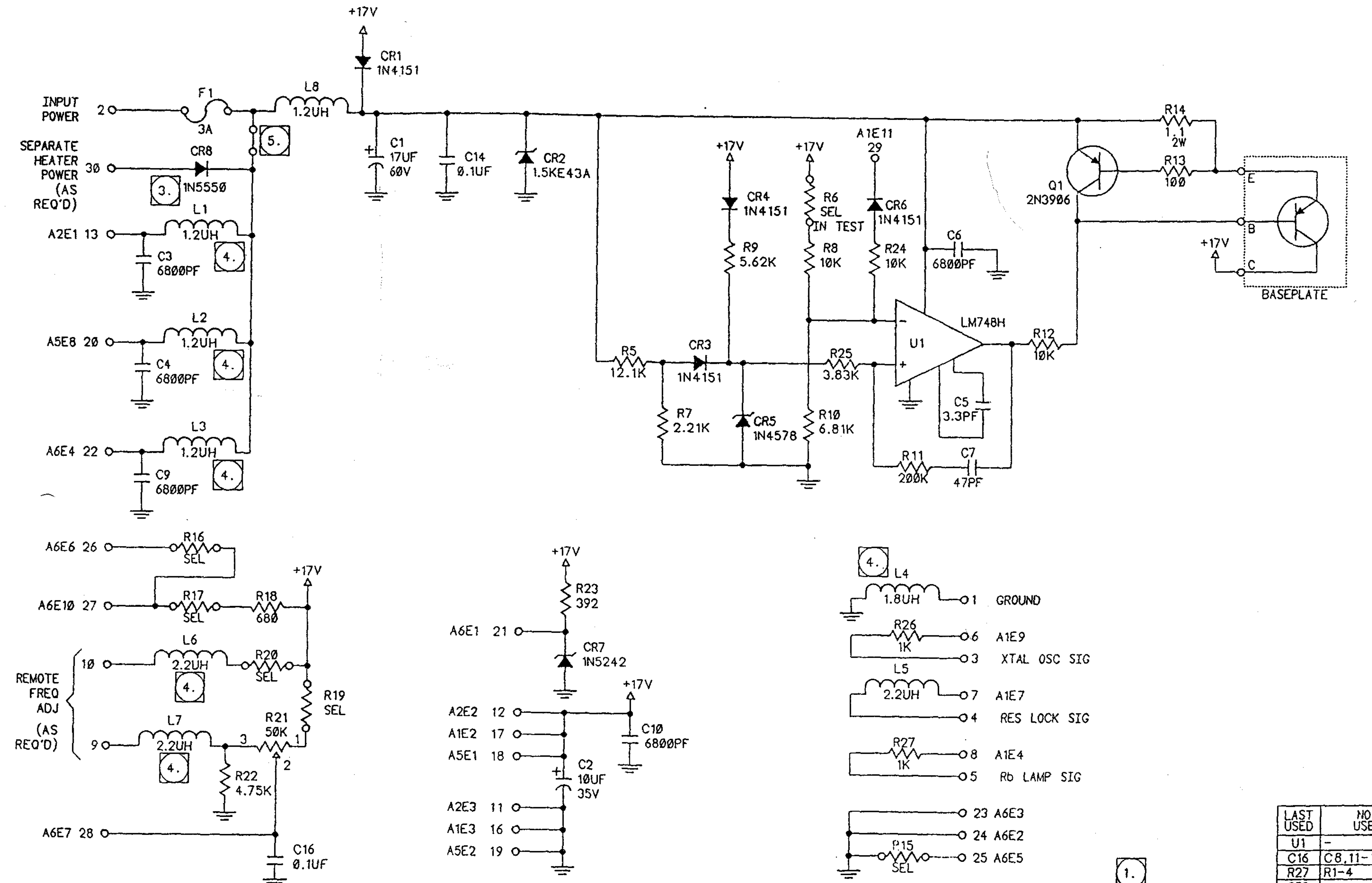
PARTS LIST, POWER SUPPLY BOARD (PL 703-253-1) PAGE 1 OF 2

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 PL 703-253-1 REVISION LTR.
REVISION DATE 91-04-25

TITLE: PARTS LIST, POWER SUPPLY (A3)

SHEET 3

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
35	1	MS75084-4	DALE	INDUCTOR 2.2UH	L5	1801448
36	1	MK2 681 OHM		RESISTOR 681 OHM	R18	4701297



ASSEMBLY TABULATION	
703-253-1	STANDARD
703-253-2	W/ FILTER CONNECTOR
703-253-3	SEPARATE HEATER POWER

LAST USED	NOT USED
U1	-
C16	C8,11-13,15
R27	R1-4
CR8	-
Q1	-
L8	-
F1	-

5. REMOVE JUMPER FOR SEPARATE HEATER POWER.

4. L1,L2,L3,L4,L6,L7 INSTALLED WITH FILTER CONNECTOR. JUMPERS INSTALLED WITHOUT FILTER CONNECTOR.

3. INSTALL CR8 WITH SEPARATE HEATER POWER ONLY.

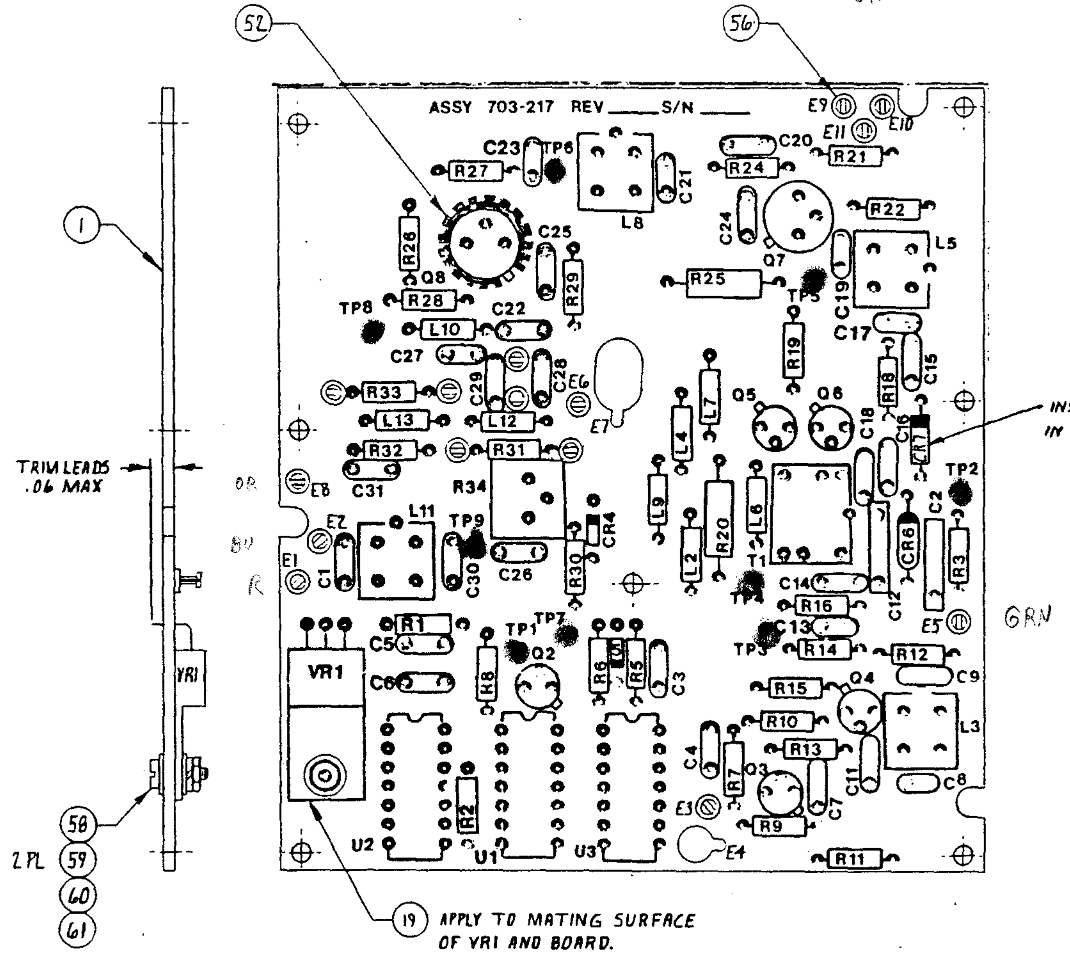
2. RESISTANCE VALUES ARE OHMS.

1. FOR ASSEMBLY SEE DWG# (TABULATION).

NOTES: UNLESS OTHERWISE SPECIFIED.

BOARD A3

SCHEMATIC, POWER SUPPLY BOARD (703-254)



NOTES: UNLESS OTHERWISE SPECIFIED.
1. FOR SCHEMATIC DIAGRAM SEE DWG NO. 703-218-1,-2.

TABULATION	
703-218-1	STD. AS SHOWN
703-218-2	LN. R7 IS 5K

ASSEMBLY, SYNTHESIZER BOARD (703-217)

BALL, EFRATOM DIV CONTRACT NO. CAGE CODE 55761 703217-1 REVISION DATE 91-04-29

TITLE: PARTS LIST SYNTHESIZER ASSEMBLY BOARD 5 (A5)

FIND NO.	QTY	PART OR IDENTIFYING NO.	SPEC. OR MANUFACTURER	NONMENLCATURE OR DESCRIPTION	REFERENCE DESIGNATOR
1	1	703-219	E	Printed Wiring Board	
2	1	EDPT 3.9 PF NPO	S-T	Capacitor 3.9 PF	C13
3		NOT USED			
4	1	EDPT 15PF NPO	S-T	Capacitor 15PF	C21
5	2	EDPT 22PF NPO	S-T	Capacitor 22PF	C19,C27
6	1	EDPT 33PF NPO	S-T	Capacitor 33PF	C23
7	1	EDPT 39PF NPO	S-T	Capacitor 39PF	C17
8	1	EDPT 47PF NPO	S-T	Capacitor 47PF	C18
9	1	EDPT 68PF NPO	S-T	Capacitor 68PF	C9
10	1	EDPT 82PF NPO	S-T	Capacitor 82PF	C29
11	2	EDPT 100PF NPO	S-T	Capacitor 100PF	C14, C28
12	1	C052C272K2G5CA	KEMET	Capacitor 2700PF +/- 10%	C30
13	14	CKR05BX682KS	AVX	Capacitor 6800PF +/- 10%	C1,3,4,7,8,11,15,16, 20,22,24,25,26,31
14	2	22NA473J	S&E1	Capacitor .047UF +/- 5% 50V	C2,12
15	2	CKR05BX104KS	KEMET	Capacitor .1UF	C5,C6
16	3	IN4151	F	Diode	CR4,5,7
17	1	MV1638	KNOX	Diode, Varactor	CR6
18	2	IM-2 .15UH	Dale	Inductor .15UH	L6,10
19	AR	TYPE 120		Thermal Joint Compound	
20	5	1025-38	Delevan	Inductor 5.6UH	L4,7,9,12,13
21	1	1025-50	Delevan	Inductor 18UH	L2
22	2	70277-4	E	Inductor, Variable (GRN,Yel)	L3,11
23	2	70277-3	E	Inductor, Variable (RED,Yel)	L5,8
24	1	7805CT	Natn'l	Voltage Reg.	VR1
25	3	2N2369A	F	Transistor	Q2-4
26	2	2N3553	M	Transistor	Q7,8
27	1	MK2 47.5 Ohms	S-T	Resistor 47.5 Ohms +/- 1% 1/4W	R1
28	4	MK2 56.2 Ohms	S-T	Resistor 56.2 Ohms +/- 1% 1/4W	R19,20,24,28

PARTS LIST, SYNTHESIZER BOARD (PL 703-217) PAGE 1 OF 3

BALL, EFRATOM DIV CONTRACT NO. · CAGE CODE 55761 703217-1 REVISION DATE 91-04-29

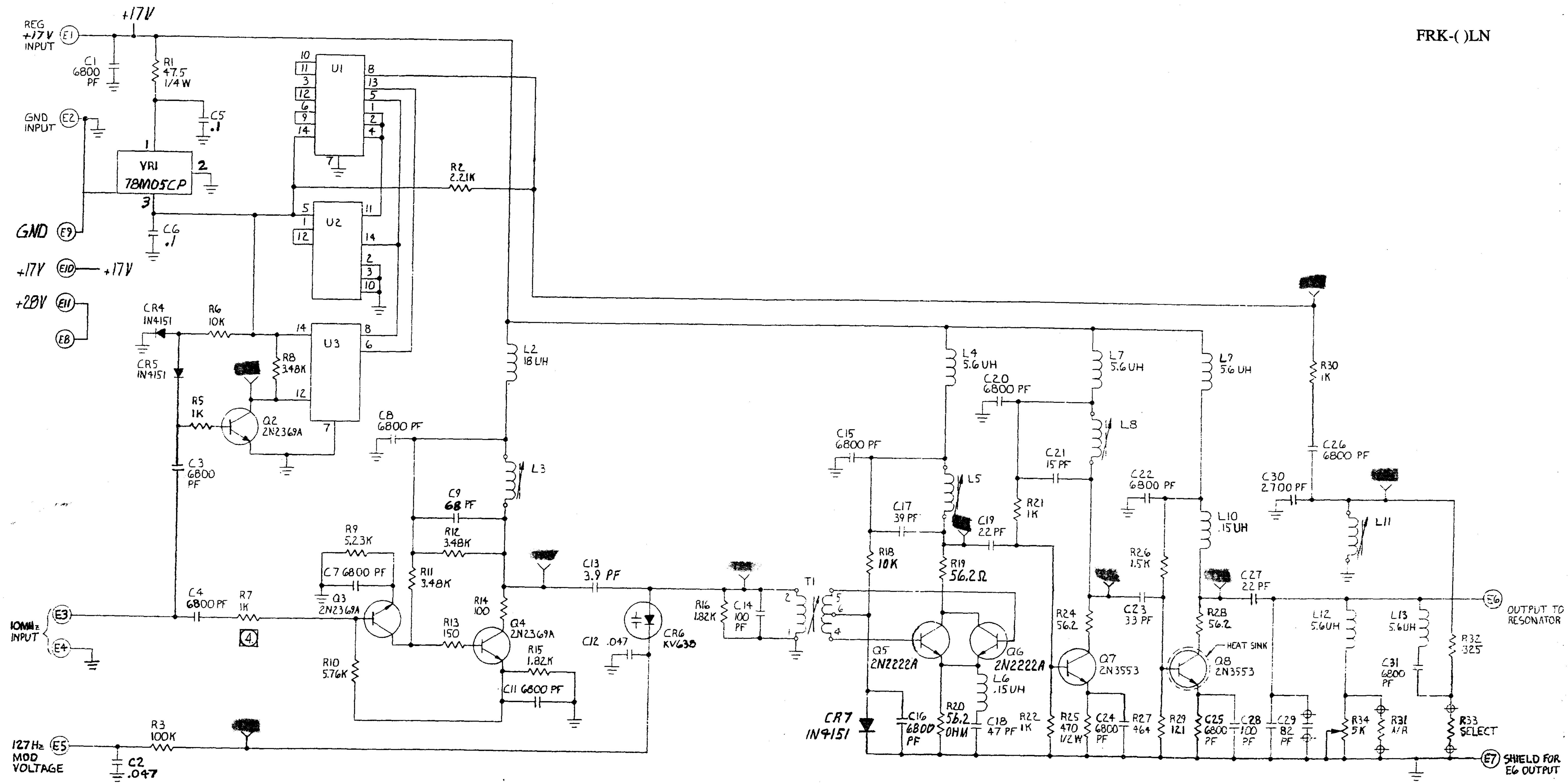
TITLE: PARTS LIST SYNTHESIZER ASSEMBLY BOARD 5 (A5)

FIND NO.	QTY	PART OR IDENTIFYING NO.	SPEC. OR MANUFACTURER	NONMENLCATURE OR DESCRIPTION	REFERENCE DESIGNATOR
29	1	MK2 100 Ohms	S-T	Resistor 100 Ohms +/- 1% 1/4W	R14
30	1	MK2 121 Ohms	S-T	Resistor 121 Ohms +/- 1% 1/4W	R29
31	1	MK2 150 Ohms	S-T	Resistor 150 Ohms +/- 1% 1/4W	R13
32	1	MK2 464 Ohms	S-T	Resistor 464 Ohms +/- 1% 1/4W	R27
33	1	MK2 825 Ohms	S-T	Resistor 825 Ohms +/- 1% 1/4W	R32
34	5	MK2 1K Ohms	S-T	Resistor 1K Ohm +/- 1% 1/4W	R5,7,21,22,30
35	1	MK2 1.5K Ohms	S-T	Resistor 1.5K Ohms +/- 1% 1/4W	R26
36	2	MK2 1.82K Ohms	S-T	Resistor 1.82K Ohms +/-1% 1/4W	R15,16
37	1	MK2 2.21K Ohms	S-T	Resistor 2.21 K Ohms +/-1% 1/4W	R2
38	3	MK2 3.48K Ohms	S-T	Resistor 3.48K Ohms +/-1% 1/4W	R8,11,12
39	1	MK2 5.23K Ohms	S-T	Resistor 5.23K Ohms +/-1% 1/4W	R9
40	1	MK2 5.76K Ohms	S-T	Resistor 5.76K Ohms +/-1% 1/4W	R10
41		NOT USED			
42	2	MK2 10K Ohms	S-T	Resistor 10K Ohms +/- 1% 1/4W	R6,18
43	1	MK2 100K Ohms	S-T	Resistor 100K Ohms +/- 1% 1/4W	R3
44	2	MK2 Select A/R	S-T	Resistor Select +/- 1% 1/4W	R31,33
45	1	RCR20G471JS	MIL	Resitor 470 Ohms +/- 5% 1/2W	R25
46	2	2N2222A		Transistor	Q5,6
47	1	3339P-1-502	Bourns	Resistor Variable 5K Ohms	R34
48	1	70278-1	E	Transformer	T1
49	1	SN54LS00J	T.I.	Integrated Circuit	U1
50	1	SN54LS93J	T.I.	Integrated Circuit	U2
51	1	SN5472J	T.I.	Integrated Circuit	U3
52	1	200-.250-.318	HSP	Heatsink	XQ8
53		NOT USED			
54	3	7717-4N	T.	TSTR PAD (TO-5)	
55	5	7717-93N	T.	TSTR PAD (TO-18 Spreader)	
56	15	90416-3	K.	Solder Terminal	

BALL, EFRATOM DIV CONTRACT NO. CAGE CODE 55761 703217-1 REVISION DATE 91-04-29

TITLE: PARTS LIST SYNTHESIZER ASSEMBLY BOARD 5 (A5)

FIND NO.	QTY	PART OR IDENTIFYING NO.	SPEC. OR MANUFACTURER	NONMENLCATURE OR DESCRIPTION	REFERENCE DESIGNATOR
57	AR	SN63WRMAP3	MIL	Solder	
58	1	85ST-MX8		Screw, Metric M3X8	
59	2	125ST-3		Washer, Flat M3	
60	1	127ST-3		Washer, Split Lock M3	
61	1	934ST-M3		Nut, Metric M3	



NOTE - R31 IS NOT USED WHEN VARIABLE RESISTOR R34 IS USED.

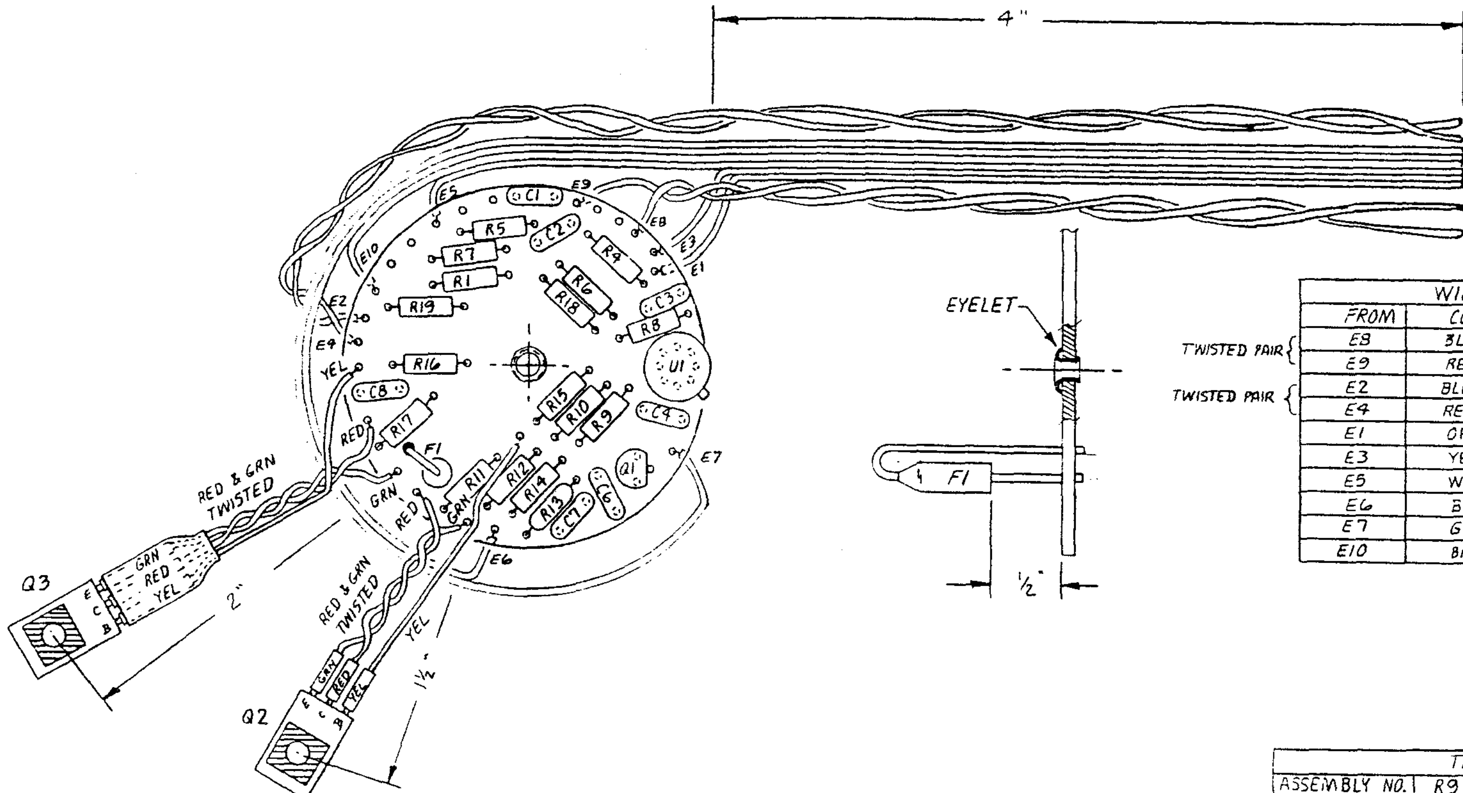
NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTANCE VALUES ARE IN OHMS.
2. CAPACITANCE VALUES ARE IN MICROFARADS.
3. FOR ASSEMBLY SEE DWG 703-217.
4. SEE TABULATION.

4

TABULATION	
703-218-1	STD, AS SHOWN
703-218-2	LN, R7 IS 5K

BOARD A5

SCHEMATIC, SYNTHESIZER BOARD (PL 703-218)



NOTES – UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC SEE DRAWING NO. 703-221.
2. FOR PRINTED WIRING BOARD SEE DRAWING NO. 703-222.

WIRE LIST

	FROM	COLOR	AWG	DESTINATION
TWISTED PAIR	E8	BLK	28	A1E5
	E9	RED	28	A1E1
TWISTED PAIR	E2	BLU	26	A3E24
	E4	RED	26	A3E22
	E1	ORN	26	A3E21
	E3	YEL	26	A3E23
	E5	WHT	28	A3E25
	E6	BLK	26	A3E26
	E7	GRN	26	A3E28
	E10	BRN	28	A3E27

TABULATION

ASSEMBLY NO.	R9	R10	R11	R13	USED ON
703-220-1	3.2K	1.0K	10K	.619Ω	FRK-H
703-220-2	SEE SEPARATE DWG				FRK-H (GPS)
703-220-3	2.32K	845Ω	4.75K	.402Ω	FRK-HLN (12VDC)

BALL, EFRATOM DIVISION CONTRACT No. CAGE CODE 55761 PL 703-220-1 REVISION LTR.
REVISION DATE 91-04-25

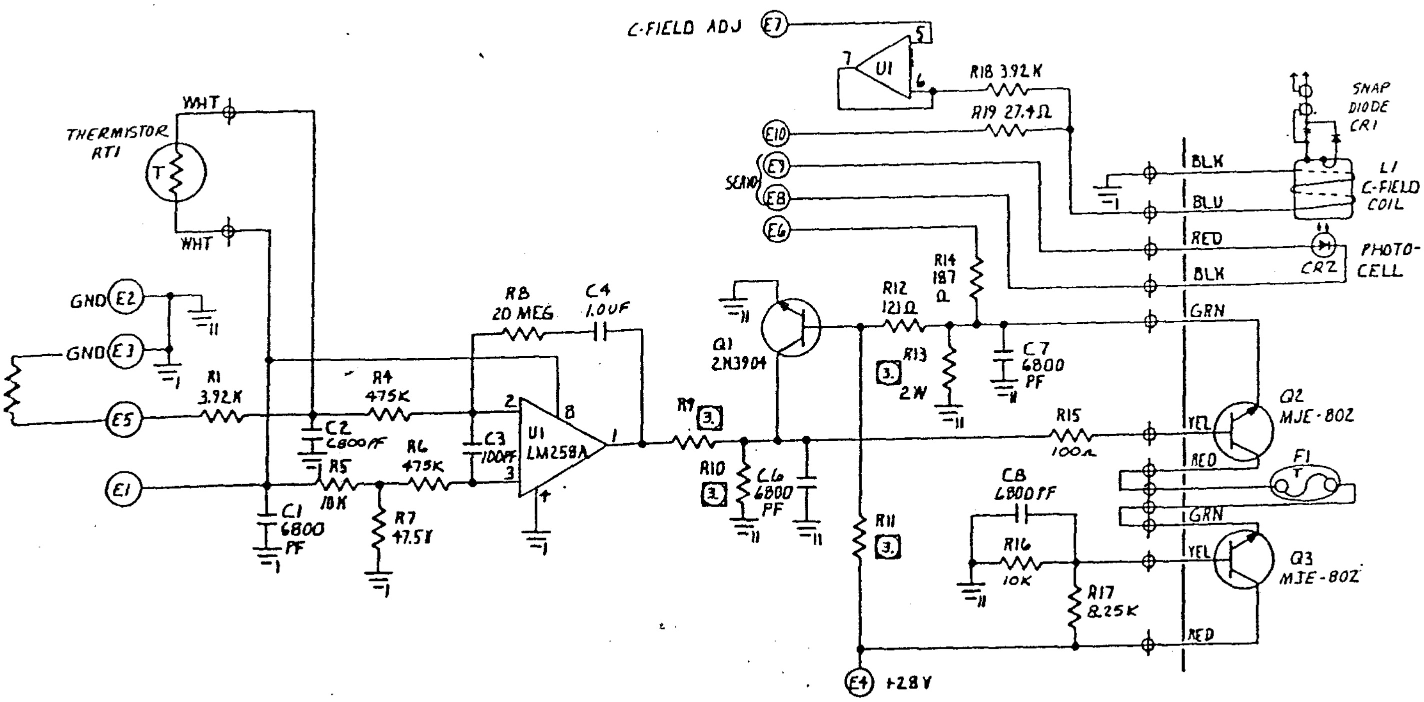
TITLE: PARTS LIST, RESONATOR HEATER (A6)

SHEET 2

FIND No.	QTY REQ	PART OR IDENTIFYING No.	SPEC. OR MANUFACTURER	NOMENCLATURE OR DESCRIPTION	REFERENCE DESIGNATOR	UNIS No.
1	1	703-222		P.W.B.		
2	1	EDPT 100PF NPO		CAPACITOR 100PF	C3	1500764
3	5	CKR05BX682KS		CAPACITOR 6800PF	C1,2,6,7,8	1500965
4	1	CKR06BX105KS		CAPACITOR 1UF	C4	1500697
5	1	2N3904		TRANSISTOR	Q1	4800197
6	1	MK2 27.4 OHM		RESISTOR 27.4 OHM	R19	4701220
7	1	MK2 100 OHM		RESISTOR 100 OHM	R15	4701171
8	1	MK2 121 OHM		RESISTOR 121 OHM	R12	4701178
9	1	MK2 187 OHM		RESISTOR 187 OHM	R14	4701191
10	1	MK2 1K		RESISTOR 1K	R10	4701153
11	2	MK2 3.92K		RESISTOR 3.92K	R1,18	4701238
12				NOT USED		
13	1	MK2 3.24K		RESISTOR 3.24K	R9	4701229
14	1	MK2 8.25K		RESISTOR 8.25K	R17	4701309
15	3	MK2 10K		RESISTOR 10K	R5,16,11	4701167
16	1	MK2 47.5K		RESISTOR 47.5K	R7	4701267
17	2	MK2 475K		RESISTOR 475K	R4,6	4701270
18	1	RCR07G206JS		RESISTOR 20 MEG 1/4W	R8	4701704
19	1	RWR80SR619FR		RESISTOR 0.619 OHM 2W	R13	
20	1	LM258A		INTEGRATED CIRCUIT	U1	3130995
21	1	D139-002	3M	THERMAL CUT-OFF, MTP	F1	4300712
22	1	A2196GS5-3	STIMPSON	EYELET		2820504
23	2	MJE-802		TRANSISTOR	Q2,3	
24	A/R	RTV-108		SILICONE RUBBER, RTV		70424-7
25	A/R	SN63WRMAP3		SOLDER		2102572
26	A/R	MIL-W-16878 TYPE E		WIRE, STRANDED, TEFLON INS		

PARTS LIST, RESONATOR HEATER (PL 703-220-1)

TABULATION					
ASSEMBLY NO.	R9	R10	R11	R13	USED ON
703-220-1	3.2K	1.0K	10K	.619Ω	FRK-H
703-220-3	2.32K	845Ω	4.75K	.402Ω	FRK-HIN(12VDC)



SCHEMATIC, RESONATOR HEATER BOARD