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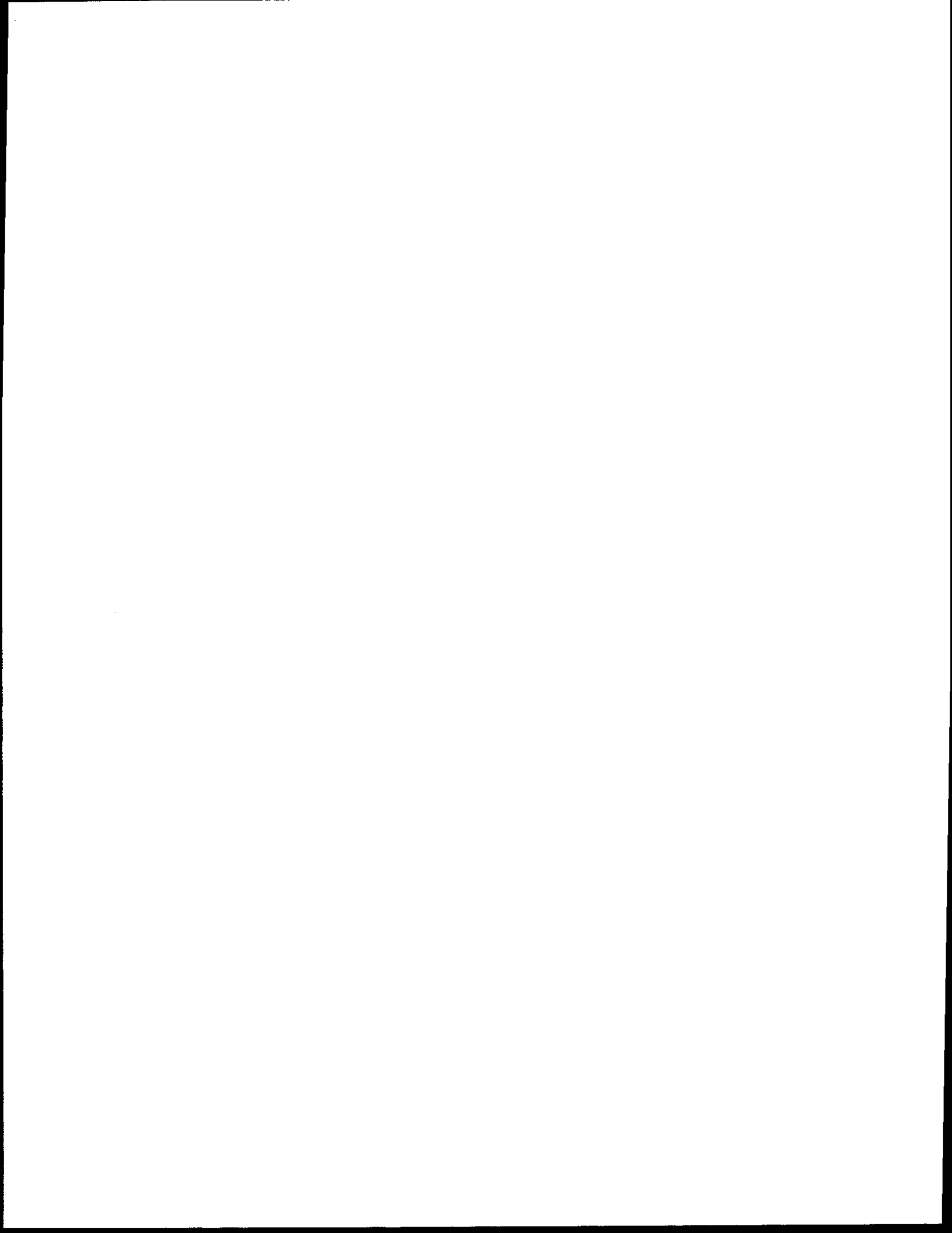
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FOREWORD

The ADT-222A Air Data Test System, Part No. 4030935-XXX and 4039390-XXX, is the most versatile, accurate, easy to use, air data test instrument currently available. When properly and effectively used it can substantially reduce test and calibration times and overall costs of maintaining air data computers and instruments. The following table is provided as a definition of ADT-222A configurations:

Dash No. -XXX	Calibration Medium	Pneumatic Port Location	Nominal Voltage Required (V ac)
-901	Air	Front	115
-902	Air	Rear	115
-911	Air	Front	230
-912	Air	Rear	230
-801	N ₂	Front	115
-802	N ₂	Rear	115
-811	N ₂	Front	230
-812	N ₂	Rear	230

This manual has been prepared to provide the operator with the information necessary to operate and maintain the ADT-222A. A full description of the system is provided in Chapter 1 along with the system specifications, theory of operation, and manual operating instructions. Chapter 2 contains the information necessary to install the system and put it "on line". Chapter 2 also contains instructions for removing the ADT-222A from service for storage and shipping.

Maintenance information, including testing, troubleshooting, calibration, and repair of the ADT-222A, is contained in Chapter 3. A complete parts list is provided in Chapter 4.

The 4030935-XXX and 4039390-XXX ADT-222A's are identical test systems, except the 4039390-XXX contains an ASCII interface option that provides capability of operating the ADT-222A automatically under control of any Automatic Test Equipment (ATE). (Refer to Chapter 5.)

It is recommended that the operator read and familiarize himself with Chapters 1 and 2 before attempting to install or operate the ADT-222A.



The following table is provided for quick reference in the use of this manual:

<u>FUNCTION</u>	<u>APPLICABLE SECTION</u>
System familiarization	Chapters 1 and 2
Handling	2-1
Installation	2-1 thru 2-4
Manual operation	1-2
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Programming for automatic operation	5-4
Testing	3-2
Troubleshooting	3-4
Calibration	3-5
Repair	3-6
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The technical instructions contained in this manual have been validated by actual performance, witnessing of actual performance, or simulation of performance, to the extent necessary to provide reasonable assurance or proof of their accuracy and sufficiency.



SERVICE BULLETIN LIST

In the serial numbering system assigned to the ADT-222A, the first three numbers of the seven-digit serial number on the identification plate represent the date of manufacture. The remaining numbers are a four-digit numeric sequence count of the item as manufactured.





SERVICE BULLETIN LIST
FOR PART NO. 4030935-XXX

Service Bulletin	MOD Letter	Date Incorporated in Manual	Description
4030935-34-1 (21-4322-03)	A	Feb 1/79	Changes fuse on 115-volt ac units to Part No. 632367-12 (3.0 amperes); and on 220-volt ac units to Part No. 632367-10 (1.5 amperes). This modification is applicable to units with date code Serial No. XXX0162 and above. Testing is not affected.
4030935-34-2 (21-4322-04)	B	Feb 1/79	Shim(s) are placed at the bottom and/or top of the ADT-222A front panel as required to reduce the vertical play of the panel to less than 0.040 inch. This modification is applicable to units with date code Serial No. XXX0162 and above. Testing is not affected.





GROUND
EQUIPMENT
MANUAL
PN 4030935, 4039390

CHAPTER 1
GENERAL INFORMATION AND OPERATING INSTRUCTIONS

CHAPTER 1
GENERAL INFORMATION AND OPERATING INSTRUCTIONS

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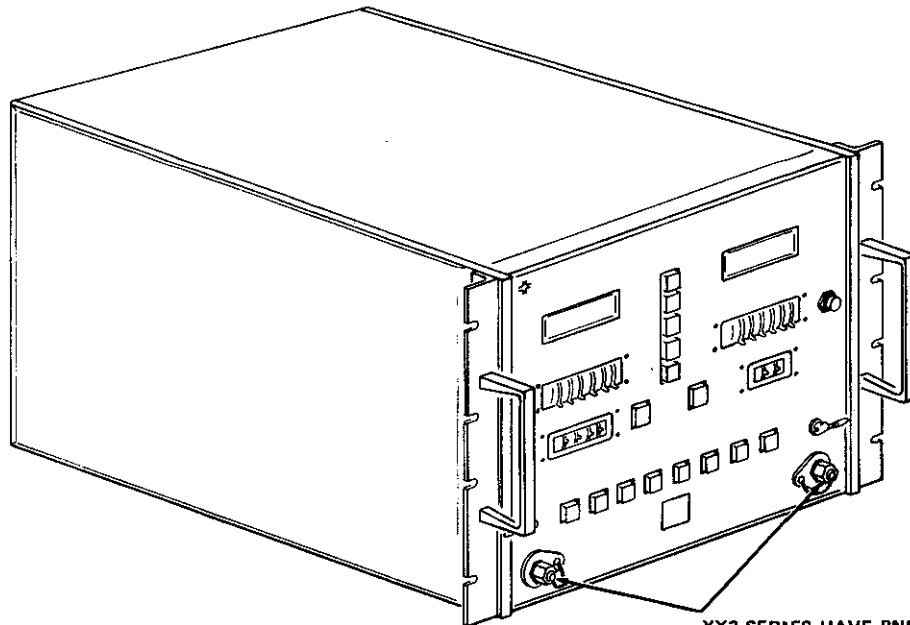
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Section 1. Description

1. General Description

The ADT-222A Air Data Test System (figure 1-1) is a precise, stable, easy to use pressure control system designed to precisely simulate and accurately measure the pneumatic pressures associated with an aircraft in flight. Its operational and design features were selected to meet the needs of those who use, repair, or manufacture precision pneumatic avionic equipment. Consequently, it is ideally suited for laboratory, shop, or production use. In addition to its manual operation capability, the ADT-222A is available with an optional automatic test equipment (ATE) interface which allows remote slave operation of the ADT-222A by an ATE. When equipped with this option, the ADT-222A is fully programmable and capable of being controlled by an ATE system or any programmable terminal employing an IEEE Standard 488-1975 interface.

Pressure measurement and control is provided in terms of inches of mercury or millibars; altitude in feet or meters; and airspeed in knots or kilometers/hour, as selected by the operator. A special purpose digital processor operates in conjunction with two precision vibrating diaphragm digital pressure sensors and electrically controlled pressure regulation valves to provide high speed control and measurement response with readout displays converted to the units desired by the operator.



XX2 SERIES HAVE PNEUMATIC
CONNECTORS ON REAR PANEL

32315 R1

ADT-222A Air Data Test System
Figure 1-1

When used as a transfer standard, the ADT-222A accurately measures the pressures applied to its input ports with sufficient resolution and stability to resolve a 1-foot change in altitude at 60,000 feet. Because of its extremely high calibration stability, it can be used to calibrate other laboratory pressure standards and air data test instruments as well as air data avionic equipment.

When used as a pressure controller, the desired pressure or altitude and airspeed values are entered via digital lever switches on the front panel. Pressure transition rates are selected by digital thumbwheel switches on the front panel and are precisely controlled to provide extremely smooth pressure transitions with no overshoot. A single pushbutton switch initiates control to the newly selected values.

The system will also respond to dynamic signals applied to a dynamic input connector on the rear panel. As an example, a function generator can be used to superimpose sinusoidal pressure waves on either P_s or P_t .

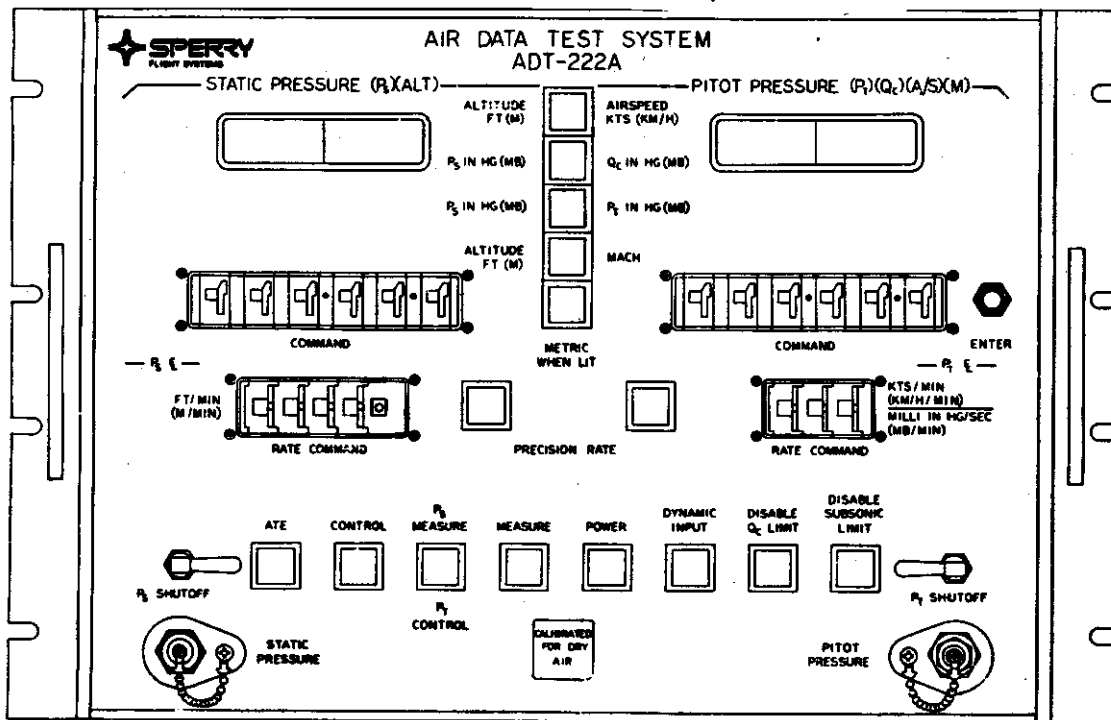
The ADT-222A employs built-in-test (BIT) programming and hardware to monitor its own operation, detect system failures and improper commands from the operator, and shut down the system when a fault is detected. This BIT capability provides fail-safe operation by protecting the unit under test (UUT) against possible hazards during test. Protection is provided against UUT damage caused by either operator error or ADT-222A failure. The operator has the option of selecting subsonic or supersonic protection limits to match the capabilities and requirements of the UUT.

In addition to electrical power, operation of the ADT-222A requires an external pressure source and two external vacuum sources. The exact requirements for all of the inputs are listed in Chapter 1, section 3. The ADT-222A is calibrated at the factory for use with either dry air (-901, -902, -911, -912) or dry nitrogen (-801, -802, -811, -812) as the pressure source. The calibration medium is designated by a front panel decal.

2. Physical Description

The ADT-222A consists of a power supply, digital control cards, two pressure sensors, and two pneumatic control systems mounted on a chassis. The front panel contains operating controls and displays, and the rear panel contains pressure fittings and connectors for external control and test equipment. It is packaged in an aluminum alloy enclosure designed for either rack mounting or bench top use. Dimensions, weight, and other leading particulars are listed in Chapter 1, section 3.

All primary operating controls and displays are located on the front panel, shown in figure 1-2. Pneumatic fittings for connection to the UUT are located on the front panel for units with dash number XX1, and for units with dash number XX2, the fittings are on the rear panel. The vertical row of five lighted pushbutton switches at the top center of the front panel visually divides the static pressure panel functions from the pitot (total) pressure panel functions. Four of the pushbutton switches are used to select the display mode (the parameter and units to be displayed). The fifth



Front Panel of ADT-222A
Figure 1-2

pushbutton switch is used to select either English or metric units for the commands and displays. The horizontal row of eight lighted pushbuttons contains the switches for turning the power on and off, selecting the UUT protection limits, and controlling the operational modes of the ADT-222A.

With the exception of the RATE COMMAND controls, the static pressure functions, on the left side, are identical to the pitot pressure functions, on the right side. The RATE COMMAND controls are ganged digital thumbwheel switches. The control on the static pressure side contains four switches and thus controls four digits; a fifth digit is fixed at 0. The control on the pitot pressure side contains only three switches and controls three digits. These controls are used to specify the transition rate to be used when changing pressures.

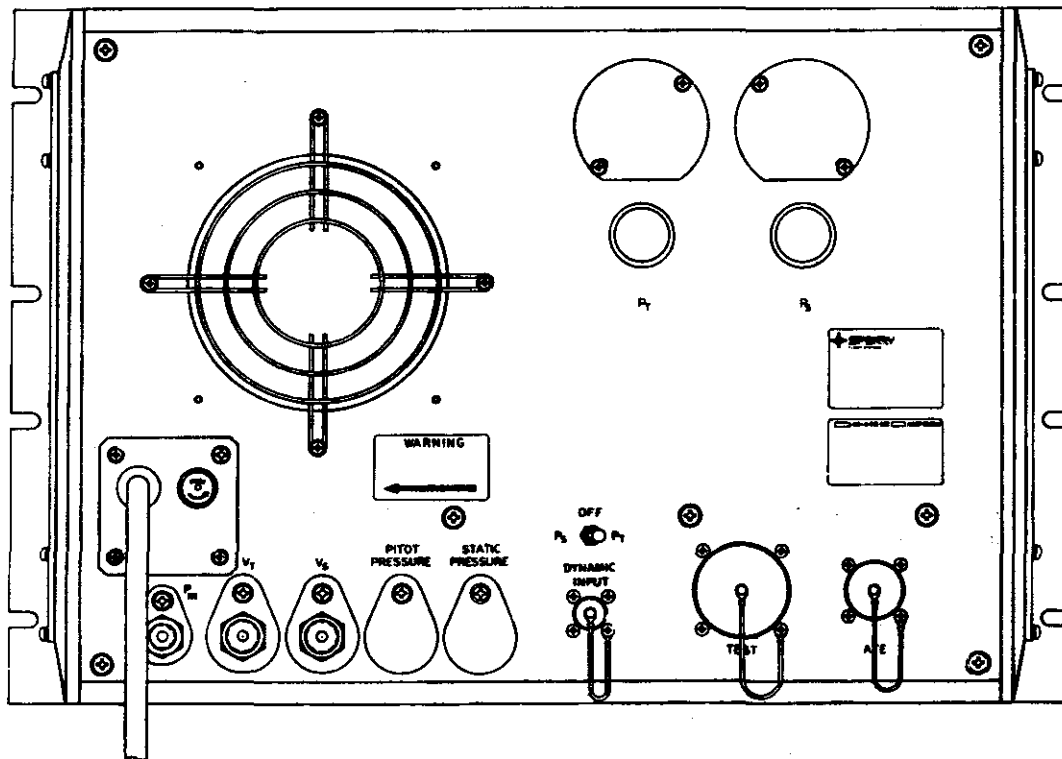
The COMMAND controls are used to specify the next pressure to be supplied to the UUT. Each control is a set of six ganged digital lever switches. Directly above each COMMAND control is the pressure readout display. Each display consists of two, three-digit, gas discharge tubes mounted side by side to provide a six digit readout with a decimal point to the right of each digit. Each digit in the display corresponds to the digit switch in the COMMAND control directly beneath it. These are situated this way because in responding to the COMMAND control the ADT-222A interprets the placement of the lighted decimal point of the command setting to be in the same digit location as that indicated on the display.

The PRECISION RATE control for each side is a lighted pushbutton switch located next to the RATE COMMAND control and is used to select extra-precise control of the pressure transitions.

The pneumatic fitting for each side is located on the front panel for -XX1 units and on the rear panel for -XX2 units, and is used to pneumatically connect the UUT to the ADT-222A. The type of fitting used is listed in Chapter 1, section 3. A manual pneumatic shutoff valve is provided for each fitting for isolating the UUT from the internal pressure system of the ADT-222A. The manual shutoff valves for all dash numbers are located on the front panel.

The lines marked $P_{S\bar{C}}$ and $P_{T\bar{C}}$ are the center lines of the sensors. The center line represents the altitude reference point (height) at which all pressures are measured.

Fittings for the pressure supply and vacuum supplies are located on the rear panel, shown in figure 1-3, along with the power cord, fuse, dynamic input connector and switch, and the ATE connector. The fittings and connectors used are listed in Chapter 1, section 3.



NOTE:
COVER PLATES FOR UNITS WITH
PITOT AND STATIC PRESSURE
CONNECTION ON FRONT PANEL.

32316

Rear Panel of ADT-222A
Figure 1-3

Also located on the rear panel are two internal pressure regulator controls. The pressure regulator controls are factory set and should not be adjusted.

The circuit cards and major subassemblies are plug-in interchangeable for quick and easy maintenance.

3. Functional Description

The pneumatic system of the ADT-222A, shown in figure 1-4, consists of two pneumatic paths, each containing a pneumatic control section and a measurement section. The sections are isolated from each other and from the UUT connection fittings (P_S and P_T ports) by solenoid operated valves. Extra UUT pneumatic isolation is provided by manual valves.

The measurement section of either path consists of a solenoid valve at each end of the section, a 30 cubic inch volume tank, and a pressure sensor. The pneumatic control section of either path consists of a pressure regulator for the inlet supply pressure, pneumatic line and fitting for the vacuum supply, and a pneumatic servo control valve. Both paths join at the pressure supply line and use a common pneumatic filter and solenoid valve for isolation from the pressure supply.

There are two basic modes of operation: the measure mode and the control mode.

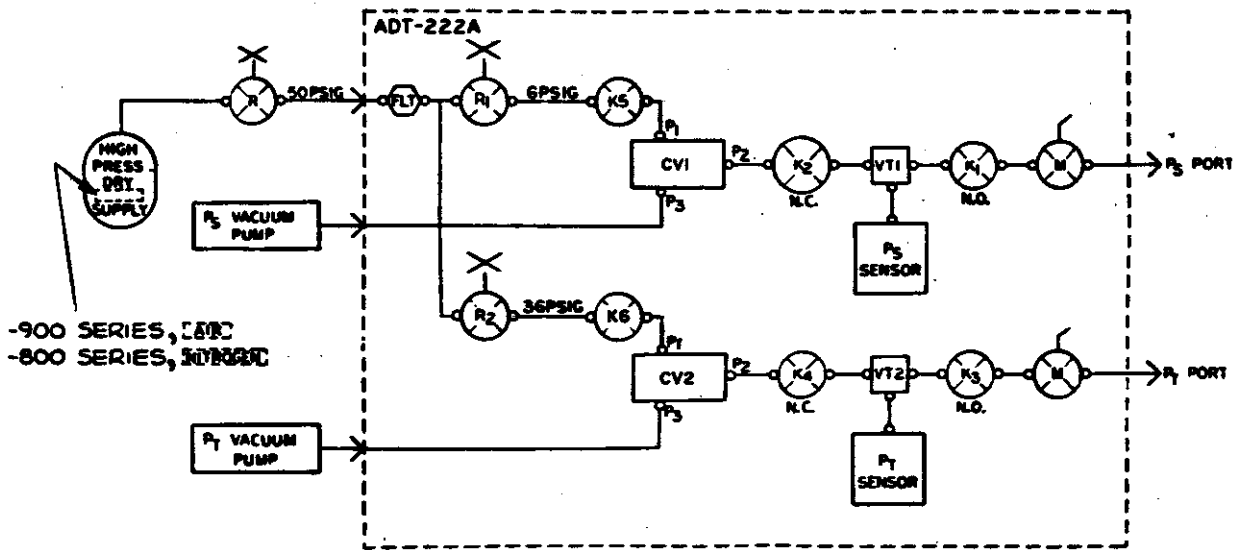
In the measure mode all pressure and vacuum supply lines are shut off and the pneumatic control section is shut off from the measurement section. The measurement section, however, is open to the test ports. Therefore, in the measure mode, valves K1 and K3 are open while valves K2, K4, K5, and K6 are closed.

In the control mode, all of the valves are open and the pressures in both paths are controlled by the respective pneumatic servo control valves, CV1 and CV2.

Operation of the ADT-222A is controlled by a system control section which receives instructions from the operator via the front panel controls or from an ATE via the optional ATE interface. It receives measurement data from the sensors, performs the necessary calculations and conversions, and sends the pressure values to the front panel for display. In the control mode, it also compares the measured values to the input commands and controls the pressure control valves to obtain the desired response.

The system control section also performs all BIT functions and causes the ADT-222A to either shut down to protect the UUT, or just ignore the input commands, whenever an equipment failure or an operator error is detected.

A more detailed description of the operation of the ADT-222A is contained in Chapter 1, section 2.



-900 SERIES, C&D
-800 SERIES, I&II

PNEUMATIC DIAGRAM

LEGEND:			
	ADJ REGULATOR		PNEUMATIC VOLUME (30 IN ³)
	SOLENOID VALVE		PNEUMATIC SERVO CONTROL VALVE
	MANUAL SHUTOFF VALVE		PNEUMATIC FILTER

E4030935-100-5(R2)

Pneumatic Diagram
Figure 1-4

Section 2. Operating Instructions

1. General

This section contains manual operating procedures only. Refer to Chapter 5, section 2 for procedures for automatic operation.

NOTE: Before operating the ADT-222A, the user should familiarize himself with subsections 7 and 8 of this section.

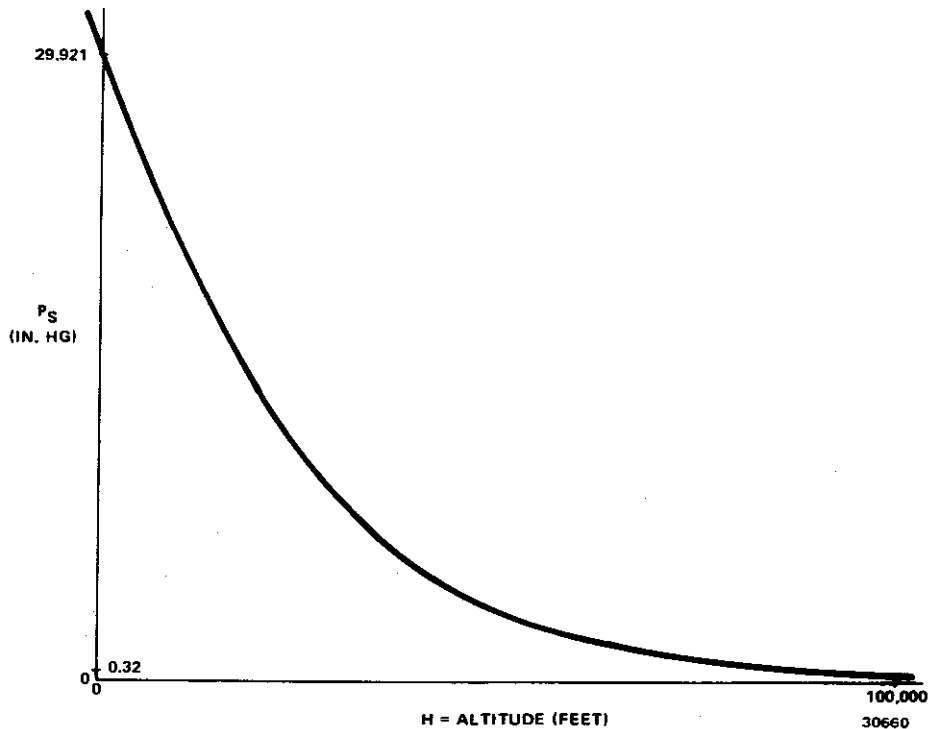
Before operating the ADT-222A it is helpful for the operator to understand the general relationships between altitude, airspeed, and pressure.

Static pressure (P_s) is the atmospheric pressure experienced by a body at rest. Static pressure is a function of altitude (H) and vice versa.

$$[P_s = f(H), H = f(P_s)]$$

The relationship between P_s and H follows the general curve of figure 1-5.

Total pressure (P_t) is the pressure experienced by a body as it moves through the atmosphere. For an aircraft in flight, it is the pressure exerted on the nose of the aircraft as it flies in a straight and level path. P_t is the sum of the static pressure and the impact pressure created by the motion of the



Relationship of P_s to H
Figure 1-5

air. Airspeed (V_C) is a function of the impact pressure (Q_C) and, therefore, a function of the relation of P_t to P_s .

$$Q_C = f(V_C), V_C = f(Q_C)$$

$$P_t = P_s + Q_C$$

$$V_C = f(P_t - P_s)$$

The relationship between Q_C and V_C follows the general curve of figure 1-6.

Mach (M) is the ratio of total pressure (P_t) to static pressure (P_s).

Subsonic: Mach 1

$$M = 5 \left(\frac{P_t}{P_s} \right)^{\frac{2}{7}} - 1 \quad \frac{1}{2}$$

Supersonic: Mach 1

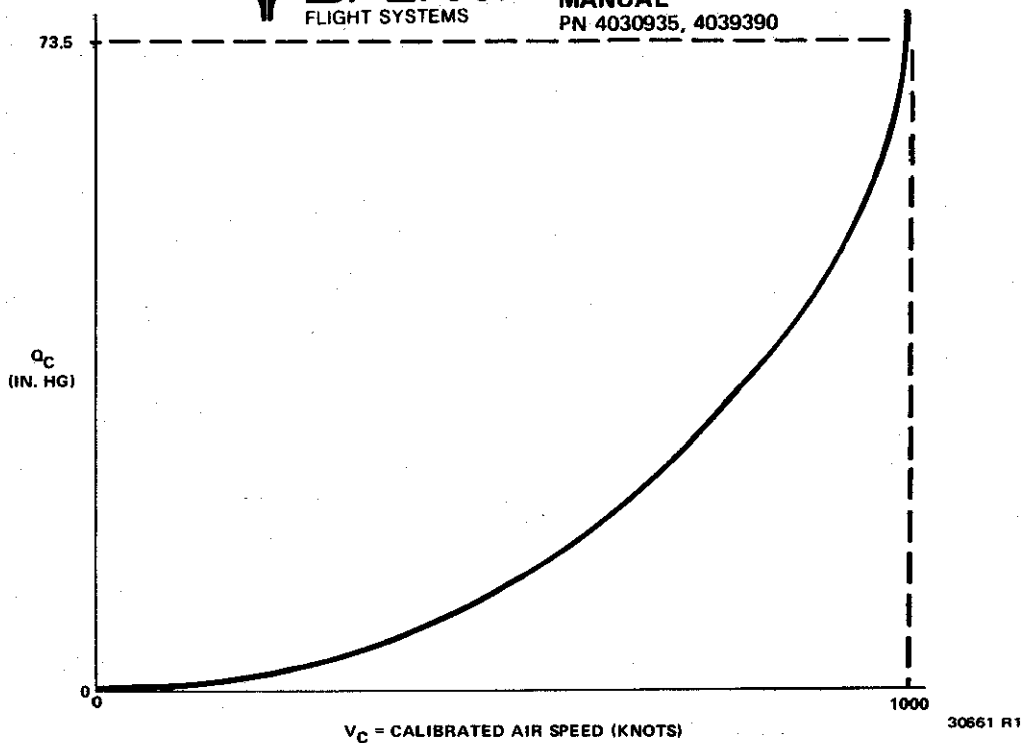
$$\frac{P_t}{P_s} = 1.66 \cdot 92162 \frac{M^7}{(7M^2-1)^{2.5}}$$

The relationship between P_t and P_s follows the general curve of figure 1-7. It should be noted, however, that this curve is in terms of a Q_C to P_s ratio; where $P_t = Q_C + P_s$.

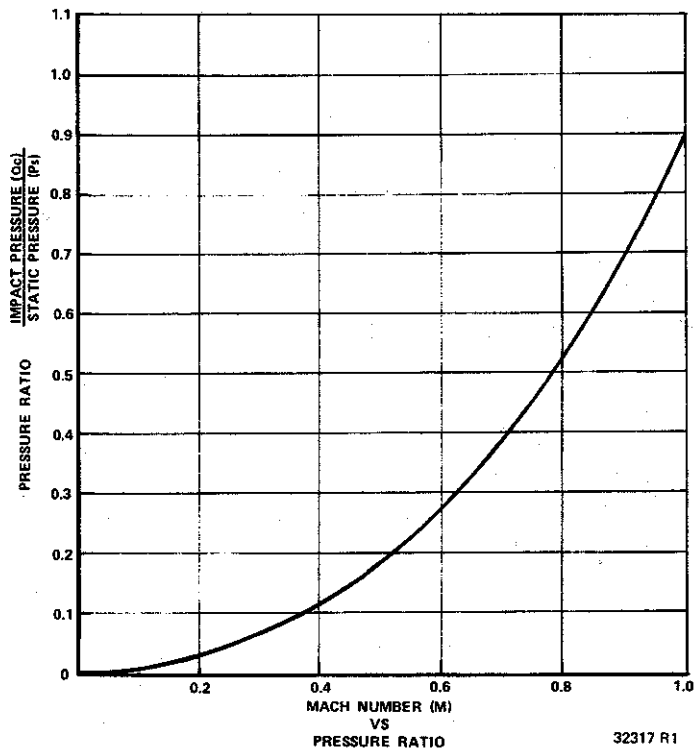
A chart of Mach number versus pressure altitude and airspeed is provided in figure 1-7A.

Many air data instruments are delicate devices and violent pressure variations can damage or cause changes in the calibration characteristics of the pressure transducers used in these devices. Without the protection limits imposed by the system design, the range and response of the ADT-222A could damage the pressure transducer of the UUT if improperly commanded by the operator. Built in protection limits are selected by the operator by use of the DISABLE Q_C LIMIT and DISABLE SUBSONIC LIMIT switches. The switch combinations and the resultant protection limits are listed in Chapter 1, section 3. The protection limits should be selected to approximate, as closely as possible, the allowable altitude and airspeed ranges of the UUT. The ADT-222A will then not accept commands to exceed these limits.

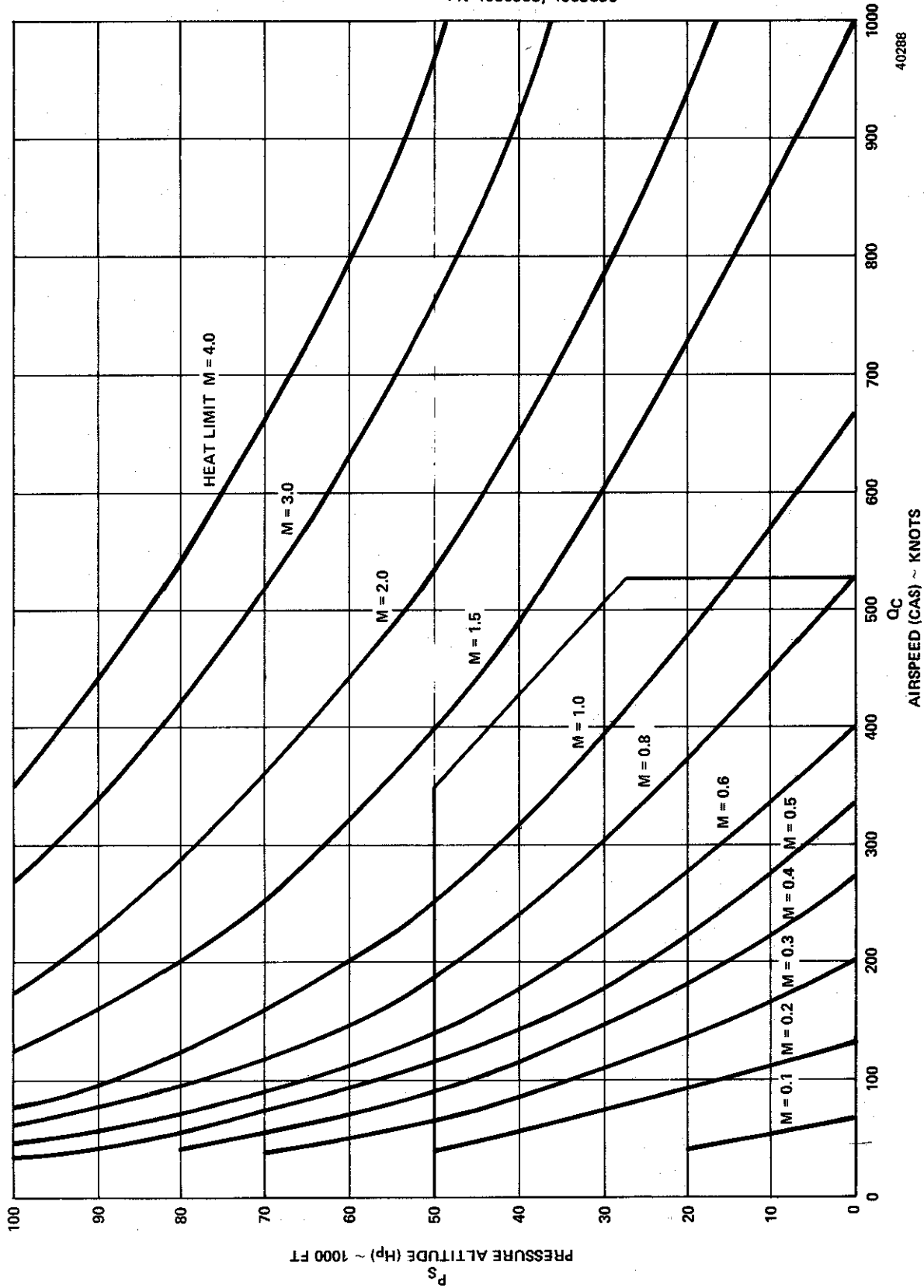
With the exception of the dynamic input control, the operation of the ADT-222A is controlled entirely by the front panel controls. The front panel controls and their functions are listed in table 1-1. For reference with these instructions, the front panel is again shown in figure 1-8.



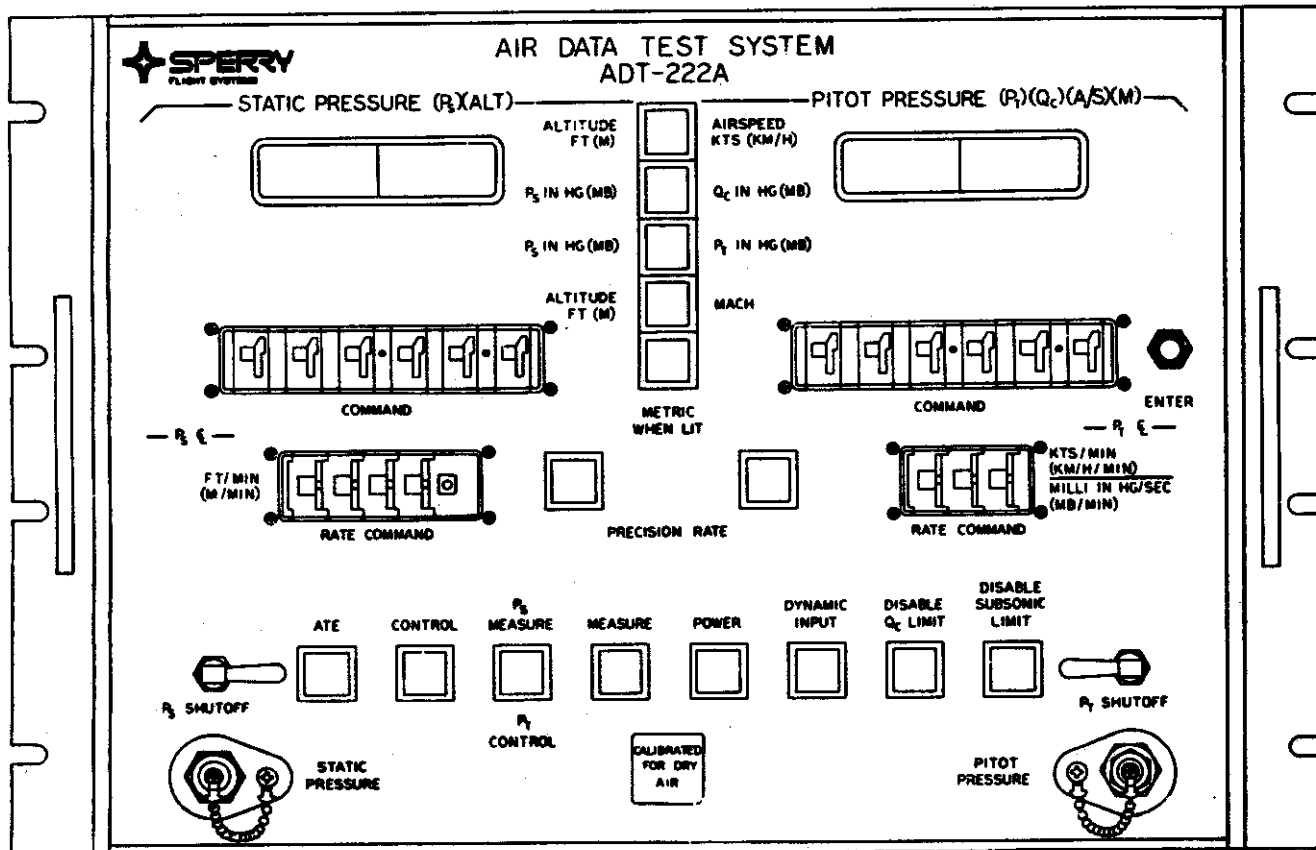
Relationship of Q_c to V_c
Figure 1-6



Mach Number (M) vs Pressure Ratio
Figure 1-7



Mach Number vs Pressure Altitude and Airspeed
Figure 1-7A



32343 R1

Front Panel of ADT-222A
Figure 1-8

2. System Initialization

Start operation of the ADT-222A by performing the following steps.

NOTE: These operating procedures are based on the assumption that the ADT-222A has been properly installed and has been allowed to warm up and stabilize in the measure mode. Refer to Chapter 2 for installation and initial turn-on procedures. The required warmup time is 30 minutes.

- A. Open the two manual shutoff valves, P_S SHUTOFF and P_t SHUTOFF, by pulling the valve levers out so they are perpendicular to the plane of the front panel. This will connect the ADT-222A pneumatics to the P_S and P_t ports. These ports should remain open, whenever the ADT-222A is not in use, to vent the pneumatic system to the atmosphere. They should also remain open during all normal operations of the ADT-222A.

NOTE: The ADT-222A and the vacuum pumps may be left on 24 hours a day. If the system is not being used, it should be placed in the measure mode with the front panel shutoff valves open to the atmosphere. Place the attached caps loosely over the P_S and P_t front panel pneumatic fittings. In the measure mode there is no consumption of inlet air and thus no air flow through the vacuum pumps. If it is desired to turn the system off, refer to Chapter 2, section 5 for shutdown procedures to avoid the possibility of allowing oil from the vacuum pumps to enter the ADT-222A.

- B. Press the POWER pushbutton to turn on the power to the ADT-222A. The green POWER pushbutton should be lighted. The ADT-222A will enter initiated BIT and begin the self test routine. The lighted pushbuttons on the front panel will all flash five times so that the operator may check for a defective light. Some lights may flash at different rates. Some lights may stay on and not flash. However, all lamps should light, including decimal points located in the COMMAND switch displays.

After the light flashing sequence is finished, the ADT-222A will cycle the displays through 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, (Blank), C, -d, E, and F. Also, the decimal point will cycle through each of its six positions from left to right. The decimal point at the far right may flash with each display change. This is normal. The displays will continue to cycle in this fashion until you perform the next step.

Front Panel Nomenclature	Reference Designation	Purpose
POWER	S16	On/off button with lamp that lights when ac power is applied
STATIC PRESSURE	P _s	UUT static pressure pneumatic connection
PITOT PRESSURE	P _t	UUT pitot pressure pneumatic connection
P _s SHUTOFF P _t SHUTOFF	P _s , P _t	Toggle valve for pneumatic isolation between UUT and ADT-222A. Valve shown in closed position. Pull to open.
ATE CONTROL	S12 S13	Lighted pushbuttons for selection of automatic or manual control of ADT-222A
P _s MEASURE P _t CONTROL	S17	Lighted pushbutton for selection of split channel measure mode. In this mode the ADT-222A measures the pressure applied to the P _s port while controlling the pressure of the P _t port.
MEASURE	S14	Lighted pushbutton for selection of measure mode to monitor pitot and static pressures applied to pressure ports. Also may be utilized for performance of leak test.
DISABLE Q _c LIMIT	S18	Lighted pushbutton for selection of Q _c limit (Flashing light indicates that the command requested would exceed the programmed limits.)
DISABLE SUBSONIC LIMIT	S19	Lighted pushbutton for selection of subsonic limit (Flashing light indicates that the command requested would exceed programmed limits.)
STATIC PRESSURE (P _s) (ALT)	-	Six-digit gas discharge tube display
PITOT PRESSURE (P _t) (Q _c) (A/S) (M)	-	Six-digit gas discharge tube display
ALTITUDE FT (M) AIRSPEED KTS (KM/H)	S1	Lighted pushbutton to select respective display mode

Functions of Front Panel Controls
Table 1-1

Front Panel Nomenclature	Reference Designation	Purpose
P _S IN HG (MB) Q _C IN HG (MB)	S2	Lighted pushbutton to select respective display mode
P _S IN HG (MB) P _t IN HG (MB)	S4	Lighted pushbutton to select respective display mode
ALTITUDE FT (M) MACH	S3	Lighted pushbuttons to select respective display mode
METRIC WHEN LIT	S20	Selects metric units when lit
PRECISION RATE (left side)	S6	Lighted pushbutton for selection of precision rate control of altitude or P _S transitions
PRECISION RATE (right side)	S7	Lighted pushbutton for selection of precision rate control of airspeed, Q _C , or P _t transitions
COMMAND	S8, S10	Digital lever switches for programming static and pitot pressure commands (Units and lighted decimal placement match the display mode selected.)
RATE COMMAND FT/MIN (M/MIN)	S9	Thumbwheel for preselecting transition rates for static pressure changes (Units are always whole feet/minute or whole meters/minute.)
RATE COMMAND KTS/MIN (KM/H/MIN) MILLI IN HG/SEC (MB/MIN)	S11	Thumbwheel for preselecting transition rates for airspeed, Q _C , and total pressure changes (Units match the display mode selected. Decimal is always at far right.)
ENTER	S5	Command enter pushbutton to activate the ADT-222A to execute all commands shown on the front panel
DYNAMIC INPUT	S15	Lighted pushbutton to permit dynamic testing, utilizing an analog function generator input and P _S , P _t switch at rear panel

Functions of Front Panel Controls
 Table 1-1 (cont)

Front Panel Nomenclature	Reference Designation	Purpose
P_t ζ	-	Represents total pressure reference center line. All P_t measurements are made with respect to this line.
P_s ζ	-	Represents total pressure reference center line. All P_s measurements are made with respect to this line.

Functions of Front Panel Controls
Table 1-1 (cont)

2. C. Press one of the first four vertical display mode pushbuttons, plus the METRIC WHEN LIT pushbutton if metric units are desired. This shall cause the ADT-222A to enter the measure mode. The pushbutton will light, and the displays will stop cycling and will display the ambient pressure in the units selected by the display mode button.

NOTE: If the ADT-222A does not respond and the displays do not stop cycling when a display mode is selected, BIT has detected a failure and will not allow the ADT-222A to enter a normal operating mode. Maintenance is required to correct the fault.

3. Measure Mode Operation

This mode is entered in either of two ways. It is always entered at the end of the initiated BIT (unless an actual failure has been detected by BIT) or it is entered from the other modes by pressing the desired MEASURE pushbutton (MEASURE or P_s MEASURE P_t CONTROL). The ADT-222A is operated in the measure mode by performing the following steps:

- A. Open the manual valves (if not already open) and select the desired display mode by pressing one of the four display mode pushbuttons:
1. ALTITUDE FT (M)/AIRSPEED KTS (KM/H)
 2. P_s IN HG (MB)/ Q_c IN HG (MB)
 3. P_s IN HG (MB)/ P_t IN HG (MB)
 4. ALTITUDE FT (M)/MACH

NOTE: If metric units are desired, press METRIC WHEN LIT pushbutton, in addition to the mode selected.

- B. The displays will indicate the pressures applied at the input ports in the units selected by the operator.

3. C. Set the state of the DQCL and DSSL pushbuttons.
- D. Connect the UUT to the P_s and P_t input ports. The manually operated valves should remain open.

4. Control Mode Operation

NOTE: These procedures assume that a UUT is connected to the system. For familiarization purposes, these procedures can be performed without connection to a UUT by closing the P_s and P_t SHUTOFF valves.

The ADT-222A is operated manually in the control mode by performing the following steps:

WARNING: THE MANUAL SHUTOFF VALVES MUST BE LEFT OPEN WHENEVER A UUT IS CONNECTED TO THE ADT-222A. THE ONLY WAY AN OPERATOR CAN MAKE THE ADT-222A DAMAGE A UUT IS BY LEAVING THE MANUAL SHUTOFF VALVES CLOSED WHEN COMMANDING THE SYSTEM TO CHANGE PRESSURES. OPENING THE VALVES AFTER CHANGING PRESSURES CAN CAUSE DAMAGING PRESSURE SURGES TO BE APPLIED TO THE UUT. ALWAYS LEAVE THE MANUAL SHUTOFF VALVES OPEN.

Important: If for any reason the operator wants to stop the pressure command, press the MEASURE pushbutton. This will immediately disconnect the ADT-222A pneumatic control system from the UUT and stop the pressure changes.

- A. Set the states of the DISABLE Q_c LIMIT and the DISABLE SUBSONIC LIMIT switches (if not already set) by pressing them to turn them on or off, as applicable, to select the appropriate protection limits for the UUT. (The available limits are given in Chapter 1, section 3.) If a UUT is connected to the system, be sure the manual shutoff valves are open.

NOTE: Once the switches have been set to match the UUT limits, do not change them until the test procedure is completed and the UUT has been disconnected from the ADT-222A. Even if the lights start flashing during your test procedure, don't touch them. Flashing lights indicate that a command has been entered that would cause the system to exceed the established protection limits for the UUT and the ADT-222A will not accept the erroneous command. Pressing the flashing button would change the protection limits and enable the system to respond to a command which could possibly damage the UUT.

- B. Press the CONTROL pushbutton. This will cause the system to enter the control mode and the pushbutton will light. If the room is quiet you will hear the closing of solenoid valves K1 and K3 followed by the opening of solenoid valves K2, K4, K5, and K6. This valve configuration

isolates the UUT from the internal pneumatic system of the ADT-222A. The internal pressure is then controlled to match the last pressures measured from the input ports. When the internal pressures have been stabilized you will hear the opening of valves K1 and K2 to connect the UUT to the internal pneumatic system of the ADT-222A. This action "initializes" the internal pressures of the ADT-222A to those of the UUT to prevent pressure surges which might harm the UUT. You are now ready to proceed. Total elapsed time: approximately 15 seconds.

4. C. Select the desired display mode by pressing one of the four display mode pushbuttons:

1. ALTITUDE FT (M)/AIRSPEED KTS (KM/H)
2. P_s IN HG (MB)/ Q_c IN HG (MB)
3. P_s IN HG (MB)/ P_t IN HG (MB)
4. ALTITUDE FT (M)/MACH

The selected button will light and the display will present the measured values in the appropriate units.

NOTE: If metric units are desired, press METRIC WHEN LIT pushbutton, in addition to the mode selected.

- D. Set the COMMAND switches to the next desired display values. Be certain that the display mode matches the units of your input command. The lighted decimal placement on the COMMAND switches matches the decimal placement on the display directly above each COMMAND switch. For example, if the P_s display now reads 28.564 inches Hg and your next command is to go to precisely 30 inches, set the P_s COMMAND switches to 030000, as there will be three digits to the right of the decimal point.
- E. Set the RATE COMMAND switches to the desired transition rates. The decimal point is always to the far right hand side. The P_s rate is always in feet or meters per minute. The P_t rate will be in knots per minute, kilometers per hour per minute, milli-inches Hg per second, or millibars per minute, depending upon the display mode and units (English or metric) selected.
- F. If a precision rate is desired, press the appropriate PRECISION RATE pushbutton. The left pushbutton will select P_s precision rate and the right pushbutton will select P_t precision rate. The PRECISION RATE light will flash, indicating that the precision rate is engaged, but the rate is not yet achieved or is in error by greater than 2 percent. After ENTER command, the light continues flashing, indicating the changing of pressures to the commanded values at a precision rate greater than 2 percent. When the precision rate reaches the transition and where rate accuracy is within 2 percent, the PRECISION RATE light will go steady. When the precision rate starts to diminish approaching the commanded value, the PRECISION RATE light will go out and then will start to flash again when the pressure has stabilized. If precision rate control is not required for the next command, press the PRECISION RATE pushbutton again and the light will remain off.

4. G. Press the ENTER pushbutton. This will initiate the command and the system will respond by changing the pressures to the commanded values at the commanded rates. The pressures will continue to change at the commanded rates until the final values are approached. At this time the rate will gradually decrease to zero, allowing the control system to stabilize at the commanded pressures without overshoot.

H. Repeat steps C thru G as required to perform the UUT test procedure.

NOTE: If for any reason you wish to rapidly stop the pressure command, press the MEASURE pushbutton. This will immediately disconnect the ADT-222A control system from the UUT and stop the pressure changes.

I. Return the system to approximately ambient pressure. This can be done by commanding the system to return to any of the following:

1. Ambient altitude and zero airspeed, or
2. Ambient P_s and zero Q_c , or
3. Ambient P_s and P_t .

J. Press the MEASURE pushbutton. This will return the ADT-222A to the measure mode. The MEASURE pushbutton will light. Solenoid valves K2, K4, K5, and K6 will close, isolating the UUT from the control section of the pneumatic system.

K. Disconnect the UUT from the ADT-222A.

5. Leak Test Operation

You can test the pressure retaining capacity of the ADT-222A/UUT test setup by performing the following steps:

NOTE: To test the ADT-222A by itself, refer to Chapter 3, section 2.

A. Ensure that the manual shutoff valves are open.

CAUTION: THE OPERATOR COULD DAMAGE THE UUT BY OPENING THE MANUAL SHUTOFF VALVES AFTER THE ADT-222A HAS BEEN COMMANDED TO A PRESSURE.

B. Press the P_s IN HG/ P_t IN HG pushbutton.

C. Select the UUT protection limits by pressing the DISABLE Q_c LIMIT and the DISABLE SUBSONIC LIMIT switches to light the pushbuttons as applicable.

D. Connect the UUT to the P_s and P_t ports.

E. Enter the control mode by pressing the CONTROL pushbutton.

5. F. Refer to table 1-2 and enter the following commands:
 1. Set P_S COMMAND to the value shown in table 1-2 (in accordance with DQCL and DSSL lights).
 2. Set P_t COMMAND to the value shown in table 1-2 (in accordance with DQCL and DSSL lights).
 3. Set P_S RATE COMMAND to 30000 ft/min.
 4. Set P_t RATE COMMAND to 300 milli-in. Hg/sec.
- G. Press the ENTER pushbutton.
- H. After the commanded pressures have been established, press the MEASURE pushbutton. Wait 5 or 6 minutes for the system temperature to stabilize and read the displays.
- I. Wait 1-minute and read the displays again. The difference between the initial values and the currently displayed values should not be greater than that specified for the UUT (in inches Hg).
- J. Re-enter the control mode.
- K. Enter the following commands in accordance with DQCL and DSSL lights:
 1. Set P_S COMMAND to the value shown in table 1-2.
 2. Set P_t COMMAND to the value shown in table 1-2.
- L. Press the ENTER pushbutton.
- M. After the commanded pressures have been established, press the MEASURE pushbutton. Wait 5 or 6 minutes to allow the system temperature time to stabilize and read the displays.
- N. Wait 1-minute and read the displays again. The leak rate should not be greater than that specified for the UUT.
- O. Re-enter the control mode and return the system to ambient pressure.
- P. Return to the measure mode.
- Q. Disconnect the UUT from the ADT-222A.

Leak Test Step	DQCL Light*	DSSL Light*	P _s Command	P _t Command
5.F	0	0	31.000	40.000
	0	1	31.000	89.000
	1	0	31.000	40.000
	1	1	31.000	89.000
5.K	0	0	3.200	3.200
	0	1	.500	1.500
	1	0	3.200	3.200
	1	1	.500	.500

*0 = Light Off (limit active)
 1 = Light On (limit disabled)

Leak Test Commands
 Table 1-2

6. Dynamic Operation

The ADT-222A can be driven to produce sinusoidal or other forms of variations in either P_s or P_t for dynamic testing of a UUT. This may be done in any of the four modes of operation with the ADT-222A in one of the control modes. The ADT-222A has the capability of having only one pressure dynamically driven at a time; the other pressure must remain constant. In the P_s MEASURE P_t CONTROL mode only the P_t channel pressure can be modulated by the dynamic input. Frequency response of either channel of the ADT-222A using the dynamic input is limited by the load volume connected to that channel, and the corner frequency will be 1.5 Hz or greater for a load of 60 cubic inches.

For dynamic operation, follow this procedure:

- A. Connect a function generator (Wavetek 154, or equivalent) to the dynamic input connector on the rear panel.
- B. Flip the DYNAMIC INPUT toggle switch on the rear panel to the position appropriate for the pressure you wish to drive (P_s or P_t).
- C. Turn the amplitude control of the function generator to zero.

6. D. Turn the function generator on and select a square wave with a period of approximately 5 seconds.
- E. Put the ADT-222A in the command mode and enter the steady state P_s and P_t values.
- F. When the ADT-222A has reached both steady state values, press the DYNAMIC INPUT pushbutton.
- G. Adjust the amplitude control of the function generator to obtain the desired magnitude of oscillation as indicated on the display then select the desired waveform and frequency on the function generator.

Example: If P_t is to oscillate ± 0.1 inches Hg from a steady state value of 40.0 inches Hg, adjust the amplitude control until the P_t display changes between 40.100 and 39.900 inches Hg.

- H. To return to normal operation, press the dynamic input pushbutton again and the dynamic response will cease.

7. Failure Procedures

There are no special procedures to be followed if the system indicates a failure while in the measure mode since no pressure is applied to the UUT. However, if the system indicates a failure by displaying "FFF" while in the control mode, the following procedures must be performed to avoid possible damage to the UUT.

- A. Close the P_s and P_t manual shutoff valves. Do not operate any other controls on the ADT-222A until these valves are closed.
- B. Your next step will depend upon the type of UUT you have connected to the ADT-222A.

CAUTION: DO NOT DISCONNECT THE UUT BEFORE READING THE FOLLOWING:

If the UUT is an altitude device requiring a single pressure input, loosen the pneumatic connection slightly to allow the pressure to slowly bleed to ambient. Care must be taken not to allow a sudden large pressure change which could damage the UUT.

If the UUT requires both P_s and P_t inputs, but does not contain a differential pressure (or Q_c) sensor, loosen the pneumatic connections slightly to slowly bleed off the pressures. Again, care must be taken to avoid a sudden pressure change which could damage the UUT.

If the UUT is connected to both the P_s and P_t ports and contains a Q_c sensor, the pressures must be bled off by using the following procedure. The objective of this procedure is to avoid either a negative Q_c or a Q_c larger than that for which the UUT was designed. Not adhering to this procedure could result in damage to the UUT Q_c sensor.

1. Refer to the UUT specifications to determine the output of the UUT related to Q_c .
 2. Determine the values of this output that correspond to the maximum Q_c and minimum Q_c limits of the UUT. (Refer to Chapter 1, section 2, paragraph 1, General Requirements, for the relationships between P_s , P_t , Q_c , altitude, and airspeed.)
 3. While monitoring the UUT output, carefully bleed the P_s pressure toward ambient by loosening the P_s connection at either the ADT-222A or the UUT. When the UUT output approaches the value corresponding to the Q_c limit, stop bleeding the pressure by tightening the P_s connection. Take care not to reach or exceed the Q_c limit.
 4. Continue monitoring the UUT output and bleed the P_t pressure in the same manner. Stop bleeding the pressure when the UUT output approaches the value corresponding to the opposite Q_c limit. Take care not to reach or exceed the Q_c limit.
 5. Continue to bleed off the P_s and P_t pressures by alternately performing steps 3 and 4 taking care to keep the UUT output within the Q_c limits.
- D. When all of the pressure has been bled off, disconnect the UUT from the ADT-222A.
- E. Turn off the vacuum pumps and pressure supply and disconnect the vacuum and pressure supply lines.
- F. Refer to Chapter 3 for system maintenance.

This procedure shall be followed when an FFF error message appears and remains on the displays or if the system will not respond to valid commands to return to ambient pressures.

8. Error Messages

The built in test function of the ADT-222A monitors the system's operation to detect any failures. When multiple failures occur, the display overlays the given failure codes for the display output. When single failures occur, one of the following will occur.

- A. The displays will indicate XXXFFF if a failure has occurred within the system.

- 8. B. A display will indicate XXXCCC if one of the sensors has not warmed up properly. A cold sensor can cause erroneous measurements.
- C. A display will indicate XXXXdd if one of the sensors is too hot. A hot sensor can produce erroneous measurements.
- D. A display will indicate XXXXXE if the system is incapable of producing the requested response. This will generally indicate a leak or other malfunction in the pneumatic control section of the ADT-222A. The E will also appear if the operator tries to operate the ADT-222A outside of its operational limits. For example, in the altitude/airspeed mode with P_s and P_t equal (as if they are both open to ambient) the AIRSPEED display will indicate 22E. The lowest airspeed the system can accurately measure is 22 knots (29.8 kilometers/hour), however, values lower but of variable accuracy are possible and are displayed for relative reference only.
- E. The DQCL or DSSL pushbutton will flash if the operator has commanded a pressure response that is beyond the established UUT protection limits.
- F. The DQCL pushbutton will flash if the operator has commanded a pressure response that exceeds the established airspeed limit.
- G. The DSSL pushbutton will flash if the operator has commanded a pressure response that attempts a Mach limit violation.



Section 3. Specifications

1. Leading Particulars

The leading particulars of the ADT-222A are listed in table 1-3.

Dimensions	
Height	12.25 inches maximum
Width	19.00 inches maximum
Length	23.00 inches maximum
Weight	75.8 pounds
*Power (single phase)	115/230 volts \pm 10% RMS, 45 to 440 Hz 175 VA maximum
Warmup Time	30 minutes maximum
Operating Temperature	+50 to +110 °F (+10 to +43 °C)
Pressure Source	Dry air or dry nitrogen, regulated, at 50 \pm 5.0 psig (Refer to Chapter 2, section 2, paragraph 3, Pressure Supply.)
Vacuum source	
P _s	300. liters per minute free air displacement
P _t	300. liters per minute free air displacement
Programming Interface	IEEE Standard 488-1975, ASCII
Fuse	3.0 amperes slo-blo (115-volt units) 1.5 amperes slo-blo (230-volt units)
Lamps (pushbutton indicators)	#327, 28 volts dc

*Refer to the ADT-222A configurations table in the FOREWORD for voltages applicable to specific part numbers.

Leading Particulars
Table 1-3

2. Connections and Fittings

Table 1-4 lists the connectors and fittings required to mate with the ADT-222A.

CONNECTION	CONNECTOR
Inlet Pressure (P_{in})	1/4 inch 37-1/2 degree male flare (MS-33656-4)
Vacuum Source (V_S and V_t)	3/8 inch 37-1/2 degree male flare (MS-33656-6)
Static Port (P_S)	3/8 inch 37-1/2 degree male flare (MS-33656-6)
Pitot Port (P_t)	1/4 inch 37-1/2 degree male flare (MS-33656-4)
Dynamic Input	Bendix Part No. JTP02RE8-35, mates with Bendix Part No. JT06RE8-98 P(SR)
Test	Bendix Part No. JTP02RE20-35, mates with Bendix Part No. JT06RE20-35 P(SR)
ATE	Bendix Part No. JTP02RE14-35S, mates with Bendix Part No. JT06RE14-35 P(SR)
Power	User selection (no connector supplied with system)

Connections and Fittings
Table 1-4

3. Range of Operation

The ADT-222A can operate within the functional ranges listed in table 1-5. These are maximum ranges available with the Q_c and subsonic protection limits disabled.

FUNCTION	CONTROL RANGE	MEASURE RANGE
P _s	0.500 to 32.000 in. Hg 16.9 to 1083.6 MB	0.320 to 40.000 in. Hg 10.8 to 1354.6 MB
P _t	1.500 to 90.000 in. Hg 50.8 to 3047.7 MB	0.500 to 100.000 in. Hg 16.9 to 3386.4 MB
Q _c	-30.500 to 89.500 in. Hg -1032.8 to 3030.8 MB	-39.500 to 99.680 in. Hg -1337.6 to 3375.6 MB
Altitude	-1800 to 90,000 ft -549 to 27,432 M	-1800 to 100,000 ft -549 to 30,480 M
Airspeed (CAS)	32 to 1000 knots 59.3 to 1852.0 KM/H	23 to 1000 knots 42.6 to 1852.0 KM/H
Altitude Rate	0 to 40,000 ft/min [1] 0 to 12,190 M/min [1] 0 to 65,000 ft/min [2] 0 to 19,810 M/min [2]	-
Airspeed Rate	0 to 500 knots min [1] 0 to 926 KM/H/min [1] 0 to 700 knots/min [2] 0 to 999 KM/H/min [2]	-
Mach Range	-	0.100 to 5.000

NOTES: [1] For external volumes larger than 60 cubic inches
 [2] For external volumes smaller than 60 cubic inches

Operating Range
 Table 1-5

4. Protection Limits

The UUT Protection limits imposed by the system are shown in table 1-6. These limits are selected either by the disable limit switches on the front panel, or by the ATE. The limit switch states are shown in the table and follow the following legend:

- DQCL Light = DISABLE Q_C LIMIT pushbutton light
- DSSL Light = DISABLE SUBSONIC LIMIT pushbutton light
- ON = Pushbutton light is on. The limit is disabled. This corresponds to an ASCII "1" from the ATE.
- OFF = Pushbutton light is off. The limit is engaged. This corresponds to an ASCII "0" from the ATE.
- < = Less than
- > = Greater than

5. Performance Specifications

The following performance specifications are listed in tables contained in this section:

- o Resolution is listed in table 1-7.
- o Accuracy and repeatability are listed in table 1-8, and
- o Control stability is listed in table 1-9.

With the exception of control stability, all of the performance specifications are the same for either the measure or control modes of system operation.

To maintain a high level of confidence that the ADT-222A is performing in accordance with these specifications, it is fundamentally important that you adhere to a disciplined application of the performance verification and calibration procedures at the intervals prescribed in Chapter 3.

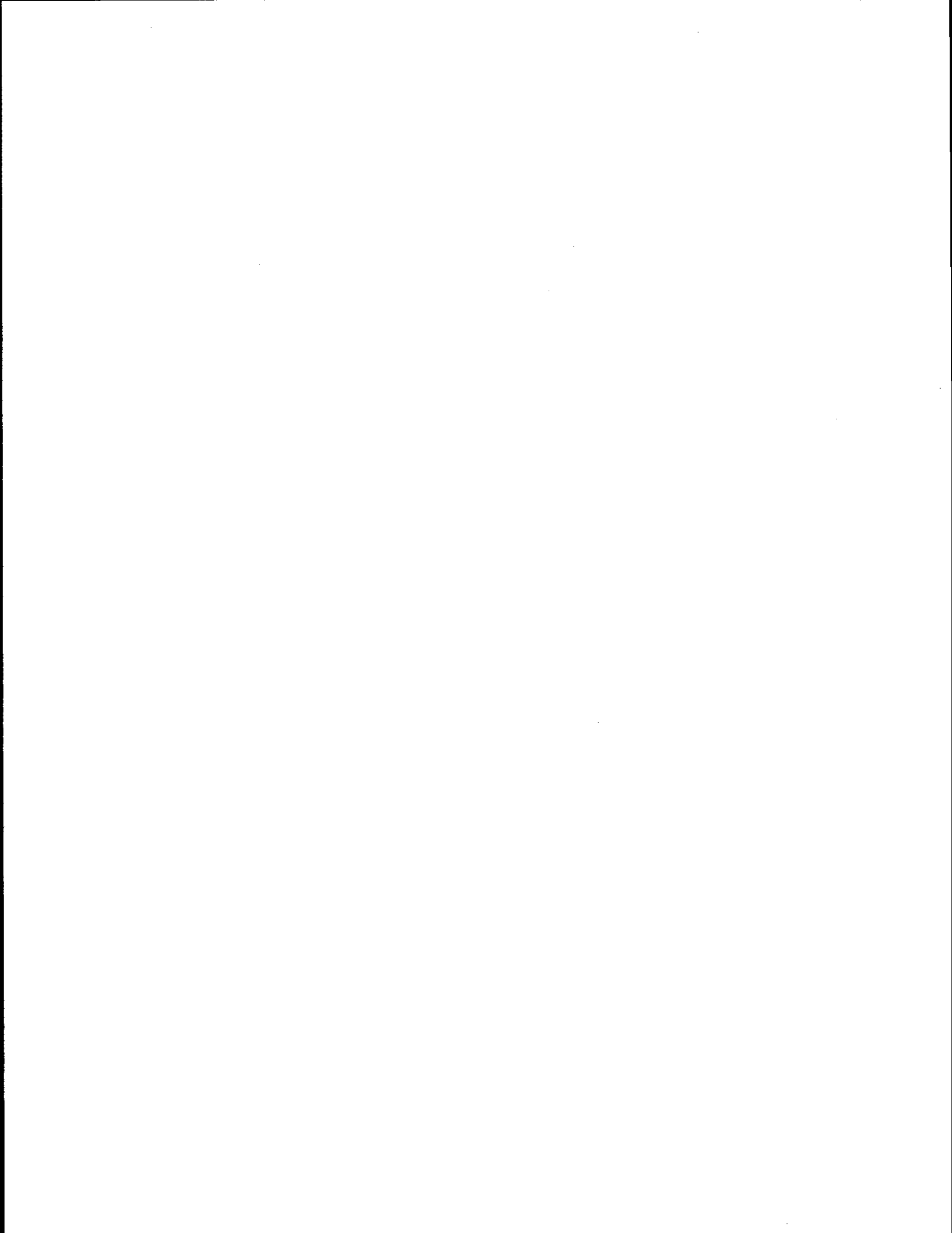


DQCL	DSSL	Altitude Range Limit (feet)	Airspeed Range Limit (knots)	Mach Limit	P _s Range Limit (inches Hg)	P _t Range Limit (inches Hg)	Q _c Range Limit (inches Hg)	Altitude Rate Limit (feet/minute)
OFF	OFF	-1888 to 55,008 [1]	-0.0 to 525.0	<1.100	2.692 to 32.019	2.692 to 47.426	-2.016 to 15.407	H <65,000
OFF	ON	-1888 to 91,337 [1]	-0.0 to 1,002.6	<3.500	0.480 to 32.019	1.480 to 90.019	-2.016 to 74.003	H <65,000
ON	OFF	-1888 to 55,008 [1]	-0.0 to 813.4	NONE	2.692 to 32.019	2.692 to 47.431	-29.327 to 44.739	H <65,000
ON	ON	-2000 to 100,683 [1]	-0.0 to 1,010.0	NONE	0.312 to 40.003 [2]	0.480 to 100.019 [2]	-39.523 to 99.707	H <65,000

NOTES: [1] Altitude rate is limited to equal or less than 65,000 feet/minute.

[2] P_s and P_t may be limited to the control range of ADT-222A.

UUT Protection Limit Ranges
Table 1-6



Display Mode	Display Units	Resolution
IN HG	P _s in. Hg	0.001 in. Hg
	P _t in. Hg	0.001 in. Hg
MILLIBARS	P _s MB	0.1 MB
	P _t MB	0.1 MB
Q _c	P _s /P _t in. Hg	0.001 in. Hg
	P _s /P _t MB	0.1 MB
ALT/AS	Altitude ft(m)	1 ft(m)
	Airspeed kts(km/hr)	0.1 kt(km/hr)

Resolution
 Table 1-7

The accuracy of the ADT-222A in both the measure and control modes is basically a function of the precision vibrating diaphragm pressure sensors and is verified with a Schwien manometer to the tolerances listed in table 1-8. Repeatability and hysteresis is included in the accuracy specifications. Repeatability is also listed separately. Because of the ADT-222A 16-bit, double-precision processor, the accuracy of the computed parameters (altitude, airspeed, Q_c, and millibars) is basically a function of the pressure tolerances.

Display Units	Range/ Reference	Accuracy	Repeatability
P_s (in. Hg)	0.32 to 40.000	± 0.003	± 0.0015
P_t (in. Hg)	0.5 to 32.000	± 0.003	± 0.0015
	32 to 65.000	± 0.004	± 0.002
	65 to 90.000	± 0.006	± 0.003
	90.0 to 100.000	± 0.010	± 0.005
Altitude (ft)	-1,800	± 3	
	10,000	± 4	
	20,000	± 6	
	30,000	± 8	
	40,000	± 12	
	50,000	± 19	
	60,000	± 31	
	70,000	± 49	
	80,000	± 80	
Airspeed (kts)	23	± 2.2	
	50	± 1.0	
	100	± 0.5	
	200	± 0.3	
	500	± 0.2	
	1000	± 0.1	
Q_c (in. Hg)	The RSS combination of applicable P_s and P_t tolerances.		

Accuracy and Repeatability
 Table 1-8

Range/ References [1]	Stability [2]
0.5 to 10.000	± 0.0002
20.000	± 0.0003
32.000	± 0.0007
40.000	± 0.0012
90.000	± 0.0020

- NOTES: [1] Units are inches
of mercury.
[2] Stability changes
linearly between
reference points.
Units are inches
of mercury.
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Control Stability
Table 1-9

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GROUND
EQUIPMENT
MANUAL
PN 4030935, 4039390

CHAPTER 2
INSTALLATION AND REMOVAL

Chapter 2
INSTALLATION AND REMOVAL

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Section 1. Handling and Mounting

1. Handling

Do not pick up the ADT-222A by the handles on the front panel. The handles have been supplied for purposes of pulling the unit out of an equipment rack when it has been mounted in an equipment drawer or on guide rails. Use handles on sides of ADT-222A when picking up unit.

There are no other special handling procedures for the ADT-222A. Although the ADT-222A is ruggedly constructed and has no components requiring delicate handling, it is a piece of precision test equipment and shall be handled carefully and with respect. It can be damaged by dropping.

2. Installation Environment

The ADT-222A has been designed to be used in an environment with an altitude of less than 6000 feet above sea level. It may be used at higher elevations provided that a sufficient flow of cooling air is supplied to keep its operating temperature below 110 degrees fahrenheit and the inlet pressure supply is capable of providing adequate volume and regulation to provide a flow of at least 0.1 cubic feet per minute (2.8 liters/minute) at a pressure of 65 ± 5 pounds per square inch absolute. The two internal pressure regulators may have to be reset. Refer to Chapter 3, section 5 for this procedure.

3. Mounting

The ADT-222A shall be installed so that it is within 2 degrees or less of being level on a bench top, equipment rack, or other mounting that is relatively free of vibration. It shall not share a mounting with the vacuum pumps.

The ADT-222A must not be mounted in a way that would restrict the air flow around its enclosure or block the exhaust air of the cooling fan.

CAUTION: DO NOT MOUNT THE ADT-222A SO THAT IT IS SUPPORTED BY THE EXTENDED FRONT PANEL ONLY. THE UNIT MUST ALSO REST ON SOME TYPE OF SHELF, DRAWER, OR RAIL MOUNTING.



Section 2. Equipment and Materials

1. General Requirements

The following additional equipment and materials, or their equivalents, are required for the installation of the ADT-222A. These items are not supplied with the ADT-222A.

Inlet supply of dry air or dry nitrogen at 50 ± 5 psig (65 ± 5 psi absolute)

Vacuum pump (two) - Model 1373B or 1373L, 300 liters/minute (10.6 cfm), Sargent Welch Scientific Co, Pomona, CA

NOTE: Listed below are three other sources for obtaining equivalent types of vacuum pumps and accessories:

Model ES330(C), 334 liters/minute (11.7 cfm), single stage, Edwards High Vacuum, Inc, Grand Island, NY

Model D-330, 320 liters/minute (11.2 cfm), single stage, Dynavac PTY LTD, Burwood Victoria, Australia

Model Hyvac 28S, 280 liters/minute (9.8 cfm), single stage, Central Scientific Co, Inc, Chicago, IL

Exhaust filter (two) - For the vacuum pumps

Pressure hose - Commercial

Vacuum hose (two 10-foot maximum lengths) - Metal tubing, 0.375 inch ID (9.52 mm), 0.875 inch OD (22.22 mm), Commercial (Flexible hose designed for vacuum applications is acceptable.) (0.375 inch ID minimum)

Anti oil suck back trap (two) - Locally fabricated

Connector plug - Three prong, commercial

In addition, use of the dynamic input capability of the system will require a waveform generator, Wavetek Model 154, or equivalent.

This additional equipment is discussed in more detail in the following paragraphs.

2. Power Connector

The power required by the ADT-222A, as defined by the dash number, is 115/230 volts (-X0X operates on 115 volts, -X1X operates on 230 volts), 45 to 440 Hz, single-phase. Operation of the system requires the connection of a safety ground. Since there is no standardized single-phase plug with a safety ground, no power plug is supplied with the ADT-222A. The user must supply a power connector plug to match the electrical wiring of the installation site.

CAUTION: DO NOT OPERATE WITHOUT A SAFETY GROUND.

3. Pressure Supply

The inlet supply shall be compressed, clean, dry, standard (ambient) air (for -9XX series) or dry nitrogen (for -8XX series) at a pre-regulated pressure of approximately 50 lbs/in² (or 3.5 kgs/cm²) gauge pressure. The air must be free of oil vapors and other contaminants, therefore oil lubricated air compressing systems should not be used. The supply air shall be filtered to pass a maximum particle size of 15 microns (15 x 10⁻⁶ meters), and shall have a maximum dew point of -50 °C. Minimum flow capability of the pressure source shall be 0.44 standard cubic feet per minute (2.1 lb. mass per hour). Dry nitrogen may be used with special calibration. A decal located just under green power pushbutton on the front panel indicates that the unit has been calibrated for either dry air or dry nitrogen. If the supply is not capable of ±5 psig regulation, it will be necessary to add a good quality two-stage commercial regulator capable of maintaining a pressure of 50 ± 5 psig.

The P_{in} connector on the rear panel of the ADT-222A is a 1/4 inch 37-1/2 degree male flare fitting (MS-33656-4). The pressure hose must have a pressure fitting designed to mate with this connector.

4. Vacuum Supply

Two separate vacuum pumps are required, one for the V_s port and one for the V_t port. The P_s vacuum requirement at the back panel of the ADT-222A is 0.1 inch Hg or less at a flow rate of 50.0 liters/minute, and 1.0 inch Hg or less at a flow rate of 110.0 liters/minute. The P_t vacuum requirement is 0.3 inch Hg or less at a flow rate of 50.0 liters/minute, and 2.0 inches Hg or less at a flow rate of 140.0 liters/minute. This requirement can be met by using two separate vacuum supplies, with 300.0 liters/minute free air displacement - Sargent Welch Model 1373B or 1373L, or equivalent.

The 1373B and 1373L are identical except for the input power used. The 1373L is designed for 115/230-volt, 50-Hz operation while the 1373B uses 115/230-volt, 60-Hz power. Vacuum pumps with flow versus vacuum capability equivalent to the Sargent Welch pumps may be substituted. The specifications of the 1373 pump are listed in table 2-1.

The Sargent Welch pumps must be equipped with exhaust filters and filter elements. Running the pumps without an exhaust filter will not damage the pumps or the ADT-222A, but the pumps will blow out some oil vapor that would normally be condensed by the filter and returned to the pump. The pump will also make much more noise without the filter. If an alternate manufacturer is selected to purchase pumps from, ensure that the appropriate exhaust filters are also obtainable from this same source.

An oil drip pan shall be placed under each vacuum pump because some oil vapor will eventually get past the filter and condense on the outside of the pump.

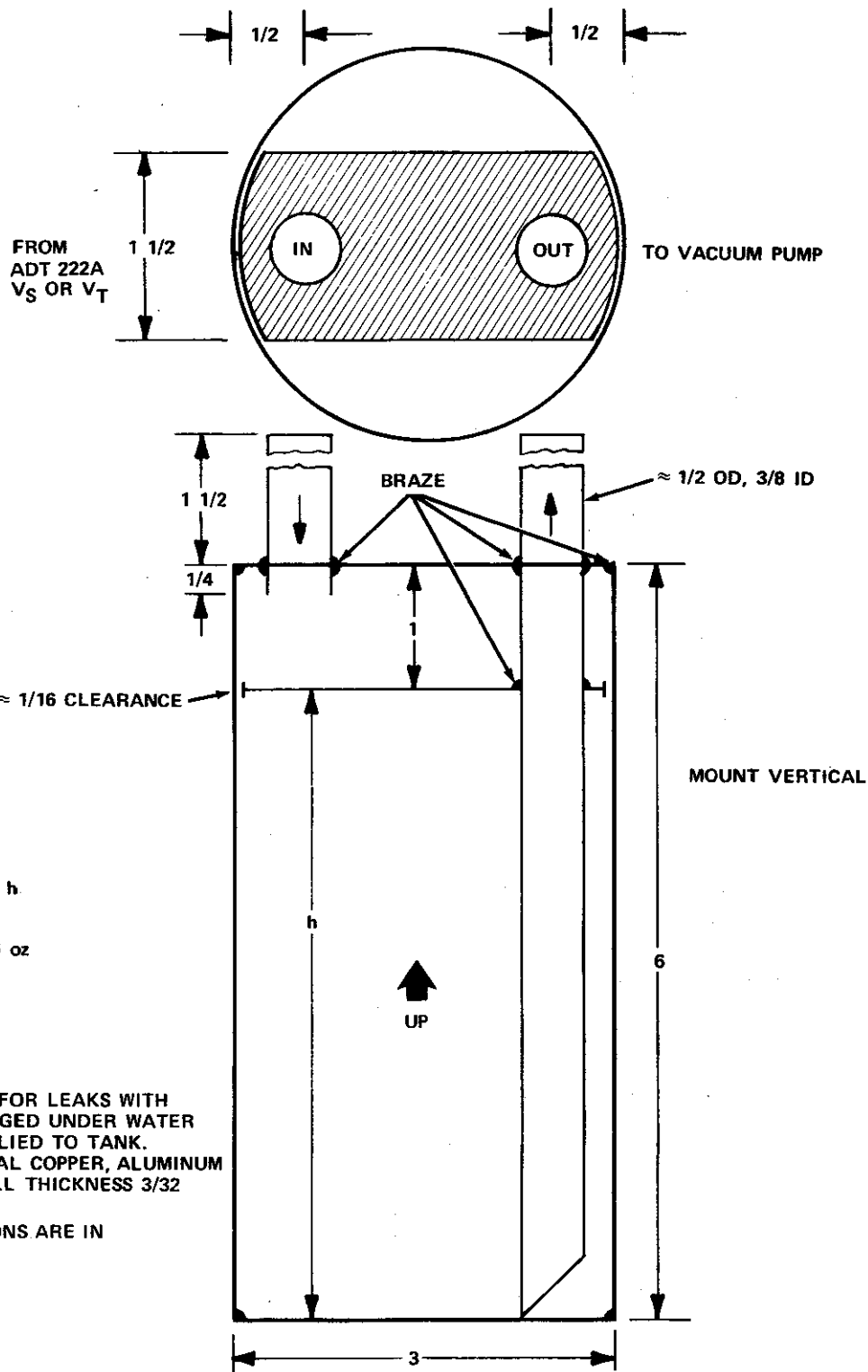
Because of differences in manufacturers, some vacuum pump models have better anti-oil suck back protection capability than others whenever pump power is lost. Therefore, it is recommended when purchasing vacuum pumps that a manufacturer's guarantee, to the effect that, "the pump will not allow oil to be sucked back into the vacuum system", is obtained. If such a guarantee is not obtainable and/or confidence in the pump capability/reliability is in question, it is further recommended that an oil trap, figure 2-1, be fabricated and installed. The trap is a simple, self-cleaning oil trap mounted vertically (figure 2-2) in each vacuum line.

Although manufactured traps may be purchased, caution must be exercised to ensure that the resistance to air flow is not any greater than that caused by two feet of 3/8-inch ID vacuum line.

The vacuum pumps may be left on 24 hours a day and if the ADT-222A is not being used, it shall be placed in the measure mode with the front panel shut off valves open to the atmosphere. Place the caps (hanging on the chains) loosely over the P_s and P_t panel pneumatic fittings. In the measure mode, there is no consumption of inlet air and thus no air flow (load) thru the vacuum pumps.

Two pumps are required for a normal installation. However, if one pump should ever fail and if only subsonic pressures are required, the ADT-222A may be temporarily operated using only one vacuum pump with the two vacuum lines tied together at the pump. This single pump operation will somewhat shorten the vacuum pump life and cause some oil vapor to escape through the exhaust filter. The rate capability of the ADT-222A will also be reduced.

The vacuum connectors, V_s and V_t , on the rear panel of the ADT-222A are 3/8-inch 37-1/2 degree male flare fittings (MS-33656-6). The vacuum hoses must have pressure fittings designed to mate with these connectors. Use only lines that are designed for vacuum, because other types of pneumatic hose will collapse under vacuum and cause a restriction in the vacuum line. Each of these lines must have a minimum of 3/8-inch inside diameter and a length of 10 feet, maximum. Any valve or filter inserted in these lines must have this equivalent cross section so it will not create a restriction.



$$V = \frac{\pi D^2 h}{4}$$

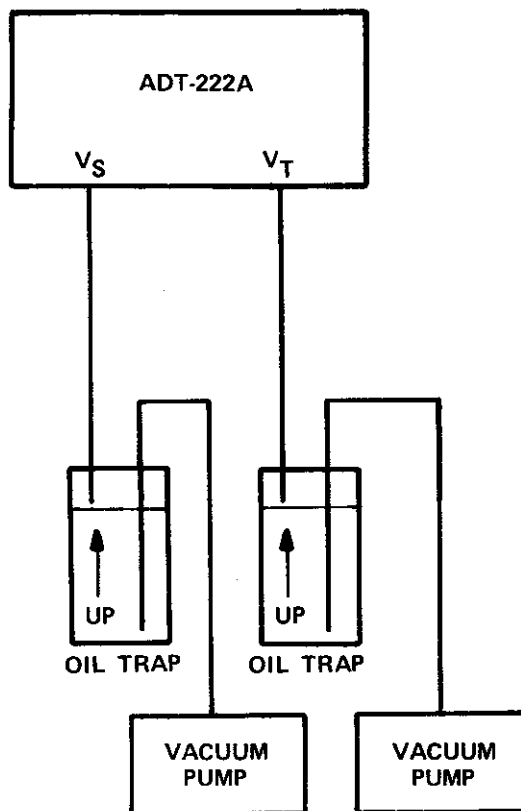
$$V = 19.6 \text{ oz}$$

NOTE:

1. BUBBLE TEST FOR LEAKS WITH TANK SUBMERGED UNDER WATER @ 30 PSIG APPLIED TO TANK.
2. TANK MATERIAL COPPER, ALUMINUM OR STEEL WALL THICKNESS 3/32 INCH MINIMUM
3. ALL DIMENSIONS ARE IN INCHES.

32320

Oil Trap Fabrication Layout
Figure 2-1



32321

Typical Oil Trap Interface
Figure 2-2

5. Control Interfaces

If the dynamic input capability of the ADT-222A is to be used, a waveform generator, Wavetek Model 154, or equivalent, should be connected to the DYNAMIC INPUT connector between J2-B (1o) and J2-A on the rear panel of the ADT-222A. This connector is a Bendix Part No. JTP02RE8-35 and mates with a Bendix Part No. JT06RE8-98 P(SR) connector.

NOTE: Facing the connector, pin J2-A is to the left of the keying slot and pin J2-B is directly below the slot.

If the ADT-222A is to be operated by an ATE or from a programmable terminal, the controlling equipment must be compatible with the IEEE Standard 488-1975 interface and connected to the ATE connector on the rear panel of the ADT-222A. This connector is a Bendix Part No. JTP02RE14-35S and mates with a Bendix Part No. JT06RE14-35 P(SR) connector.

Refer to Chapter 5 for instructions applicable to ATE operation.

1373B Pump - Complete with base, motor, oil, belt, belt guard and cord with line switch and plug. For operation from 115/230-volt, 60-Hz power, wired for 115-volt operation.

1373L Pump - Identical to 1373B but for operation from 115/230-volt, 50-Hz power.

Free Air Displacement - 300 Liters/Minute (10.6 cfm)

Guaranteed Ultimate Pressure - 1.5×10^2 Torr (McLeod Gauge)

Number of Stages - 1

Pump Speed - 525 RPM

Motor - 1/2 HP

Motor Speed - 1725 RPM

Drive - 1 V-Belt

Oil Capacity - 2-1/2 Qts

Tubing Required - 1-5/8 Inch ID

Intake Connection - Nipple Thread Type, 1-1/2 - 12, inside dia, 1-1/8 in.

Exhaust Connection - Thread type, 1-20

Weight (pump only) - 68 Pounds

Shipping Weight (pump only) - 75 Pounds

Weight (pump, motor, base, drive) - 102 Pounds

Shipping Weight (pump, motor, base, drive) - 115 Pounds

Overall Dimensions (inches) - 19-1/4 length by 12-1/4 width by 15-3/8 height

Exhaust Filter - 1417A

Filter Element - 1417G

Vented Exhaust - Not Available

Belt Guard - Standard

Quick Disconnect Coupling - Optional, 1393E

Specifications for Recommended Vacuum Pump
(Sargent Welch Model 1373B/1373L)
Table 2-1

Section 3. Installation Procedure

NOTE: Installation procedures for the optional ATE interface are contained in Chapter 5.

1. Do not break the seal on the top or bottom cover of the ADT-222A.
2. Do not adjust the pressure regulators on the back panel of the ADT-222A.
3. If the ADT-222A is to be rack-mounted, mount it in a standard EIA 19-inch rack.

CAUTION: DO NOT MOUNT THE ADT-222A SO THAT IT IS SUPPORTED BY THE EXTENDED FRONT PANEL ONLY. THE UNIT MUST ALSO REST ON SOME TYPE OF SHELF, DRAWER, OR RAIL MOUNTING.

Alternatively, the ADT-222A can rest on a bench top.

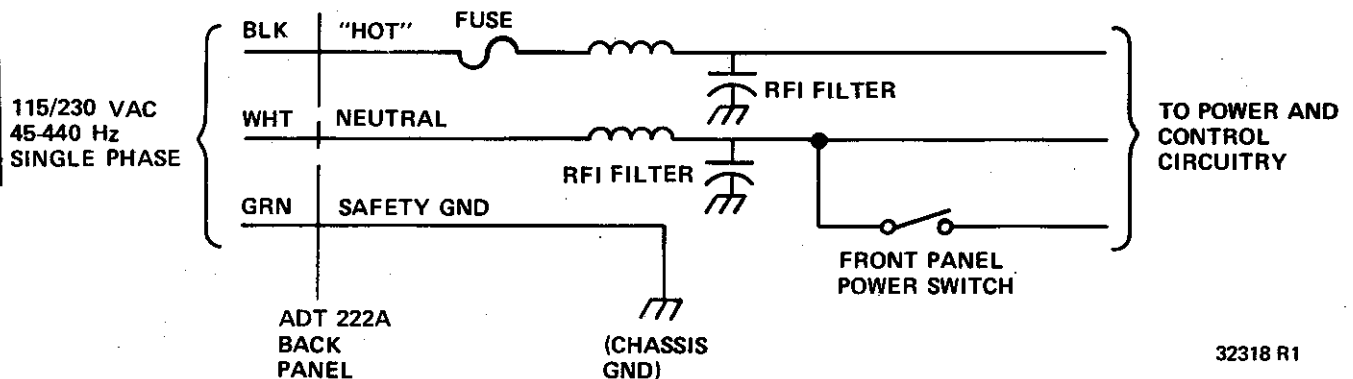
CAUTION: REFER TO THE ADT-222A CONFIGURATIONS TABLE IN THE FOREWORD FOR VOLTAGE SOURCE FOR EACH SPECIFIC PART NUMBER. OPERATING VOLTAGE IS INDICATED ON REAR PANEL INSTRUCTION PLATE.

4. Install a power plug consistent with your electrical wiring. A power plug installation schematic is shown in figure 2-3. A 115/230 volt rms, 45 to 440 Hz, single-phase plug with a safety ground is required. The reason that your ADT-222A did not come with a plug is because there is no standardized single-phase plug with a safety ground.

INSTALLATION CRITICAL

The following step fulfills the INSTALLATION CRITICAL requirement to prevent electrical shock by ensuring that continuity exists between chassis and chassis ground wire at plug end of power cable.

5. Measure for resistance of less than 1 ohm between ADT-222A chassis and chassis ground wire at plug end of power cable. Connection of this green safety ground to the chassis ground is mandatory.



Power Connection Schematic
Figure 2-3

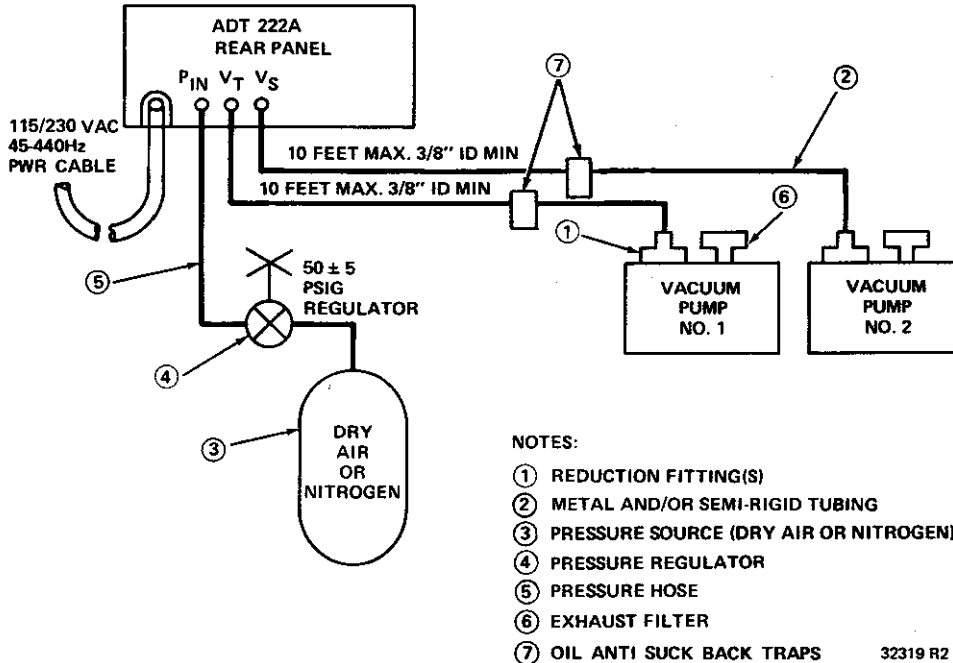
32318 R1

6. Connect a 50 ± 5 psig inlet supply of dry air or dry nitrogen to the P_{in} (1/4 inch 37-1/2 degree MS-33656-4) male flare fitting on the back panel of the ADT-222A. (See figure 2-4.) A decal located just under the front panel green power pushbutton indicates that the unit has been calibrated for either dry air or dry nitrogen. Also, the dash number of the ADT-222A defines the medium that the unit has to be calibrated for (i.e., -8XX indicates dry nitrogen and -9XX indicates dry air).
7. Connect two Sargent Welch Vacuum pumps (Model 1373B, or equivalent) to the V_s and V_t pneumatic fittings on the back panel of the ADT-222A. Use a separate line between V_s and one pump, and a separate line between V_t and the other pump. These back panel vacuum fittings are 3/8 inch 37-1/2 degree (MS-33656-6) male flare. Use 3/8 inch inside diameter vacuum line up to 10 feet long. Longer lines may be used if the inside diameter is increased. The following equation may be used to calculate the required minimum inside diameter for line lengths longer than 10 feet.

$$D \geq \left(\frac{L}{505} \right)^{\frac{1}{4}}$$

D = ID in inches.
L = Length in feet.

8. Connect the ADT-222A to the power source but do not turn in on yet. You are now ready to perform the installation verification procedure.



Pneumatic Connection Schematic
Figure 2-4

Section 4. Installation Verification

NOTE: Before operating the ADT-222A, read Chapter 1.

1. Measure Mode

- A. Press the POWER pushbutton on the ADT-222A front panel to turn on power. The green light should light. The ADT-222A will begin its self test routine. Self test starts by flashing the lights on the front panel five times in order so that the operator may check for a defective lamp. Some lights may stay on and not flash. Some lights may flash at different rates. However, all lamps plus COMMAND switch decimal points should light.

After the 5 cycle light flashing sequence is finished, the ADT-222A will cycle the displays thru 0, 1, 2, ... A, blank, C, -d, E, F etc. until the operator selects the units he wants to use (i.e. presses one of the four vertical pushbuttons: ALTITUDE FT(M)/AIRSPEED KTS (KM/H); P_S IN HG (MB)/ Q_C IN HG (MB); P_S IN HG (MB)/ P_t IN HG (MB); ALTITUDE FT (M)/MACH. If the self test fails, the ADT-222A will just continue to flash the front panel lights and will not allow the operator to select the desired measurement units.

- B. Open the P_S and P_t front panel manual shutoff valves (pull) and remove the caps from the P_S and P_t pneumatic fittings.
- C. Press one of the four pushbuttons. For the following example, push P_S IN HG (MB)/ P_t IN HG (MB). The ADT-222A will enter the measure mode and you will hear the solenoid valves open.

The warmup cycle will take between 15 and 30 minutes. During this time, both displays will indicate CCC in the three right-hand digits. When the warmup cycle is complete, the displays will cease to indicate CCC.

The ADT-222A is in the measure mode measuring the static pressure input in inches of Hg and the pitot pressure input in inches of Hg. Both the P_S and P_t displays will be measuring the local atmospheric pressure in inches of Hg absolute.

Any pressure within the measurement range of the ADT-222A may now be connected to the P_S and P_t ports and measured accurately. The measurement ranges are listed in Chapter 1, section 3.

By pressing any of the other three vertical pushbuttons, the measurement of these input pressures may be read directly in units of millibars, meters, kilometers/hour, feet, knots or mach. Press METRIC WHEN LIT pushbutton to change readout to metric units, press again to return to English units.

2. Control Mode

- A. Turn on the 50 psig air (or nitrogen) supply. Verify that the pressure at the back panel is 50 ± 5 psig.
- B. Turn on both vacuum pumps.
- C. Turn on the ADT-222A power and put the ADT-222A in the measure mode with P_s/P_t inches of Hg displayed (as described previously).
- D. Open the P_s and P_t shutoff valves and remove the caps, thus venting the P_s and P_t measurement systems to the atmosphere.

NOTE: Normally with the ADT-222A in this state, a unit to be tested (UUT) would be connected to the P_s and P_t front panel pneumatic fittings for -XX1 units, and -XX2 units for rear panel pneumatic fittings. The state of the DISABLE Q_c LIMIT (DQCL) and the DISABLE SUBSONIC LIMIT (DSSL) should already be set. These limits are intended to protect the UUT from an improper command and should be set prior to connecting the UUT to the ADT-222A. Once the state of these limits are set, do not push them until the UUT has been removed from the ADT-222A. Even if the lights flash, don't push them because this will change the protection limits and allow the ADT-222A to accept a UUT over range command. Also, once a UUT has been connected to the ADT-222A, do not close the manual shutoff valves unless an "FFF" appears in the display.

- E. Until you are familiar with the operation of the ADT-222A, do not connect a UUT, but instead close both the P_s and P_t front panel manual shutoff valves.
- F. Press the CONTROL pushbutton. The CONTROL button will light. Verify that the inlet pressure at the rear panel is still 50 ± 5 psig.

The vacuum pumps will sound louder especially if no exhaust filter has been installed. This is normal.

As soon as you press CONTROL, the ADT-222A pneumatically disconnects itself from the UUT and begins to initialize its control system pressure to the pressure being measured just prior to pressing the CONTROL pushbutton. This sequence will take about 15 seconds to complete. When it has completed, the ADT-222A will pneumatically reconnect itself to the UUT. You will hear a solenoid operate inside the ADT-222A when complete.

Section 5. Removal from Service

For accuracy and stability, the ADT-222A should not be turned off and the vacuum pumps may be left on 24 hours a day. If the ADT-222A is not being used, it shall be left in the measure mode with the P_s and P_t shutoff valves open to the atmosphere. Place the caps, hanging on the chains, loosely over the P_s and P_t input ports. In the measure mode, there is no consumption of inlet air and no air flow through the pumps.

If you desire to shut off the vacuum pumps or turn off the ADT-222A, perform the following shutdown procedure:

1. Press the P_s IN HG (MB)/ P_t IN HG (MB) pushbutton.
2. Close the P_s SHUTOFF and P_t SHUTOFF valves.
3. Press the CONTROL pushbutton.
4. Set both sets of the COMMAND select switches to 020000.
5. Set Rate Command switches to 40,000 ft/min and 500 milli-in Hg/sec.
6. Press the ENTER pushbutton.
7. When both displays have reached "20.000", turn off both vacuum pumps.
8. When a steady "E" appears in both displays, open the P_s SHUTOFF and P_t SHUTOFF valves to vent the ADT-222A to the atmosphere.
9. Wait 15 seconds.
10. Place the port caps loosely over the P_s and P_t ports.
11. Press the MEASURE pushbutton.
12. Press the POWER pushbutton to turn off the ADT-222A.

The above procedure relieves the high vacuum in the vacuum lines and removes any possibility of vacuum pump oil diffusing into the ADT-222A pneumatic system. The ADT-222A can now be disconnected from the electrical, pressure, vacuum, and control sources, and removed from its mounting.



2. G. Dial the P_S/P_t COMMAND switches to:

$P_S = 30.000$ in. Hg.
 $P_t = 30.000$ in. Hg.

P_S Rate to 10000 feet/minute
 P_t Rate to 200 milli-in. Hg/second

NOTE: The lighted decimal point in the COMMAND switches traces the display decimal point. The rate decimal point is always on the extreme right.

- H. Press the ENTER pushbutton. The ADT-222A will control the P_S and P_t pressure from your local ambient pressure to 30.000 inches Hg at 10,000 feet/minute and 200 milli-in. Hg/second respectively, if the ADT-222A is connected correctly, and, if for both measure and control states, the P_{in} pressure at the ADT-222A back panel is 50.0 ± 5 psig. If this pressure is not regulated properly in the measure mode, the ADT-222A may not open a pneumatic solenoid and allow this inlet pressure to reach the internal control system. Thus the control system will not operate.

If the ADT-222A does not command to 30.000 inches Hg or if there is an "E" in either display (30.00E), the system has detected a failure. Recheck your installation.

- I. After both displays reach 30.000 in. Hg, dial these new commands.

$P_S = 000.500$ in. Hg
 $P_t = 001.500$ in. Hg
 P_S rate = 30,000 ft/min
 P_t rate = 300 milli-in. Hg/sec

- J. Press the DISABLE Q_C LIMIT and DISABLE SUBSONIC LIMIT pushbuttons to turn on their lights.
- K. Press ENTER. The P_S and P_t displays shall control to $P_S = 0.500$ in. Hg and $P_t = 1.500$ in. Hg. If either display does not reach the commanded value, a steady "E" will appear in the display. This steady "E" means that something is wrong. In this case, you probably have a leak in the vacuum line between the back panel and the vacuum pumps, or else there may be a restriction in the vacuum lines.

These lines must be a minimum of 3/8-inch ID throughout their entire length (10 feet maximum). Any valve or filter installed in these lines must have this effective size, otherwise a pressure drop will occur at the restriction. If you are not using tubing designed for vacuum, you may have a collapsed hose.

2. L. If the ADT-222A displays go to the commanded pressures, dial in these new commands.

$P_s = 32.000$ in. Hg

$P_t = 90.000$ in. Hg

- M. Press ENTER. If the displays do not reach the commanded values a steady "E" will appear in the display. If this happens, check the P_{in} inlet pressure for 50 psig regulation.
- N. Press MEASURE, then press P_s MEASURE/ P_t CONTROL pushbutton; button shall light indicating ADT-222A is in split channel mode.
0. Press ENTER. If P_t display does not reach commanded values, a steady "E" will appear in the display. If display responds properly, P_t shall indicate last pressure commanded.

If these tests pass, your ADT-222A is installed and operating properly. Please continue operating the front panel controls to become familiar with their operation. Commands may be given directly in any of the measurement units. Wait until the pressures reach the last commanded values and try different units.

Important: If for any reason you wish to rapidly stop the pressure command, press the MEASURE pushbutton. This will immediately disconnect the ADT-222A control system from the UUT and stop the pressure changes.

Section 6. Storage and Shipping

NOTE: Sperry Flight Systems' warranty responsibility is contingent upon the use of the procedures, equipment, and materials specified for the handling, storage, and preparation for shipment of the ADT-222A.

1. Storage

If the ADT-222A is to be removed from service and stored for long periods of time it must be protected from dust, moisture, and other contaminants. The best way to provide this protection is to package the ADT-222A for shipment before storage. The original shipping materials are reusable and should be saved for this purpose.

2. Equipment and Materials

Polyethylene wrapping, 6 by 6 feet (1.83 by 1.83 m)

Expanded polystyrene bead board (two pieces), 29.25 by 12.25 by 2 inches (74.3 by 27.5 by 5.1 cm) with a 0.125 inch (0.3 cm) wide by 0.75 inch (1.9 cm) deep groove cut across the 29.25 by 12.25 inch (74.3 by 27.5 cm) face. The groove is parallel to, and 3 inches (7.6 cm) from, the 12.25 inch (27.5 cm) side. (See figure 2-5, detail A.)

Expanded polystyrene bead board (two pieces), 29.25 by 12.25 by 0.5 inches (74.3 by 27.5 by 1.3 cm)

Inner container, 29.25 by 23.0 by 12.25 inches (74.3 by 58.4 by 27.5 cm) high, double covered carton sleeve with end caps to fit

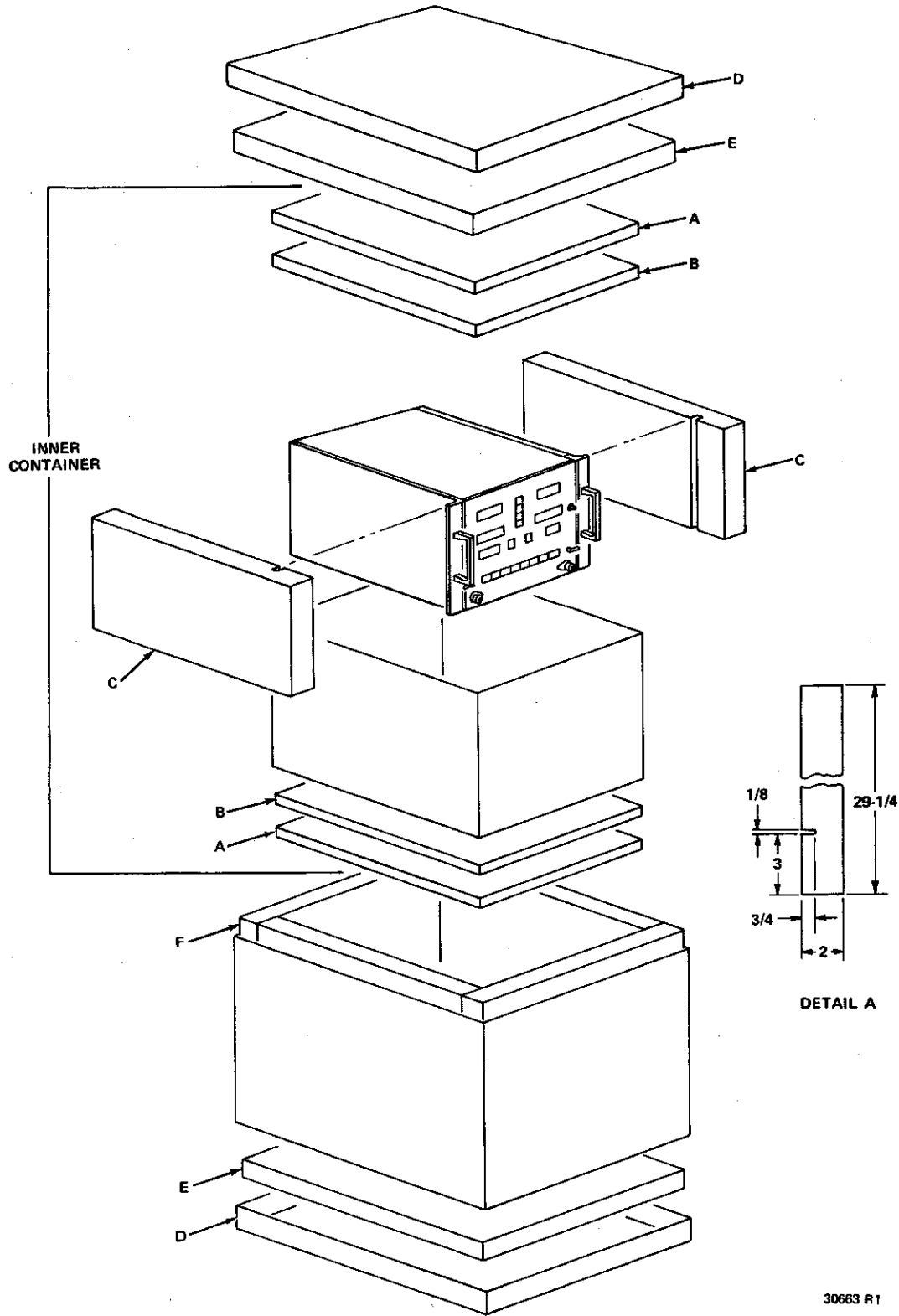
Barrier bag, 46.5 by 60 inches (118.1 by 152.4 cm) (Required for overseas shipment only.)

Uncompressed bound fiber cushioning material (two pieces), 23 by 12.25 by 3 inches (58.4 by 31.1 by 7.6 cm)

Uncompressed bound fiber cushioning material (two pieces), 35 by 29 by 3 inches (88.9 by 73.7 by 7.6 cm)

Outer container, 35.25 by 29 by 17 inches (89.5 by 73.7 by 43.2 cm) high, double covered carton sleeve with end caps to fit

Strapping, 3/8-inch (0.9 cm) plastic, with required strapping tool



30663 R1

ADT-222A Storage and Shipping Container
Figure 2-5

3. Preparation for Shipping

- A. Place the inner container sleeve, open end up, in one of the end caps (A, figure 2-5). Place one piece of polystyrene bead board (B) on the end cap inside the sleeve.
- B. Important: Close both manual shutoff valves on the ADT-222A and cover all connectors and pneumatic fittings with the attached caps.
- C. Wrap the ADT-222A in polyethylene wrapping. Place polystyrene bead board (C) on ADT-222A so that the protruding edges of the front panel fit into the grooves in the polystyrene.
- D. Place the ADT-222A and polystyrene into the inner container sleeve with the power cable in the area at the rear of the ADT-222A.
- E. Place the remaining piece of polystyrene on top of the ADT-222A and cover with the remaining end cap. Sleeve the end caps in place with two strapping bands.
- F. Place the inner container in the barrier bag, exhaust the air from the bag, and heat seal the open end of the bag. (This step is required only for oversea shipment.)
- G. Place the outer container sleeve in one of the end caps (D). Place cushioning material (E, F) at the bottom and all sides of this container.
- H. Place the inner container into the outer container, within the cushioning material. Place the remaining cushioning material on top of the inner container and cover with the remaining end cap. Secure the end caps with two to four strapping bands.
- I. Mark the container to identify the contents and date of packaging.





GROUND
EQUIPMENT
MANUAL
PN 4030935, 4039390

CHAPTER 3
MAINTENANCE

CHAPTER 3
MAINTENANCE

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Section 1. Introduction

This manual assumes no specific maintenance philosophy. The user should decide to what extent he should test, calibrate, repair, and provision the ADT-222A based on his assessment of his available resources and his usage of the system.

The ADT-222A should be tested periodically in accordance with Chapter 3, section 2 and calibrated as necessary to correct out-of-tolerance conditions discovered during testing. If a failure is detected, either by BIT or during the performance verification tests, refer to Chapter 3, section 4 for troubleshooting procedures to isolate faults to the malfunctioning circuit or subassembly. The troubleshooting procedures will indicate what additional diagnostic tests and calibration or repair actions are necessary to correct the fault.

PRODUCTION CRITICAL

Sperry has identified as PRODUCTION CRITICAL continuity between terminal E6 (see 4-4, figure 4-1, item 47) and ADT-222A chassis. If, in the course of maintenance, the nut securing terminal E6 is loosened, it must be re-tightened to a torque of 8 pound-inches. This will prevent a condition that may cause electrical shock by ensuring that chassis is grounded.

Sperry does not specify a finite verification cycle for the ADT-222A, as most customers prefer to establish their own. The verification period is normally derived by each customer, considering any unique test requirements and his experience with the equipment. As a baseline, Sperry recommends that the equipment be checked upon initial installation and rechecked on a 30-day cycle until the user obtains sufficient confidence to extend the period.



Section 2. Performance Verification

1. Verification Interval

To maintain a high level of confidence that the ADT-222A is performing in accordance with the specifications, it is necessary to perform periodic verification tests of the system's performance. You should determine the verification intervals commensurate with your usage of the ADT-222A and your required level of confidence. Although no limits for the rate of drift of the ADT-222A sensors have been established, Sperry guarantees that the system will retain the accuracy specified in Chapter 1, section 3 for a period of 6 months after delivery. It is recommended that during your initial 6 months operation of the ADT-222A you conduct the performance verification tests every 30 days and retain the test records. By comparing the shifts in test data over this period, you can establish the drift rate for your system and adjust the test interval to fit your requirements.

2. Test Equipment Accuracy

The performance specifications listed in Chapter 1, section 3 can only be maintained if you use the Schwien manometer specified by the test and calibration procedures. If a slight degradation of the accuracy specifications is acceptable to your requirements, however, other test equipment can be used to test and calibrate the ADT-222A. Keep in mind that the accuracy of the ADT-222A is only as good as the equipment used to calibrate it.

NOTICE

Limiting the accuracy verification to the pressure ranges required for UUT test does not affect performance of the ADT-222A in any way and does not affect the equipment's guarantee, when operated within the established ranges.

Accuracy verification and minor calibration of P_s and P_t pressure only over the ranges required to support the UUT (air data computer, etc) will reduce both verification and calibration times. Verification of the ADT-222A can be accomplished using the procedures presented in this manual, but excluding the pressure test points outside the required ranges. A nameplate listing the ranges over which the accuracy is verified should be located on the front panel in a prominent place.

Either another ADT-222A or a Sperry ADT-321 Air Data Pressure Standard can be used for the calibration of your ADT-222A with only slight degradation of the accuracy specifications.

If another ADT-222A, or an ADT-321, is to be used to test and calibrate your system, it should be used as a transfer standard. The transfer standard is first calibrated on the specified pressure standard (Schwien manometer) and is then used to calibrate your ADT-222A. The most important factor in the

performance of a transfer standard is its capability to repeat measurements. Regardless of its specified accuracy, if the transfer standard has high repeatability (low error between separate measurements of the same pressure), it can be used with its calibration charts to achieve a measurement accuracy approaching that of the Schwien manometer.

For the sake of comparison, the specifications for the Schwien manometer are listed in table 3-1. The applicable specifications for the ADT-222A and ADT-321 are listed in table 3-2 and table 3-3, respectively.

If an ADT-222A is used to test or calibrate your system, it can be used in exactly the same way as the Schwien manometer. The test and calibration procedures are the same. If an ADT-321 is used, however, the procedures are not the same. Since the ADT-321 is a measurement device only, your system must provide the pressure control to obtain the pressures specified in the procedures. To do this, you have to operate your system so that the required value is displayed on the ADT-321. In all other aspects, the procedure is the same.

Schwien Precision Manometer Model 1025EX100
Schwien Engineering, Inc

Range	0.3 to 100.0 inches Hg
Accuracy	± 0.0003 inches Hg $\pm 0.003\%$ of reading
Resolution	± 0.0001 inches Hg
Offset	± 0.0005 inches Hg (automatic null) Zero (manual null at pressure)

Schwien Manometer Specifications
Table 3-1

Display Units	Range	Accuracy	Repeatability
P_s (inches Hg)	0.32 to 40.000	± 0.003	± 0.0015
P_t (inches Hg)	0.500 to 32.000	± 0.003	± 0.0015
	32.001 to 65.000	± 0.004	± 0.002
	65.001 to 90.000	± 0.006	± 0.003
	90.001 to 100.000	± 0.010	± 0.005
Resolution (P_s and P_t)	0.001 inches Hg		

ADT-222A Specifications
Table 3-2

<u>Display Units</u>	<u>Range</u>	<u>Accuracy</u>	<u>Repeatability</u>
P _s (inches Hg)	0.32 to 32.000	±0.002	±0.001
P _t (inches Hg)	0.500 to 60.000	±0.004	±0.002
	60.000 to 90.000	±0.005	±0.0025
Resolution (P _s and P _t)		0.001 inches Hg	

ADT-321 Specifications
Table 3-3

3. Test Procedure

The performance verification test procedure is contained in the integrated test specification (IT) for the ADT-222A. The IT is used by Sperry for final acceptance testing of the ADT-222A. Consequently, successful attainment of the requirements of the IT constitutes verification that the ADT-222A is properly calibrated and operating in accordance with the factory specifications. The IT is shown in table 3-4.

NOTICE

Procedures in table 3-4 are based on Sperry Integrated Test Specification, IT4030935-901, revision E(R).



1. SCOPE

This integrated test specification establishes the test requirements for the ADT-222A Air Data test system Part No. 4030935-901, -902, -911, -912, -801, -802, -811, -812, in order to assure that the complete system is operating properly.

2. DELETED

3. GENERAL INFORMATION

The ADT-222A Air Data test system provides both pressure measurement and Pressure Control of the static pressure (P_S) and the total pressure (P_T). Pressure readouts and digital control input commands are presented in inches of mercury, millibars, or altitude and airspeed as selected by the operator. Precision digital rate control can be commanded by the operator in units of feet per minute, meters per minute, knots per minute, kilometers per hour per minute, millibars per minute, or milli-inches of mercury per second. The ADT-222A also provides control of Q_C transients during pressure rates in the P_S/Q_C and Altitude/Airspeed Modes. In addition, sinusoidal pressure waves can be generated by feeding an audio signal generator into the dynamic input connector on the back panel of the ADT-222A.

4. POWER AND SIGNAL REQUIREMENTS

4.1 Power Sources.

4.1.1 Part No. 4030935-901, -902, -801, -802, 115 volts rms $\pm 10\%$, 45 to 440 Hz single phase power with safety ground, 3.0 amperes or greater.

4.1.2 Part No. 4030935-911, -912, -811, -812, 230 volts rms $\pm 10\%$, 45 to 440 Hz single phase power with safety ground, 1.5 amperes or greater.

4.2 Signal Sources.

Square wave signal generator with 1 volt peak to peak and 15 volts peak to peak at 0.1 Hz.

5. TEST EQUIPMENT

110 inches of mercury Schwien Manometer (or equivalent)*
Vacuum Pumps; two Sargent Welch No. 1373B (or equivalent)
Signal Generator, Wavetek VCG Model III; or equivalent
Two 30-cubic inch volume tanks SPN = 4022677
Pressure Source; Dry Air for Part No. 4030935-901, -902, -911, -912 or
Dry Nitrogen for Part No. 4030935-801, -802, -811, -812.

*In the event that a field service depot or an ADT-222 customer does not have access to a primary pressure standard such as a Schwien manometer, a pressure transfer standard such as an ADT-321 may be used to calibrate an ADT-222 throughout its control pressure range ($0.5 \leq P_s < 32$ in. Hg Abs and $1.5 < P_t < 90$ in. Hg Abs) per EB4034629. This procedure will not allow calibration throughout the full measure range of the ADT-222. ($0.32 \leq P_s < 40$ in. Hg Abs and $0.5 < P_t < 100$ in Hg Abs). If calibration through the full measure range is actually required, the ADT-222 must be sent to the nearest 100 in. Hg Schwien manometer location and calibrated normally. This field calibration procedure may not be used during initial manufacture at Sperry Flight Systems.

6. TEST SETUP

6.1 Initial Switch Settings

<u>Switch Description</u>	<u>Position</u>
Ps SHUTOFF	Off (Down)
Pt SHUTOFF	Off (Down)
DYNAMIC INPUT	Off (Rear Panel)

6.2 Unit Under Test (UUT) Connections (Figure 1)

The UUT Line Cord shall be connected to the appropriate power source (refer to 4.1). The green wire shall be grounded before connecting unit to power source. Turn off the green power switch immediately if it comes on when unit is plugged in. Refer to Test No. 1.

6.2.2 Vacuum Connection

Connect vacuum pumps (Sargent Welch Model No. 1373 or equivalent) to Vt and Vs fittings provided at rear of UUT. Each fitting is to be connected to a separate pump. Use 3/8 ID minimum hose with a maximum length of 10 feet.

6.2.3 Pressure Connection

Connect a pressure supply of clean dry air or dry nitrogen (N₂) to the P_{in} fitting at the rear of the UUT. The pressure shall be pre-regulated to 50 lbs/in² ± 5 (Gage Pressure). Refer to paragraph 5 for proper supply.

NOTE 1: Static and pitot pressure ports are located on the front (as shown) for Part No. 4030935-901, -911, -801, -811. Static and pitot pressure ports for Part No. 4030935-902, -912, -802, -812 are located on the rear between the dynamic input switch and the V_S port.

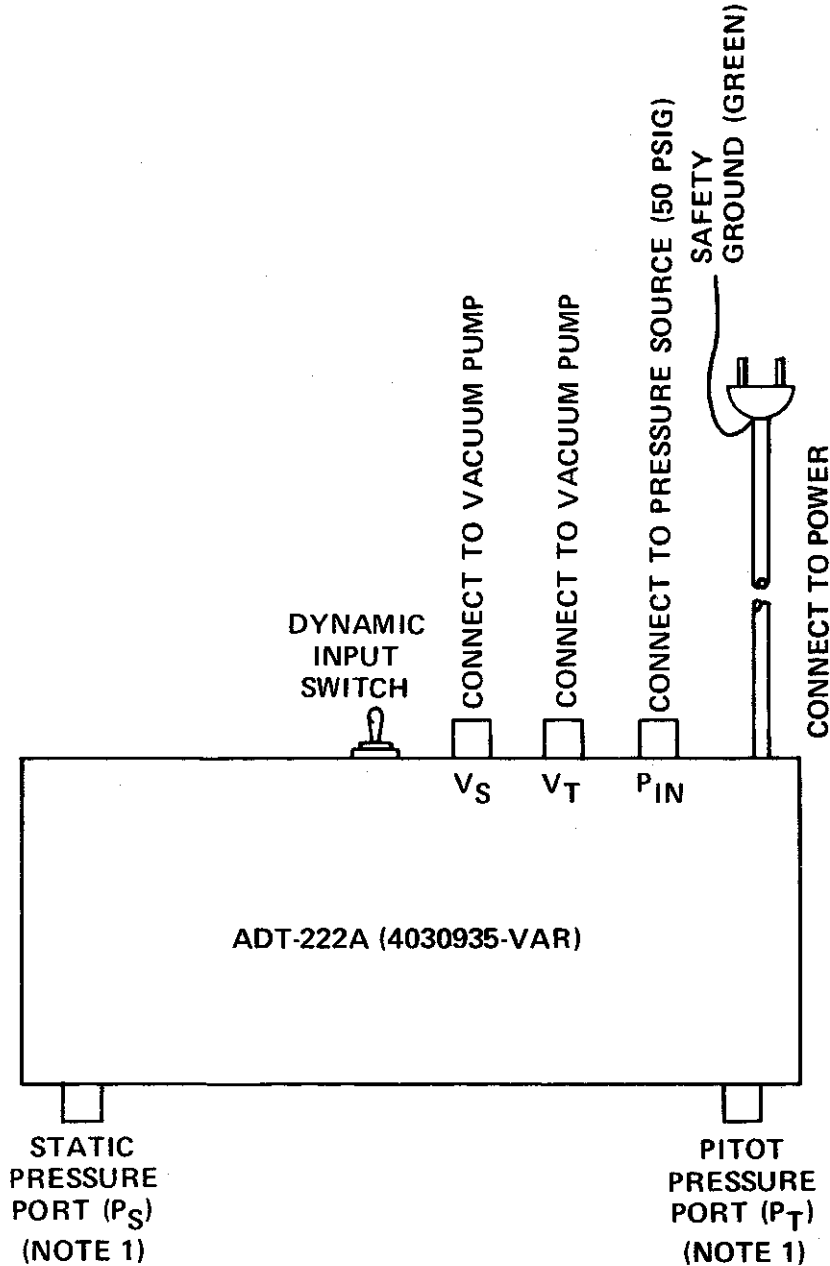


Figure 1
ADT-222A Test Connections

REF I.D. 31926

7. TEST REQUIREMENTS

<u>Column</u>	<u>Description</u>
Test No.	Tests are normally numbered in sequence. If any tests are added in future revisions, such as after Test 4, these added tests may be numbered 4.1, 4.2, 4.3.
Switch Pos	Perform switch settings in order specified. When an item is entered in Work Steps column opposite a switch setting other than the first, or when there is an additional space between switches, perform this work before setting any other switches.
Work Steps	When work step items are entered opposite first switch pos, perform all switch setting other than first setting or when there is an additional space between switches, perform work step item before setting any other switches.
Opr Limits	Units under test shall meet these limits prior to operational use. When an item is marked optional in this column, the corresponding test is not required except as an aid in troubleshooting.
Test Description	These items are the parameters to which the unit under test was designed. In addition, these items aid in troubleshooting by specifying the input and output signal terminals. For brevity all conditions required need not be repeated for each test. Conditions established in previous tests may also apply.

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
1.00	15 to 30 min.		<u>SENSOR WARM-UP</u> With power applied (per Section 6.2) to the UUT, both Static Pressure and Pitot Pressure displays shall indicate CCC in the least significant positions for the time specified.	Power On P _S /P _T On		<u>SENSOR WARM-UP</u> <u>NOTE</u> Power must be left off the UUT for at least 4 hours prior to this test. Start a timer when power is turned on. When lamps stop flashing (5 flashes) operate the P _S /P _T switch. Do not remove power for more than 30 seconds total during this test. Stop Timer when all CCC disappear.

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
2.00			<p><u>SELF TEST</u></p> <p>When power is cycled (off to on) the UUT shall initialize in the self test mode. The response of the front panel lamps and displays shall be as described below.</p>			<p><u>SELF TEST</u></p>
2.01	All lamps OK All decimal points OK		The total number of lamps is 15, plus 4 LED decimal points.	DISABLE Q _c Limit - Off DISABLE Subsonic Limit - Off Power - Off Power - On		Cycle power quickly so time duration in Test 1 will not be affected. All lamps shall come on. Some may flash, some may not, but all lamps shall turn on.
2.02	All displays OK					When the lamps stop flashing, each display digit shall cycle exhibiting the following characters: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, (Blank), C, -d, E, F, (Decimal Point) Decimal point shall shift through all six positions of each display.

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
3.00			<p><u>LEAK TEST</u></p> <p>With the UUT connected as shown in Figure 1 and the front Ps and Pt ports capped (Ps and Pt Shutoff valves open), the leak rate shall be as specified. The test shall be conducted at 31 ± 1 in. Hg on Ps side and at 89 ± 1 in. Hg on the Pt side. The measurement shall be taken with the UUT in the Measure/Ps-Pt mode after allowing 5 to 6 minutes for the system to stabilize. The readings will be taken 1 minute apart.</p> <p style="text-align: center;"><u>NOTE</u></p> <p>Use the Ps and Pt caps hanging on the chains on the panel.</p>	Measure - On P _S /P _T - On P _S /P _T SHUTOFF Valves - Open Control - - On Disable Q _C Limit - On Disable Subsonic Limits - On Measure - On		<p><u>LEAK TEST</u></p> <p>Cap Ps and Pt fittings using attached caps.</p> <p>Set digit switches to Ps = 031.000 in. Hg Pt = 089.000 in. Hg Ps Rate H = 40,000 ft/minute Pt Rate P_T = 500 milli-in. Hg/sec</p> <p>Operate ENTER. Wait until the displays reach the commanded pressures.</p> <p>Wait at least 5 minutes before taking readings. Take readings from Ps and Pt displays one minute apart.</p>
3.01	-.005 to +.005 in. Hg/minute (Ps)					
3.02	-.005 to +.005 in. Hg/minute (Pt)					

TEST NO.	SPECIFICATION		PROCEDURE	
	OPR LIMITS	C	SWITCH POS	C
3.03	-.005 to +.005 in. Hg/minute (Ps)		Control - On	
3.04	-.005 to +.005 in. Hg/minute (Pt)		Measure - On	

The test shall be conducted as described above (3.01 and 3.02) except the pressures on both Ps and Pt sides shall be 1.75 ± .25 in. Hg. The leak rate shall be as specified. The measurement shall be taken with the UUT in the measure Ps/PT mode after allowing at least 5 minutes for the air temperature to stabilize. The readings will be taken 1 minute apart.

Set digit switches to
 Ps = 1.75 in. Hg
 Pt = 1.75 in. Hg

Operate ENTER.

Wait until the displays reach the commanded pressure.

Wait at least 5 minutes before taking readings. Take readings from Ps and Pt displays one minute apart.

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
			<p>With the Ps and Pt ports connected to a vacuum source (.5 to 1.0 in. Hg) and the rear ports capped, the leak rate as determined from the Static Pressure and Pitot Pressure displays shall be as specified when the Ps and Pt shut off valves are closed. The system shall be allowed to stabilize from 5 to 6 minutes prior to taking measurement. The measurement shall be taken for a total duration of 1 minute with the UUT in the Control/Ps-Pt mode.</p>	<p>Control - ON</p> <p>Ps/Pt Manual Valves - Open</p> <p>Hold ATE pushbutton depressed.</p> <p>Release ATE pushbutton.</p>		<p>Set digit switches to Ps = 32.000 in. Hg Pt = 32.000 in. Hg Remove caps from ports.</p> <p>Wait for solenoids to operate approximately 15 seconds after operating panel. Operate ENTER.</p> <p style="text-align: center;"><u>NOTE</u></p> <p>An E will appear in both displays.</p> <p>Cap off the V_S, V_T and P_{in} rear panel ports.</p> <p>Connect vacuum pump to the P_S and P_T fittings. As soon as the P_S or P_T display falls between .5 and 1.0 in. Hg, shut the corresponding manual valve.</p> <p>Quickly tap MEASURE pushbutton. System will remain in Control mode and displays will indicate X.XXXE,* permitting observation of milli-inch reading.</p> <p>*If system reverts to Measure mode (sound of K1 and K3 closing), revert to Control mode by pressing CONTROL pushbutton and then repeat this work step.</p>

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
3.05	-.010 to +.010 in. Hg/minute (Ps)			Ps/Pt Manual Valves - Closed		Wait at least 5 minutes before taking readings. Take readings from Ps and Pt displays one minute apart.
3.06	-.010 to +.010 in. Hg/minute (Pt)					



TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
4.00			<p><u>STATIC PRESSURE ACCURACY</u></p> <p>The static pressure accuracy when the UUT is in the Measure/Ps-Pt mode shall be as specified. The input pressures listed in Table I shall be established at the Ps port for each reading. The system must pass the leak test prior to taking any data.</p>	<p>Power - ON Ps/Pt - On Measure - On Ps/Pt Manual Valves - Open</p>		<p><u>STATIC PRESSURE ACCURACY</u></p> <p>The power must be on for 8 hours and (uninterrupted for at least 1 hour and in the Ps/Pt Measure Mode with the UUT vented to Atmosphere) prior to data taking.</p> <p style="text-align: center;">————— CAUTION —————</p> <p>This document assumes the operator is familiar with the correct operation of his precision manometer (Schwien or equivalent).</p>
4.01 thru 4.16	Per Table I					<p>Put Schwien on proper gas. Connect Schwien to the Ps fitting and level UUT and set center line of UUT to center line of Schwien within ±1 inch. Using Schwien, leak test system at 1.0 in. Hg. If the UUT is held near 1.0 in. Hg for more than 10 minutes you must recycle .5 to 40 in. Hg. once. If the UUT is held near 1.00 in. Hg for more than 20 minutes you must vent the UUT to Atmosphere and leave unit with power on in Measure Mode for 8 hours.</p>
	-.010 to +.010 in. Hg/minute					

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
						<p>Using Schwien, cycle the pressure three times from .5 to 40. in. Hg. The pressure rate during the cycle must not exceed 50 in. Hg/minute. Take the data (Ps display) starting at .320 in. Hg in ascending pressure to 40.000 in. Hg. Plot this data on a graph and label Run No. 1. Run Pressure to 28.5 in. Hg for 5 minutes ± 1 minute and then repeat data run from .320 in. Hg to 40.000 in. Hg. The calibration switches must not be adjusted between these two runs. Plot these data points on the same graph and label Run No. 2. Fill in the data blocks and calibration switch positions on the plots.</p> <p>Put the Plots in the Inspection, Test, Assembly (ITA) Packet.</p>

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE	
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C
					<p>NOTES:</p> <p>1) If either Run 1 or Run 2 does not pass the accuracy specification, bring the pressure back to atmospheric, leave power on for at least 24 hours and then repeat the pressure cycling and accuracy runs called out in Test 4.00 and 5.00. Do not adjust the calibration switches. If the unit fails the accuracy test, repeat this 24 hour cycle for a maximum of six days. On the sixth day the calibration switches may be adjusted. If the calibration switches do not have enough range to bring the sensor into accuracy specification, the sensor must be rejected and reallocated. This note applies to both the P_S and P_T sensors. After calculating the new switch positions, set them on the switches and take Run 1 and Run 2 data over again using the same sequence described above. Skip the pressure cycling.</p>

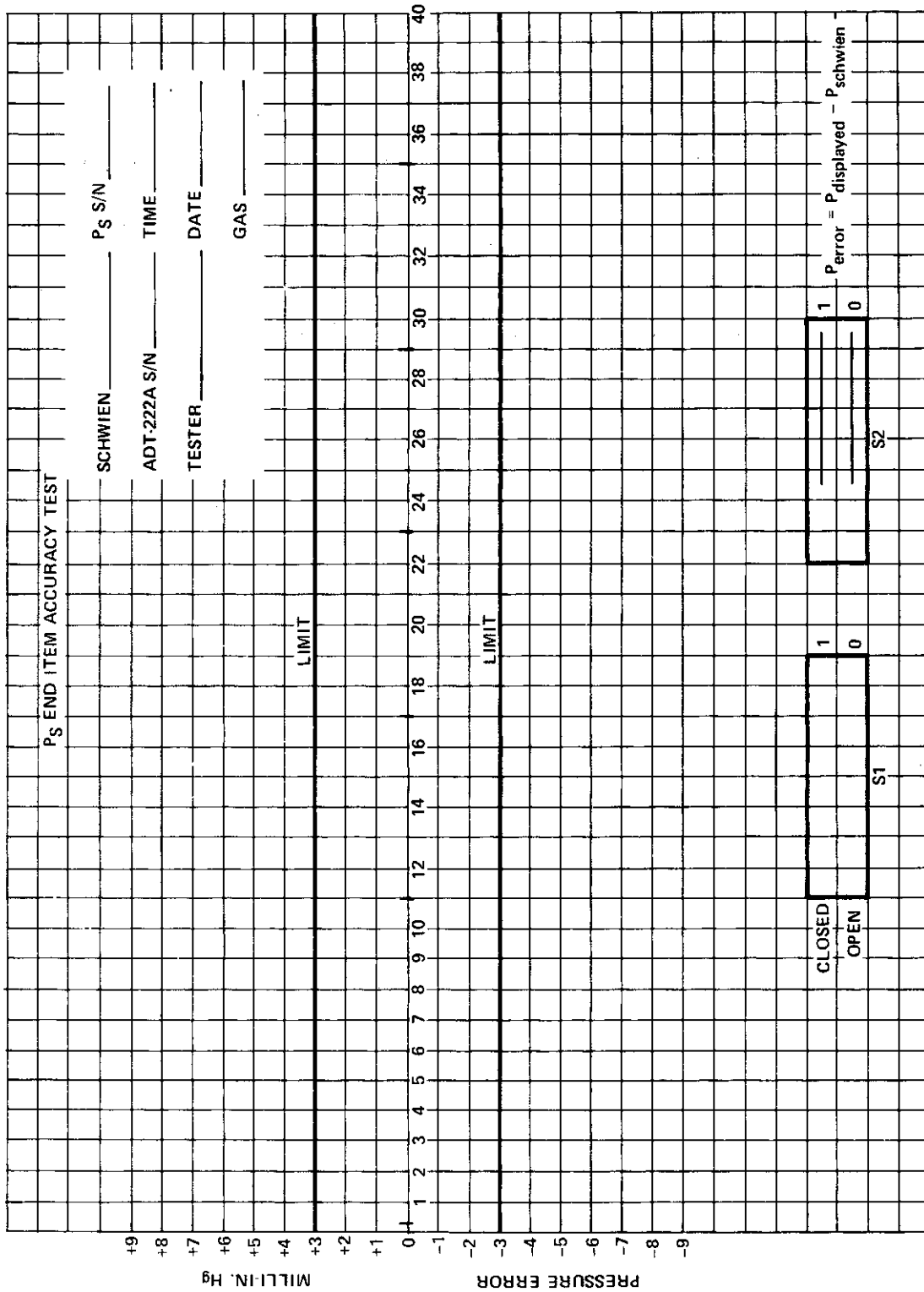
 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
						<p>2) The UUT covers must not be off the unit for more than one minute out of any ten minute period during any part of this accuracy test.</p> <p>3) CAUTION: The UUT will valve off from outside world and bleed down the internal pressure to near atmospheric whenever the Ps or Pt pressure sensors are overpressured. ($P_s \geq 40.024$ or $P_t > 100.024$). If this happens when the unit is connected to the Schvien, close the UUT Ps/Pt shutoff valves. Run the Schvien back to 31. in. Hg. Put the UUT back in the Ps/Pt in Hg measure mode and read the display. Dial the Schvien to equal the proper (Ps/Pt) displayed pressure and then open the Ps/Pt shutoff valves. Be sure the Schvien is in Low accuracy when you open the shutoff valves. You may now proceed with your tests.</p>

 Integrated Test Specification
 Table 3-4 (cont)

TABLE I
STATIC PRESSURE ACCURACY

Test No.	Input Pressure (In. Hg)	Static (minimum)	Pressure Display (Maximum)	Reading (Nominal)
4.01	.320	.317	.323	.320
4.02	1.000	.997	1.003	1.000
4.03	3.000	2.997	3.003	3.000
4.04	5.000	4.997	5.003	5.000
4.05	8.000	7.997	8.003	8.000
4.06	11.000	10.997	11.003	11.000
4.07	14.000	13.997	14.003	14.000
4.08	17.000	16.997	17.003	17.000
4.09	20.000	19.997	20.003	20.000
4.10	23.000	22.997	23.003	23.000
4.11	26.000	25.997	26.003	26.000
4.12	29.000	28.997	29.003	29.000
4.13	32.000	31.997	32.003	32.000
4.14	35.000	34.997	35.003	35.000
4.15	38.000	37.997	38.003	38.000
4.16	40.000	39.997	40.003	40.000



REF I.D. 31925

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
5.00			<u>PITOT PRESSURE ACCURACY</u> The pitot pressure accuracy when the UUT is in the Measure/Ps-Pt mode shall be as specified. The input pressures listed in Table II shall be established at the Pt port for each reading.	Power - On Ps/Pt - On Measure - On Ps/Pt Manual Valves - Open		<u>PITOT PRESSURE ACCURACY</u> The power must be on for 8 hours and (uninterrupted for at least 1 hour and in the Ps/Pt Measure Mode with the UUT vented to atmosphere) prior to data taking.
5.00 thru 5.20						Put Schwien on proper gas. Connect Schwien to the Pt fitting, and level UUT and set center line of UUT to center line of Schwien within ± 1 inch. Using Schwien, leak test system at 1.0 in. Hg. If the UUT is held near 1.0 in. Hg for more than 10 minutes, you must recycle from .5 to 100 in. Hg once. If the UUT is held near 1.0 in. Hg for more than 20 minutes you must vent the UUT to Atmosphere and leave unit with power on in the measure mode for 8 hours.

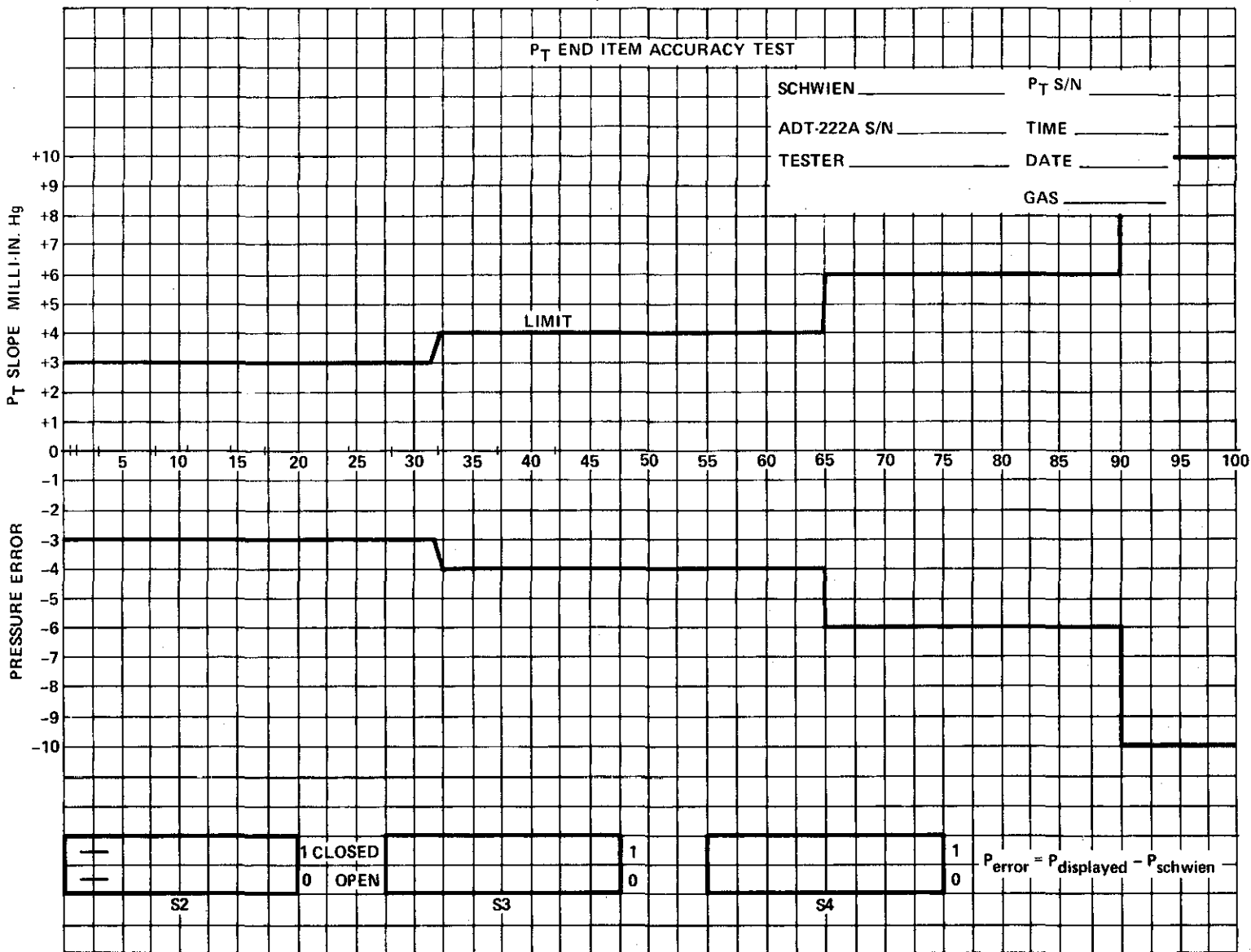
 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
						<p>Using Schwien cycle the pressure three times from .5 to 100.000 in. Hg. Take the data (P_T display) starting at .500 in. Hg in ascending pressure to 100.00 in. Hg. Plot this data on a graph and label Run No. 1. Run pressure to 28.5 in. Hg for 5 minutes ±1 minute and then repeat data run from .500 in. Hg to 100.00 in. Hg. the calibration switches must not be adjusted between these two runs. Plot these data points on the same graph and label Run No. 2. Fill in the data blocks and calibration switch positions on the plots.</p> <p>Put the plots in the ITA packet.</p> <p>See notes 1 thru 3 under test 4.</p>

Integrated Test Specification
Table 3-4 (cont)

TABLE II
 PITOT PRESSURE ACCURACY

<u>Test No.</u>	<u>Input Pressure (IN. Hg)</u>	<u>Pitot (Minimum)</u>	<u>Pressure Display (Maximum)</u>	<u>Reading (Nominal)</u>
5.01	.500	.497	.503	.500
5.02	1.000	.997	1.003	1.000
5.03	3.000	2.997	3.003	3.000
5.04	5.000	4.997	5.003	5.000
5.05	8.000	7.997	8.003	8.000
5.06	11.000	10.997	11.003	11.000
5.07	14.000	13.997	14.003	14.000
5.08	17.000	16.997	17.003	17.000
5.09	20.000	19.997	20.003	20.000
5.10	24.000	23.997	24.003	24.000
5.11	28.000	27.997	28.003	28.000
5.12	32.000	31.996	32.004	32.000
5.13	37.000	36.996	37.004	37.000
5.14	42.000	41.996	42.004	42.000
5.15	50.000	49.996	50.004	50.000
5.16	60.000	49.996	60.004	60.000
5.17	70.000	69.994	70.006	70.000
5.18	80.000	79.994	80.006	80.000
5.19	90.000	89.994	90.006	90.000
5.20	100.000	99.990	100.010	100.000



REF I.D. 31924

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
6.00			<u>CONTROL OPERATION</u> The UUT shall be connected as described in Paragraph 6.2 with the Ps and Pt Shutoff valves closed. The Static Pressure displays shall read as specified when the input commands listed in Table III are entered in the control/Ps-Pt (In. Hg) mode. Modes shall be switched as indicated in Table III to make the corresponding readings.	Power - On Ps/Pt - On Ps/Pt Manual Valves - Closed Control - On DSSL - ON DQCL - ON		<u>CONTROL OPERATION</u> Connect UUT as indicated in paragraph 6.2. Verify that all readings are within specification. Do not record.
6.01 thru 6.157	Per Table III					

 Integrated Test Specification
 Table 3-4 (cont)

TABLE III
 CONTROL OPERATION

P_S/P_T ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 000.500
 PITOT PRESSURE INPUT COMMAND 001.500
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.01	Ps	Ps-Pt (In. Hg)	.499	.501
6.02	Pt	Ps-Pt (In. Hg)	1.499	1.501
6.03	Ps(mb)	Ps-Pt(mb)	16.8	17.0
6.04	Pt(mb)	Ps-Pt(mb)	50.7	50.9
6.05	Qc	Ps-Qc (In. Hg)	.999	1.001
6.06	ALT	ALT(Ft)-A/S(Kts)	90448	90468
6.07	A/S	ALT(ft)-A/S(Kts)	143.6	143.8
6.08	ALT	ALT(M)-A/S(KM/H)	27568	27574
6.09	A/S	ALT(M)-A/S(KM/H)	265.9	266.3
6.10	Qc	PS(Mb)-Qc(mb)	33.7	34.1
6.11	MACH	ALT(M)-MACH	1.383	1.389
6.12	MACH	ALT(Ft)-MACH	1.383	1.389

TABLE III

CONTROL OPERATION

Ps/Pt ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 003.000
 PITOT PRESSURE INPUT COMMAND 003.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.13	Ps	Ps-Pt (In. Hg)	2.999	3.001
6.14	Pt	Ps-Pt (In. Hg)	2.999	3.001
6.15	Ps(mb)	Ps-Pt(mb)	101.5	101.7
6.16	Pt(mb)	Ps-Pt(mb)	101.5	101.7
6.17	Qc	Ps-Qc(In. Hg)	-0.001	0.001
6.18	ALT	ALT(Ft)-A/S(Kts)	52753	52757
6.19	A/S	ALT(Ft)-A/S(Kts)	-0.E	0.E
6.20	Qc	Ps-Qc(mb)	-0.2	0.2
6.21	ALT	ALT(M)-A/S(KM/H)	16079	16080
6.22	A/S	ALT(M)-A/S(KM/H)	-0.E	0.E
6.23	MACH	ALT(M)-MACH	-0.01E	0.01E
6.24	MACH	ALT(Ft)-MACH	-0.01E	0.01E

TABLE III

CONTROL OPERATION

 Ps/Pt ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 005.000
 PITOT PRESSURE INPUT COMMAND 005.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.25	Ps	Ps-Pt (In. Hg)	4.999	5.001
6.26	Pt	Ps-Pt (In. Hg)	4.999	5.001
6.27	Ps(mb)	Ps-Pt(mb)	169.2	169.4
6.28	Pt(mb)	Ps-Pt(mb)	169.2	169.4
6.29	Qc	Ps-Qc(In. Hg)	-0.001	0.001
6.30	ALT	ALT(Ft)-A/S(Kts)	42125	42127
6.31	A/S	ALT(Ft)-A/S(Kts)	-0.E	0.E
6.32	Qc	Ps-Qc(mb)	-0.2	0.2
6.33	ALT	ALT(M)-A/S(KM/H)	12839	12840
6.34	A/S	ALT(M)-A/S(KM/H)	-0.E	0.E
6.35	MACH	ALT(M)-MACH	-0.01E	0.01E
6.36	MACH	ALT(Ft)-MACH	-0.01E	0.01E

TABLE III
 CONTROL OPERATION

Ps/Pt ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 008.000
 PITOT PRESSURE INPUT COMMAND 011.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.37	Ps	Ps-Pt (In. Hg)	7.999	8.001
6.38	Pt	Ps-Pt (In. Hg)	10.999	11.001
6.39	Ps(mb)	Ps-Pt(mb)	270.8	271.0
6.40	Pt(mb)	Ps-Pt(mb)	372.4	372.6
6.41	Qc	Ps-Qc(In. Hg)	2.999	3.001
6.42	ALT	ALT(Ft)-A/S(Kts)	32282	32284
6.43	A/S	ALT(Ft)-A/S(Kts)	246.0	246.2
6.44	QC	Ps-Qc(mb)	101.4	101.8
6.45	ALT	ALT(M)-A/S(KM/H)	9838	9841
6.46	A/S	ALT(M)-A/S(KM/H)	455.6	455.9
6.47	MACH	ALT(M)-MACH	0.689	0.691
6.48	MACH	ALT(Ft)-MACH	0.689	0.691

TABLE III
 CONTROL OPERATION

 PS/PT ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 011.000
 PITOT PRESSURE INPUT COMMAND 020.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.49	Ps	Ps-Pt (In. Hg)	10.999	11.001
6.50	Pt	Ps-Pt (In. Hg)	19.999	20.001
6.51	Ps(mb)	Ps-Pt(mb)	372.4	372.6
6.52	Pt(mb)	Ps-Pt(mb)	677.2	677.4
6.53	Qc	Ps-Qc (In. Hg)	8.999	9.001
6.54	ALT	ALT(Ft)-A/S(Kts)	25213	25215
6.55	A/S	ALT(Ft)-A/S(Kts)	413.1	413.3
6.56	Qc	Ps-Qc(mb)	304.6	305.0
6.57	ALT	ALT(M)-A/S(KM/H)	7685	7686
6.58	A/S	ALT(M)-A/S(KM/H)	765.1	765.4
6.59	MACH	ALT(M)-MACH	0.964	0.966
6.60	MACH	ALT(Ft)-MACH	0.964	0.966

TABLE III

CONTROL OPERATION

Ps/Pt ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 014.000
 PITOT PRESSURE INPUT COMMAND 026.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.61	Ps	Ps-Pt (In. Hg)	13.999	14.001
6.62	Pt	Ps-Pt (In. Hg)	25.999	26.001
6.63	Ps(mb)	Ps-Pt(mb)	474.0	474.2
6.64	Pt(mb)	Ps-Pt(mb)	880.4	880.6
6.65	Qc	Ps-Qc (In. Hg)	11.999	12.001
6.66	ALT	ALT(Ft)-A/S(Kts)	19568	19570
6.67	A/S	ALT(Ft)-A/S(Kts)	470.3	470.5
6.68	Qc	Ps-Qc(mb)	406.2	406.6
6.69	ALT	ALT(M)-A/S (KM/H)	5964	5965
6.70	A/S	ALT(M)-A/S(KM/H)	871.0	871.4
6.71	MACH	ALT(M)-MACH	0.982	0.986
6.72	MACH	ALT(Ft)-MACH	0.982	0.986

TABLE III

CONTROL OPERATION

 PS/PT ON, METRIC ON
 STATIC PRESSURE INPUT COMMAND 00575.7
 PITOT PRESSURE INPUT COMMAND 01083.6
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.73	Ps	Ps-Pt (In. Hg)	16.999	17.001
6.74	Pt	Ps-Pt (In. Hg)	31.999	32.001
6.75	Ps(mb)	Ps-Pt(mb)	575.6	575.8
6.76	Pt(mb)	Ps-Pt(mb)	1083.5	1083.7
6.77	Qc	Ps-Qc (In. Hg)	14.998	15.001
6.78	ALT	ALT(Ft)-A/S(Kts)	14832	14834
6.79	A/S	ALT(Ft)-A/S(Kts)	518.9	519.1
6.80	Qc	Ps-Qc(mb)	507.7	508.1
6.81	ALT	ALT(M)-A/S(KM/H)	4520	4521
6.82	A/S	ALT(M)-A/S(KM/H)	961.0	961.4
6.83	MACH	ALT(M)-MACH	0.994	0.996
6.84	MACH	ALT(Ft)-MACH	0.994	0.996

TABLE III

CONTROL OPERATION

PS/PT ON, METRIC ON
 STATIC PRESSURE INPUT COMMAND 00677.3
 PITOT PRESSURE INPUT COMMAND 01354.6
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.85	Ps	Ps-Pt (In. Hg)	19.999	20.001
6.86	Pt	Ps-Pt (In. Hg)	39.999	40.001
6.87	Ps(mb)	Ps-Pt(mb)	677.2	677.4
6.88	Pt(mb)	Ps-Pt(mb)	1354.5	1354.7
6.89	Qc	Ps-Qc (In. Hg)	19.998	20.002
6.90	ALT	ALT(Ft)-A/S(Kts)	10730	10732
6.91	A/S	ALT(Ft)-A/S(Kts)	586.9	587.1
6.92	Qc	Ps-Qc(mb)	677.1	677.5
6.93	ALT	ALT(M)-A/S(KM/H)	3270	3271
6.94	A/S	ALT(M)-A/S(KM/H)	1086.9	1087.3
6.95	MACH	ALT(M)-MACH	1.045	1.047
6.96	MACH	ALT(Ft)-MACH	1.045	1.047

TABLE III
 CONTROL OPERATION

Ps/Pt ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 023.000
 PITOT PRESSURE INPUT COMMAND 050.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.97	Ps	Ps-Pt (In. Hg)	22.999	23.001
6.98	Pt	Ps-Pt (In. Hg)	49.999	50.001
6.99	Ps(mb)	Ps-Pt(mb)	778.8	779.0
6.100	Pt(mb)	Ps-Pt(mb)	1693.1	1693.3
6.101	Qc	Ps-Qc (In. Hg)	26.998	27.002
6.102	ALT	ALT(Ft)-A/S(Kts)	7100	7102
6.103	A/S	ALT(Ft)-A/S(Kts)	664.2	664.4
6.104	Qc	Ps-Qc(mb)	914.1	914.5
6.105	ALT	ALT(M)-A/S(KM/H)	2164	2166
6.106	A/S	ALT(M)-A/S(KM/H)	1230.0	1230.5
6.107	MACH	ALT(M)-MACH	1.115	1.117
6.108	MACH	ALT(Ft)-MACH	1.115	1.117

TABLE III

CONTROL OPERATION

PS/PT ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 026.000
 PITOT PRESSURE INPUT COMMAND 060.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.109	Ps	Ps-Pt (In. Hg)	25.999	26.001
6.110	Pt	Ps-Pt (In. Hg)	59.998	60.002
6.111	Ps(mb)	Ps-Pt(mb)	880.4	880.6
6.112	Pt(mb)	Ps-Pt(mb)	2031.7	2031.9
6.113	Qc	Ps-Qc (In. Hg)	33.998	34.002
6.114	ALT	ALT(Ft)-A/S(Kts)	3835	3837
6.115	A/S	ALT(Ft)-A/S(Kts)	728.4	728.6
6.116	Qc	Ps-Qc(mb)	1151.1	1151.5
6.117	ALT	ALT(M)-A/S(KM/H)	1168	1170
6.118	A/S	ALT(M)-A/S(KM/H)	1349.0	1349.4
6.119	MACH	ALT(M)-MACH	1.164	1.166
6.120	MACH	ALT(Ft)-MACH	1.164	1.166

TABLE III
 CONTROL OPERATION

PS/PT ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 029.000
 PITOT PRESSURE INPUT COMMAND 070.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.121	Ps	Ps-Pt (In. Hg)	28.999	29.001
6.122	Pt	Ps-Pt (In. Hg)	69.998	70.002
6.123	Ps(mb)	Ps-Pt(mb)	982.0	982.2
6.124	Pt(mb)	Ps-Pt(mb)	2370.4	2370.6
6.125	Qc	Ps-Qc (In. Hg)	40.998	41.002
6.126	ALT	ALT(Ft)-A/S(Kts)	862	864
6.127	A/S	ALT(Ft)-A/S(Kts)	785.1	785.3
6.128	Qc	Ps-Qc(mb)	1388.2	1388.6
6.129	ALT	ALT(M)-A/S(KM/H)	262	264
6.130	A/S	ALT(M)-A/S(KM/H)	1454.0	1454.4
6.131	MACH	ALT(M)-MACH	1.201	1.203
6.132	MACH	ALT(Ft)-MACH	1.201	1.203

TABLE III

CONTROL OPERATION

 P_S/P_T ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 032.000
 PITOT PRESSURE INPUT COMMAND 080.000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.133	Ps	Ps-Pt (In. Hg)	31.999	32.001
6.134	Pt	Ps-Pt (In. Hg)	79.998	80.002
6.135	Ps(mb)	Ps-Pt(mb)	1083.5	1083.7
6.136	Pt(mb)	Ps-Pt(mb)	2709.0	2709.2
6.137	Qc	Ps-Qc (In. Hg)	47.998	48.002
6.138	ALT	ALT(Ft)-A/S(Kts)	-1872	-1870
6.139	A/S	ALT(Ft)-A/S(Kts)	836.9	837.1
6.140	Qc	Ps-Qc(mb)	1625.3	1625.7
6.141	ALT	ALT(M)-A/S(KM/H)	-570	-569
6.142	A/S	ALT(M)-A/S(KM/H)	1549.9	1550.3
6.143	MACH	ALT(M)-MACH	1.230	1.232
6.144	MACH	ALT(Ft)-MACH	1.230	1.232
6.145	Deleted			

TABLE III
 CONTROL OPERATION

 PS/PT ON, METRIC OFF
 STATIC PRESSURE INPUT COMMAND 032000
 PITOT PRESSURE INPUT COMMAND 090000
 OPERATE ENTER

<u>Test NO.</u>	<u>Parameter</u>	<u>Mode</u>	<u>Minimum</u>	<u>Maximum</u>
6.146	Ps	Ps-Pt (In. Hg)	31.999	32.001
6.147	Pt	Ps-Pt (In. Hg)	89.998	90.002
6.148	Ps(mb)	Ps-Pt(mb)	1083.5	1083.7
6.149	Pt(mb)	Ps-Pt(mb)	3047.6	3047.8
6.150	Qc	Ps-Qc (In. Hg)	57.998	58.002
6.151	ALT	ALT(Ft)-A/S(Kts)	-1872	-1870
6.152	A/S	ALT(Ft)-A/S(Kts)	0904.7	0904.9
6.153	Qc	Ps-Qc(mb)	1963.9	1964.3
6.154	ALT	ALT(M)-A/S(KM/H)	-571	-569
6.155	A/S	ALT(M)-A/S(KM/H)	1675.5	1675.9
6.156	MACH	ALT(M)-MACH	1.330	1.332
6.157	MACH	ALT(Ft)-MACH	1.330	1.332

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
7.00			<u>MEASURE MODE TRANSIENT</u> <u>Control to Measure:</u> The pressure transient at the Ps and Pt ports shall be as specified when the operation mode is changed from control to Measure.	Metric - OFF Ps/Pt - ON Measure - On Ps/Pt Manual Valves - Open Pt Manual Valve - Closed Control - ON		<u>MEASURE MODE TRANSIENT</u> Connect a Schwien, ADT-321, mercury manometer or equivalent to the Ps fitting. Set digit switches to Ps = .500 Pt = 30.000 in. Hg. Operate ENTER.
7.01	-.020 to +.020 in. Hg		<u>Measure to Control:</u> The pressure transient at the Ps and Pt ports shall be as specified when the operation mode is changed from Measure to Control.	Measure - ON		Wait until display and manometer settle out. Read maximum transient pressure on manometer.
7.02	-.020 to +.020 in. Hg			Control - ON		Read maximum pressure transient on manometer. Set digit switches to Ps = 15.000. Operate ENTER.

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
7.03	-.020 to +.020 in. Hg			Measure - ON		Wait until display and manometer settle out. Read maximum transient pressure on manometer.
7.04	-.020 to +.020 in. Hg			Control - ON		Read maximum transient pressure on manometer. Set digit switches to Ps = 32.000. Operate ENTER. Wait until display and manometer settle out.
7.05	-.020 to +.020 in. Hg			Measure - ON		Read maximum transient pressure on manometer.
7.06	-.020 to +.020 in. Hg			Control - ON		Read maximum transient pressure on manometer.
			Control to Measure: The pressure transient at the Ps and Pt ports shall be as specified when the operation mode is changed from Control to Measure.	Ps/Pt - ON Ps/Pt manual Valves - Open Ps Manual Valve - Closed Control - ON		Connect a mercury manometer or equivalent to the Pt fitting. Set digit switches to Ps = 30.000 Pt = 1.500 in. Hg.

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
7.07	-.020 to +.020 in. Hg		<u>Measure to Control:</u> The pressure transient at the Ps and Pt ports shall be as specified when the operation mode is changed from Measure to Control.	Measure - ON		Operate ENTER. Wait until display and manometer settle out. Read maximum transient pressure on manometer.
7.08				Control - ON		Read maximum pressure transient on manometer. Set digit switches to $P_T = 45.000$. Operate ENTER. Wait until display and manometer settle out.
7.09	-.020 to +.020 in. Hg			Measure - ON		Read maximum transient pressure on manometer.
7.10				Control - ON		Read maximum transient pressure on manometer. Set digit switches to $P_T = 90.000$. Operate ENTER. Wait until display and manometer settle out.

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
7.11	-.020 to +.020 in. Hg			Measure - ON		Read maximum transient pressure on manometer.
7.12	-.020 to +.020 in. Hg			Control - ON		Read maximum transient pressure on manometer.
				PS/PT Manual Valves - Closed		Set digit switches to PT = 30.000 Operate ENTER. Wait until display and manometer settle out. Remove manometer.

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
8.00			<u>CONTROL OVERTHOOT</u> <u>Static Control:</u> The pressure as read on the Static Pressure display shall not overshoot more than specified when a 1 in. Hg. change is commanded. The test shall be conducted in both directions.	PS/PT Manual Valves - Closed PS/PT - ON Control - ON		<u>CONTROL OVERTHOOT</u> Set digit switches to Ps = .500 Pt = 30.000. Operate ENTER. Wait until displays settle out to commanded pressures. Set digit switches to Ps = 2.500. Operate ENTER and immediately set digit switches to Ps = .500. When Ps display exceeds 1.5 in. Hg operate ENTER. Watch Ps display as pressure comes into .500 in. Hg. Overshoot must not exceed Set digit switches to Ps - 15.000. Operate enter. Wait until displays settle out to commanded pressures.
8.01	0 to .002 in Hg					

TEST NO.	SPECIFICATION		PROCEDURE	
	OPR LIMITS	C	SWITCH POS	C
8.02	0 to .002 in. Hg			<p>Set digit switches to Ps = 17.000.</p> <p>Operate ENTER and immediately set digit switches to Ps = 15.000.</p> <p>When Ps display exceeds 16.000 in. Hg operate ENTER.</p> <p>Watch Ps display as pressure comes into 15.000 in. Hg.</p> <p>Overshoot must not exceed</p> <p>Set digit switches to Ps = 13.000.</p> <p>Operate ENTER and immediately set digit switches to Ps = 15.000.</p> <p>When Ps display goes below 14.000 operate ENTER.</p> <p>Overshoot must not exceed</p> <p>Set digit switches to Ps = 32.000.</p>
8.03	0 to .002 in. Hg			<p>Overshoot must not exceed</p> <p>Set digit switches to Ps = 32.000.</p>

Integrated Test Specification
Table 3-4 (cont)



TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
8.04	0 to .002 in Hg		<p><u>Pitot Control:</u></p> <p>The pressure as read on the Pitot Pressure display shall not overshoot more than specified when a 1 in. Hg. change is commanded. The test shall be conducted in both directions.</p>	<p>P_S/P_T Manual Valves - Closed P_S/P_T - ON Control - ON</p>		<p>Operate ENTER.</p> <p>Wait until displays settle out to commanded pressures.</p> <p>Set digit switches to Ps = 30.000, operate ENTER and immediately set digit switches to Ps = 32.000.</p> <p>When Ps display goes below 31.000 in. Hg operate ENTER. Watch Ps display as pressure comes into 32.000 in. Hg.</p> <p>Overshoot must not exceed</p> <p>Set digit switches to Ps = 30.000 Pt = 3.500.</p> <p>Operate ENTER.</p> <p>Wait until displays settle out to commanded pressures.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
8.05	0 to .002 in. Hg					<p>Set digit switches to Pt = 5.500.</p> <p>Operate ENTER and immediately set digit switches to Pt = 3.500.</p> <p>When display exceeds 4.5 in. Hg operate ENTER.</p> <p>Watch Pt display as pressure comes into 3.500 in. Hg.</p> <p>Overshoot must not exceed</p> <p>Set digit switches to Pt = 45.000.</p> <p>Operate ENTER.</p> <p>Wait until displays settle out to commanded pressures. Set digit switches to Pt = 47.000 in. Hg.</p> <p>Operate ENTER and immediately set digit switches to Pt = 45.000 in. Hg.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE	
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C
8.06	0 to .002 in. Hg				<p>When Pt display exceeds 46.000 in. Hg operate ENTER.</p> <p>Watch Pt display as pressure comes into 45.000 in. Hg.</p> <p>Overshoot must not exceed</p> <p>Set digit switches to Pt = 43.000.</p> <p>Operate ENTER and immediately set digit switches to Pt = 45.000.</p> <p>When Pt display goes below 44.000 operate ENTER.</p> <p>Watch Pt display as Pt pressure comes into 45.000 in. Hg.</p>
8.07	0 to .002 in. Hg				<p>Overshoot must not exceed</p> <p>Set digit switches to Pt = 90.000.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
8.08	0 to .002 in. Hg					<p>Operate ENTER.</p> <p>Wait until displays settle out to commanded pressures.</p> <p>Set digit switches to Pt = 88.000. Operate ENTER and immediately set digit switches to Pt = 90.000.</p> <p>When Pt display goes below 89.000 in. Hg operate ENTER. Watch Pt display as pressure comes into 90.000 in. Hg.</p> <p>Overshoot must not exceed</p>

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
9.00			<u>PRECISION ALTITUDE RATE</u> <u>Ascending:</u> The time for the (ALT) display to change from 10,000 to 70,000 feet shall be as specified. The test shall be started at sea level (0 feet) and the final altitude shall be 90,000 feet with the precision ALTITUDE - RATE COMMAND set at 20,000 feet/min.	P _S /P _T Manual Valves - Closed Control - ON Altitude/ Airspeed - ON Both Precision Rates ON.		<u>PRECISION ALTITUDE RATE</u> Set digit switches to ALT = 0000 feet A/S = 300.0 knots Rates: H = 20,000 ft/min, V _C = 250 knots/min. Operate ENTER. Wait until displays reach commanded values. Set digit switches to Alt = 90,000 feet. Operate ENTER. When Altitude passes 10,000 ft start timer. When Altitude passes 70,000 ft stop timer.

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
9.01	178.2 to 181.8 seconds (180.0 nom)		<p><u>Descending:</u></p> <p>The above test shall be repeated for descending altitudes (70,000 to 10,000 feet).</p>			<p>Elapsed time must be</p> <p>Set digit switches to Alt = 0000. feet.</p> <p>Operate ENTER.</p> <p>When Altitude passes 70,000 ft start timer.</p> <p>When Altitude passes 10,000 ft stop timer.</p> <p>Elapsed time must be</p>
9.02	178.2 to 181.8 seconds (180.0 nom)					



TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
10.00			<p><u>PRECISION AIRSPEED RATE</u></p> <p><u>Increasing:</u></p> <p>The time for the (A/S) display to change from 100 to 850 knots shall be as specified. The test shall be started at 50 knots and the final airspeed shall be 900 knots with the precision AIRSPEED - RATE COMMAND set at 250 knots/min.</p>	<p>P_S/P_T Manual Valves - Closed Control - ON Altitude/ Airspeed - ON Both Precision Rates - ON</p>		<p><u>PRECISION AIRSPEED RATE</u></p> <p>Set digit switches to Alt = 30,000 ft. A/S = 50.0 knots</p> <p>Operate ENTER.</p> <p>Wait until displays reach commanded values. Set digit switches to A/S = 900.0 knots. Operate ENTER. When A/S passes 100 knots start timer.</p> <p>Stop timer when A/S passes 850 knots.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
10.01	178.2 to 181.8 sec (180.0 nom)		<p><u>Decreasing:</u></p> <p>The above test shall be repeated for decreasing airspeeds (850 to 100 knots).</p>			<p>Elapsed time must be</p> <p>Set digit switches to A/S = 50.0 knots.</p> <p>Operate ENTER.</p> <p>When A/S passes 850 knots start timer.</p> <p>When A/S passes 100 knots stop timer.</p> <p>Elapsed time must be</p>
10.02	178.2 to 181.8 sec (180.0 nom)			Both Precision Rates - OFF		

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
11.00			<u>DYNAMIC INPUT</u> <u>Drift Rate:</u> The UUT shall be stabilized in the Control/Ps-Pt mode with no dynamic input (Dynamic Input switch in OFF position) and the Static Pressure and Pitot Pressure displays controlled to the proper pressure. When the Dynamic Input switch on the front panel is turned on, the drift rate of the displayed pressures shall be as specified. The measurements shall be taken 1 minute apart.	Ps/Pt - ON Control _ ON Dynamic input - ON		<u>DYNAMIC INPUT</u> Turn off dynamic input switch on back panel (middle position). Set digit switches to Ps = .500 Pt = 1.500. Rates H = 40,000 ft/min Pt = 500. mil/in. Hg/ sec Operate ENTER. Wait until displays reach commanded pressures. Wait 15 seconds more. Measure Ps and Pt display drift for one minute.
11.01	-.005 to +.005 in. Hg (Ps)					The maximum drift must be
11.02	-.005 to +.005 in. Hg (Pt)					

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
11.03	-.005 to +.005 in. Hg (Ps)			Dynamic Input - OFF		Set digit switches to Ps = 15.000 and Pt = 45.000 in. Hg. Operate ENTER. Wait until displays reach commanded pressures. Wait 15 seconds more.
11.04	-.005 to +.005 in. Hg (Pt)			Dynamic Input - ON		Measure Ps and Pt display drift for one minute. The maximum drift must be
				Dynamic Input - OFF		Set digit switches to Ps = 32.000 and Pt = 90.000 in Hg. Operate ENTER. Wait until displays reach commanded pressures. Wait 15 seconds more.
				Dynamic Input - ON		Measure Ps and Pt display drift for one minute.

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE	
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C
11.05	-.005 to +.005 in. Hg (Ps)				
11.06	-.005 to +.005 in. Hg (Pt)				
			<u>FEED-THROUGH</u>	Dynamic Input - OFF Ps/PT - ON Control - ON	<p>The maximum drift must be</p> <p><u>FEED-THROUGH:</u></p> <p>Connect signal generator to dynamic input connector on back panel.</p> <p>Set digit switches to Ps = 30.000, Pt = 30.000 in. Hg. Set dynamic input switch on back panel to Ps. Operate ENTER.</p> <p>Wait until displays reach command pressures.</p> <p>With a 15 ± 1 volt P-P, square wave .1 Hz signal applied across pins A (Hi) and B (Lo) of Dynamic Input connector and the Dynamic Input switch on the back panel in the Ps position, the respective Static Pressure or Pitot Pressure display shall indicate the specified modulation.</p>

TEST NO.	SPECIFICATION		PROCEDURE	
	OPR LIMITS	C	SWITCH POS	C
11.07	0 to .002 in. Hg Peak to Peak			
11.08	0 to .002 in. Hg Peak to Peak (Pt)			
			Ps/PT - ON Control - ON Dynamic Input - OFF	
		<u>MODULATION:</u>		<u>MODULATION:</u> Set digit switches to Ps = 30.000 and Pt = 30.000 in. Hg. Operate ENTER. Wait until displays reach commanded pressures. Wait 15 seconds longer. Set dynamic input switch on back panel to Ps.

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
11.09	.025 to .075 in. Hg Peak to Peak (Ps)			Dynamic Input - OFF		<p>With 1 ± .1 volt P-P, square wave .1 Hz signal applied across [redacted] and [redacted] of Dynamic Input connector and the Dynamic Input switch on the back panel in the Ps or Pt position, the respective Static Pressure or Pitot Pressure display shall indicate the specified modulation. The test shall be conducted at 30 ± 1 in. Hg in the Control/Ps-Pt mode.</p> <p>The Ps display modulation shall be</p> <p>Wait 15 seconds.</p> <p>Set dynamic input switch on back panel to Pt.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
11.10	.025 to .075 in. Hg Peak to Peak (Pt)			Dynamic Input - ON Dynamic Input - OFF		The Pt display modulation shall be Set dynamic input switch on back panel to off (mid-position). Remove signal generator from dynamic input connector on back panel.

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
12.00			<u>Q_cCONTROL</u> <u>Increasing P_s:</u> When the static pressure is changed from 1.5 to 32.0 in. Hg at a rate equivalent to 20,000 feet/min. the (Q _c) display shall read as specified. The UUT shall be in the Control/P _s -Q _c (In. Hg) mode and the (Q _c) display controlled to 0 at start of test.	P _s /Q _c - ON Control - ON		<u>Q_cCONTROL</u> Set digit switches to P _s = 1.500 and Q _c = .000 In. Hg. Operate ENTER. Wait until displays reach commanded pressures. Set digit switches to P _s = 32.000 Q _c = .000. Rates $\dot{H} = 20,000$ ft/min, $\dot{P}_T = 500$ milli-in. Hg/sec Operate ENTER.

TEST NO.	SPECIFICATION			PROCEDURE	
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C
12.01	-.025 to +.025 in. Hg (Qc)		<p><u>Decreasing Ps:</u></p> <p>When the same test described above is performed except static pressure is changed from 32.0 to 1.5 in. Hg, the (Qc) display shall read as specified.</p>		
12.02	-.025 to +.025 in. Hg (Qc)				<p>Watch for the maximum transient on the Qc display. The maximum transient on the Qc display during the entire Ps pressure run to 32.000 in. Hg shall be</p> <p>Set digit switches to Ps = 1.500 Qc = .000 in. Hg. Operate ENTER.</p> <p>Watch for the maximum transient on the Qc display.</p> <p>The maximum transient on the Qc display during the entire Ps pressure run to 1.5 in. Hg shall be</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
13.00			<u>Load Test</u>	Altitude/ Airspeed - ON Measure - ON P _S /P _T Manual Valves - Open		<u>Load Test</u> Slowly vent the UUT P _S and P _T pressure to ambient. Connect two thirty cubic inch volume tanks SPN = 4022677 to the P _S pneumatic fitting. Use 24 ± 1 inch 3/16 ID hose between the fitting and the volume tank and a 12 ± 1 inch 3/16 ID hose between the two volume tanks. Set digit switches to ALT = -1800 ft Altitude Rate H = 40,000 ft/min A/S = 200 knots Airspeed Rate V _C = 500 knots/min Operate ENTER.
				P _T Manual Valve - Closed Control - ON		

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE	
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C
13.01	≤ 8. sec				<p>Wait until displays reach Commanded values. Set Altitude = 90,000 feet. Operate enter. Watch Altitude display during entire rate to 90,000 feet. An "E" shall not appear in the Altitude display for a total duration of more than 8. seconds.</p> <p>Set ALT = -1800. feet Operate ENTER. Watch Altitude display during entire rate to -1800. feet. An "E" shall not appear in the Altitude display for a total duration of more than 8 seconds.</p>
13.02	≤ 8. sec			<p>Altitude/ Airspeed - ON Measure - ON Ps/Pt Manual Valves - Open</p>	<p>Remove volume tanks from Ps fitting.</p> <p>Slowly vent the UUT Ps and Pt pressure to ambient.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
13.03	< 8. sec			Ps Manual Valve - Closed Control - ON		<p>Connect the two volume tanks to the Pt fitting.</p> <p>Set digit switches to Altitude = 16,000. feet Airspeed = 50. knots</p> <p>Operate ENTER.</p> <p>Wait until display reaches commanded values.</p> <p>Set Airspeed to 1000.0 knots. Operate ENTER.</p> <p>Watch Airspeed display during entire rate to 1000. knots. An "E" shall not appear in the Airspeed display for a total duration of more than 8. seconds.</p> <p>Set Airspeed to 50. knots</p> <p>Operate ENTER.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION		PROCEDURE			
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
13.04	≤ 8. sec					<p>Watch Airspeed display during entire rate to 50. knots. An "E" shall not appear in the Airspeed display for a total duration of more than 8. seconds.</p> <p>Set digit switches to Altitude = 67,000 feet Airspeed = 50. knots Operate ENTER.</p> <p>Wait until displays reach commanded values.</p> <p>Set Airspeed to 1000. knots. Operate ENTER.</p>
13.05	≤ 8. sec					<p>Watch Airspeed display during entire rate to 1000. knots. An "E" shall not appear in the Airspeed display for a total duration of more than 8. seconds.</p> <p>Set Airspeed to 50.0 knots. Operate ENTER.</p>
13.06	≤ 8. sec					<p>Watch Airspeed display during entire rate to 50.0 knots. An "E" shall not appear in the airspeed display for a total duration of more than 8. seconds.</p>

Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
14.00			<u>DQCL AND DSSL LIMITS</u> With the Disable Qc Limit and Disable Subsonic Limit switches off, the UUT shall not accept the following commands:	Metric - OFF Ps/Pt - ON Control - ON DQCL - OFF DSSL - OFF		<u>DQCL AND DSSL LIMITS</u> Set digit switches to Ps = 30.000 Pt = 30.000 in. Hg Operate ENTER.
14.01	DSSL and DQCL Lamp flashing and pressure must not move		1. Qc greater than 15 in. Hg. (DQCL and DSSL lamp shall flash) 2. Ps less than 3.2 in. Hg (DSSL lamp shall flash) 3. Pt greater than 45 in. Hg (DSSL lamp shall flash)			Set digit switches to Ps = 10.000 Pt = 30.000 in. Hg. Operate ENTER.
14.02	DSSL and DQCL light stop flashing		When each of the above conditions are commanded the appropriate lamp shall flash and when an acceptable condition is commanded the lamp shall stop flashing.			Set digit switches to Ps = 30.000 Pt = 30.000 in Hg Operate ENTER.
14.03	DSSL Lamp and DQCL Lamps flashing					Set digit switches to Ps = 3.000 Pt = 30.000 in. Hg Operate ENTER.

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
14.04	DSSL and DQCL lights stop flashing		DQCL = Disable Qc Limit DSSL = Disable Subsonic Limits The pressure shall not move during these invalid commands.			Set digit switches to Ps = 30.000 Pt = 30.000 in. Hg Operate ENTER.
14.05	DQCL and DSSL lights flash					Set digit switches to Ps = 30.000 Pt = 50.000 in. Hg Operate ENTER.
14.06	DSSL and DQCL lights stop flashing					Set digit switches to Ps = 30.000 Pt = 30.000 in. Hg Operate ENTER.
14.07	DQCL light flashes			DSSL - ON		Set digit switches to Ps = 30.000 Pt = 27.000 Operate ENTER.
14.08	DQCL light stops flashing					Set digit switches to Ps = 30.000 Pt = 29.000 Operate ENTER.
15.00			Deleted.			

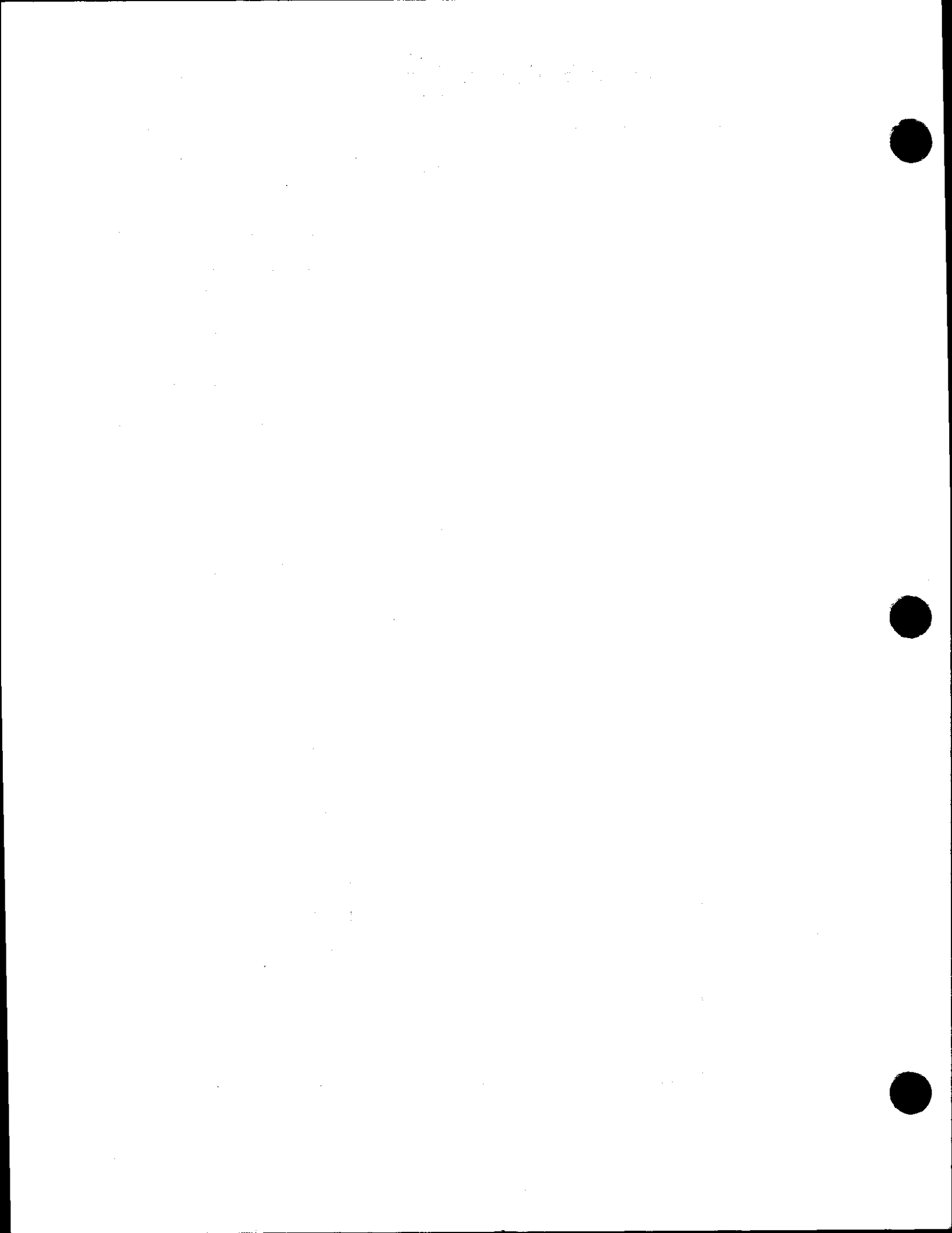
Integrated Test Specification
Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE		
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C	WORK STEPS
16.00			<u>Overpressure Test</u>			<u>Overpressure Test</u>
16.01				Metric - OFF Ps/Pt - ON Measure - ON DSSL - ON DQCL - ON Ps/Pt Manual valves - open		Connect a regulated pressure source to the Ps pneumatic fitting and slowly increase the pressure until the pressure equals 41. in Hg \pm 0.5 in. Hg. The UUT shall valve off and bleed the pressure down to near ambient and then go to self test. Disconnect the pressure source.
				Ps/Pt - ON Metric - OFF		

 Integrated Test Specification
 Table 3-4 (cont)

TEST NO.	SPECIFICATION			PROCEDURE	
	OPR LIMITS	C	TEST DESCRIPTION	SWITCH POS	C
				POWER OFF	<p>Connect a regulated pressure source to the Pt front panel pneumatic fitting and slowly increase the pressure until the pressure equals 101. in. Hg. \pm 0.5 in. Hg. The UUT shall valve off and bleed the pressure down to near ambient and then go to self tet. Disconnect the pressure source.</p> <p>End of Test</p> <p>THANK YOU.</p>

Integrated Test Specification
Table 3-4 (cont)

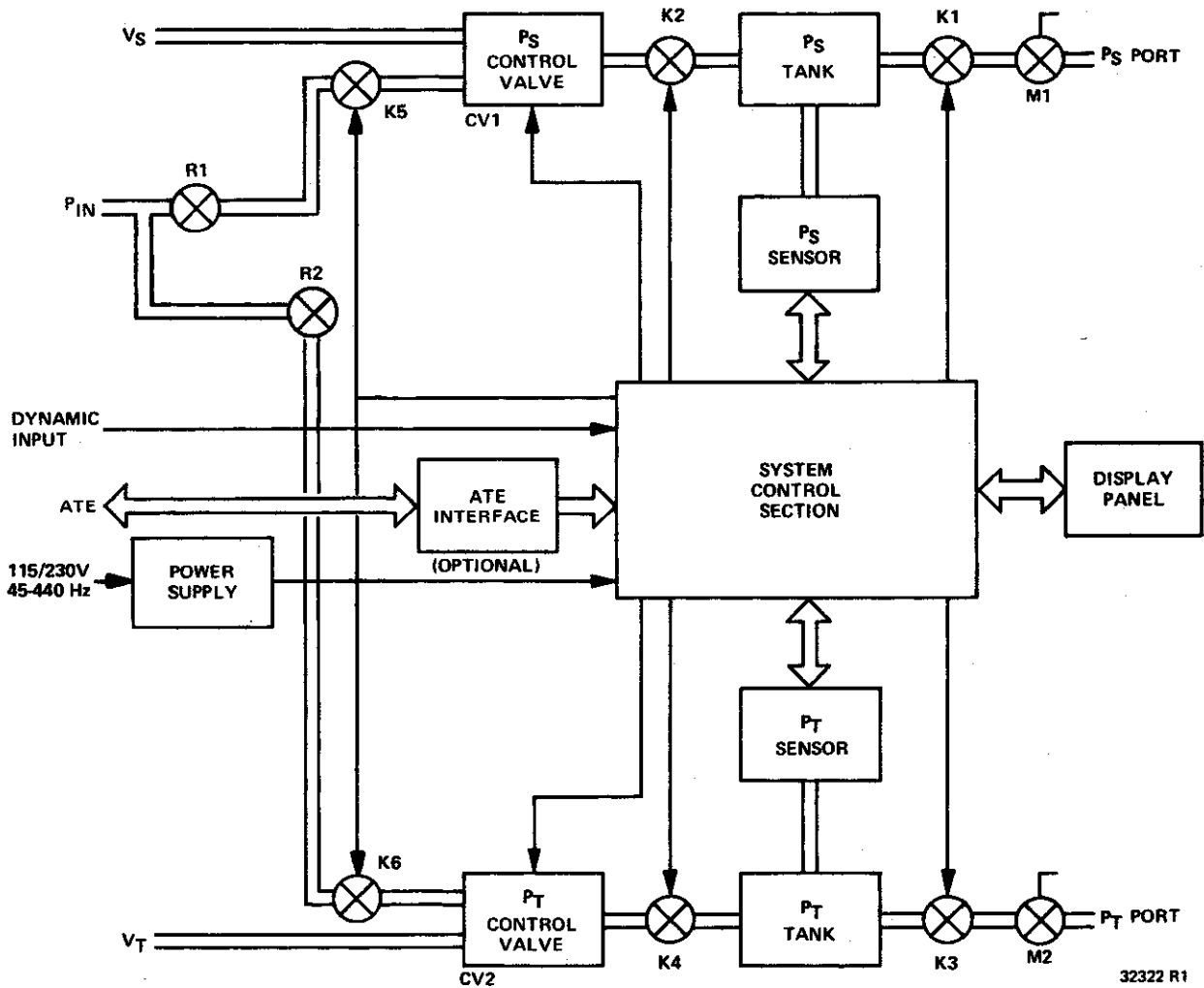


Section 3. Theory of Operation

1. General

A simplified block diagram of the ADT-222A is shown in figure 3-1. The ADT-222A consists of a pneumatic system, a system control section, a display panel, and a power supply. As an option, an ATE interface card is included. Operation of the ATE interface is explained in Chapter 5.

The pneumatic system consists of the P_s and P_t sensors; the P_s and P_t pressure control valves, CV1 and CV2; two pressure regulators, R1 and R2; solenoid valves, K1 thru K6; and the P_s and P_t manual shutoff valves, M1 and M2.



ADT-222A Simplified Block Diagram
Figure 3-1

Operation of the pneumatic system is controlled by the system control section. The control section contains all of the system electronics with the exception of the display panel, power supply, and the optional ATE interface. It interrogates the display panel for operator commands or (if applicable) the ATE interface for commands from an ATE, and controls the operating modes of the ADT-222A by operating the solenoid valves.

In the measure mode, the control section calculates absolute pressures by matching the raw output signals from the sensors to the sensor characteristics stored in the calibration memories. It then converts the absolute pressures to the measurement units selected by the operator and transmits them to the display panel for display.

In the control mode the control section periodically interrogates the display panel for the operator's commands, performs the calculation and conversion of the sensor measurements, compares the measured values to the commanded values, and operates the control valves to cause the pressures to reach the commanded values at the commanded rates and within the commanded UUT protection limits.

When the operator is an ATE, the processor talks to the ATE interface instead of the display panel. In this mode, although the processor doesn't respond to display panel commands (except the command to go to, or return from, ATE control), it still transmits display information to the display panel.

An important function of the system control processor is the operation of the built-in-test (BIT) capability. BIT monitors the functional status of the ADT-222A, detects any failures, and causes the system to: (a) indicate the failure on the displays and (b) protect the UUT from any possibility of damage by isolating the UUT from the internal pneumatic system of the ADT-222A. BIT also causes the ADT-222A to ignore any commands which would exceed the UUT protection limits. When this happens, the appropriate limit switch on the front panel will flash.

A. There are actually two forms of BIT employed by the ADT-222A: self test and continuous monitoring. Self test is initiated whenever the input power is cycled or whenever the UUT protection limits are actually reached. Self test operates as follows:

1. Self test is initiated whenever
 - (a) the pressure exceeds the UUT protection limits,
 - (b) the ADT-222A is turned on, or
 - (c) power to the ADT-222A is temporarily interrupted.
2. All of the solenoid valves will close.
3. The lighted pushbuttons and decimal points on the front panel will cycle five times.

1. A. 4. When the pushbuttons stop flashing, the displays will flash (all digits in unison) through the following sequence: 0,1,2,3,4,5,6,7,8,9,A,(blank),C,-d,E,F. Also, the decimal point in each display will cycle through each of the six decimal positions from left to right.
5. During the flashing sequences, the processor will perform a check sum of the memories and check the status of the system test points to determine if a software or hardware failure has occurred.
6. The displays will continue to cycle until the operator selects a specific display mode by pressing one of the four vertical pushbuttons.
7. When the operator selects a specific display mode, the ADT-222A will enter the measure mode, solenoid valves S1 and S3 will open, and the displays will stop flashing and will indicate the measured pressure.
- B. The purpose of the light and display flashing is to enable the operator to determine that all of the pushbutton lights and the display readouts are in operating order. The continuous monitoring form of BIT performs the following functions:
 1. It monitors the output from the power supply to detect power loss or power supply failure.
 2. It interprets each input command and determines if the command is within the UUT protection limits selected by the operator.
 3. It causes the system to ignore any commands which are immediately outside the constraints of the protection limits.
 4. It causes the DISABLE Q_C LIMIT switch or the DISABLE SUBSONIC LIMIT switch to flash whenever a command is entered which would cause a response that would exceed the protection limits.
 5. It monitors the system's response to detect if and when the pressures reach the protection limits.
 6. If the pressures reach the protection limits, BIT immediately causes the system to enter self test, thereby stopping all pressure changes.
 7. If a hardware failure is detected, both displays will indicate "FFF" in the three least significant digits, all solenoid valves will close, and the ADT-222A will ignore any further commands (except power off).

CAUTION: CLOSE MANUAL VALVES BEFORE CYCLING POWER.

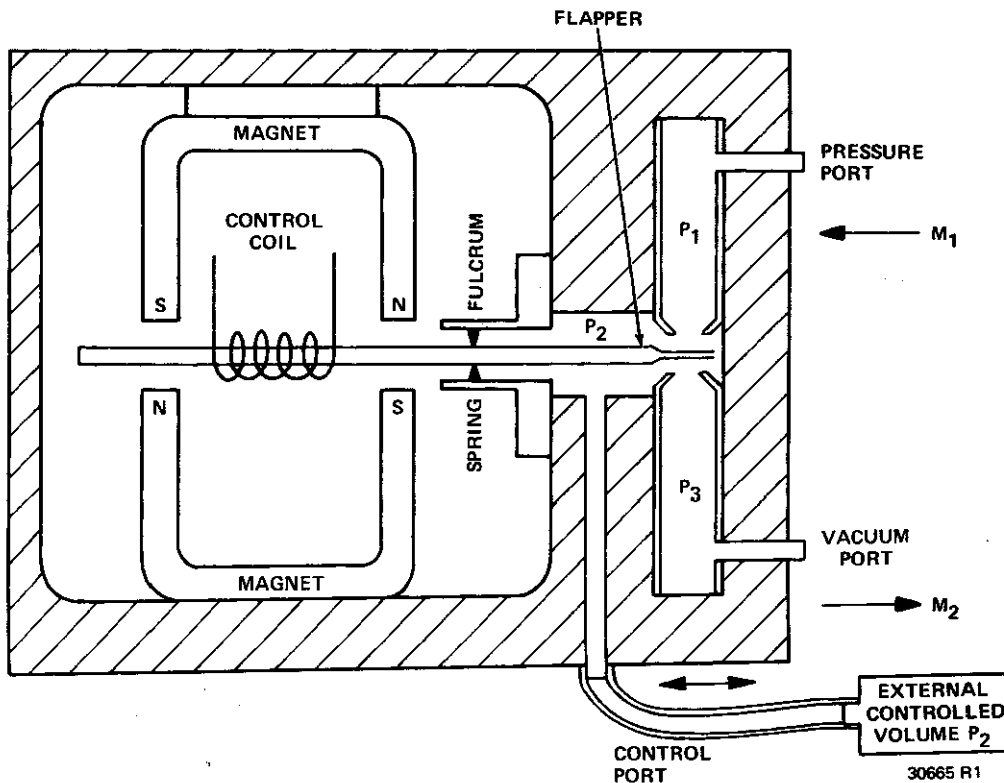
8. BIT also displays other error messages on the displays. An explanation of the BIT messages is contained in Chapter 3, section 4.

2. Functional Operation

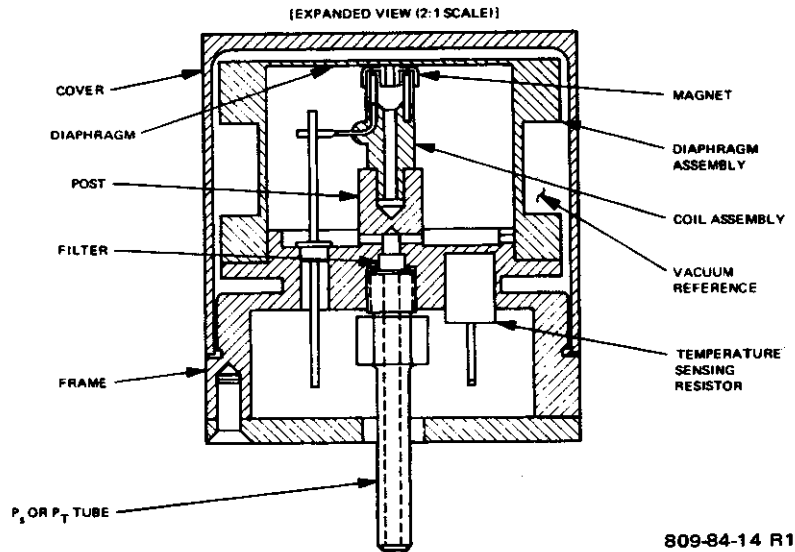
Controlled pressures within the ADT-222A are a result of the operation of the P_s and P_t control valves, CV1 and CV2. A cross section of the control valve is shown in figure 3-2. The valve consists of a flapper pivoted about a fulcrum point, an inlet pressure nozzle, a vacuum nozzle, a controlled pressure chamber, a permanent magnet, and a control coil.

The fulcrum acts as a center return spring as well as an air tight seal. By positioning the flapper, the pressure, P_2 , in the controlled pressure chamber can be controlled over a range of pressures between the inlet pressure P_1 and the vacuum pressure P_3 . Since the position of the flapper relative to the two nozzles is controlled by the current in the control coil, the pressure P_2 is a function of the current applied to the coil.

Pressure measurements in the ADT-222A are made by a vibrating diaphragm pressure sensor shown in figure 3-3. The sensor contains a flat resonant diaphragm connected to a permanent magnet and driving coil assembly. The driving coil is connected to an amplifier to form an oscillator circuit in a configuration similar to a quartz crystal oscillator, the high-Q resonant diaphragm assembly taking the place of the crystal. Since the resonant frequency of the diaphragm is a function of the absolute pressure loading, this configuration results in a nonlinear but direct pressure to frequency transducer. The output frequency of the sensor is, therefore, a direct, monotonic function of the pressure applied to the input tube.



Pressure Control Valve
Figure 3-2



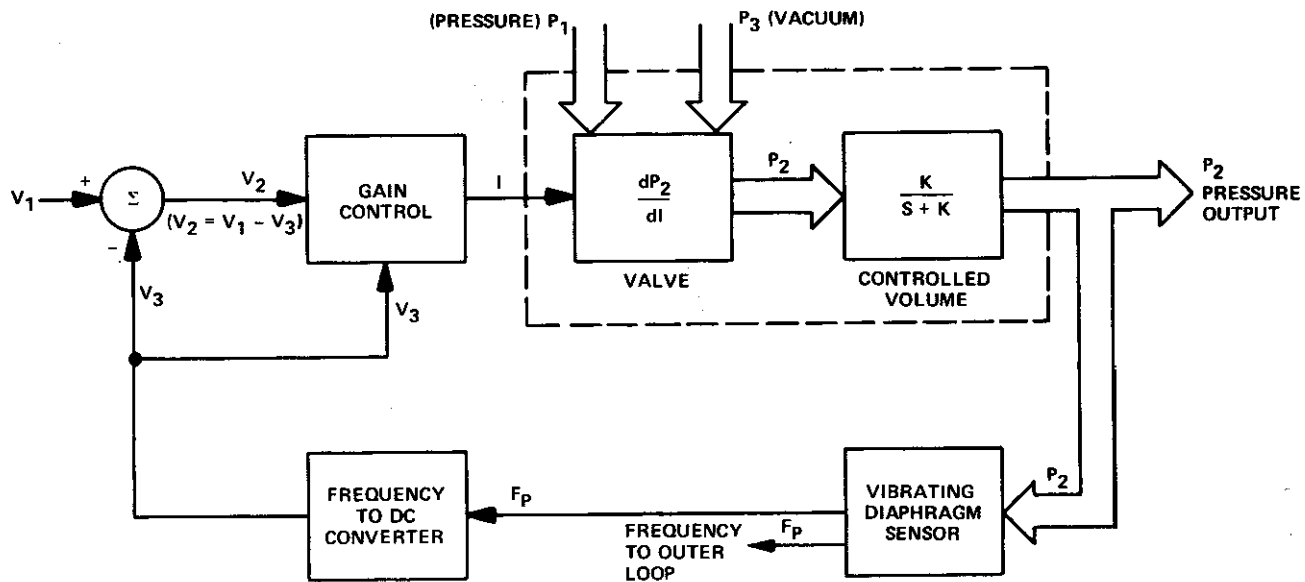
Vibrating Diaphragm Pressure Sensor
Figure 3-3

The control valves and the sensors are operated by the system control section to provide controlled pressures to the UUT. Since the measure mode consists of the same measurement processes that are used in the control mode, the following paragraphs explain the operation of the system control section in the control mode only.

Functionally, the system control section consists of an analog inner loop control system and a digital outer loop control system for each pressure channel. In the ALTITUDE/AIRSPEED and P_S/Q_C display modes, the system control section coordinates the operation of the two control systems (P_S and P_t) to obtain the required pressure response.

All internal operations of the ADT-222A are performed in terms of inches of mercury for P_S and P_t . The digital processor contained in the system control section performs all of the calculations and conversions necessary to receive commands and display measurements in the other available display units.

A block diagram of the inner loop control system is shown in figure 3-4. The inner loop system consists of a vibrating diaphragm pressure sensor, a pressure control valve, a volumetric pressure load (volume tank), a frequency to dc voltage converter, and a feedback loop employing adaptive gain control. The output of the pressure control valve is P_2 . P_2 is P_S in the P_S channel and P_t in the P_t channel.



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Inner Loop Block Diagram
Figure 3-4

The control valve responds to its input current, I , derived from V_1 , V_2 , and V_3 , by controlling the output pressure, P_2 . P_2 is measured by the sensor whose output frequency, F_p , is a function of P_2 . This sensor signal is fed into the frequency to DC (F/V) converter which converts the signal to a DC voltage which is proportional to F_p . The DC output of the F/V converter, V_3 , is subtracted from the command voltage, V_1 , in a summing network to produce an error signal. The error voltage, V_2 , is converted to the control valve input current in a gain control network.

The gain control network compensates for the non-linearities of the control valve and the sensor. These non-linearities are evident in the transducer response curves shown in figure 3-5. Since the loop gain is a function of P_2 , the DC output, V_3 , of the F/V converter is used by the gain control network to determine the magnitude modification to be applied to the error signal, V_2 .



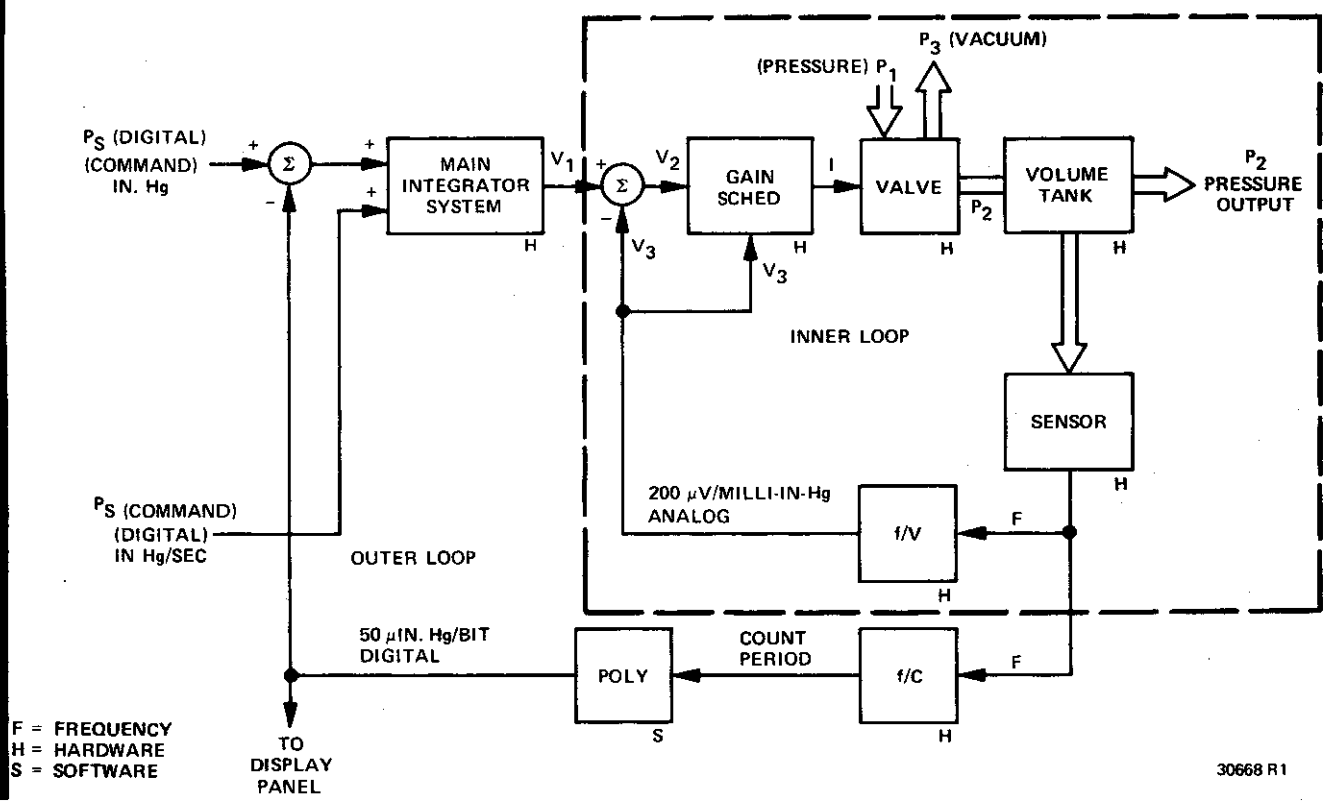
Transducer Response Curves
Figure 3-5

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The net result of this fast, high resolution analog inner loop is to provide a one-to-one correspondence between the command voltage, V_1 , and the output pressure P_2 . This inner loop has the advantage of providing extremely fast and smooth transient pressure response with excellent short term stability. The only disadvantage is the long term analog drift (inherent in all analog circuitry) that varies with time and temperature. However, this disadvantage is completely removed by the digital outer loop.

The description of the digital outer loop will be given in three levels of ascending complexity. The simplest block diagram is shown in figure 3-6. The inner loop is shown in the upper right corner of figure 3-6.

The basic purpose of the outer loop is to generate the proper command voltage, V_1 , to obtain the desired pressure response from the inner loop. The outer loop hardware is mostly digital and is controlled by the system software to generate V_1 to compensate for the offset and long term drift errors inherent in the analog inner loop. To accomplish this, the sensor output, which is fed into the frequency to DC converter of the inner loop, is also fed into a frequency to count (F/C) converter. The output of the F/C converter is used to develop a digital number that is proportional to the measured pressure and is subtracted from the digital command signal. The resultant digital error signal is changed into an analog error signal by the D/A and used by the main integrator section to generate V_1 . The main integrator section also uses the rate command to determine the rate at which V_1 is to change to cause P_2 to change at the desired rate.



Outer Loop Block Diagram (Simplified)
Figure 3-6

The F/C output is a digital number (m) which specifies the sensor count, or more precisely, the period of the sensor output signal. The equation for the conversion is:

$$m = \frac{N F_C}{F_P}$$

where N is the number of sensor periods averaged, F_C is the frequency of the high speed reference clock (37.5 MHz), and F_P is the sensor frequency. Since N and F_C are constants, m is inversely proportional to F_P and a non-linear function of pressure.

The digital processor calculates the absolute pressure in inches Hg by inserting m as the independent variable of a sixth order, six segment polynomial equation. The 42 coefficients of the six polynomial segments are the calibration constants of the sensor. The calibration constants are calculated during initial calibration of the sensor and are stored in programmable read only memory (PROM) chips on the calibration memory circuit card. The PROM contents are custom blown for each sensor. Calculation of the polynomial determines the absolute pressure applied to the sensor. For example, segment three of the P_t polynomial covers the pressure range of 24.000 to 46.000 inches Hg absolute. The equation for this segment is:

$$P_t = A_0 + A_1m + A_2m^2 + A_3m^3 + A_4m^4 + A_5m^5 + A_6m^6$$

24.000 < P_t < 46.000 inches Hg. ABS

where A_0 thru A_6 are stored in the PROM's and m is the count. This value of P_t is further corrected for sensor aging effects by conversion in another polynomial which uses the positions of the calibration switches for its coefficients. The calibration switches are set during subsequent recalibration of the system.

The end result of the processor calculations is a two's complement binary word that specifies the exact pressure applied to the sensor. The processor transmits this word to the display panel in BCD for readout on the gas discharge displays. The processor also subtracts this measured pressure from the command pressure to determine a difference pressure (error) word which it sends to the main integrator section, along with the rate command word, to generate the proper V_1 for driving the inner loop.

As previously stated, all of the operations within the ADT-222A are performed in terms relating to inches of mercury. It is the function of the digital processor to convert all input commands to these units for the internal control system and to convert the measured values from these units back into the units applicable to the display mode selected by the operator. The processor also controls the generation of pressures within the system by "talking" to the applicable circuits with digital words. Operation of the outer loops, therefore, is a function of the processor.

The pressure control circuits of the ADT-222A employ input registers to store the command words from the processor, a digital-to-analog (D/A) converter for converting the command words into their voltage equivalents, and sample and hold (S&H) circuits for "remembering" the resultant command voltages.

All operations of the processor (and the ADT-222A) are performed at least once during each processor cycle. The time phasing of key operations is fixed and is controlled by timing and control cards. The time required to complete each processor cycle is 224 milliseconds, derived from the master clock phase repetition frequency (PRF) of 4.47 Hz. For simplicity, a processor cycle will be referred to as a PRF (pulse repetition frequency).

During each PRF, the processor interrogates the front panel for input commands, converts the input values to inches Hg, compares these values with the measured values from the sensors, determines the appropriate response to be obtained during that PRF, and transmits the appropriate command values to the pressure control circuitry to initiate the desired pressure response. It also transmits the measured values to the front panel for display to the operator.

For a more precise explanation of the operation of the digital outer loop, refer to figure 3-7 which includes the functional blocks of the main integrator section. Below each functional block in this diagram and the diagrams to follow will be either an S or an H to specify whether that block specifies a primarily software function, performed by the processor, or a primarily hardware function, performed by the control circuitry.

During each PRF, the processor calculates the current pressure, P_2 , from the output of the F/C converter and interrogates the front panel for the input commands. It then performs the necessary calculations to convert the front panel commands into the proper units. The processor uses the current pressure as a reference to calculate an instantaneous rate in inches Hg/second.

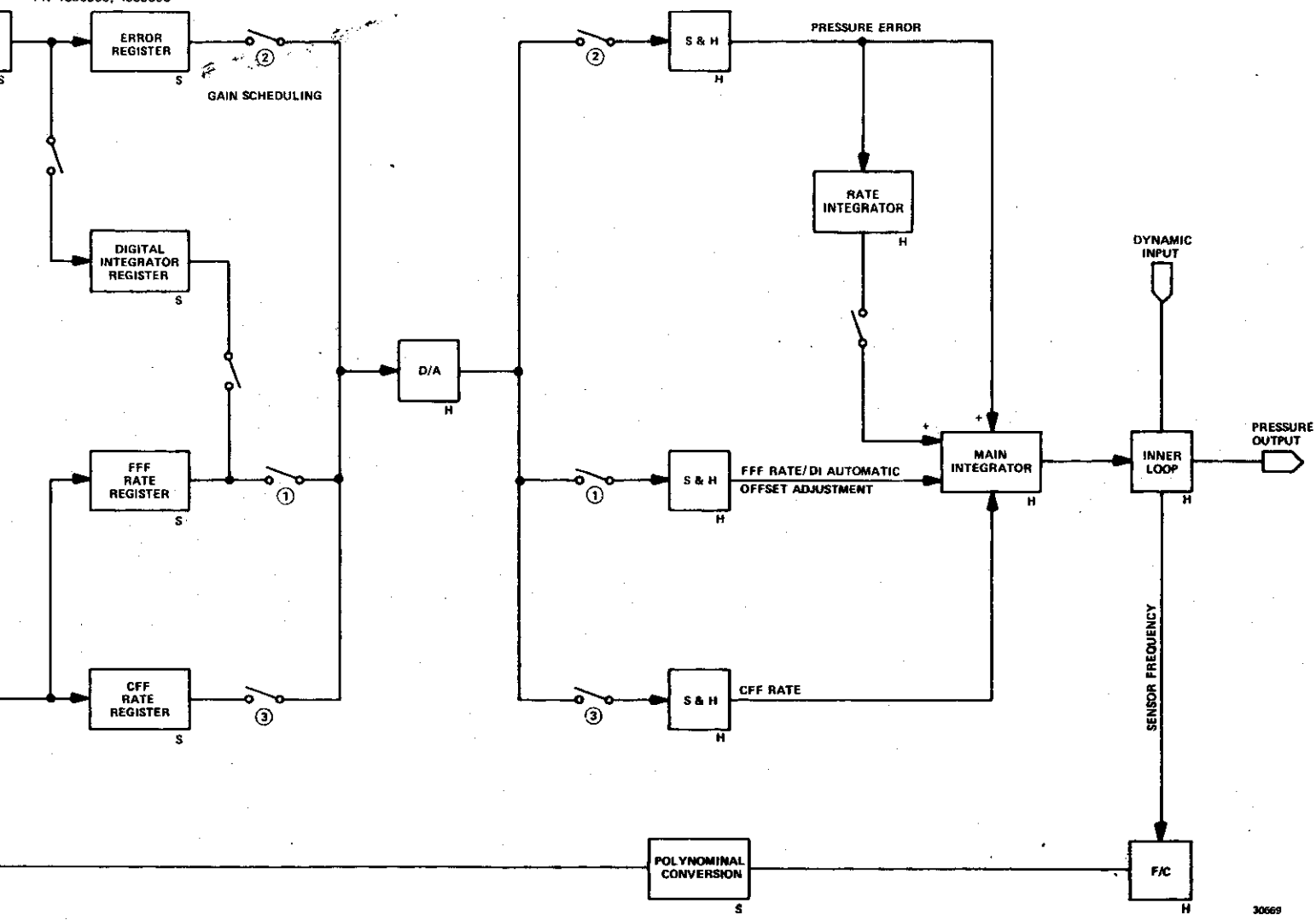
The values stored in these registers are sequenced into a DA converter and their analog equivalents are fed into S&H circuits. The S&H circuits store the analog commands and their output values drive the main integrator which drives the inner loop to obtain the desired pressure response for the PRF.

During each subsequent PRF the whole process is repeated and when the response approaches the final value the successive values being placed into the error register get smaller and smaller because the pressure response gets closer and closer to the commanded final value stored in the final value register.

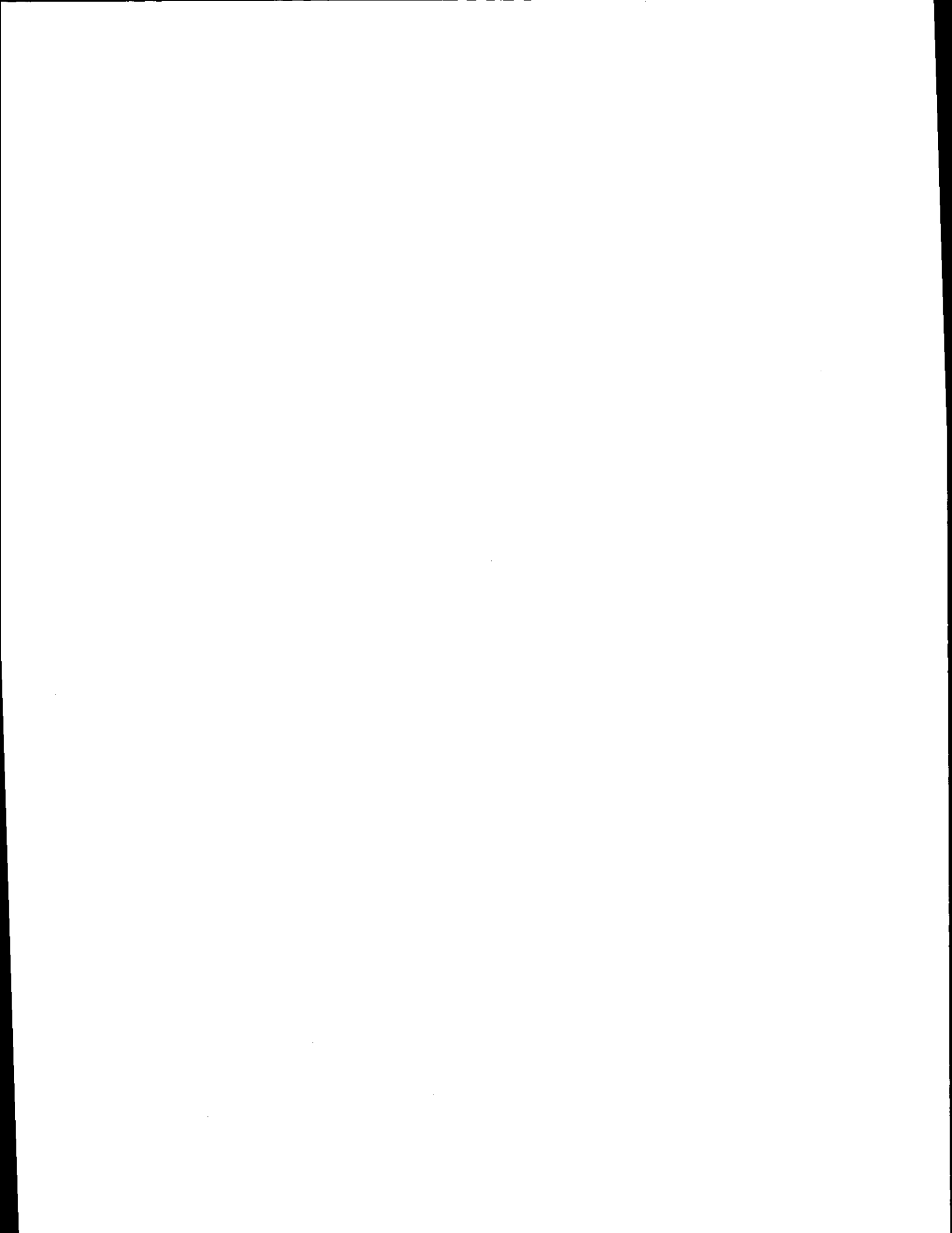
When precision rate is selected by the operator, an additional integrator is switched into the main integrator section. The rate integrator is an operational amplifier which integrates the output of the error S&H and applies it to the main integrator. Use of this fourth driving input to the main integrator enables the maintenance of a transition rate that is normally within ± 1 percent of the commanded rate.

As the response approaches the final value, the processor evaluates the commanded rate. When the response reaches a point where continuing at the commanded rate would cause the response to overshoot the final value, the processor decreases the value in the rate registers.





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When the difference between the final value and the value in the command register is 50 microinches of Hg or less, the final value is placed into the command register and the processor starts a 5-second timer. By this time the values in both rate registers have been reduced to zero. After 5 seconds, the function of the digital integrator (DI) register comes into play.

During pressure transition and the 5-second delay, the DI register is held constant. Its entire function is to overcome the long term offset drift effects of the analog inner loop. After the 5-second delay, the contents of the error register are algebraically added to the contents of the DI register. The DI contents are then converted to an analog voltage by the D/A converter and used by the S&H that was used previously for the FFF rate value to drive the main integrator to overcome the inner loop offset error. This process is repeated for each PRF to drive the absolute loop error to zero. When the value in the error register is zero, the DI register contains the value of the total analog offset errors in the inner and outer loops. Thus the pressure is controlled exactly to the commanded value and the displayed pressure equals the commanded pressure.

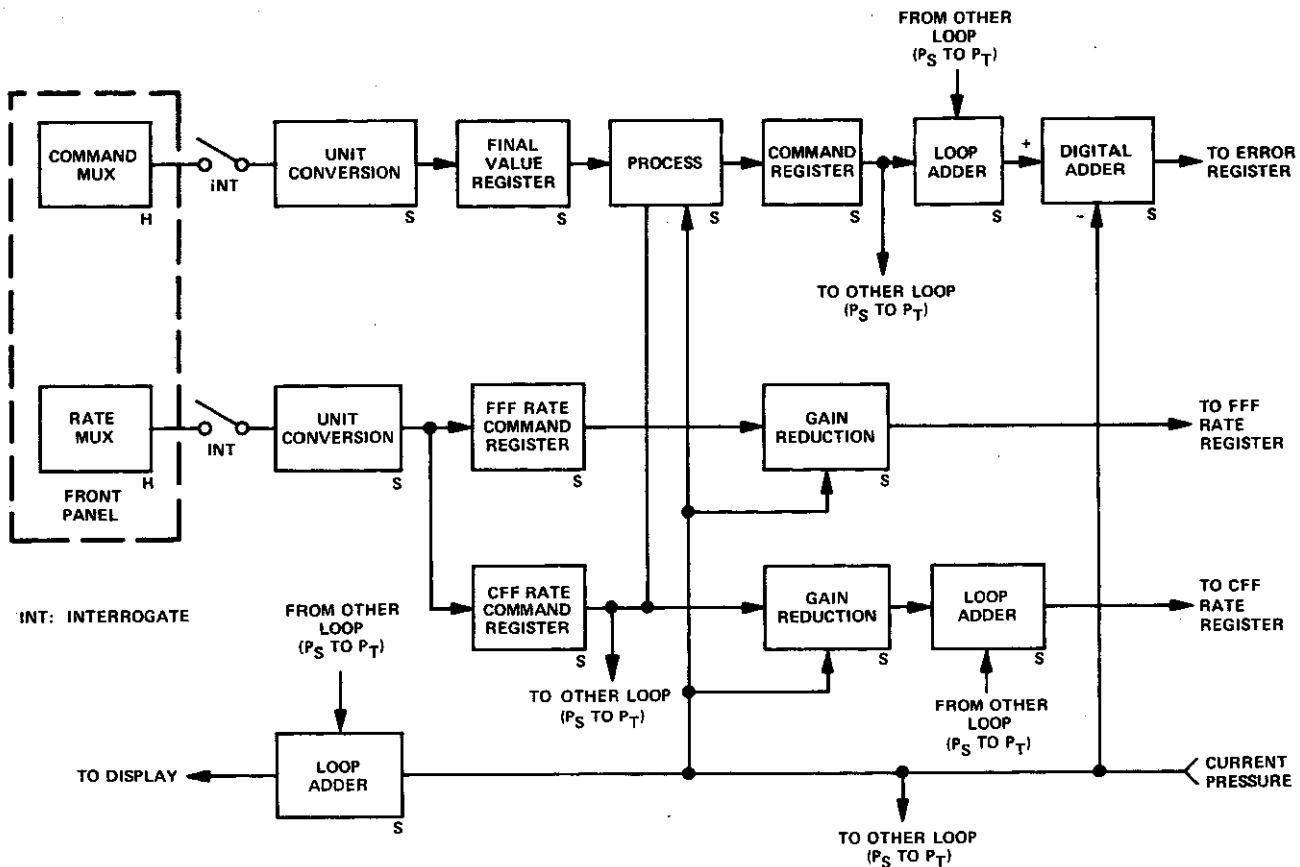
Until new commands are fed into the display panel, the system remains in a state referred to as pressure maintenance and the error and DI registers are updated every PRF to compensate for any pressure fluctuations which might be generated either internally or externally of the ADT-222A.

During pressure maintenance, a dynamic input can be used to drive the pressure system to produce pressure waves in response to the input waveform. The dynamic input is applied directly to the summing amplifier of the inner loop to provide fast and accurate response. To avoid the possibility of the dynamic response being interpreted as offset error by the processor, the DI automatic offset adjustment is held constant and the error register value is set at zero during the dynamic input mode. Because of this, the pressure at zero dynamic input may drift slightly (up to 0.005 inches Hg/minute) due to thermal effects on the inner loop amplifier offset voltages.

The block diagram of figure 3-8 is an expanded view of the outer loop control provided by the processor.

The processor interrogates the front panel MUX registers for changes in the command words. If the command words are new (i.e. if the COMMAND ENTER button has been pressed since the last PRF), the commands are converted to pressure units, if necessary, and stored in final value registers. As previously explained, the current pressure and the commanded pressure rate are used to determine the pressure change to be accomplished during the PRF and this pressure step is added to the command register.

As previously explained, the values stored in the rate registers are gradually reduced to zero from the values in the rate command registers once the pressure output gets close to its final value. This is done to aid in the elimination of overshoot.



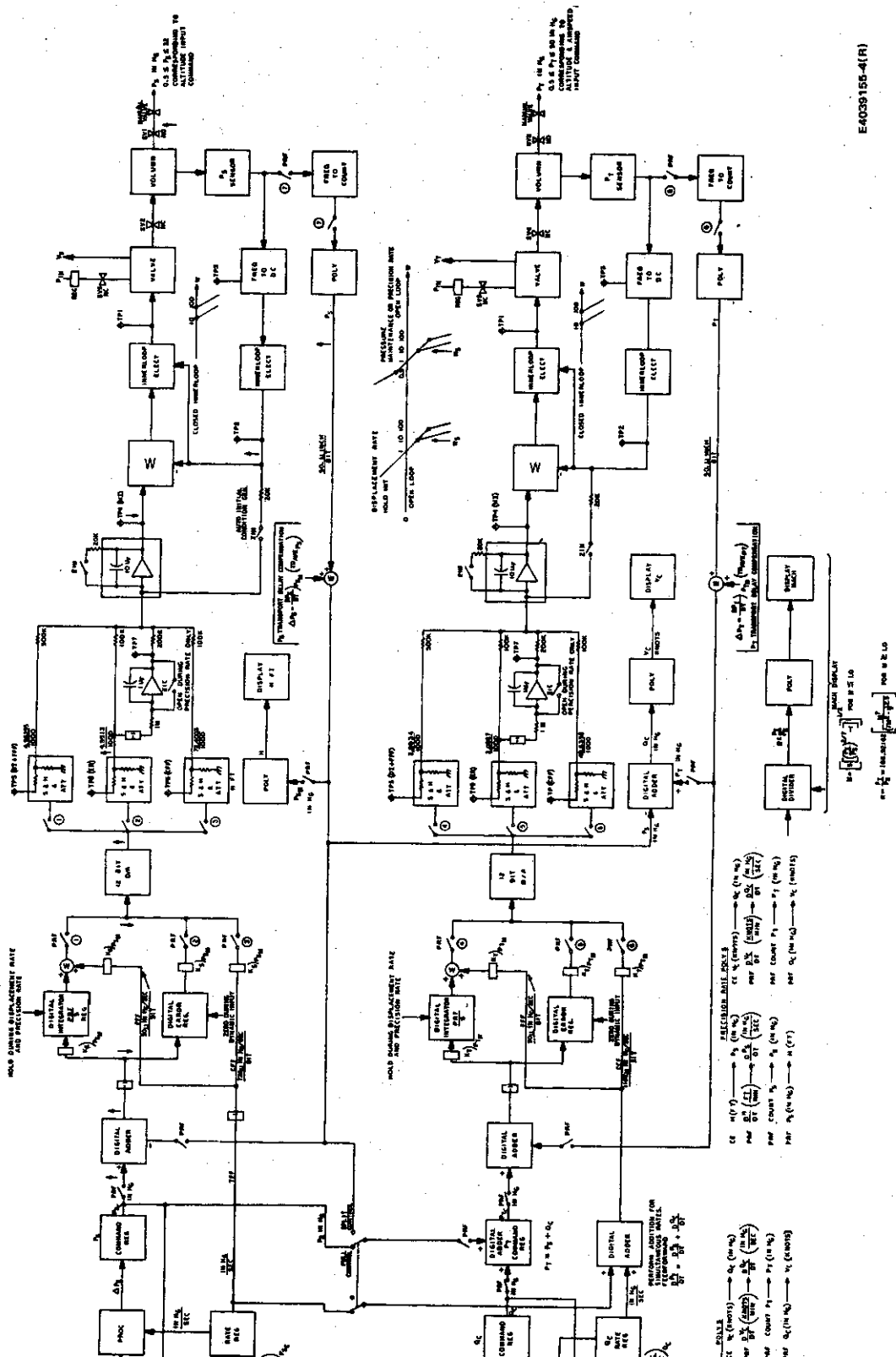
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Outer Loop Control
Figure 3-8

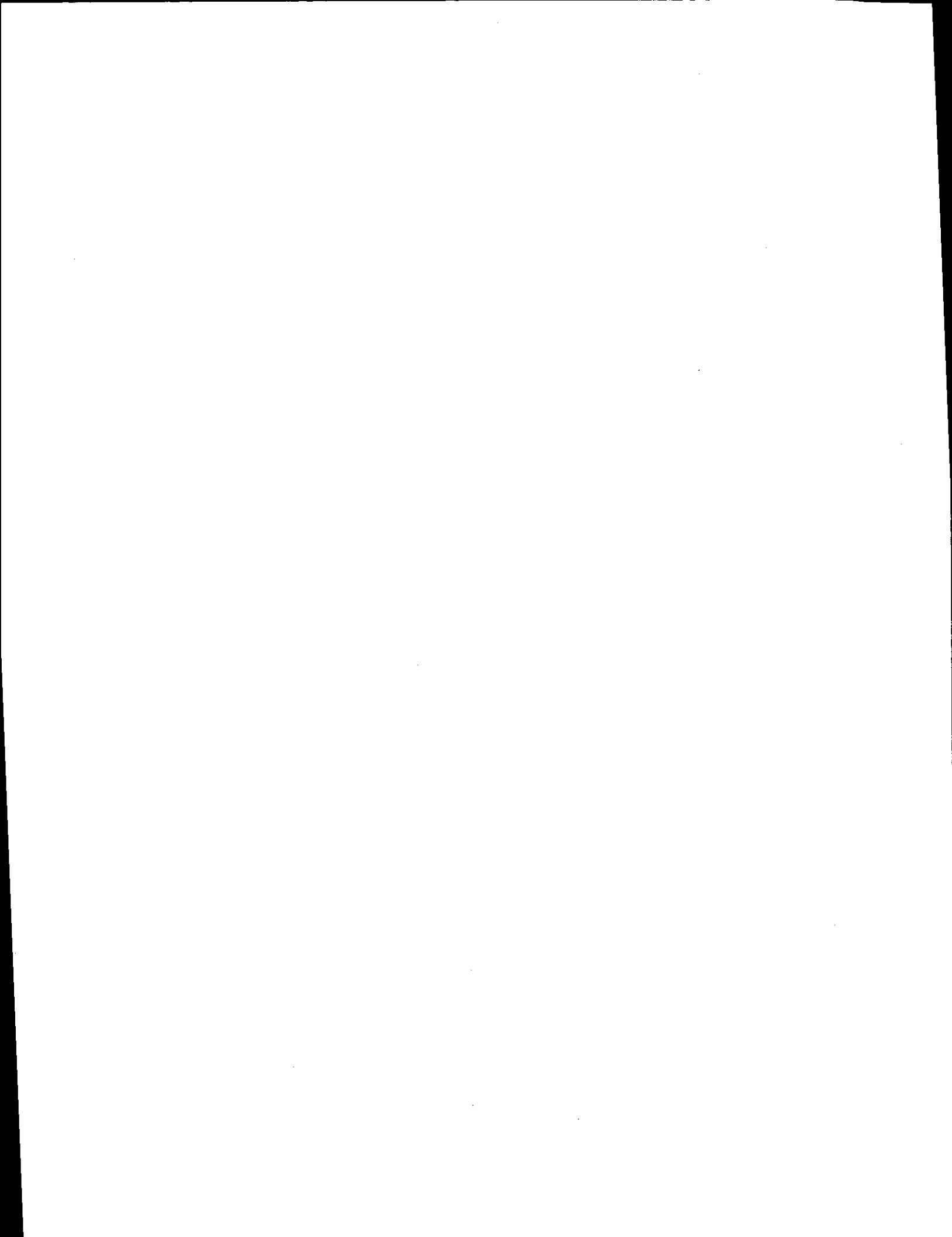
The main functional difference between this block diagram and that of figure 3-7 is the addition of the loop adder blocks. These blocks are only used in the P_t outer loop system and only when the ADT-222A is operating in a combined display mode. When operating in a combined display mode (either P_s/Q_c or altitude/airspeed), the command values and measured pressure from the P_s system must be used to coordinate the operation of the P_t system. In these combined modes, the rate of the P_s change is added to the airspeed or Q_c commanded rate to determine the appropriate P_t rate. Similarly, the incremental P_s command from the command register is added to the incremental Q_c command to determine the incremental P_t command, and the measured P_s output is subtracted from the measured P_t output to determine the airspeed or Q_c value to be displayed.

With the exception of the intra-loop connections just described, the only differences in operation among all four display modes are purely mathematical. Since the differences are generated by the system software, they will not be further explained here. The functional block diagrams for the four display modes are shown in figures 3-9 thru 3-12.

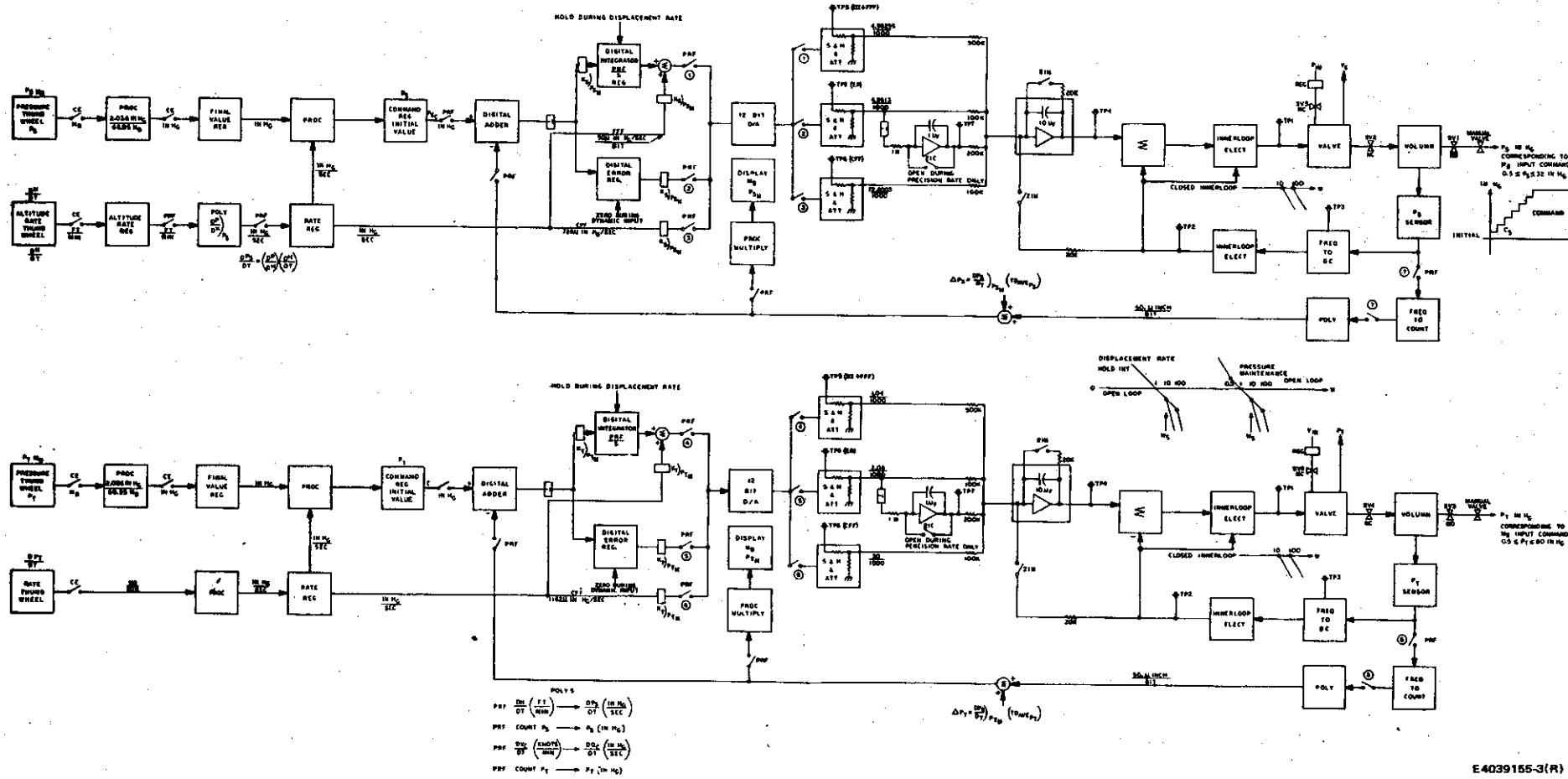
ALTITUDE/AIRPEED (FEET)(KNOTS), (FT/MIN KNOTS/MIN) DISPLACEMENT RATE AND PRECISION RATE AND PRESSURE MAINTENANCE



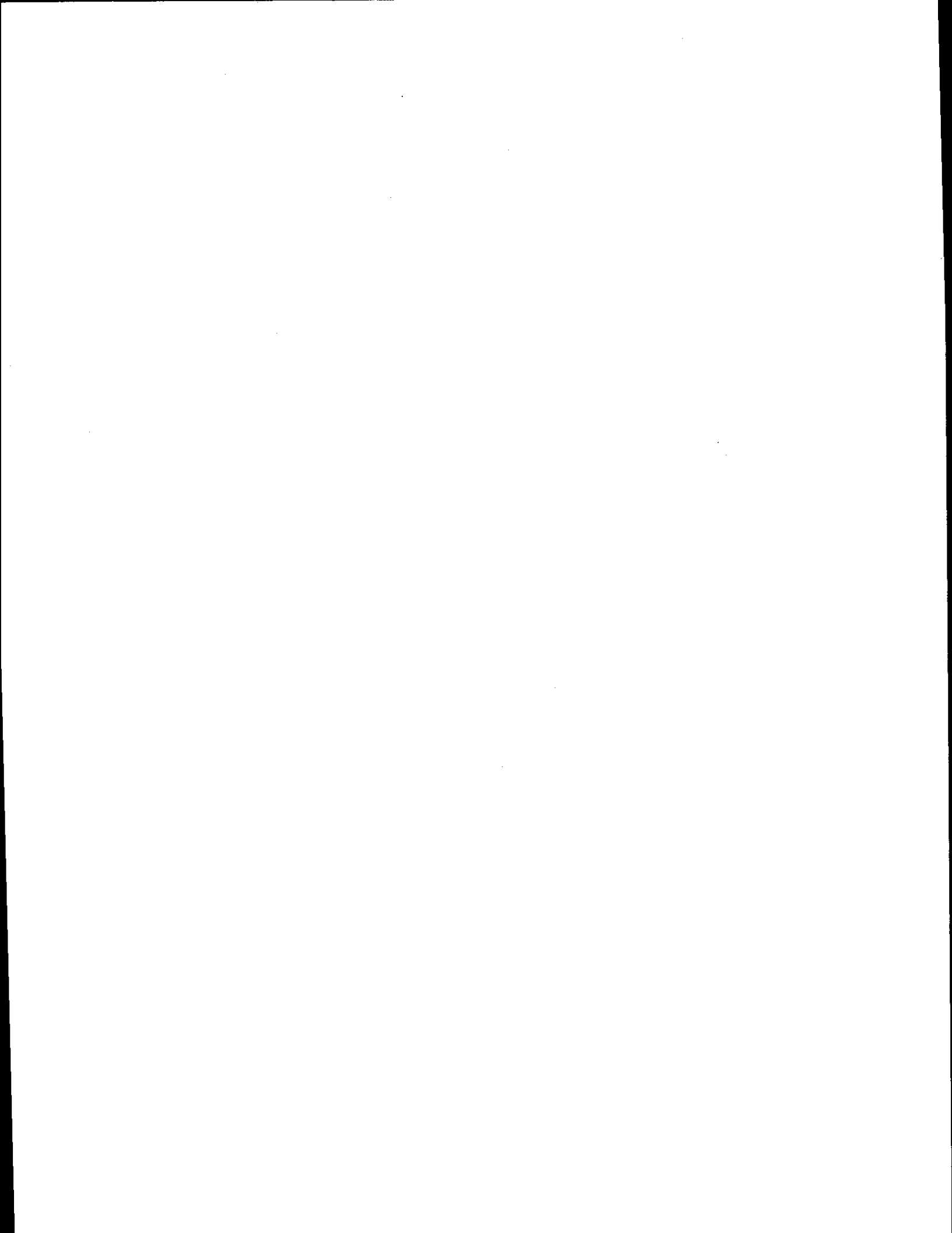
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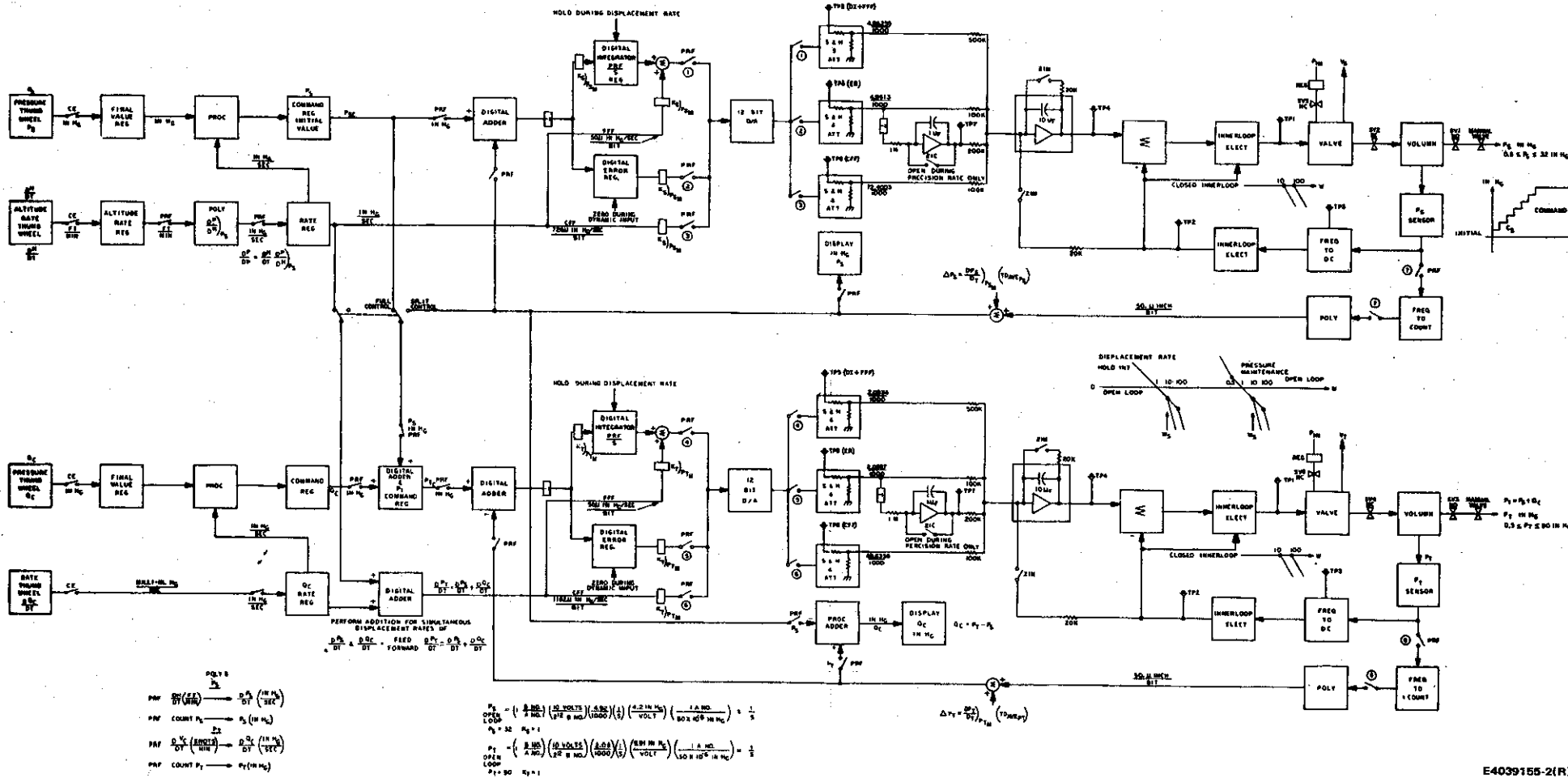
P₅/P₇ MILLIBARS, DISPLACEMENT RATE AND PRESSURE MAINTENANCE



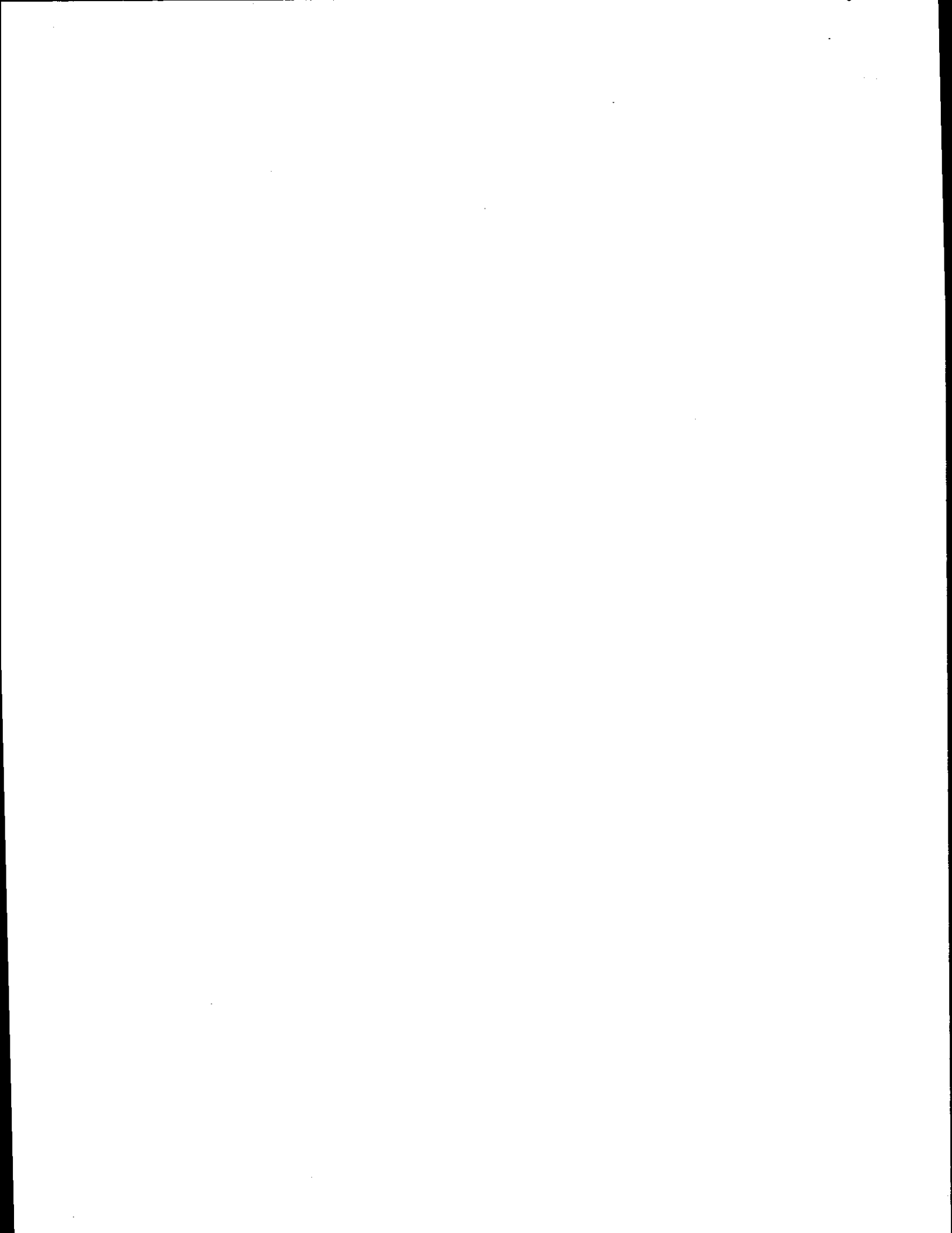
Mode 2 Block Diagram
Figure 3-10

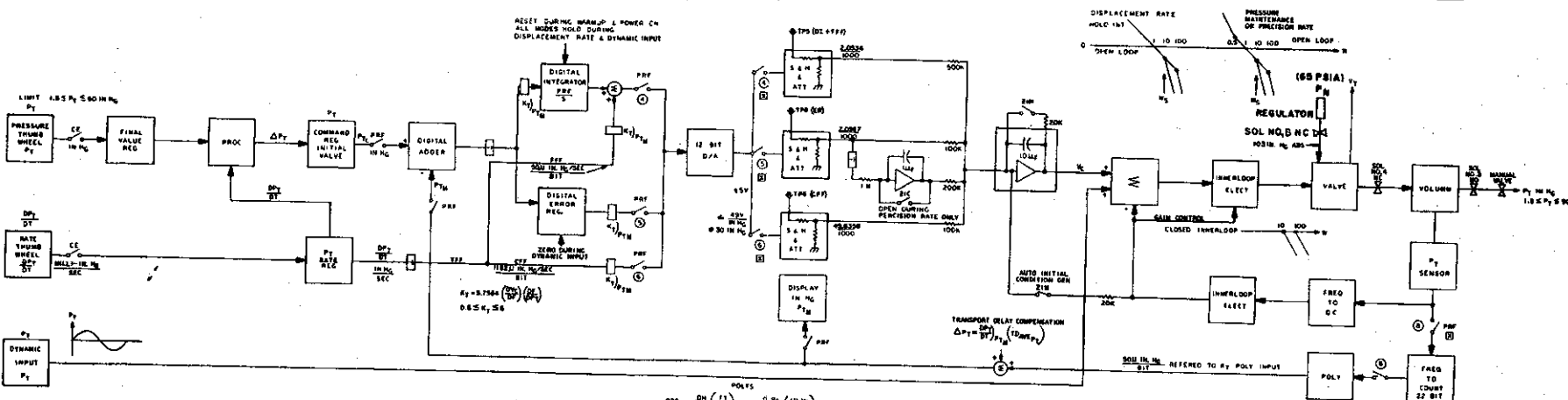
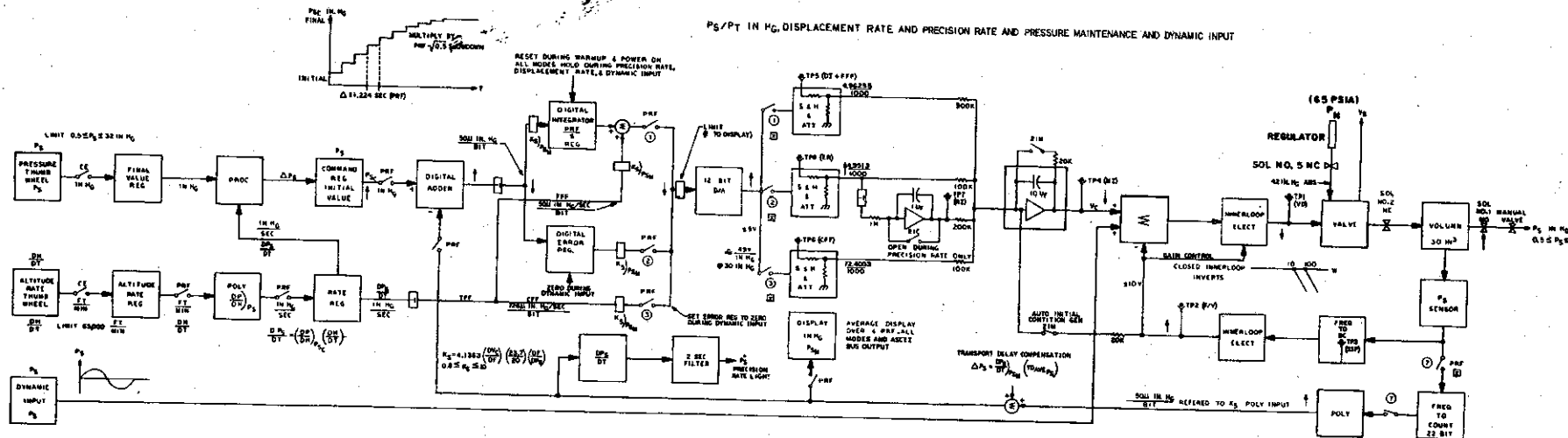


P_2/Q_C IN H_G , DISPLACEMENT RATE AND PRESSURE MAINTENANCE



Mode 3 Block Diagram
Figure 3-11





NOTES:

1. DIGITAL INTEGRATOR WILL BE HELD 0.5 SEC AFTER END OF DISPLACEMENT RATE AND PRECISION RATE; END IS DEFINED AS THE PRF THAT COMMAND REG IS SET TO FINAL VALUE REG.
2. DISPLAY WILL AVERAGE 4 PRF.
3. (H) MEANS KEEP THESE EVENTS TO THE SAME PHASE OF EACH PRF (4 PLACES EACH LOOP).
4. SYSTEM NOT CAPABLE OF SIMULTANEOUS RATES OF BOTH P₅ AND P₁ AT MAXIMUM RATES OF 49000 FT/MM AND 300 KNOTS/MIN.
5. THE DIFFERENCE IN VELOCITY ERRORS BETWEEN P₅ AND P₁ IS THE Q_T TRANSIENT ERROR.

$$PRF \frac{DP}{DT} \left(\frac{21}{25} \right) = \frac{0.25}{1} \left(\frac{10}{10} \right)$$

$$PRF \text{ COUNT } P_5 = P_5 \left(\frac{10}{10} \right)$$

$$PRF \frac{DP}{DT} \left(\frac{21}{25} \right) = \frac{0.25}{1} \left(\frac{10}{10} \right)$$

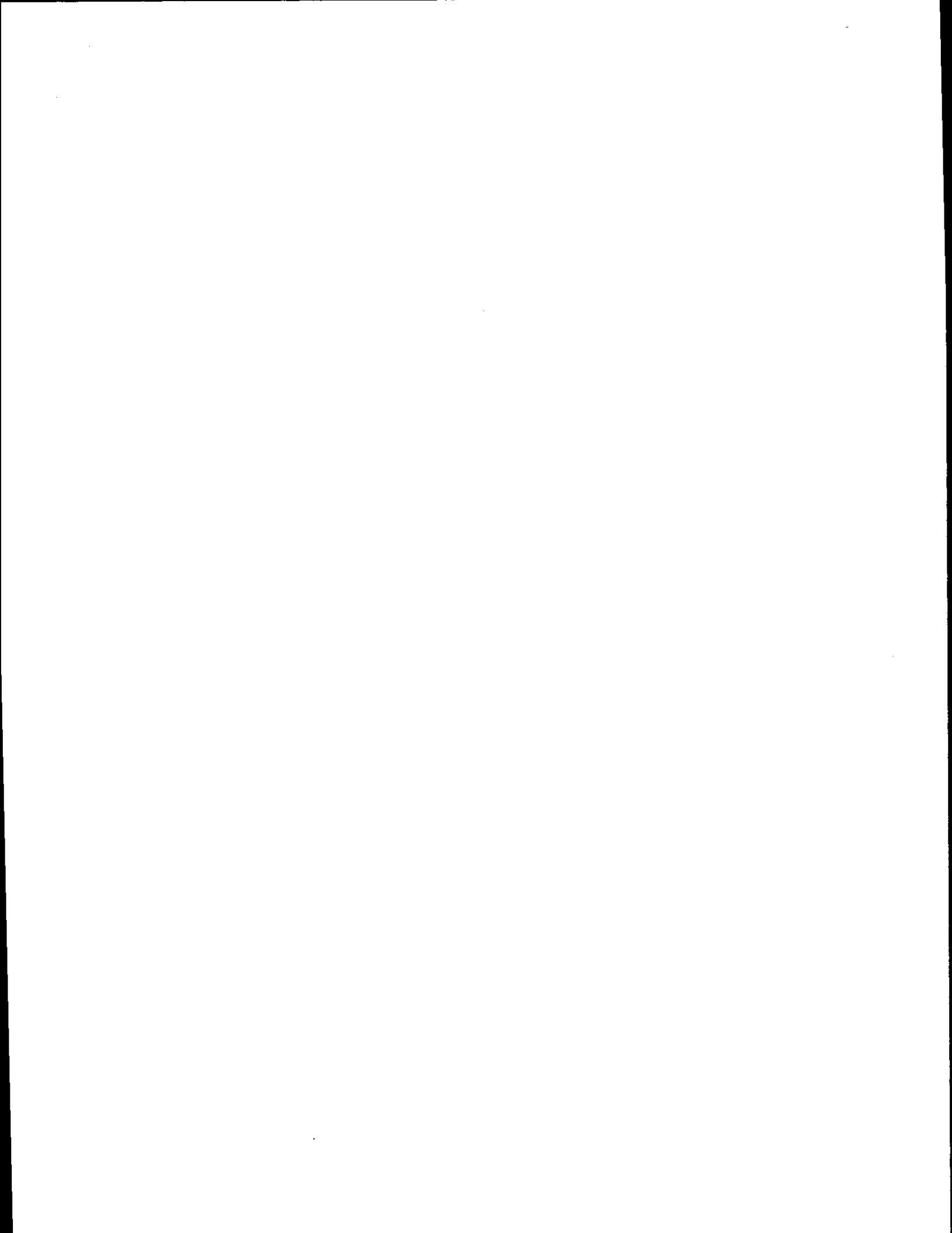
$$PRF \text{ COUNT } P_1 = P_1 \left(\frac{10}{10} \right)$$

$$R \text{ RATE } \left(\frac{3.5 \times 0.25}{5} \right) \left(\frac{1}{5} \right) \left(\frac{10}{10} \right)$$

$$D \text{ RATE } \left(\frac{1}{5} \right) \left(\frac{10}{10} \right)$$

$$PRESS \text{ MAINT } \left(\frac{2.5 \times 0.25}{5} \right) \left(\frac{1}{5} \right) \left(\frac{10}{10} \right)$$

Mode 4 Block Diagram
Figure 3-12



3. Detailed Operation

Since it is strongly urged that the user not attempt to troubleshoot and repair the four circuit cards constituting the digital processor, no detailed theory of operation for the four processor cards is included here. The four processor cards are: timing control (A1), program control (A2), arithmetic A (A3), and arithmetic B (A4). (The arithmetic cards are identical and functionally interchangeable.) For information, the block diagram for the processor is shown in figure 3-13 with the I/O block diagram shown in figure 3-14. Figure 3-15 shows the timing sequences generated by the timing card. The processor instruction formats are shown in figure 3-16, and the operation of the processor instructions is shown in figure 3-17.

No block diagram is included for the memory No. 1 card A5 (program memory). This card consists of a group of read only memories and a 16-word scratch pad. The program memory consists of approximately 5600 16-bit words which are addressed by the S register of the processor and the ROM outputs are connected to the input data bus of the processor. A 16-bit wide, 16-word random access scratch pad is also located on this card which reads from the TS-2 register and outputs to the input data bus.

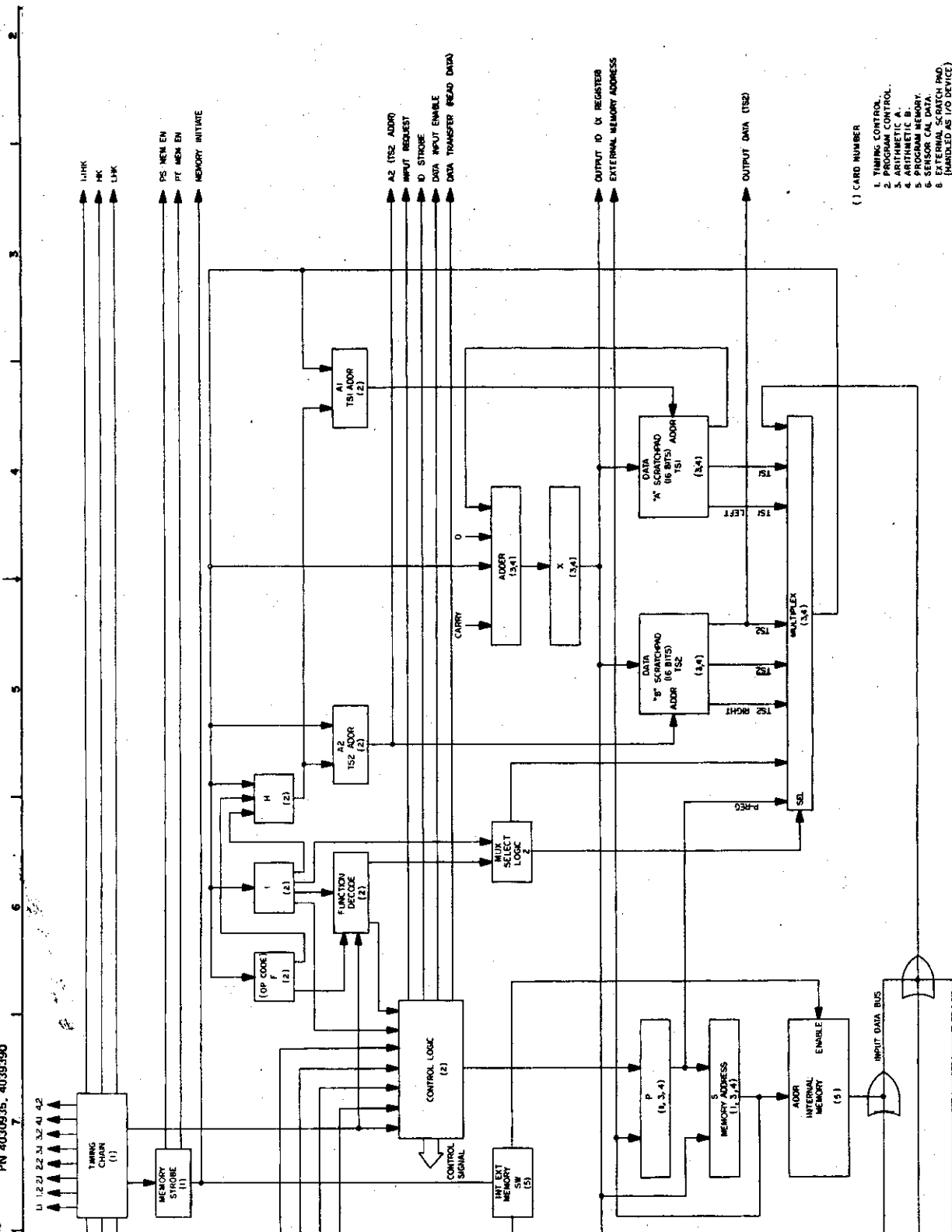
The memory No. 2 card A6 (calibration memory) is similar to the program memory card insofar as it contains PROM's and an address MUX. It also contains the calibration switches and a decoding network for the switches.

The functional blocks contained on the control and D/A card A7 are shown in figure 3-18. This card actually performs three separate functions. The system control function is shown in figure 3-18(A). All system control is determined by the digital processor which inserts system control words into its X register. It then sends a data transfer pulse (DTP) to the A7 card. When the A7 card receives the DTP, it inserts the X register contents into the system control registers. The contents of these registers are then decoded by the central address decoding logic (CADL) network. The CADL output constitutes the system control lines to the other components of the ADT-222A. The A7 card also contains the driving logic for the six solenoid valves for the different modes of operation. It uses the input from the dynamic input P_s/P_t switch on the front panel and the CADL output to enable either the P_s or P_t inner loop to be driven by the dynamic input. (The dynamic input enable signal is supplied by the CADL output.) The mode status network also decodes the processor OK (POK) word from the CADL for use by the BIT circuitry.

The D/A converter function is shown in figure 3-18(B). When the D/A latch (DAL) pulse is received, the contents of the output data bus (TS2) are fed into the data register. The contents of the data register are then converted to its equivalent analog voltages by the 12-bit D/A converter. The analog output is fed to the P_s and P_t inner loop cards for storage in the appropriate sample and hold circuit.



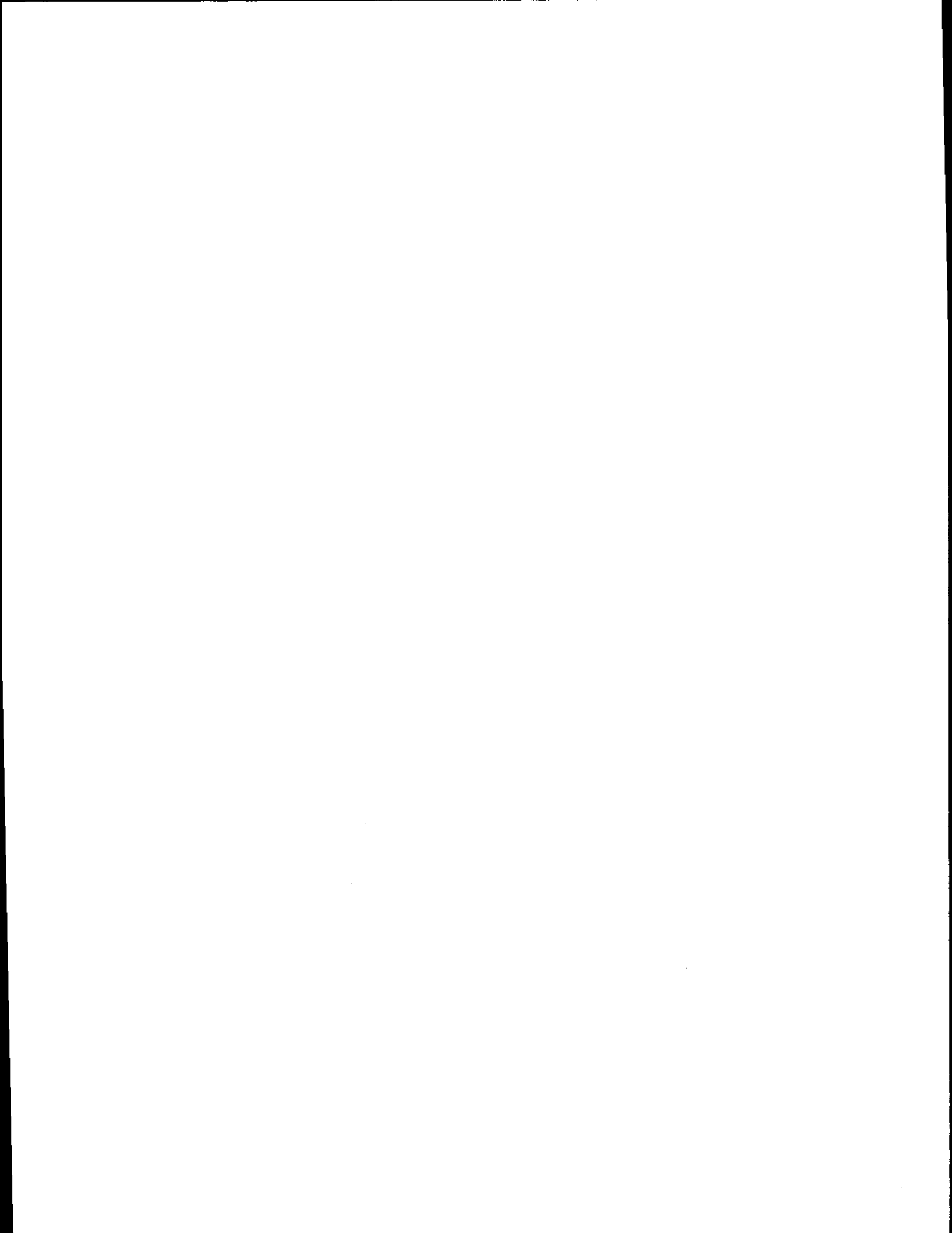
U1 1,2,3 2,2 3,1 3,2 4,1 4,2

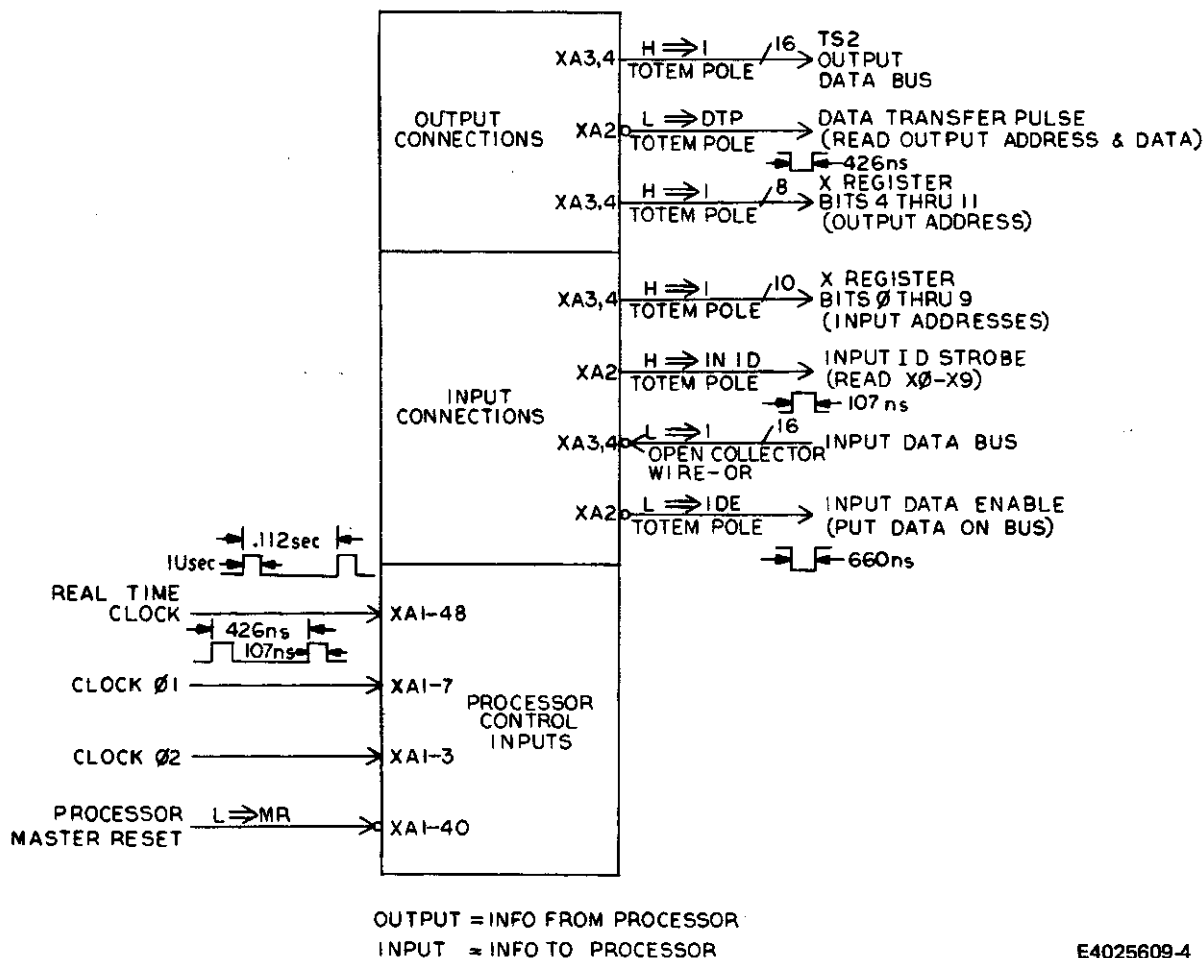


- (1) CARD NUMBER
1. TIMING CONTROL.
 2. PROGRAM CONTROL.
 3. ARITHMETIC A.
 4. PROGRAM MEMORY.
 5. PROGRAM MEMORY.
 6. SENSOR CAL DATA.
 7. EXTERNAL SCRATCH PAD.
 8. EXTERNAL SCRATCH PAD.
- (HANDLED AS I/O DEVICE)

E-4025609-1

Processor Block Diagram
Figure 3-13

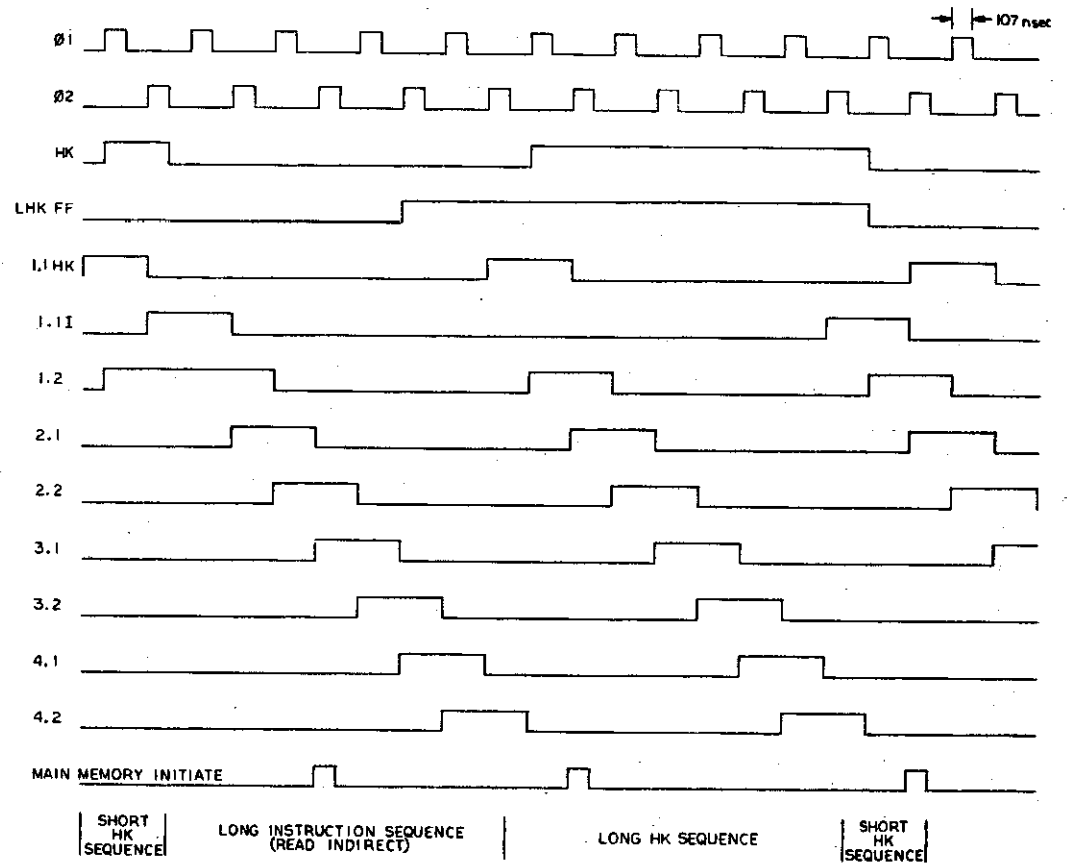




Processor I/O Block Diagram
Figure 3-14

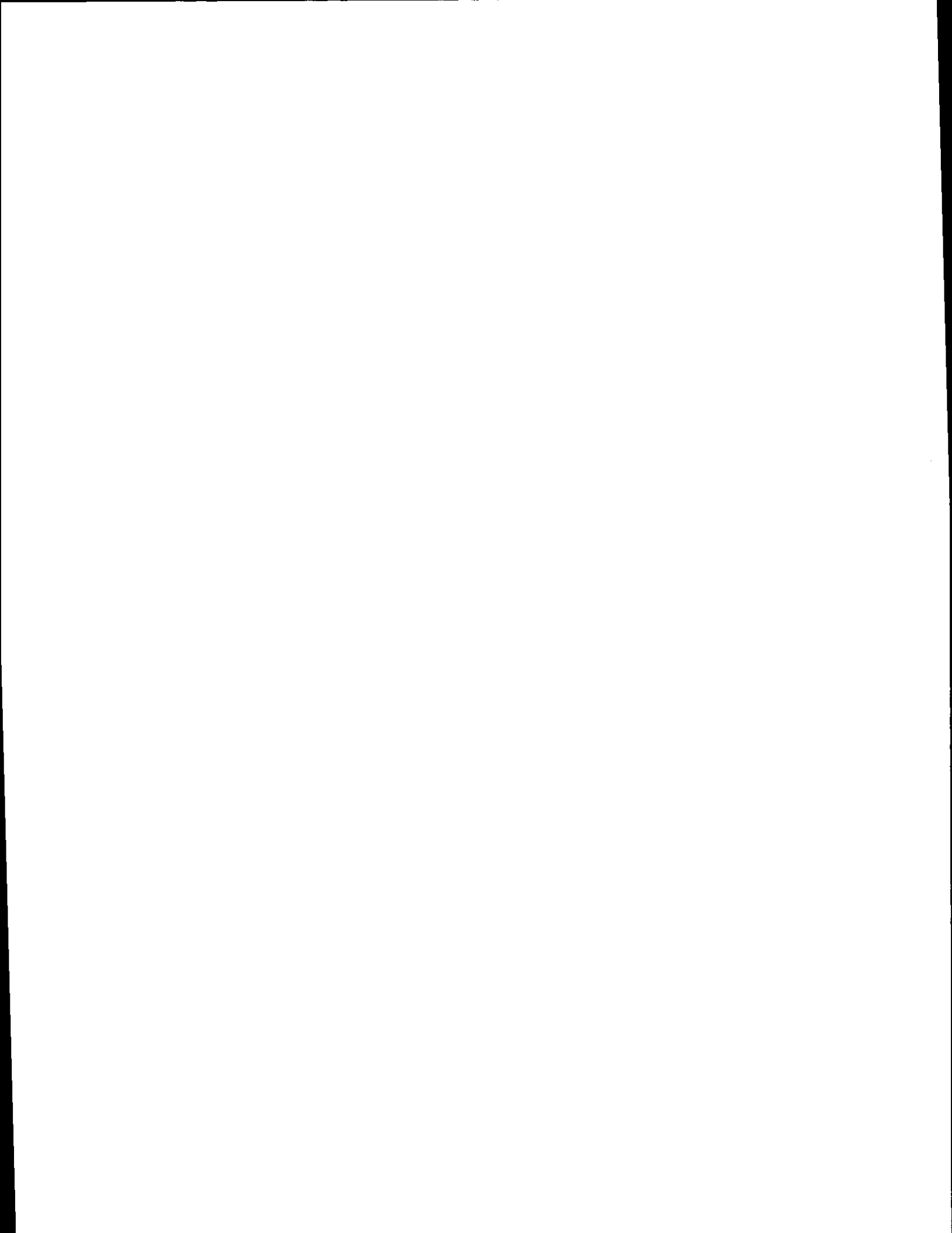
The BIT function, shown in figure 3-18(C) monitors the power supply output to detect power interruptions. If a power interruption of greater than 10 milliseconds occurs in the +5 volts dc logic supply output from the power supply, the BIT circuit will send a master reset pulse to the processor and to the display panel MUX causing the system to enter the initiated BIT cycle. The same thing happens if a processor OK (POK) signal is not received within 0.32 seconds after the last POK. The POK signal is a decoded CADL output resulting from the transmission of a processor OK status word from the processor via the X register. The POK timer is a counter circuit which is driven by a 400-Hz signal from the power supply. The POK timer is reset to zero by every POK pulse, but if the timer finishes its count before a POK pulse is received, the timer sends a PFAIL signal to the BIT circuit to start initiated BIT. The system will not leave initiated BIT unless the +5 volt dc line is valid and a POK signal is received.

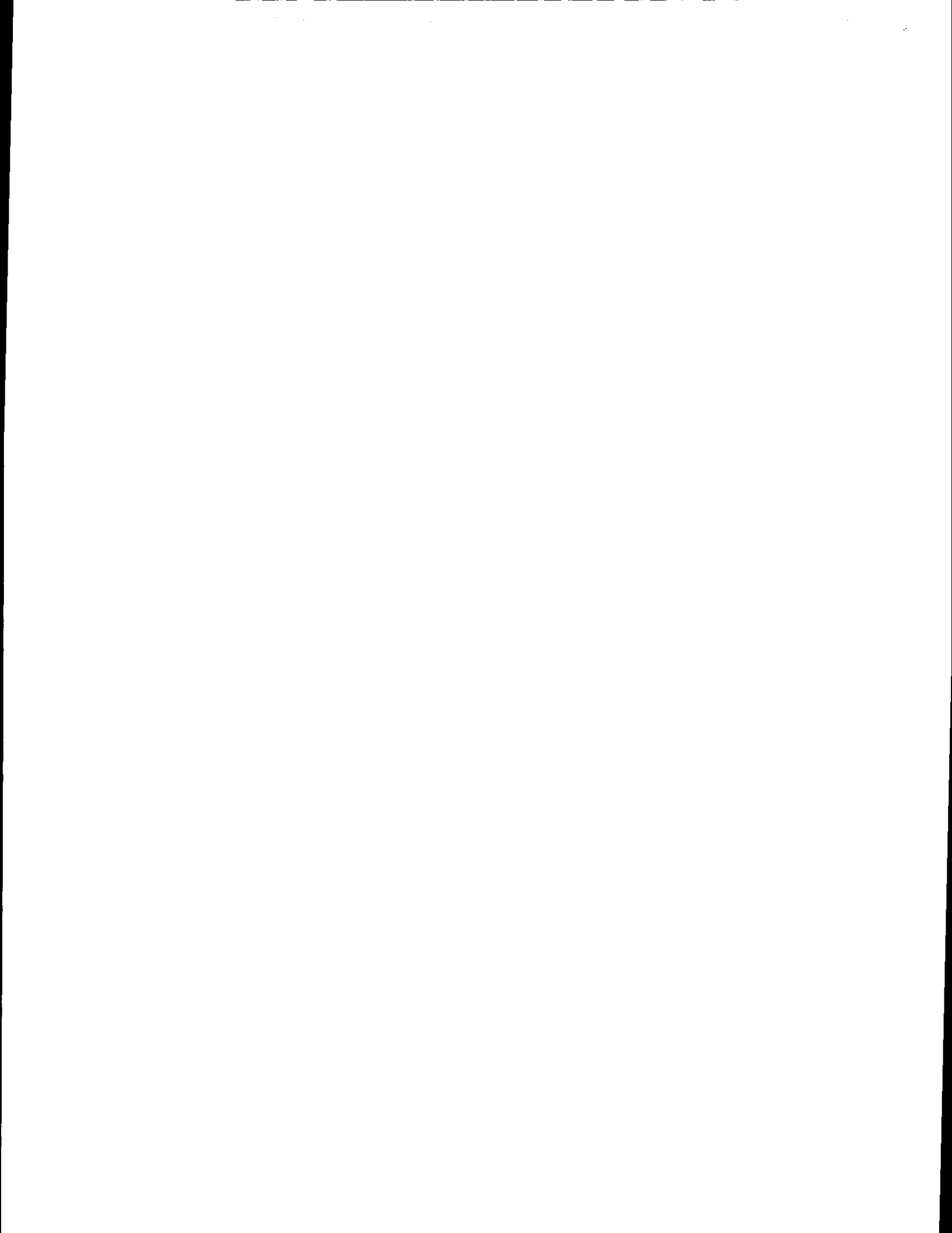


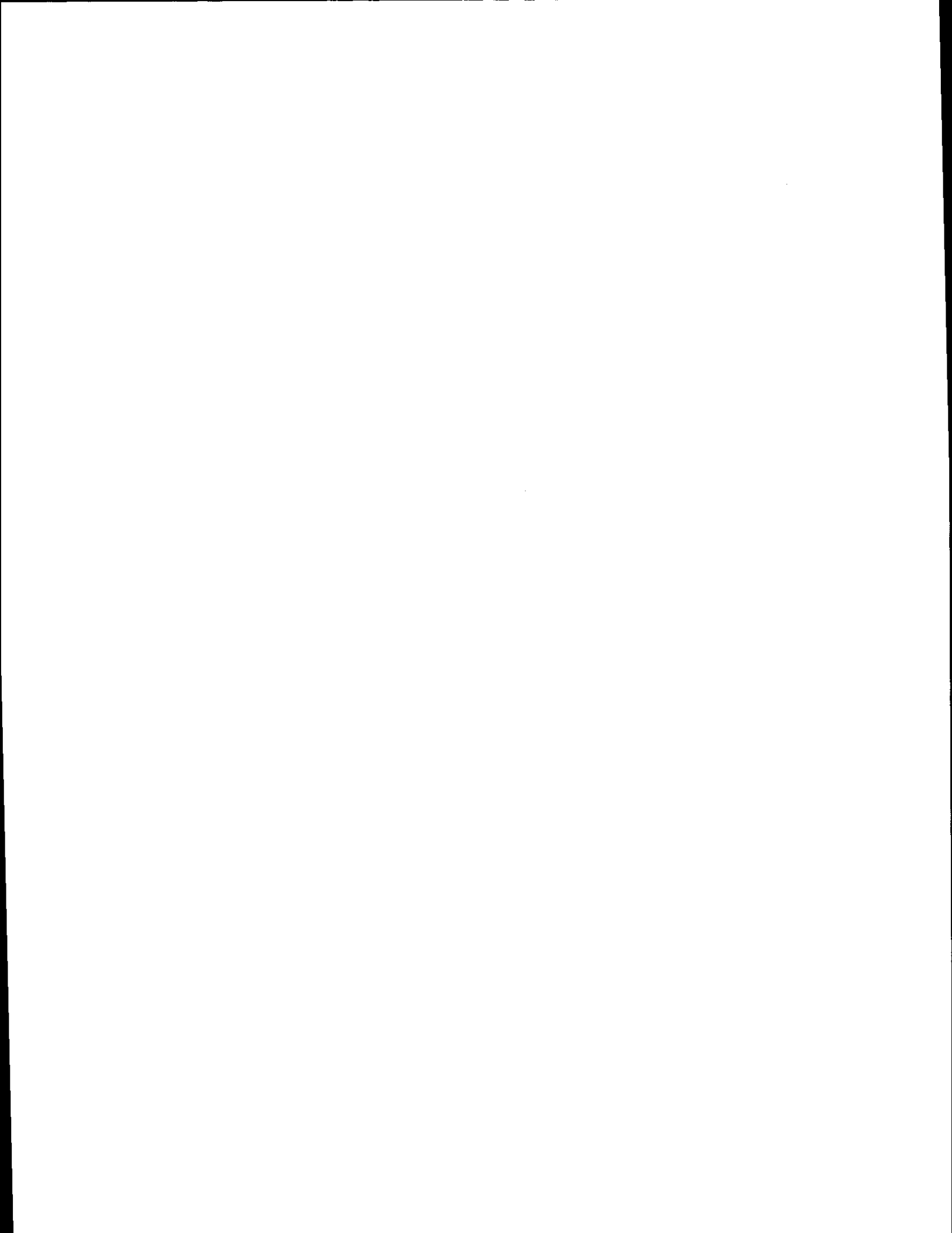


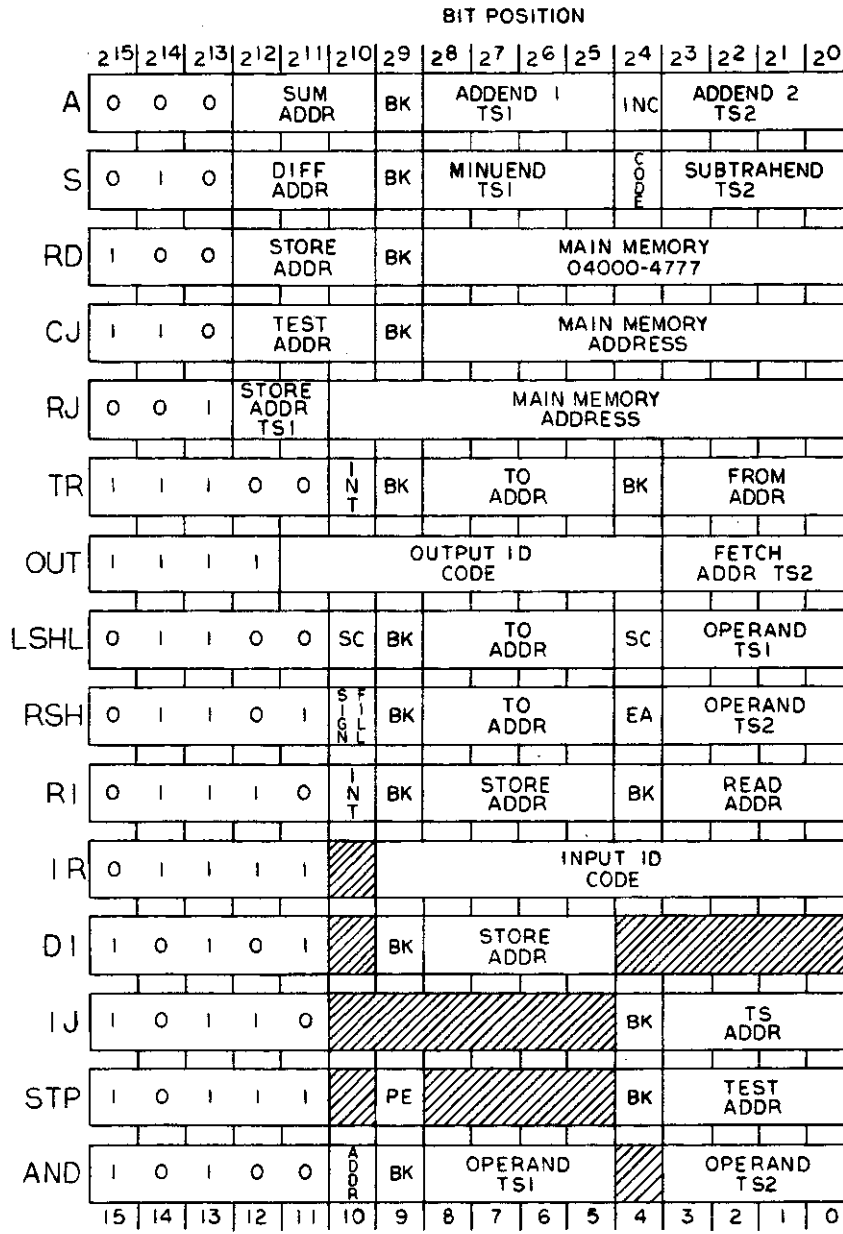
E4025609-4

Clock Phase Relationships
Figure 3-15









LSHL	BIT 10	BIT 4	RSH	BIT 10	BIT 4	STP, BIT 9 PROGRAM END
0 FILL	0	0	0 FILL	0	0	RI, BIT 10 READ INT MEM
CIRCULAR	0	1	CIRCULAR	0	1	IN EXT MODE
GRAY	1	0	SIGN FILL	1	0	RJ, STORE IN A10121416ONLY
0 FILL	1	1	0 FILL	1	1	CJ, JUMP MUST BE SAME QUAD OF MEM

E4025609-3 (R)

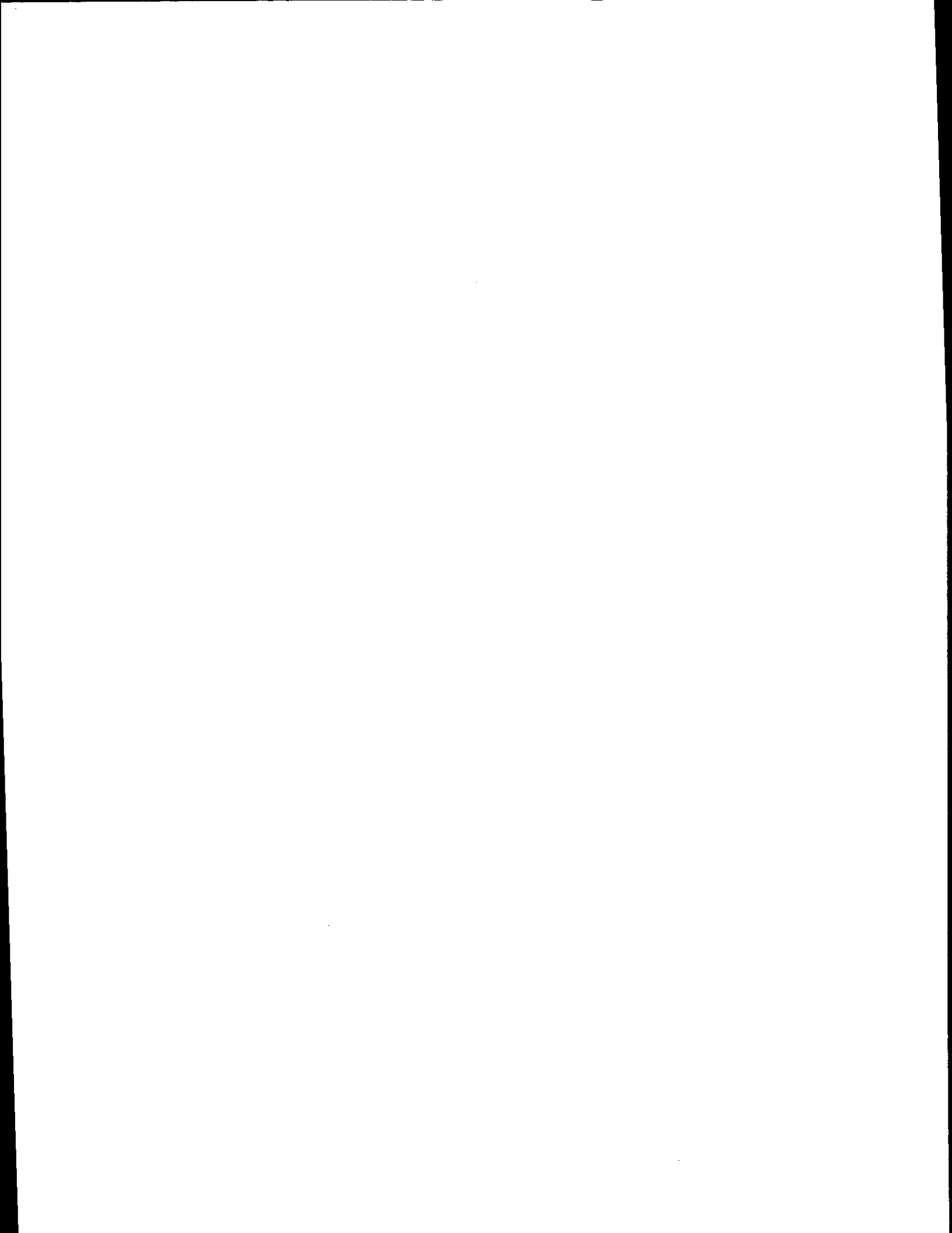
Processor Instruction Formats
Figure 3-16



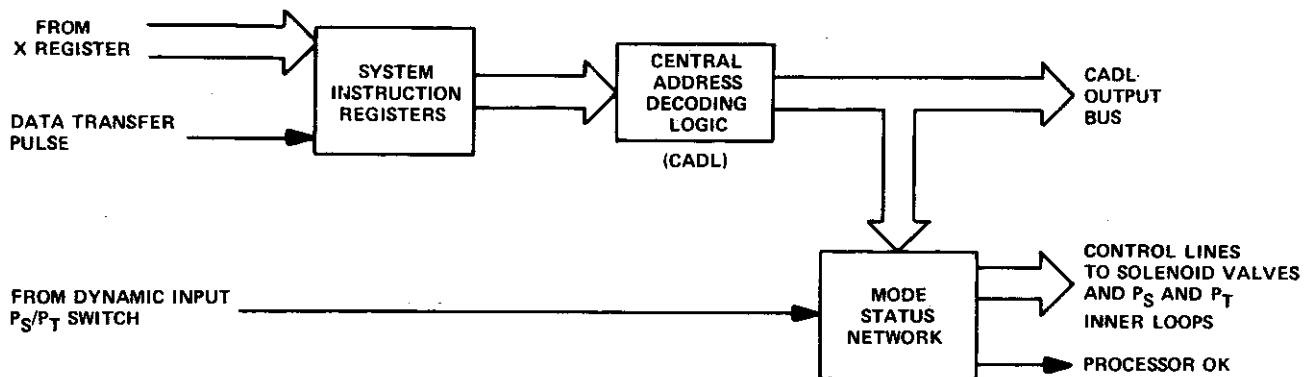
ADC-3 PROCESSOR INSTRUCTION OPERATION

LONG HOUSEKEEPING	TIME	ADD	SUBTRACT	READ DIRECT	CONDITIONAL JUMP	RETURN JUMP	TRANSFER	OUTPUT	LEFT SHIFT	RIGHT SHIFT	READ INDIRECT	INPUT REQUEST	DATA INPUT	INDIRECT JUMP	STOP	AND	TIME	REMARKS	
MEM → ADDER ADDER → X	1.1 HK	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	1.1 HK	COMPUTER SET TO THIS INTERVAL WHEN POWER IS APPLIED ON MC. SIGNAL IS ENABLED HK FF SET DURING INTERVAL	
SET MEM FF P → S	1.2 HK	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	X → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	X → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	P → S MUX 5 → 8 → H	1.2 HK	DON'T CARE THE OPERATION IS PERFORMED BUT THE RESULT IS NOT USED	
	1.1 I	CLEAR HK, LHK, FF MEM FF H → A1	CLEAR HK, LHK, FF MEM FF H → A1	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF DATA INSTR	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF	CLEAR HK, LHK, FF MEM FF H → A1	1.1 I	☆ DATA INSTR TIME LASTS FROM 1.1 I — 4.2	
	1.2	TS2 → ADDER INC. IF I0, EN. TS1 IF I0, I2,3 F0,1 → H SET MEM FF P → S	TS2 → ADDER 2'S COMP. IF I0 EN. TS1 IF I0, I2,3 F0,1 → H SET MEM FF P → S	SET MEM FF I2,3 F0,1 → H X → S0-8 O → S9,10 S11 P → S	I2,3 F0,1 → H P → S	O1,13, F0,1 → H SET MEM FF X → S	SET MEM FF P → S	OUTPUT DATA & ID CODES AVAILABLE SET MEM FF P → S	SET MEM FF P → S	SET MEM FF P → S		STROBE ID X → ID SET MEM FF P → S	ENABLE INPUT DATA → ADDER P → S		SET MEM FF P → S	I2, I3, F0, F1 TO H P S EN. TS1, TS2 TO MUX	1.2		
	2.1	TS2 → ADDER EN TS1 IF I0 ADDER → X	TS2 → ADDER EN TS1 IF I0 ADDER → X	ADDER → X		P → ADDER ADDER → X		DATA XFER SIGNAL ADDER → X	TS1 LT1 → ADDER ADDER → X	TS2 RT1 → ADDER ADDER → X	TS2 → ADDER I0 DISABLE TS2 ENABLE TS1 ADDER → X	DATA → ADDER ENABLE INPUT DATA ADDER → X	TS2 → ADDER I0 DISABLE TS2 EN TS1 TO ADDER ADDER → X	TS2 → ADDER I0 DISABLE TS2 EN TS1 TO ADDER ADDER → X	TS1 & ADDER ADDER → X		2.1		
CLR P	2.2	H → A1A2 CLR P	H → A1A2 CLR P	H → A1A2	H → A1A2 CLR P OF TS1 IS1 X S0 8 SET MEM FF	H → A1A2 CLR P	H → A1A2 CLR P	CLR P	H → A1A2 CLR P	H → A1A2 CLR P	H → A1A2 X S SET MEM FF	SET MEM FF H → A1A2 CLR P	SET MEM FF H → A1A2 X S CLR P SET MEM FF	CLR P H → A1A2 SET MEM FF	CLR P H → A1A2 SET MEM FF		2.2	TIMING CHAIN WILL ADVANCE TO 3I IF: 1 I1 BTC OR 2 I1 X15 OR 3 I1 DIS STOP	
X → TSj S → P	3.1	X → TSj S → P	X → TSj S → P			X → TSj S → P	S P X → TSj HOLD COMMAND IS NOT PRESENT	S → P	X → TSj S → P	X → TSj S → P		SEND INPUT DATA REQUEST S → P	X → TSj S → P	S → P	S → P	X → TSj	3.1	TSj = TEMPORARY STORAGE BANK SELECTED BY BIT 9 TS9 B9=1 TS1 B9=0	
	3.2	TO HK	TO HK	SET LHK FF TO LONG HOUSEKEEPING		TO HK	TO HK	TO HK	TO HK	TO HK	SET LHK FF	TO HK			TO HK		3.2	LHK = LONG HOUSEKEEPING FOR OPERATION EX MEM MODE TIMING CHAIN WILL NOT ADVANCE FROM 3.1 TO 3.2 UNIT EXT. RESUM	
MEM → ADDER ADDER → X INC. P. MUX12-15 → F MUX49-11 → I MUX0-3 → A1A2	4.1																	4.1	
MUX5-8 → H TO 1.1 I	4.2																	4.2	

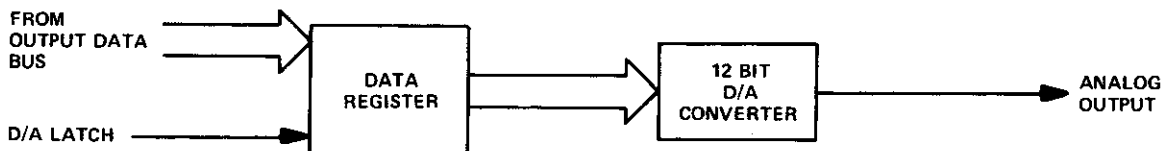
Processor Instruction Operation
Figure 3-17



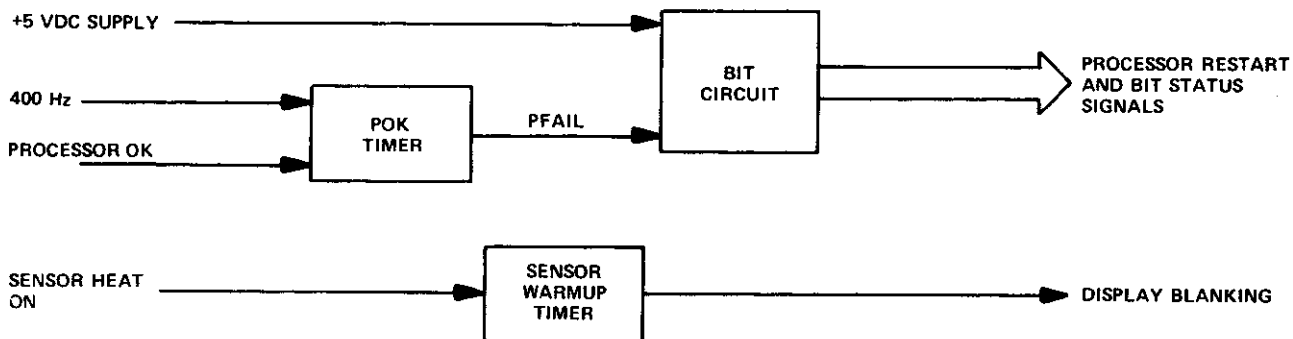
(A) CONTROL SIGNAL DECODING:



(B) DIGITAL TO ANALOG CONVERSION:



(C) BUILT-IN TEST (BIT):



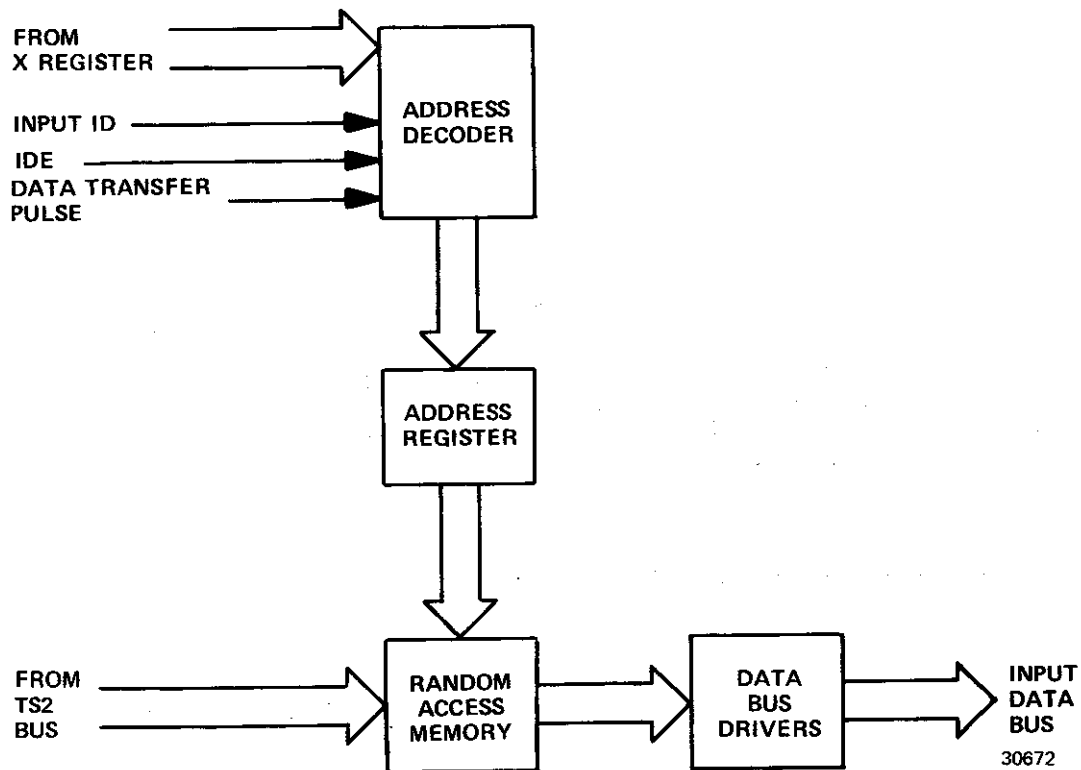
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Control and D/A Block Diagram
Figure 3-18

The remaining circuit on the A7 card is the sensor warmup timer. It serves the pseudo-BIT function of transmitting a CCC signal to the display panel to blank the P_s and P_t displays until sufficient time has elapsed for the sensors to heat up and stabilize. This circuit charges a 150-microfarad capacitor through a FET network to generate the time delay for sensor warmup. This configuration provides the timer with the additional capability of being able to remember the total time the sensor heat has been turned off. When the sensor heat is turned off, the discharge path from the capacitor is through the FET resulting in an extremely slow discharge rate.

The block diagram for the scratch pad card (A8) is shown in figure 3-19. Unlike the scratch pad memory contained in the arithmetic A and B cards of the processor, the memory contained on this card is not directly accessible through the processor's memory address registers. This scratch pad memory is accessed as an I/O device.

The X register is used as the address register for the A8 card. When the scratch pad input ID signal is present, the contents of the X register are decoded by the address decoder and stored in the address register. If the operation is to be an output from the processor, upon receipt of the data transfer pulse (DTP) the contents of the TS2 bus from the processor are clocked into the random access memory (RAM) in the location whose address is stored in the address register. For an input operation, the IDE clocks the contents of the addressed RAM location onto the input data bus via the data bus drivers.



Scratch Pad Block Diagram
Figure 3-19

In addition to the scratch pad, the A8 card also contains some CADL decoding and BIT driving circuitry orphaned by lack of space on the control and D/A card.

The clock and F/C card (A9) is another multipurpose card as shown in figure 3-20. The clock function is shown in figure 3-20(A). The output of a free running 37.5-MHz oscillator is fed into a clock phase encoder to generate the basic timing signals for the system. The timing control card (A1) uses $\emptyset 1$ and $\emptyset 2$ to generate the basic clock phases for the digital processor. RTC (real time clock) is used by the program control card (A2) to control operation of the digital processor program. LOX is fed into the front panel MUX to control the frequency of flashing of the DQCL, DSSL, and the precision rate pushbuttons.

The frequency to count function is shown in figure 3-20(B). Four separate frequency to count conversions are provided to the processor for both the P_s and P_t outputs. The processor then averages the four counts to minimize the effects of P_s and P_t sensor frequency fluctuations caused by random noise. The processor requests that a count be initiated through a control word in the X register. The count control word is decoded by the A7 card and placed on the CADL bus.

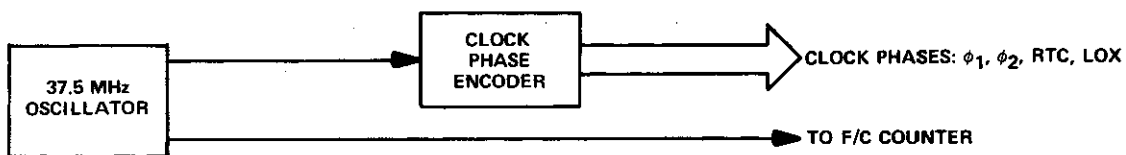
The start count request enters this card from the CADL bus and is further decoded by the CADL decoder which generates a 1.4 millisecond pulse on the appropriate count sequence line to tell the system which count is being generated. The CADL decoder enables the appropriate (P_s and P_t) count by gating the appropriate sensor output into the sensor output squarer. The squarer amplifies and limits the sensor output to eliminate amplitude fluctuations and minimize noise.

The squared sensor output is gated together with the high speed clock (37.5 MHz) to drive the F/C counter. The count is started by the count select pulse from the CADL which is actually a pulse on either the PSC (P_s count) or PTC (P_t count) select line to the squarer. The count will continue for a specific number of complete sensor output periods which are counted by the cycle counter.

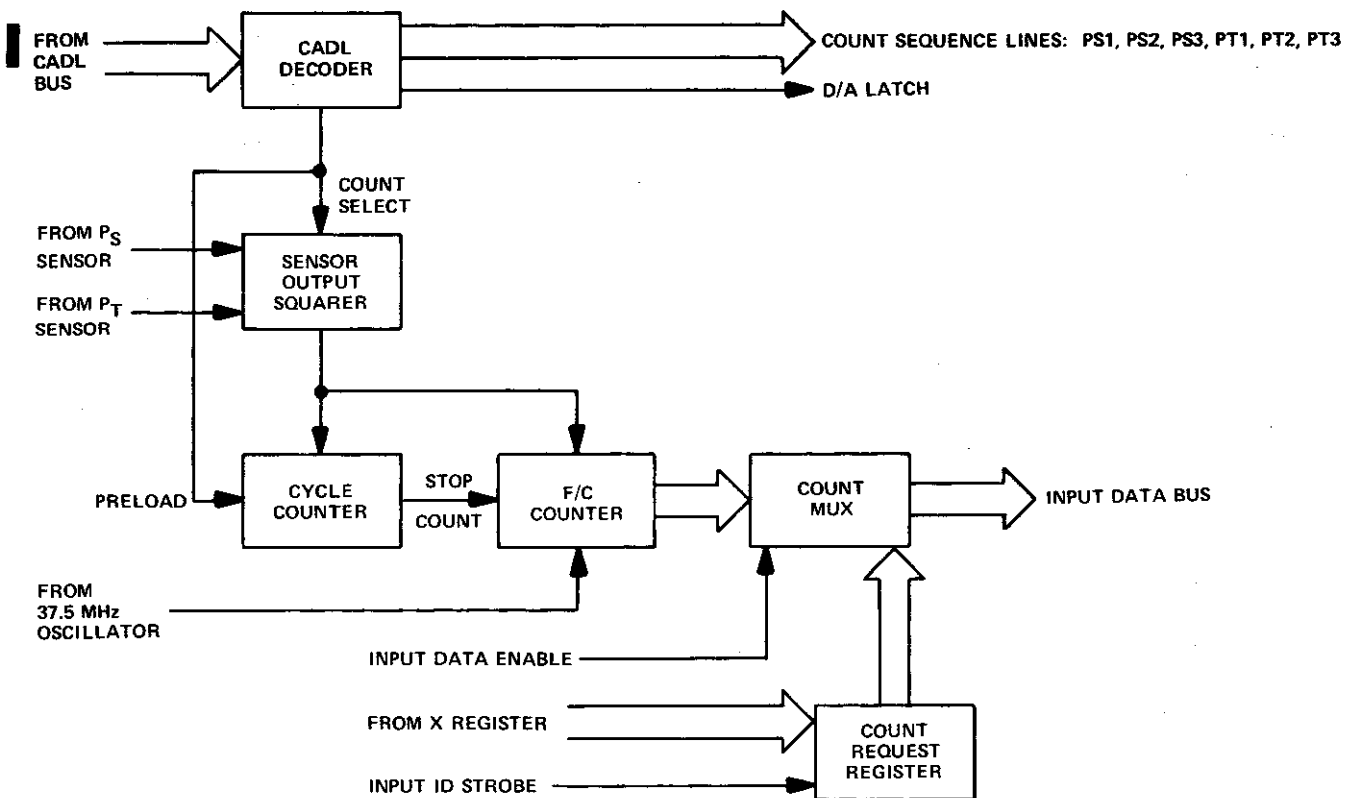
The cycle counter will count to a value of 255. The reset to zero (the 256th count) is used to stop the F/C counter. To obtain the proper number of sensor cycles to be used for the F/C count, the cycle counter is preloaded with 199 for a P_s count by the PSC pulse. This results in the P_s count being performed over 57 cycles (256-199). Similarly, the PTC pulse preloads the cycle counter with 94 resulting in a 162-cycle count period.

When the count stops, the F/C counter contains the value of the count. When a count input request word is placed in the X register and an input ID strobe is received from the processor, the X register contents are placed in the count request register to select which half of the count (coarse or fine) value is to be transmitted. Then, receipt of an input data enable signal will cause the MUX to transfer the appropriate value from the F/C counter to the input data bus for use by the processor.

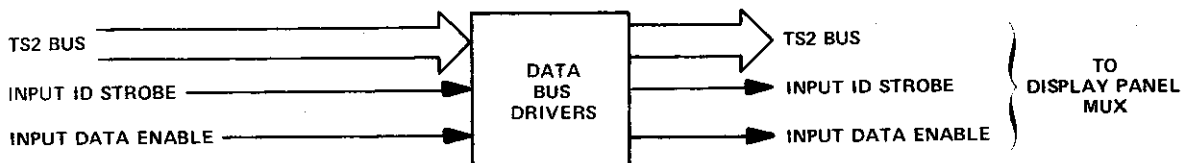
(A) CLOCK PHASE GENERATION:



(B) FREQUENCY TO COUNT CONVERSION:



(C) DISPLAY PANEL MUX DRIVER:



30673 R1

Clock and F/C Block Diagram
Figure 3-20

An additional, unrelated, function of the CADL decoder on this card is the decoding of the D/A latch (DAL) signal for use by the A7 card.

Figure 3-20(C) shows another unrelated function of this card. Data bus drivers are placed on this card to provide buffering for the TS2 bus, input ID strobe, and input data enable signals to be used by the display panel MUX. These drivers are situated on this card because of the available space and this card's close proximity to the processor cards.

The block diagrams for the P_t and P_s inner loop cards (A12 and A13) are shown in figures 3-21 and 3-22, respectively. Although these cards are not functionally interchangeable, they are quite similar. In addition to the inner loops, these cards contain the main integrators and the sample and hold circuits of the outer loops. In other words, these cards contain all of the analog circuitry of the inner and outer loops with the exception of the D/A converter.

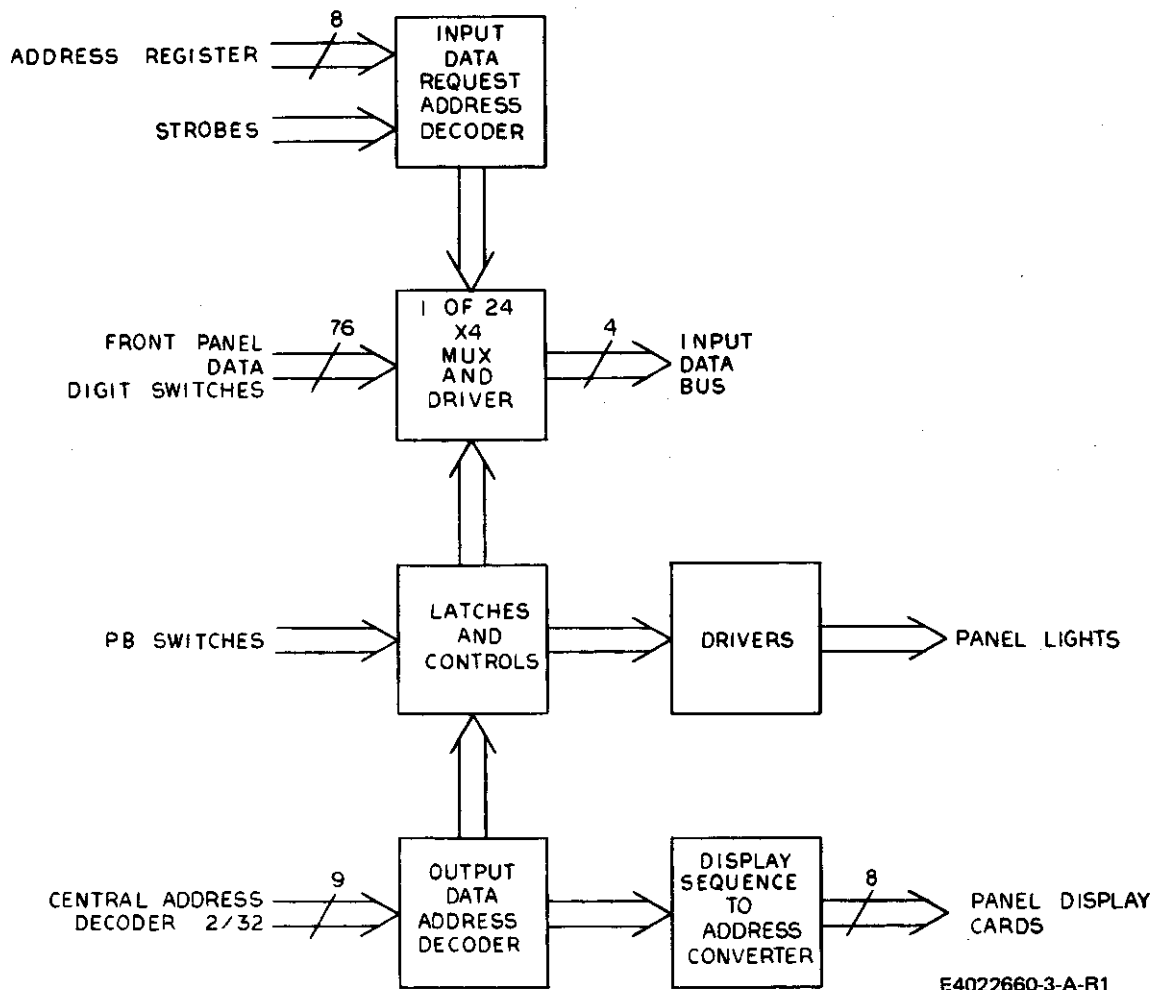
The majority of these block diagrams were explained previously. The frequency-to-digital (F/D) converter, however, will be explained further.

To eliminate the effects of amplitude fluctuations and to minimize noise, the sensor output is fed into a squaring circuit which amplifies the sensor output and limits its amplitude, thus producing a square wave with a stable amplitude and fast rise time. This square wave is then fed into the F/D converter and a pulse generator.

During the positive half cycle of the square wave, a capacitor is rapidly and fully charged. During the negative half cycle the capacitor is slowly discharged. At the end of the negative half cycle, the pulse generator triggers a sample and hold circuit which then stores the value of the dc voltage on the capacitor. During the next positive half cycle the capacitor is recharged again and the process is repeated. The net result of this is that the sample and hold circuit will always contain a dc voltage that is directly proportional to the frequency of the sensor output since, as the frequency of the sensor output increases, the discharge time of the capacitor decreases and the charge left on the capacitor (and thus the voltage left across the capacitor) increases.

The display panel (or front panel) consists of the front panel (FP) MUX card, two display cards, and the front panel itself, which contains the mode switches and the command input switches. Most of the display panel logic is contained on the FP MUX card (A14). Its block diagram is shown in figure 3-23.





Front Panel MUX Block Diagram
Figure 3-23

Operation of the FP MUX is controlled by the processor. Outputs to be displayed by the display panel are sent to the FP MUX by the processor through the control and D/A card. The display address word is decoded by the output data address decoder and fed into the display sequence to address converter which converts it to the proper format for use by the display cards.

Mode switching commands from the processor are also received on the CADL lines. These commands are decoded and sent to the mode switching network to cause the lamp drivers to illuminate the appropriate pushbutton lights. The pushbutton lights are energized to inform the operator that the requested mode has indeed been entered.

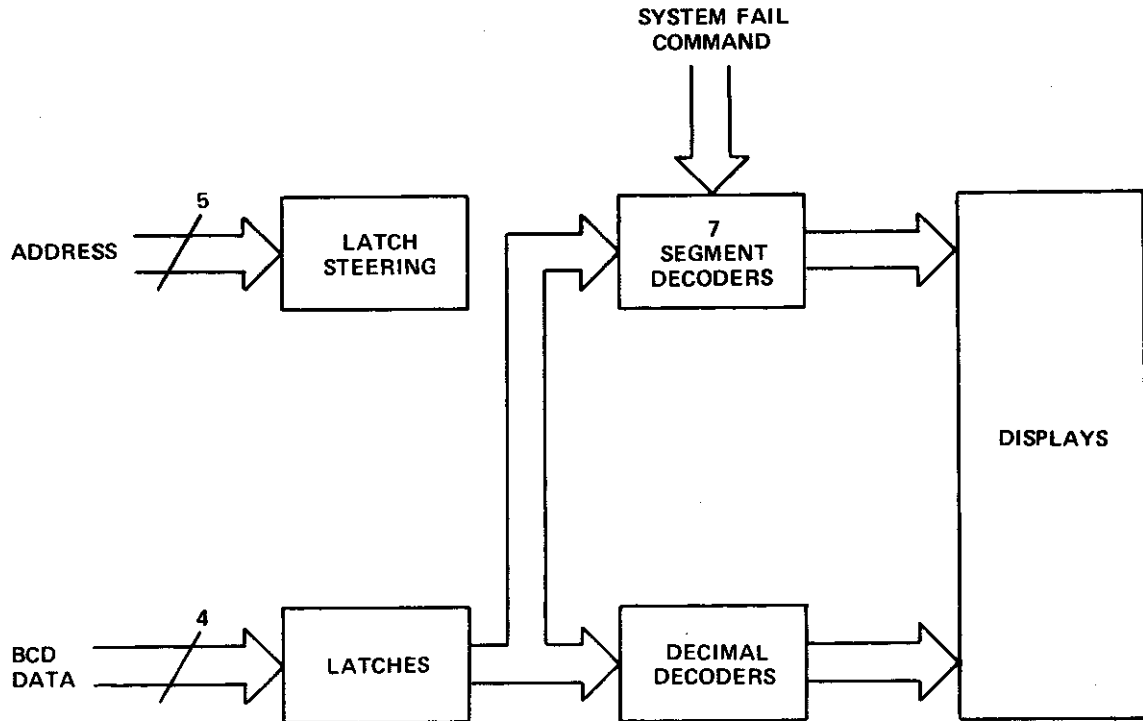
Most of the lighted pushbutton switches control their own lamp driving networks so that pressing a pushbutton will turn the pushbutton lamp on or off at the same time that the corresponding switch state is put into the MUX. Pressing one of these pushbuttons will generate a signal that is used to toggle (set or reset) a flip-flop circuit on the FP MUX card. The output of the flip-flop controls the MUX information that is passed along to the processor and also controls the lamp driver for the lighted pushbutton. The F.P. MUX card also contains gating circuitry which will inhibit the flip-flop operation, thus inhibiting mode switching, when the requested mode change is not allowed by system operation constraints. For example, the CONTROL pushbutton is inhibited whenever the system is in self test because control is not meaningful until a proper display mode has been selected.

Pressing the DSSL, DQCL, or either precision rate pushbutton will only set the appropriate MUX bit. The lamp driver is under the direct control of the processor via the CADL network. The processor (via the CADL) can also set or reset any of the flip-flops to change the mode of any of the other lighted pushbuttons. Thus, use of the flip-flops for mode switching and lamp driving allows the system to be completely operated by an ATE (via the processor) through the optional ATE interface card.

Data input commands operate in a similar manner. Pressing the command enter places a 1 in CE bit of the X4 MUX. The processor interrogates the MUX each PRF to determine if the command enter has been pressed. If the MUX bit has been set, the processor proceeds to interrogate the MUX for all of the data words in the MUX. The MUX contents are determined by the positions of the digital lever and thumbwheel switches on the front panel. The processor will continue to interrogate all of the data words, four bits at a time, until it has received all of the input data. It also resets the command enter bit to 0. During further interrogation, the processor will not request data input from the MUX until the CE bit is again set to 1 by the operator's pressing of the command enter pushbutton.

Regardless of the CE bit status, the processor will continue to interrogate the MUX for mode switching requests from the front panel switches via the mode switching network. It also continues to transmit data to the displays via the TS2 bus.

A block diagram for the display card (A15 and A16) is shown in figure 3-24. Expanded BCD data is received from the FP MUX card and fed into the proper input data latches by latch steering circuits. The latches consist of a group of seven, four bit, data registers. The input data from the FP MUX card is not true BCD data, because it also contains six alphabetic character codes and six decimal point location codes as well as the ten decimal character codes.



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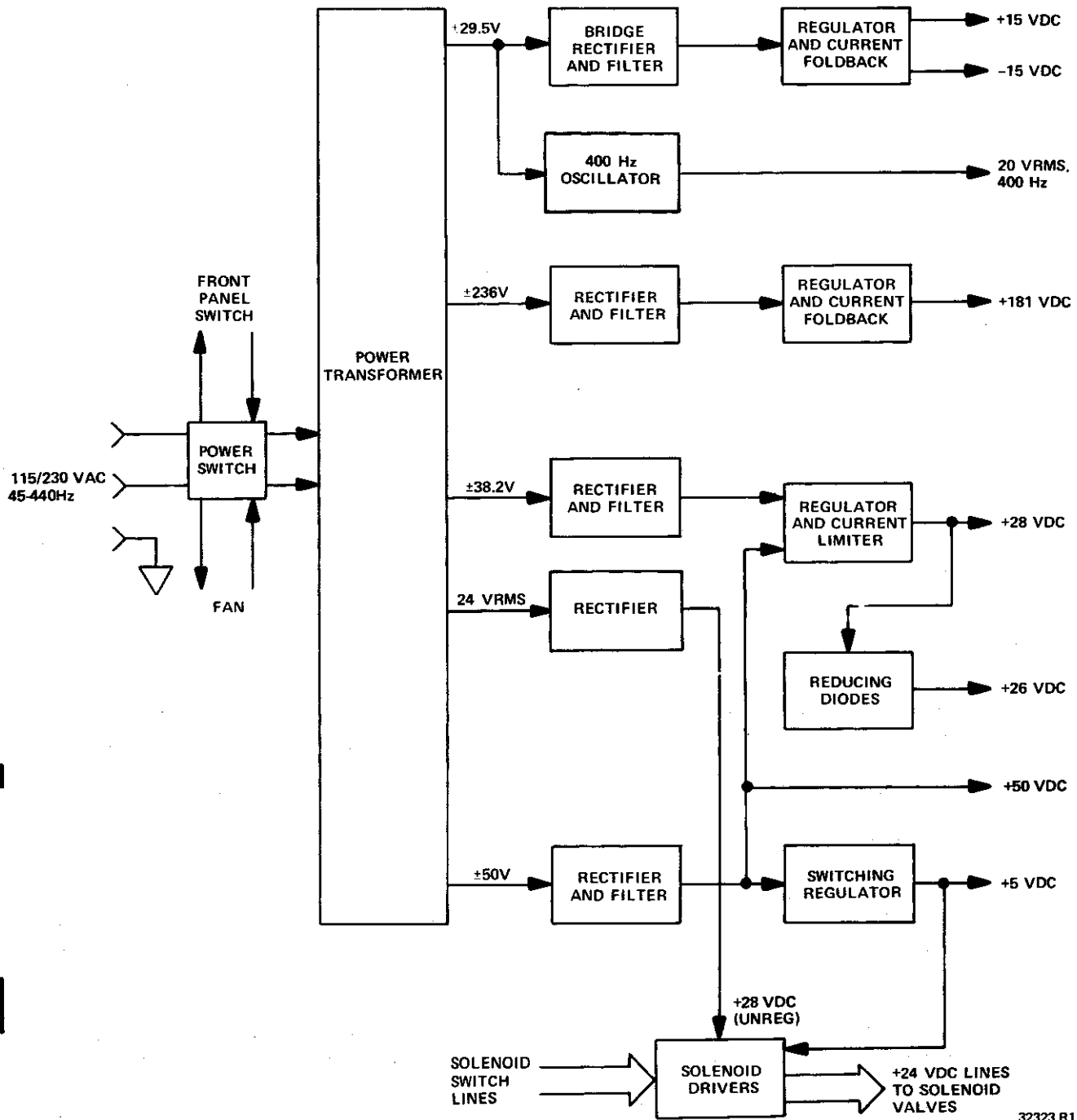
Display Block Diagram
Figure 3-24

The data stored in the latches is then decoded by two decoding circuits. One decoder is used for the decimal data and the other is used for the alphabetic characters and the decimal point location. The decoder outputs are fed into display data registers which drive the gas discharge display. The display data registers also receive a system status signal from the A7 card. SFAIL blanks the lowest significant digit when it is low.

Two display cards are used, one for P_s and one for P_t .

Figure 3-25 shows the block diagram of the power supply A17. The power switch is a triac circuit controlled by the POWER switch on the front panel. The triac acts as a solid-state relay to apply the 115/230 volt, 45 to 440 Hz input power to the power transformer.

The power transformer has five secondary windings with center taps. The 29.5-volt winding supplies power to a bridge rectifier and filter whose output is then controlled to +15 volts dc and -15 volts dc by a regulator circuit employing current foldback for overload protection. A free-running oscillator generates a 20-volt rms, 400-Hz signal which is fed to the A7 card to drive the POK timer.



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Power Supply Block Diagram
Figure 3-25

The output of the 236-volt winding is fed through a rectifier and filter circuit to another regulator, using current foldback, to produce the +181-volt dc output required for the gas discharge displays. The 38.2-volt output from the transformer is rectified, filtered, and regulated to provide a +28-volt dc output that is current limited.

The +5-volt dc logic supply is generated by rectifying and filtering a separate winding output to produce a +50-volt dc unregulated output which is used to drive a switching regulator that produces the final +5-volt dc output. The switching regulator provides output protection by simply shutting down for the duration of any overload condition. The unregulated +50-volt dc output of the rectifier is also provided as an output for use by the P_s and P_t sensor assemblies.

The power supply also provides power switching for controlling the solenoid valves. The +5-volt dc supply is used to provide power for the switching transistors which drive the output switch transistors for the solenoid valves. The output transistors use the +28-volt unregulated dc supply to drive the solenoid valves. The input control lines for the solenoid drivers originate on the A7 card.

No detailed theory of operation will be given here for the P_s and P_t sensor assemblies (A18 and A19). Any attempted repair of either of these assemblies will necessitate recalibration of the sensor. Since the sensor can only be recalibrated at the factory, it must be returned to Sperry Flight Systems for repair.

