M83-0004

AS210A-PM

PORTABLE MAINFRAME

Revised 8/84

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PREFACE

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

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.

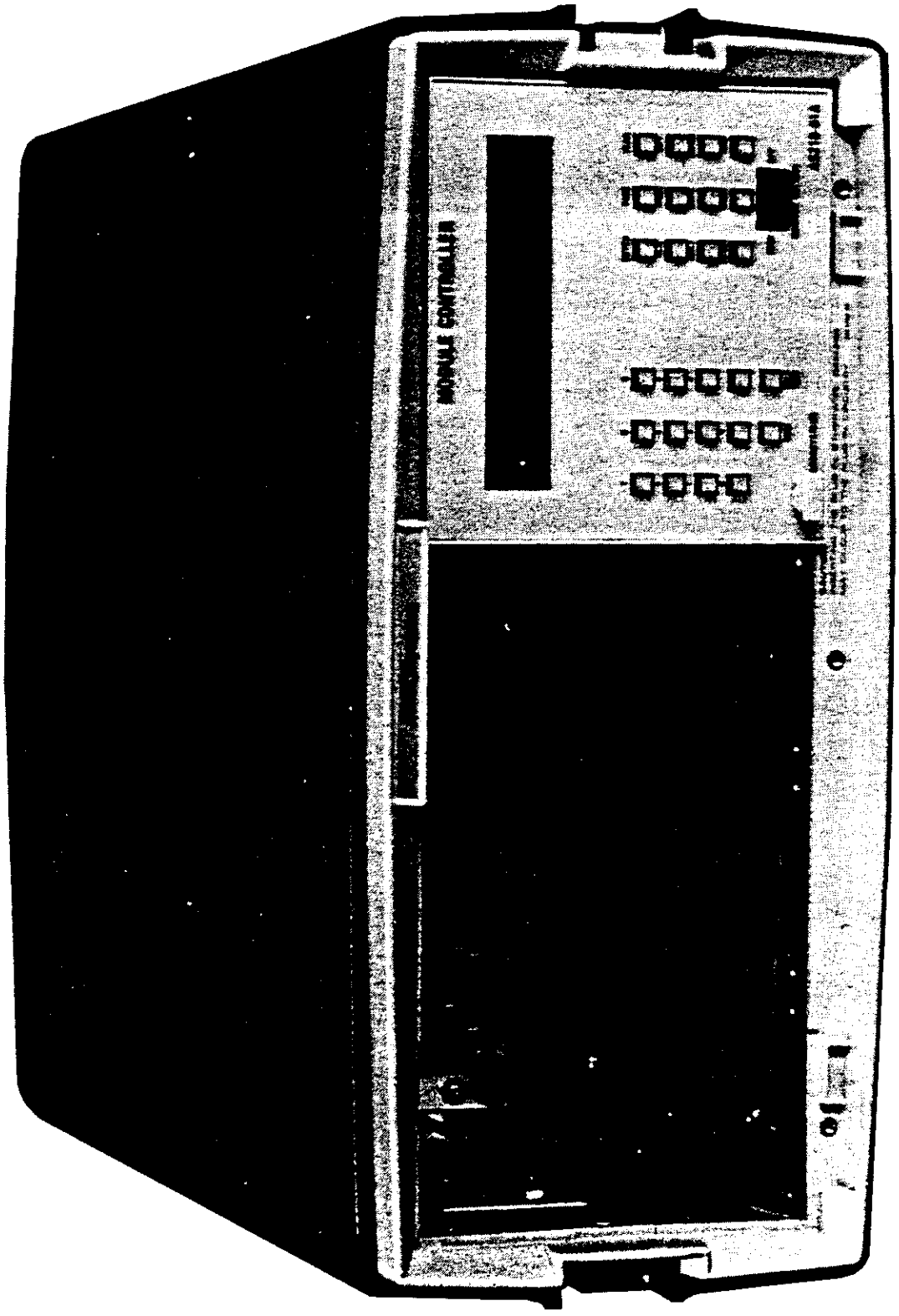

Figure 1.1 Portable Mainframe with AS210-01A Module Controller Installed

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)	$+1 \times 10^{-10}$	$+5 \times 10^{-11}$
+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.

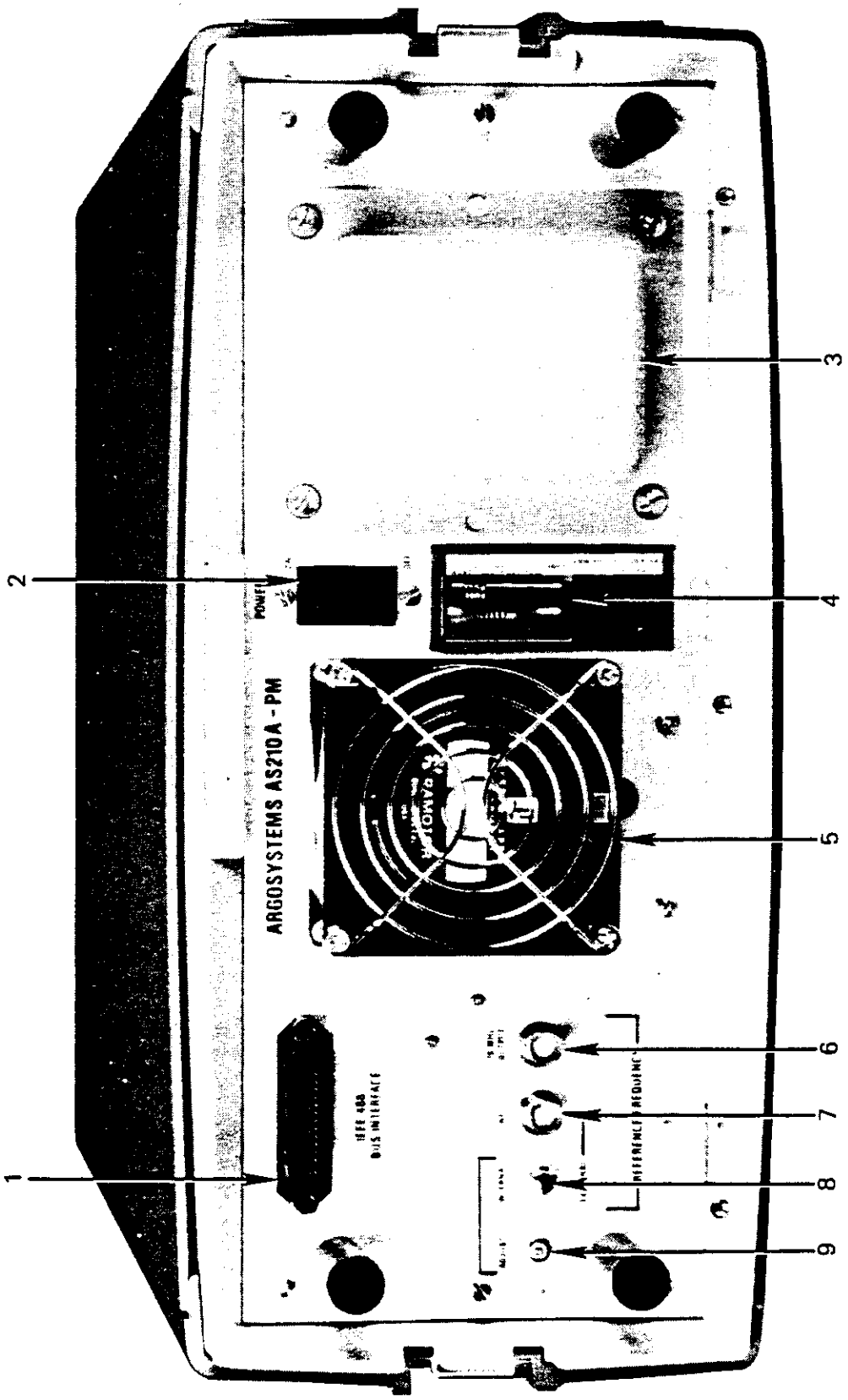

Figure 3.1 Portable Mainframe Rear Panel Controls and Connectors

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.

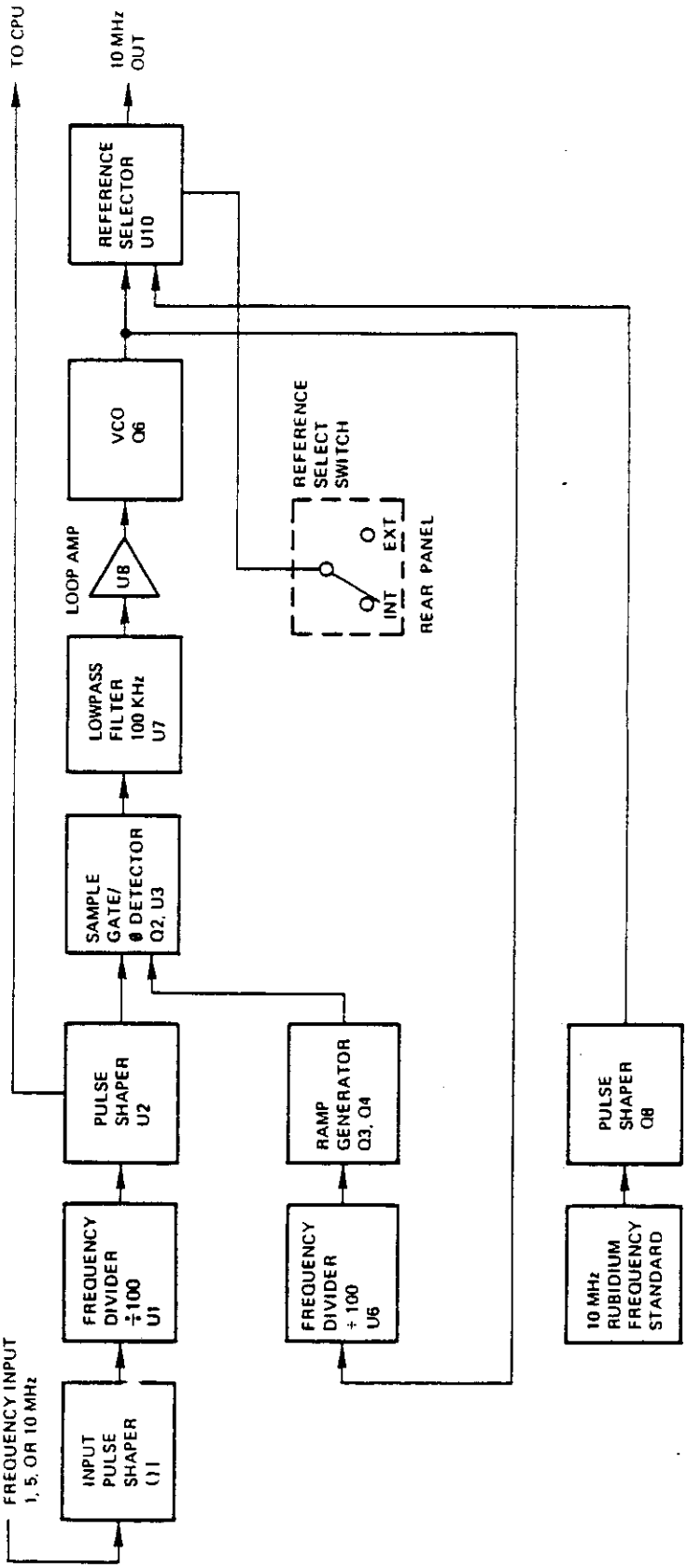

Figure 4.1 AS210A-PM Functional Block Diagram

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 ±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

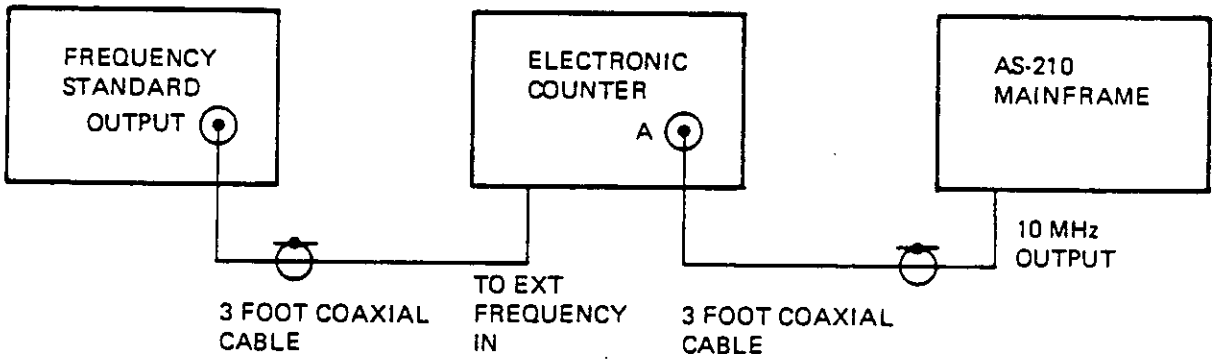

Figure 5.1 AS210 Internal Frequency Standard Test Configuration

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.

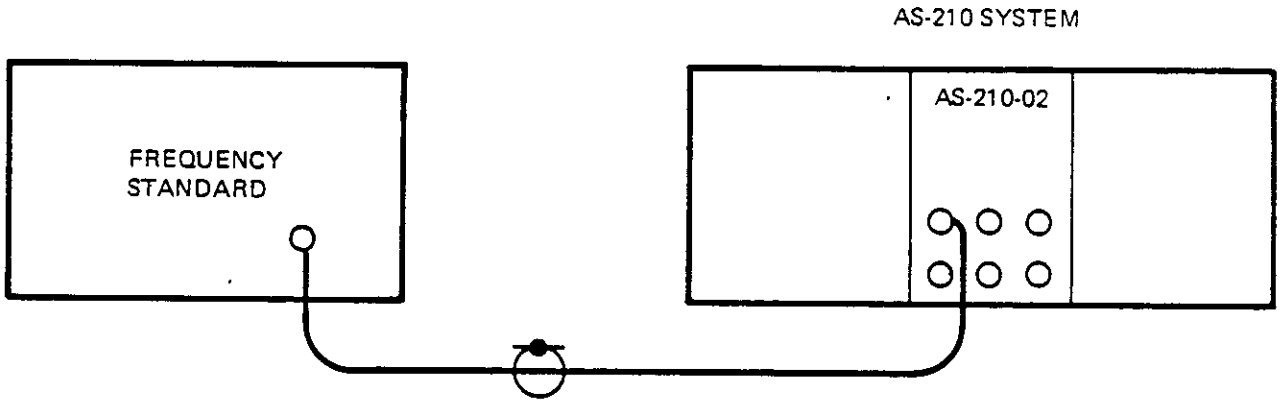

Figure 5.2 AS210 Internal Frequency Standard Drift Test Configuration

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.

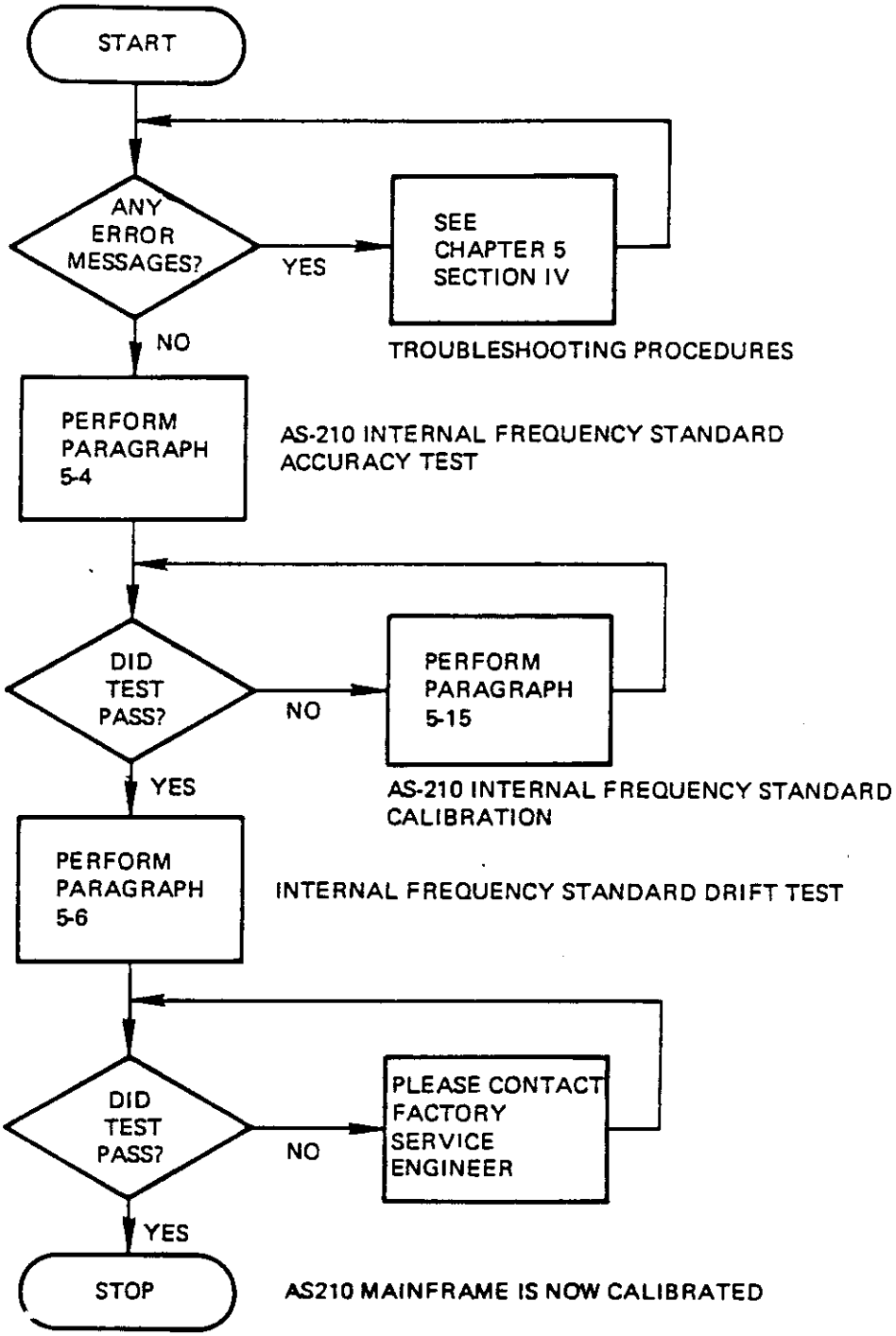

Figure 5.3 Flow Diagram of the Calibration/Alignment Procedure for the AS210 System Mainframe

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.

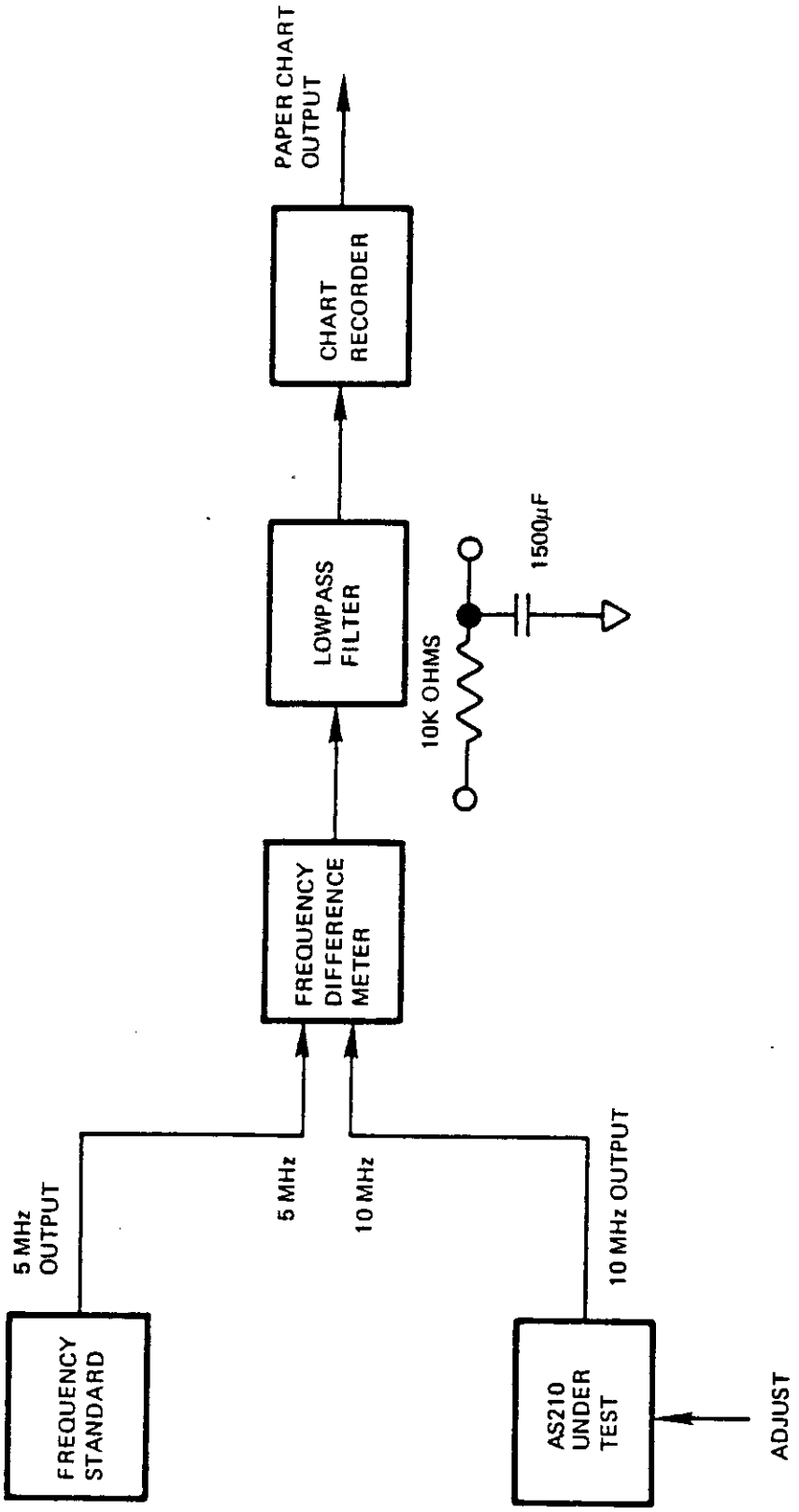

Figure 5.4 Block Diagram of Rubidium Frequency Standard Calibration Configuration

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 $\pm$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.

M83-0005

AS210-01A
MODULE CONTROLLER

Revised 7/85

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

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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
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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.

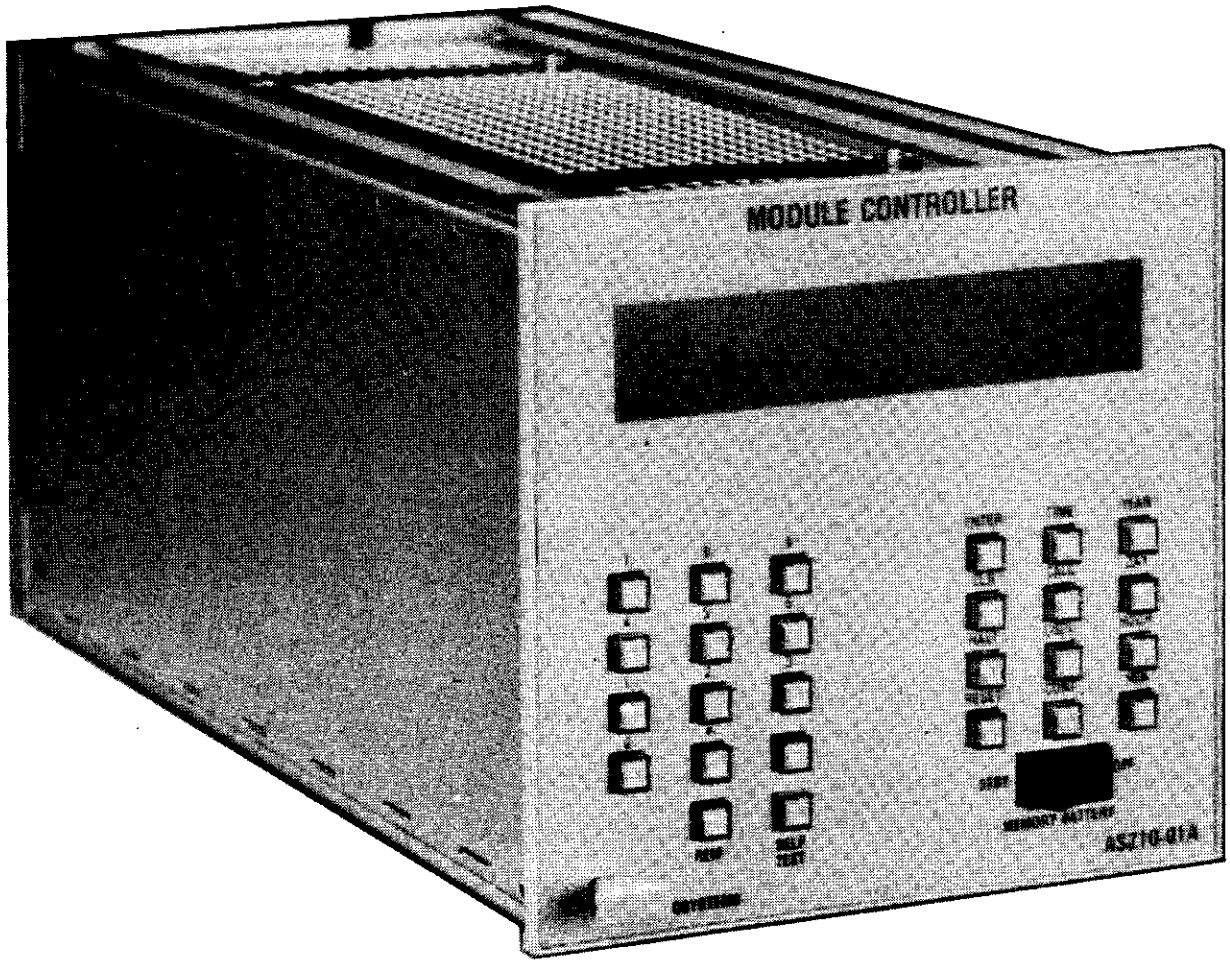


Figure 1.1 AS210-01A Module Controller

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.

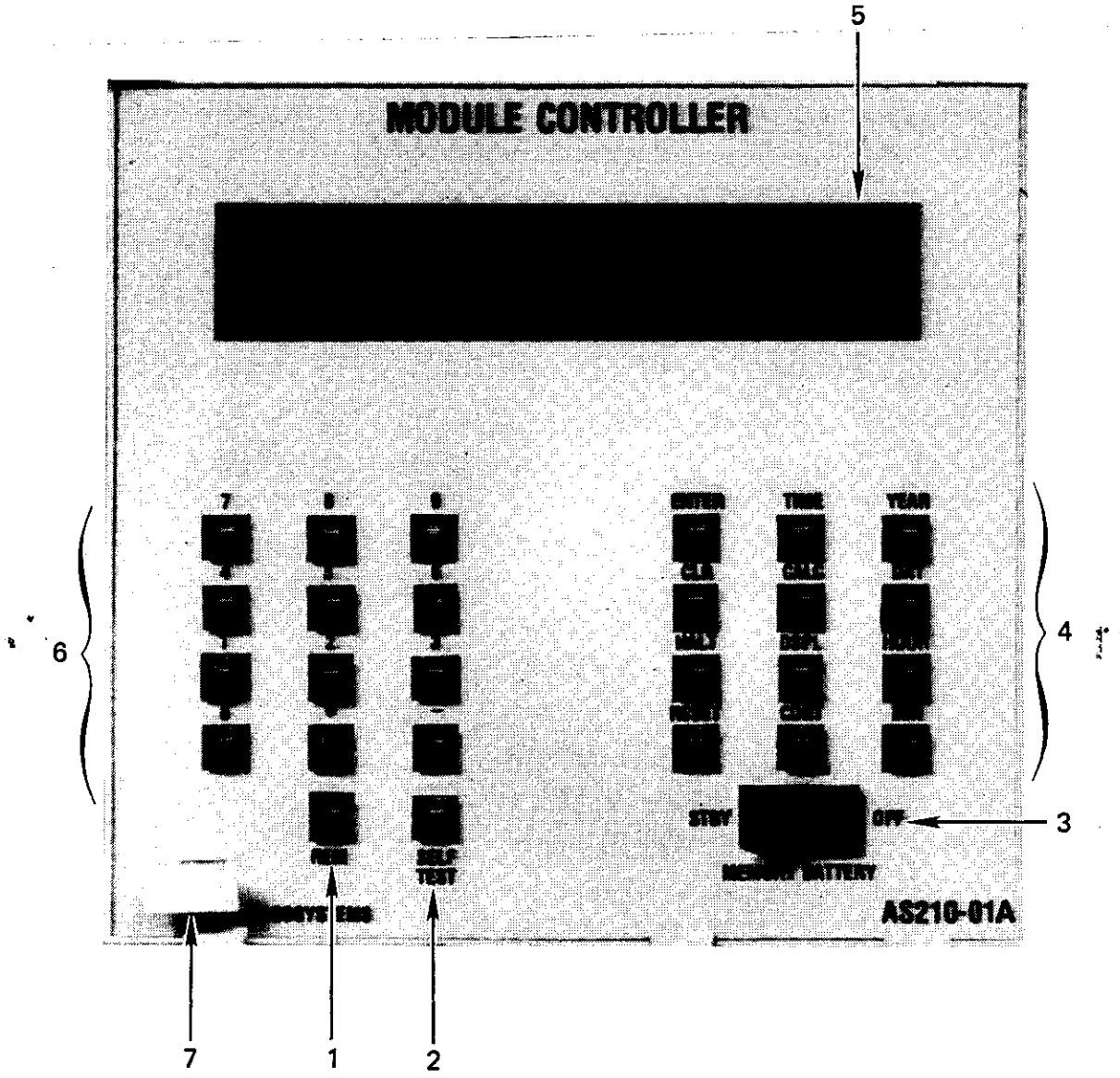


Figure 3.1 AS210-01A Front Panel Controls and Indicators

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 Δtime 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.

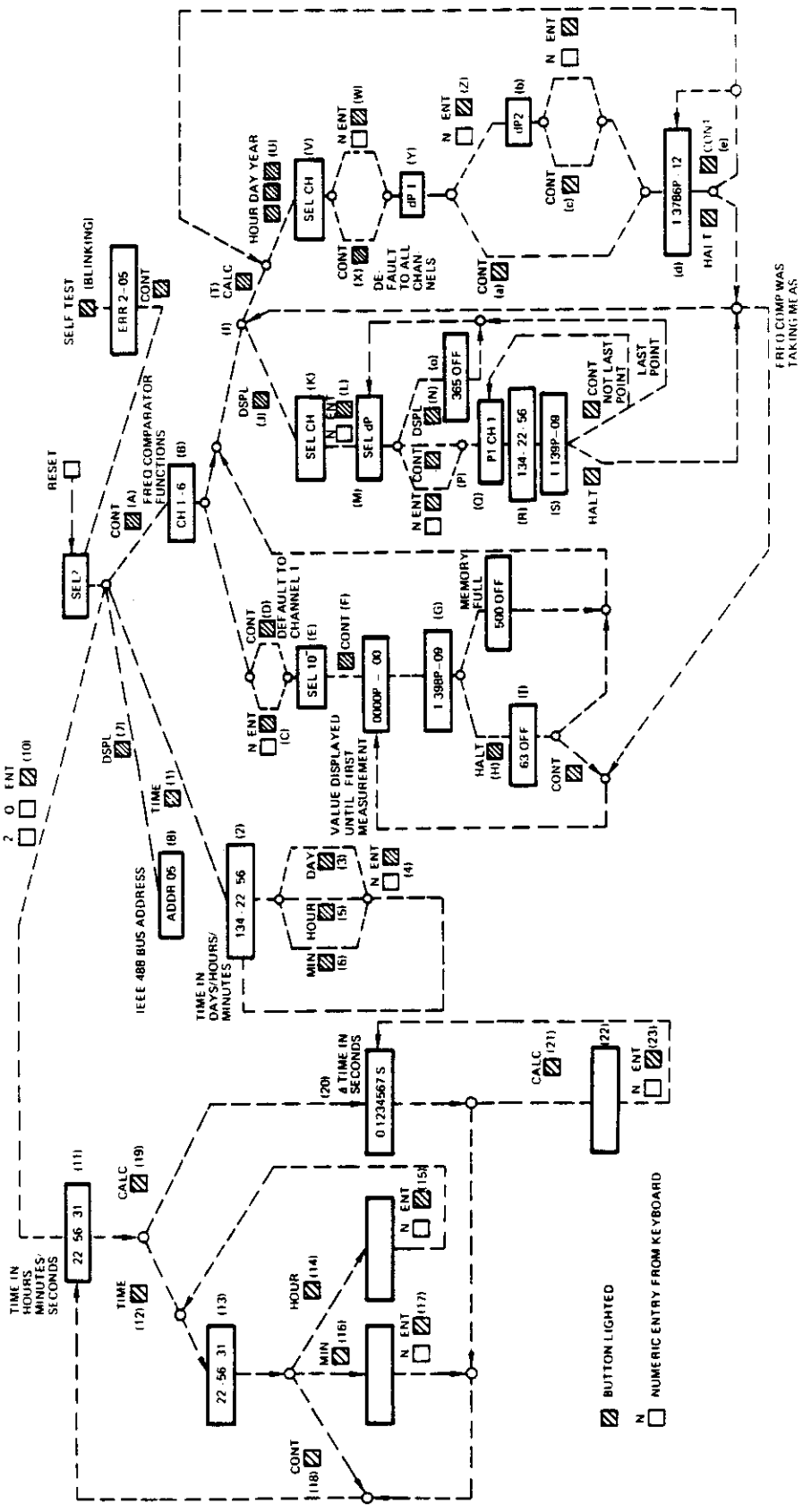


Figure 3.2 Operational Flow Diagram

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 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 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

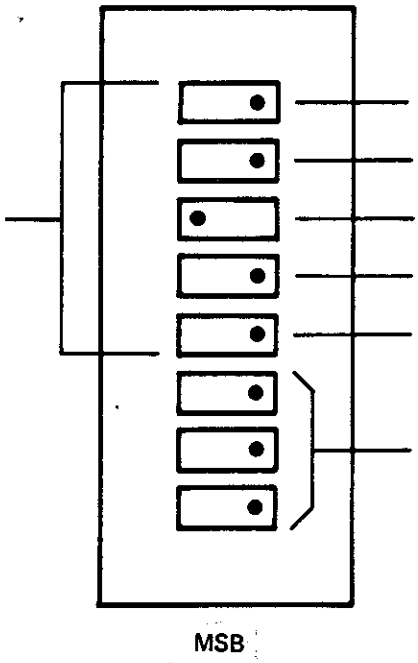
A. To read the time differential between the 1 pps signal generated by the -20 circuitry and the external 1 pps applied to the -20 1 pps IN connector, the -20 module is addressed by pressing 2, 0, ENTER (10) and then pressing the CALC button (19). The -01A will then display the time difference in seconds 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 always 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:

xΔyyyyP-zz<CR><LF>
↑
EOI

where x = input channel number
y = mantissa
z = exponent
Δ = 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
↑ (1 ≤ x ≤ 500)
EOI

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 ≤ x ≤ 6)

X = Initial data point select

y = data point number (1 ≤ y ≤ 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 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 ($1 \leq x \leq 6$)

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-33<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 ($1 \leq x \geq 500$
y = channel number ($1 \leq y \leq 6$)
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

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

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

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

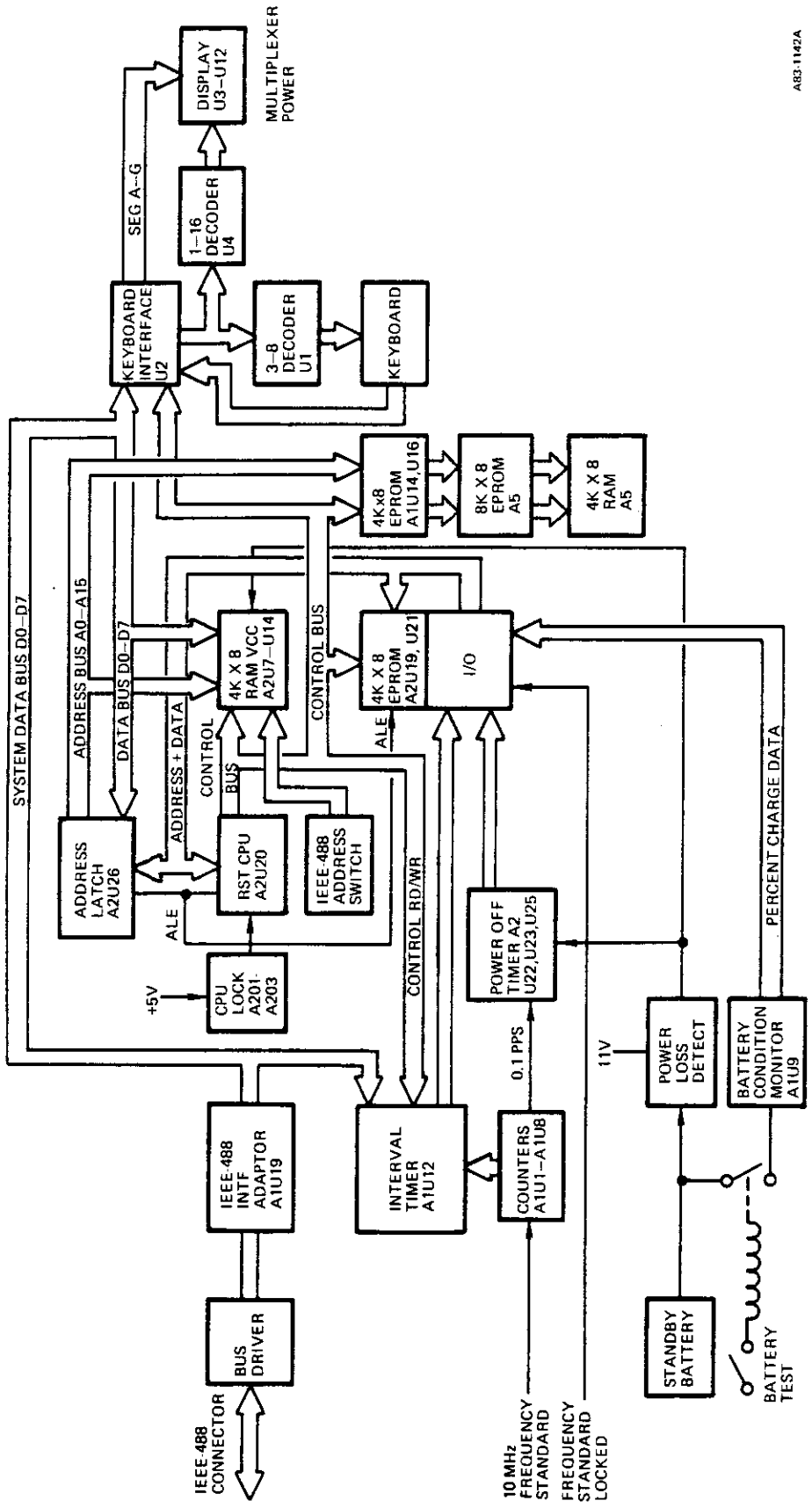


Figure 4.1 Module Controller Functional Block Diagram

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 frequency 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 O4 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 DI01 through DI08. 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.

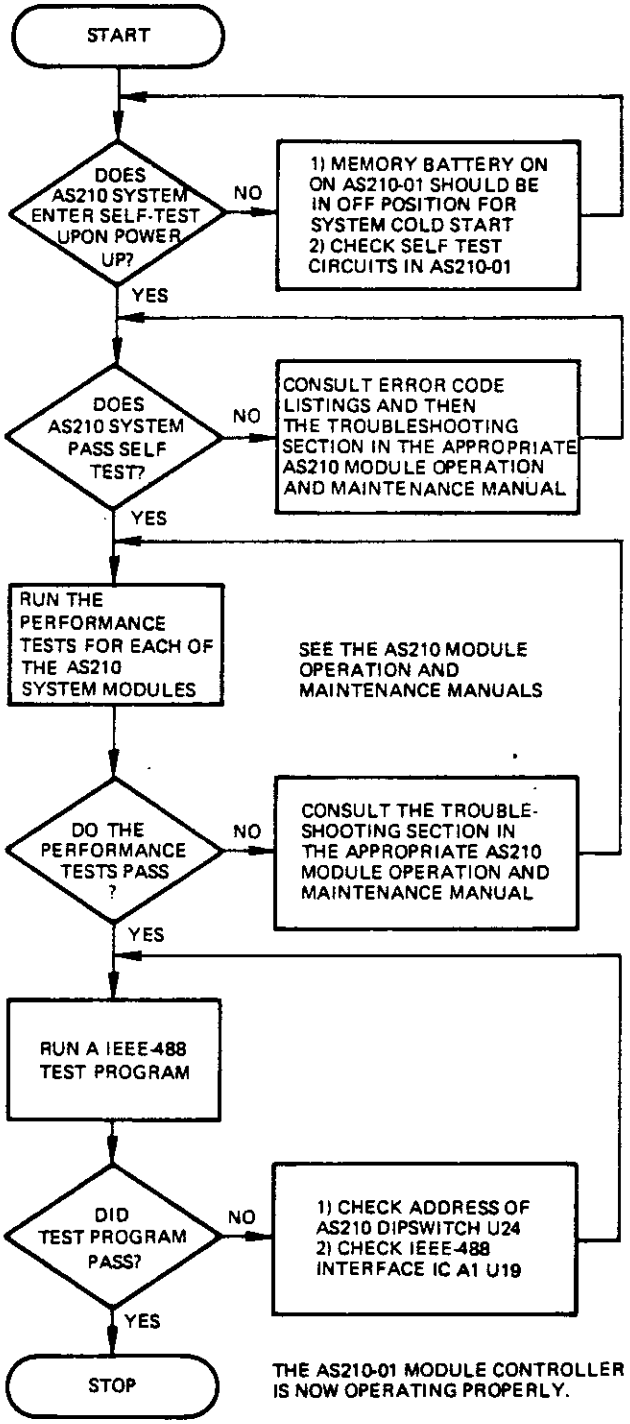


Figure 5.1 Flow Diagram of the Troubleshooting Procedure for the AS210-01A Module Controller