PPC2 AF™

Operation and Maintenance Manual

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1. INTRODUCTION

1.1 PRODUCT OVERVIEW

PPC2 AF is a high precision pressure controller/calibrator intended to apply and measure accurate values of gas pressure for the calibration and testing of pressure measuring instruments.

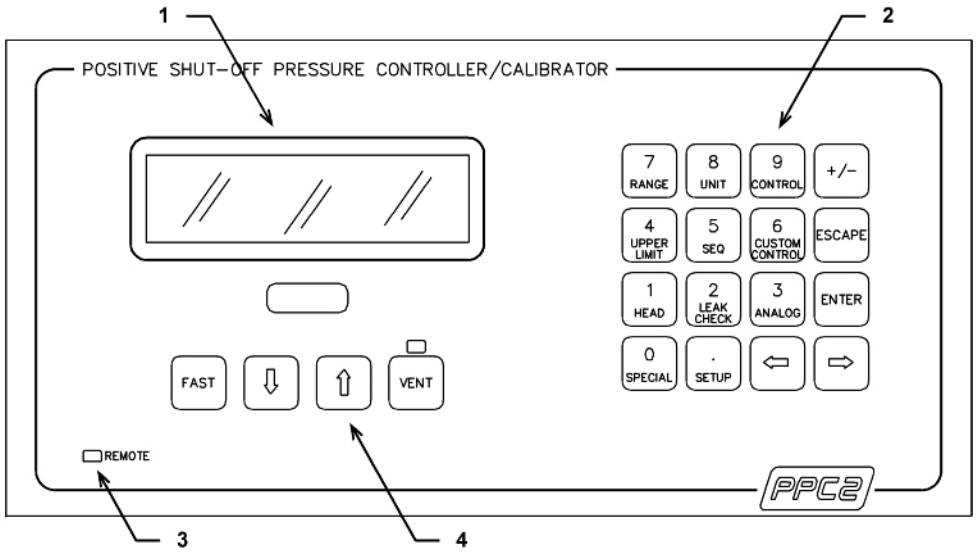
PPC2 AF measures and controls pressures in the range of 0 to 1 000 psi (0 to 7 MPa) in both gauge and absolute mode. Six pressure measuring ranges are available using two high accuracy reference transducers and an on-board barometer. Internal valving chooses the appropriate transducer for the desired range and protects the lower pressure transducer when working at high pressures. Pressures are controlled by a pneumatic module consisting of fast and slow inlet and exhaust solenoid valves and differential pressure regulators.

PPC2 AF can be controlled locally by the operator using a front panel display, keypad and special function keys or remotely by a computer using ASCII character command strings over an RS232 interface.

A Self Purging Liquid Trap (SPLT) can be used to protect PPC2 AF from liquid contaminants in the device or system being tested.

1.2 SUBASSEMBLY DESCRIPTION AND LOCATION

1.2.1 FRONT PANEL ASSEMBLY

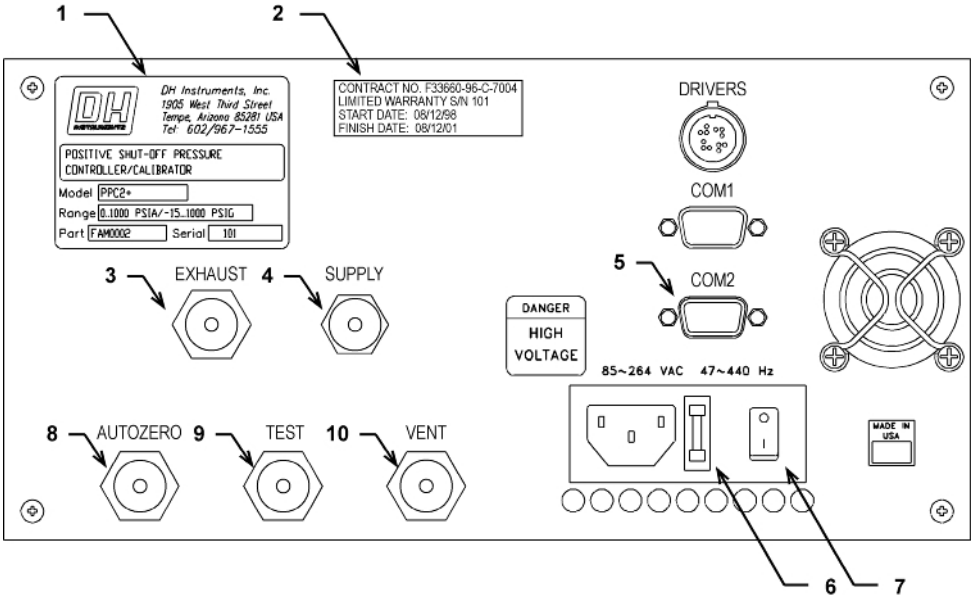


1. Display
2. Multi-Function Keypad
3. Direct Pressure Control Keys
4. Remote Indicator

Front Panel

The front panel assembly provides a 2 X 20 vacuum fluorescent display of PPC2 AF operating status and a membrane keypad for local user control.

1.2.2 REAR PANEL ASSEMBLY

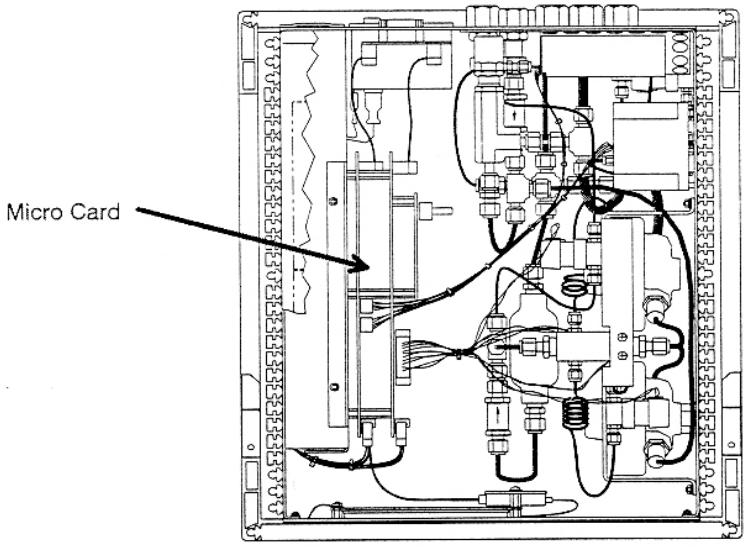


1. Label, Product
2. Label, Warranty
3. Pressure Connection, EXHAUST
4. Pressure Connection, SUPPLY
5. COM1 Port
6. Fuse
7. Power Switch
8. Fitting, AUTOZERO
9. Fitting, TEST
10. Fitting, VENT

Rear Panel

The rear panel assembly provides pressure connections, the host communications interface and the power on/off module, and product and warranty labeling. Pressure fittings are internally secured to prevent loosening when making and breaking connections.

1.2.3 POWER SUPPLIES

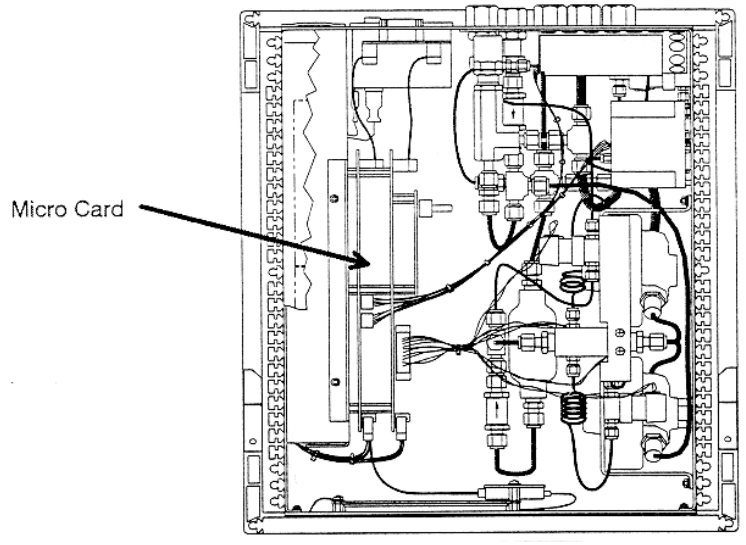


Internal Layout

PPC2 AF has two independent power supplies.

1. + 12 V DC (± 2 %) @ 3.3 Amps: for internal and external valve execution.
2. + 5 V DC (± 2 %) @ 3.0 Amps; + 15 V DC (± 10 % / - 3 %) @ 2.0 Amps; - 15 V DC (± 5 %) @ 0.35 Amps: for the supply of the micro board and driver board electronics.

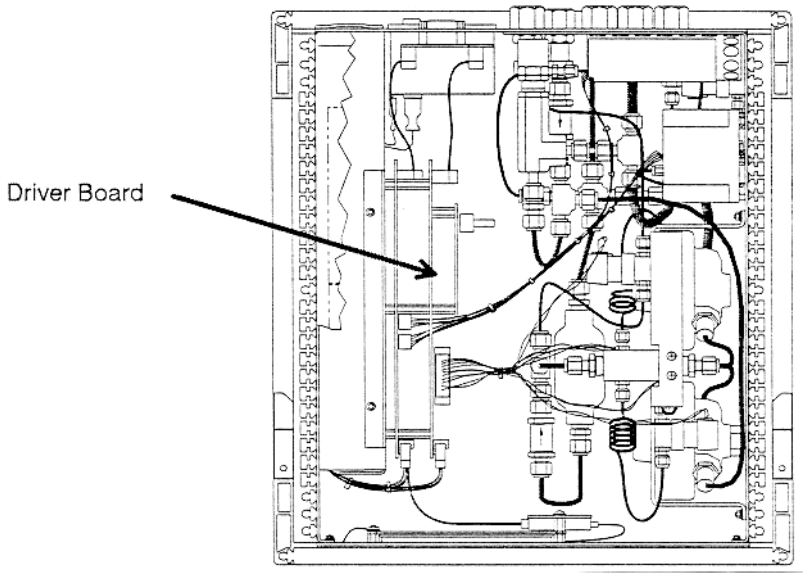
1.2.4 MICRO CARD



Internal Layout

The micro card supports a Motorola 68302 microcontroller; EPROM, EEPROM, NVRAM and flash memories; RS-232 communications; the front panel keypad and display control; and a two channel frequency counter for reading reference pressure transducers. An I/O port controls other boards and devices in PPC2 AF.

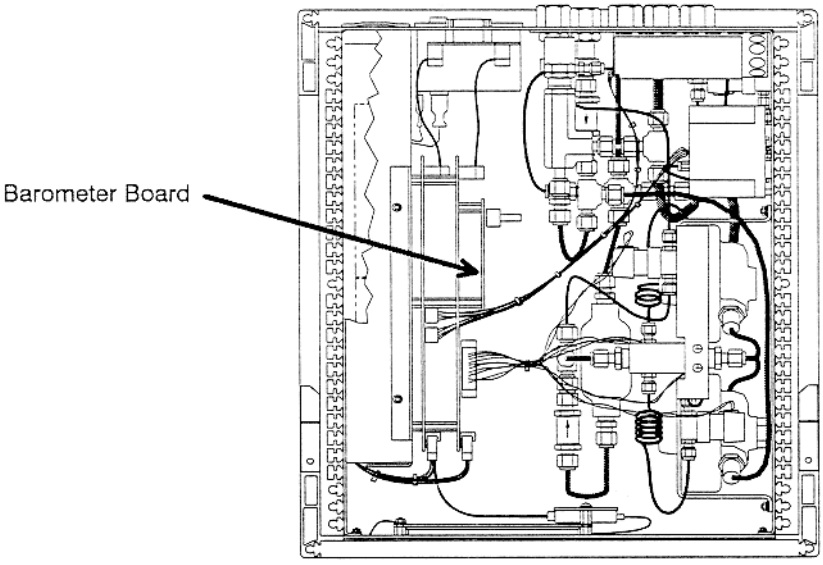
1.2.5 DRIVER BOARD



Internal Layout

The driver board is controlled by the micro card (see Section 1.2.4). It supports the 12 V drivers for the internal and external solenoid valve actuation and the barometer board (see Section 1.2.6). It also supplies power to the cooling fan.

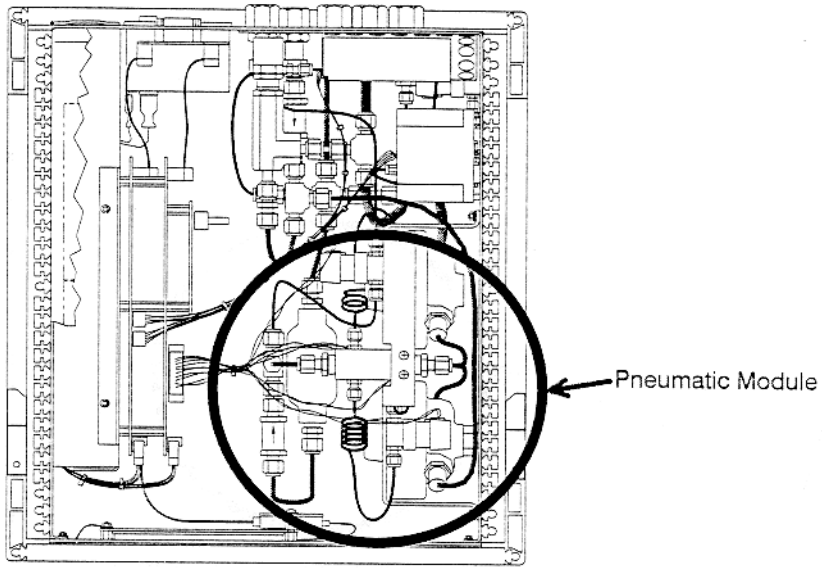
1.2.6 BAROMETER BOARD



Internal Layout

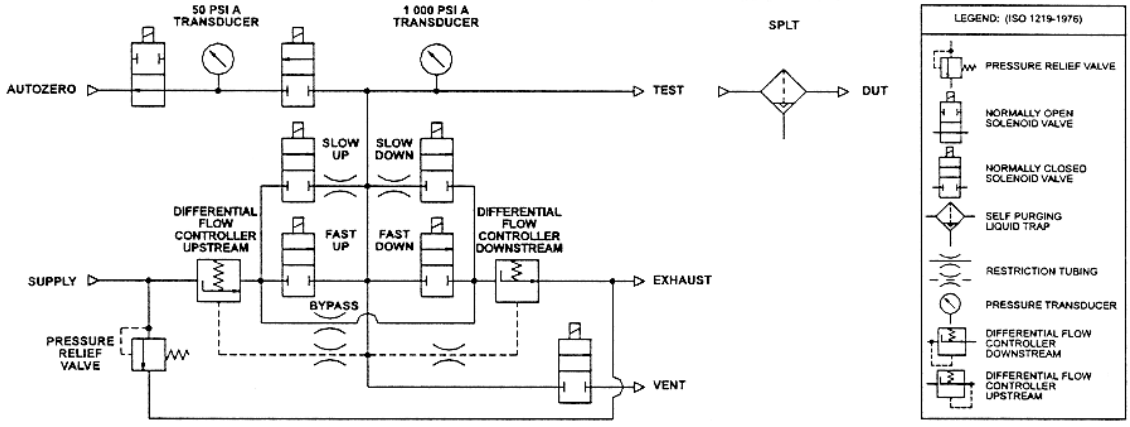
The barometer board supports a board mounted, barometric range, micromachined silicon sensor and an ambient temperature sensor. The barometer readings are used for dynamic atmospheric pressure compensation when measuring gauge pressure with an absolute reference transducer.

1.2.7 PNEUMATIC MODULE



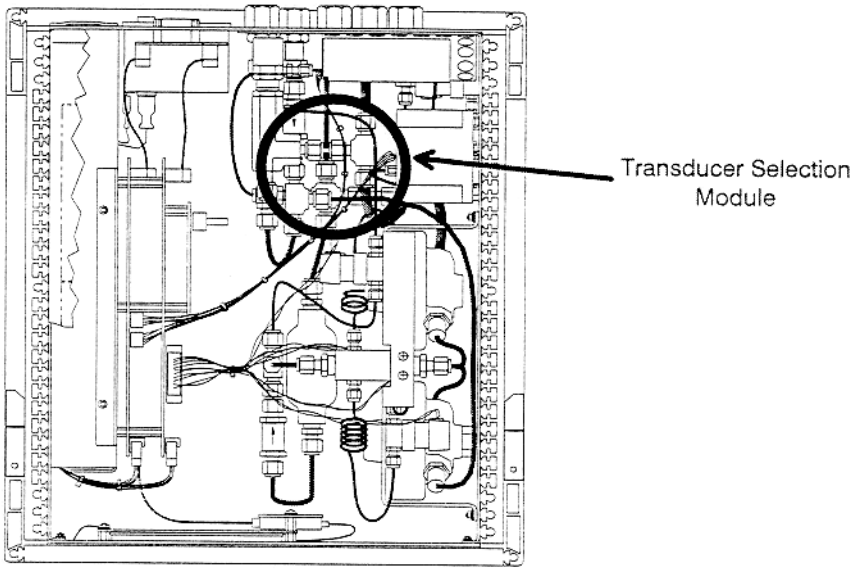
Internal Layout

The pneumatic module is an integrated assembly that includes two inlet (fast and slow) and two exhaust control valves and differential pressure regulators. The differential pressure regulators use pressure feedback to maintain a constant differential pressure across the control valves. The control valves are solenoid type actuated by 12 V.



Pneumatic Module

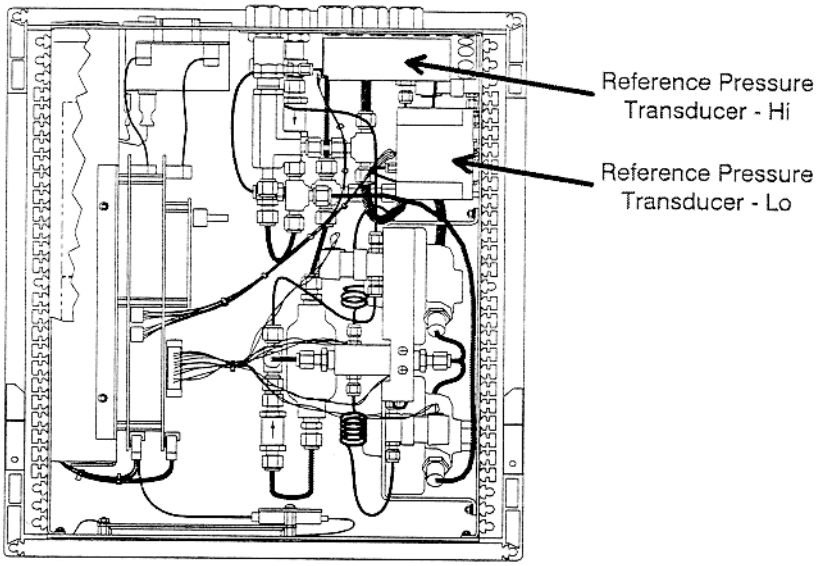
1.2.8 TRANSDUCER SELECTION MODULE



Internal Layout

The transducer selection module includes solenoid valves to connect and disconnect the low pressure (secondary) reference transducer from the test system and to independently vent the low pressure reference transducer.

1.2.9 REFERENCE PRESSURE TRANSDUCERS



Internal Layout

There are two reference pressure transducers. Their basic sensing principle is the measurement of the change in the natural oscillating frequency of a quartz tuning fork with temperature and with mechanical stress resulting from the change in pressure applied to a connecting bellows or bourdon tube. Two independent quartz elements are used: one subjected to pressure related stress; the other is used only to monitor temperature.

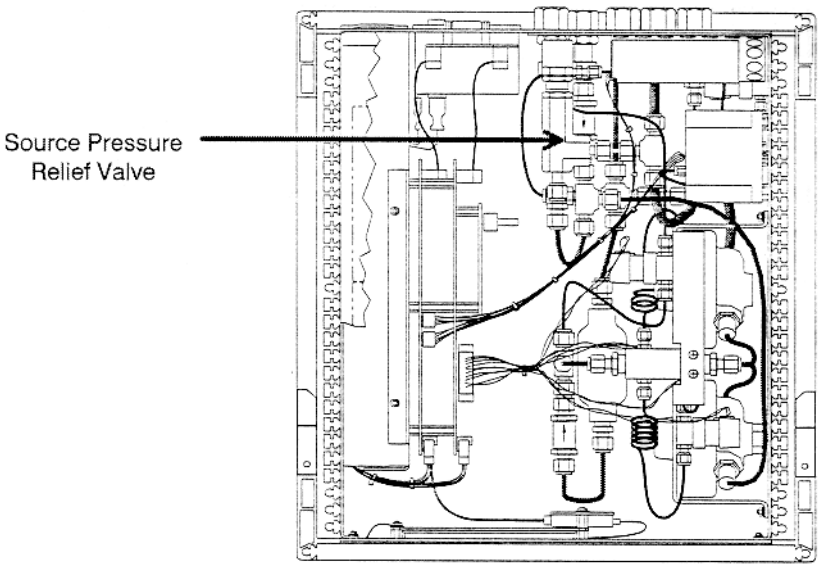
1.2.9.1 HIGH (PRIMARY) PRESSURE REFERENCE TRANSDUCER

The high pressure reference transducer has a full scale range of 1 000 psi (7 MPa) in gauge and absolute mode.

1.2.9.2 LOW (SECONDARY) PRESSURE REFERENCE TRANSDUCER

The low pressure reference transducer has a full scale range of 35 psi (220 kPa) in gauge mode and 50 psi (330 kPa) in absolute mode.

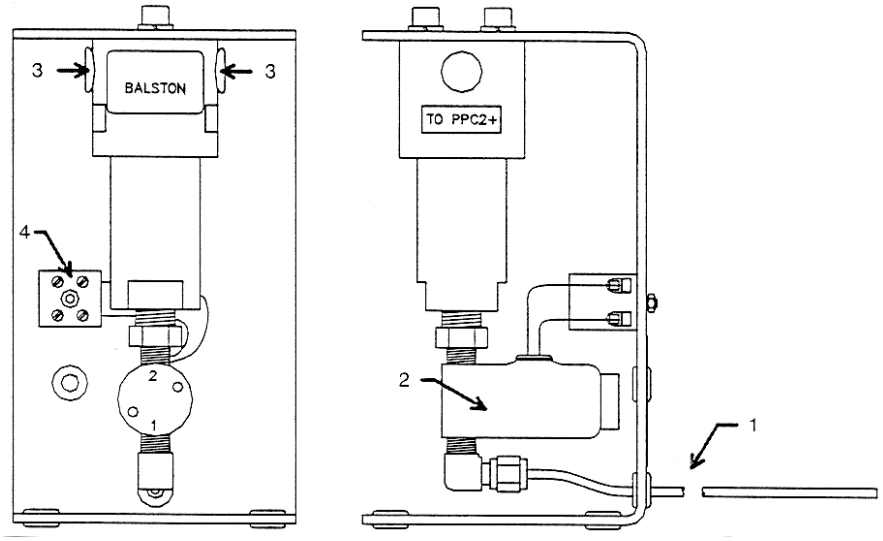
1.2.10 SOURCE PRESSURE RELIEF VALVE



Internal Layout

The source pressure relief valve is a factory set, adjustable, spring loaded pressure relief valve with a brass body, Viton O-ring seal and stainless steel internal parts. The valve is set to relieve at 1 200 psi (8.3 MPa).

1.2.11 SELF PURGING LIQUID TRAP (SPLT)



1. Purge Tube
2. Exhaust Valve
3. Pressure Connections
4. Electrical Connection

SPLT (Overall View)

The SPLT is a free standing accessory designed to protect the PPC2 AF from liquid contamination returning form the system or device under test. It is made up of a stainless steel body with an internal X-Type coalescing filter and a bottom drain port fitting with an electrically actuated purge valve. The filter valve assembly is installed in a mounting stand.

1.3 SPECIFICATIONS

1.3.1 GENERAL SPECIFICATIONS

Power Requirements	85 to 264 VAC, 47 to 440 Hz, 30 VA max consumption.
Operating Temperature Range	15 to 35 °C
Storage Temperature Range	- 20 to 70 °C
Vibration	Meets MIL-T-28800D
Weight	12.8 kg (28.2 lb)
Dimensions	7.1" H X 12.6" W X 15.8" D (18 cm X 32 cm X 40 cm)
Microprocessor	Motorola 68302, 16 MHz
Communication Port	RS232 (COM1)
Pressure Ranges	-15 to 1 000 psi (7 MPa) gauge/0 to 1 000 psi absolute in six ranges using two reference pressure transducers and a barometer
Operating Medium	Clean, dry, non-corrosive gas
Pressure Connections	Supply: 1/8 in. NPT F Test: 1/4 in. NPT F Vent: 1/4 in. NPT F Exhaust: 1/4 in. NPT F AutoZero: 1/4 in. NPT F

1.3.2 PRESSURE MEASUREMENT SPECIFICATIONS

PPC2 AF measures pressures in gauge and absolute mode in six ranges using two reference pressure transducers and a barometer.

The reference pressure transducers are of the absolute pressure type using an evacuated, permanently sealed reference. They are used to measure gauge pressures by atmospheric offset determined by direct measurement when the reference transducer is vented. The atmospheric offset is dynamically compensated while operating in gauge mode using measurements of the changes in atmosphere provided by a separate barometer.

1.3.2.1 HIGH PRESSURE REFERENCE TRANSDUCER (HI REF)

Ranges	High (3): 0 to 1 000 psi (7 MPa) gauge/absolute Mid (2): 0 to 600 psi (4 MPa) gauge/absolute Low (1): 0 to 300 psi (2 MPa) gauge/absolute
Measurement Precision (Combined Linearity, Hysteresis and Repeatability)	± 0.01% F.S. of each range
Stability (6 Month with Use of AutoZero Function)	± 0.005% F.S. of maximum range
Resolution	1 ppm of maximum range

1.3.2.2 LOW PRESSURE REFERENCE TRANSDUCER (LO REF)

Ranges	High (3): - 15 to 35 psi (250 kPa) gauge 0 to 50 psi (350 kPa) absolute Mid (2): - 15 to 15 psi (100 kPa) gauge 0 to 30 psi (200 kPa) absolute Low (1): - 15 to 0 psi gauge 0 to 15 psi (100 kPa) absolute
Measurement Precision (Combined Linearity, Hysteresis and Repeatability)	± 0.01 % F.S. of each range
Stability (6 Month with Use of AutoZero Function)	± 0.005 % F.S. of maximum range
Resolution	1 ppm of maximum range

1.3.2.3 BAROMETER

The barometric sensor is not used to provide absolute accuracy, it is used only to measure the changes in atmospheric pressure to provide dynamic compensation of the reference pressure transducer atmospheric pressure offset measurements when using a reference pressure transducer to make gauge pressure measurements.

Range	11 to 16 psia (70 to 110 kPa)
Accuracy (Nominal)	± 0.5 % of reading
Resolution	0.001 psi (7 Pa)

1.3.3 PRESSURE CONTROL SPECIFICATIONS

Control Modes Available	Static and dynamic
Control Volume	0 to 30 in^3 (500 cc), ideal 7 to 15 in^3 (125 to 250 cc)
Control Limits	System defaults provided for each pressure measurement range but can be customized by the user using the CUSTOM CONTROL function.

1.3.3.1 STATIC PRESSURE CONTROL

Default Hold Limit	± 1 % of F.S. of the active pressure measurement range
Default Stability Limit	± 0.005 % of F.S./sec of the active pressure measurement range

1.3.3.2 DYNAMIC PRESSURE CONTROL

Default Hold Limit	± 0.05 psi (138 Pa) for Hi Ref ranges (1 to 3)
	± 0.0025 psi (7 Pa) for Lo Ref ranges (1 to 3)
Default Stability Limit	± 0.05 psi (350 Pa)/sec for Hi Ref ranges (1 to 3)
	± 0.0025 psi (18 Pa)/sec for Lo Ref ranges (1 to 3)

2. INSTALLATION AND SHORT TERM STORAGE

2.1 UNPACKING AND INSPECTION

2.1.1 REMOVING FROM PACKAGING

PPC2 AF is delivered in a molded medium density polyethylene shipping case with a custom foam insert for holding the PPC2 AF, SPLT if included, documentation and accessories.

Remove all PPC2 AF elements from the shipping case and remove each element from its protective plastic bag.

2.1.2 INSPECTING CONTENTS

Check that all items are present and have no visible damage.

PPC2 AF includes:

DESCRIPTION	PART NO.
PPC2 AF Pressure Controller/Calibrator	401270
Calibration Certificate	550200
Test Report	550102
ACCESSORIES:	**401273**
User's Manual	550090
Power Cord (7.5 ft.)	100770
(4) Rubber Feet Caps	400202
1/4 in. NPT Male X KF 16 SS Vacuum Adaptor	102519
Male Electrical Connector for Drivers	102478
SPLT on Stand (with filter) *	401271
(1) Spare SPLT Filter Element *	102502
Shipping Case with Inserts	401272

* If supplied.

2.2 SITE REQUIREMENTS

The PPC2 AF can be installed on any **flat, stable surface** at a convenient height. The front feet can be extended so that the unit can be inclined slightly for easier viewing. The PPC2 AF can also be mounted in a standard 19" rack mount using the optional rack mount kit.

Minimizing the length of tubing between the PPC2 AF to the device or system to be tested will enhance control performance and reduce pressure setting times.

Ready access to the PPC2 AF rear panel should be considered to facilitate making and breaking pressure connections.

The SPLT, if used, needs to be mounted vertically at the low point of the pneumatic system.

Support facilities required include:

- **An electrical power source** of 85 to 264 VAC, 47 to 440 Hz.
- **A continuous regulated source pressure** of 1 100 psi (8 MPa) clean, dry, non-corrosive gas to connect to the pressure supply. Lower gas pressure sources can be used but should exceed the maximum desired test output pressure by 10 to 20%.
- **A vacuum source** of less than 1 psia (7 kPa) and at least 3 cfm (90 lm) is needed to control under 2 psi (14 kPa) gauge.

When supply pressure is applied to the PPC2 AF supply port, there is a constant gas exhaust through the EXHAUST port of PPC2 AF to which the vacuum source will be connected. Therefore, the vacuum source should either be continuously "on" or should bypass to atmosphere when the vacuum source is "off" to avoid building up pressure on the EXHAUST port and/or the vacuum pump. To conserve gas, vent the test volume and shut off the pressure supply when PPC2 AF is not in use.

2.3 INITIAL SETUP

2.3.1 PREPARING FOR OPERATION

To prepare PPC2 AF for check out and operation:

- Remove the plastic caps from the five (5) PPC2 AF rear panel pressure connections.
- Remove the protective plastic sheet from the front panel display.
- Install the rubber feet caps onto the bottom case feet, if desired.

2.3.2 POWER CONNECTION

- Check that the PPC2 AF power switch is off.
- Connect the supplied power cable to the rear panel power module.
- Connect the other end of the power cable to an electrical supply of 85 to 264 VAC, 47 to 440 Hz.

2.3.3 CONNECTING TO A PRESSURE SUPPLY (SUPPLY PORT)

Using a pressure connecting hose of appropriate pressure rating, connect the pressure supply to the SUPPLY connection on the rear panel of PPC2 AF. The PPC2 AF SUPPLY connection is **1/8 in. NPT female**.

Never connect a pressure supply greater than 1 200 psi (8 MPa) to PPC2 AF.

2.3.4 CONNECTING A VACUUM PUMP (EXHAUST PORT)

For PPC2 AF to set pressures under atmosphere and/or to reliably set pressure under 2 psi (914 kPa) gauge other than zero gauge, a vacuum pump must be connected to the exhaust port.

Never connect a pressure supply to or plug the PPC2 AF EXHAUST port.

When changing the pressure applied to the EXHAUST port from vacuum to atmosphere, be sure to change the control reference setting (see Section 3.3.1).

2.3.5 CONNECTING TO THE DEVICE UNDER TEST (TEST PORT)

See Section 2.3.5.1 before proceeding to connect the device under test.

Using a pressure connecting hose of appropriate pressure rating, connect the device or system to be tested to the TEST port of the PPC2 AF. The PPC2 AF TEST connection is **¼ in. NPT female.**

Minimizing the length of the test connection hose will enhance control performance and reduce pressure setting time. For normal operation, the total volume of the device of system under test including connecting tubing should be less than 30 in^3 (500 cc).

PPC2 AF pressure control will not operate properly if there are excessive leaks in the test system (see Section 3.2.8).

PPC2 AF pressure may be adversely affected if the test connection hose is too restrictive. For optimum results, the inner diameter of the connecting hose should be > 0.07" (1.75 mm).

NEVER apply pressure to the TEST port without having a pressure supply equal to or great than the applied pressure connected to the SUPPLY port. When controlling pressure externally, or measuring external pressure through the SUPPLY port, NEVER cause the pressure to change at a very rapid rate. For example, do not vent suddenly by opening an external valve. Internal PPC2 AF damage may result.

2.3.5.1 INSTALLING THE SPLT

The SPLT (if provided) is intended to collect and exhaust liquid contaminants that may be present in the device or system under test so that they do not return to the PPC2 AF.

The SPLT is installed in the test connection line at a low point between PPC2 AF and the device or system under test. The SPLT pressure connections are **1/4 in. NPT female**. Teflon tape or another sealing material should be used to assure leak free connection of adapters installed in the SPLT pressure connections.

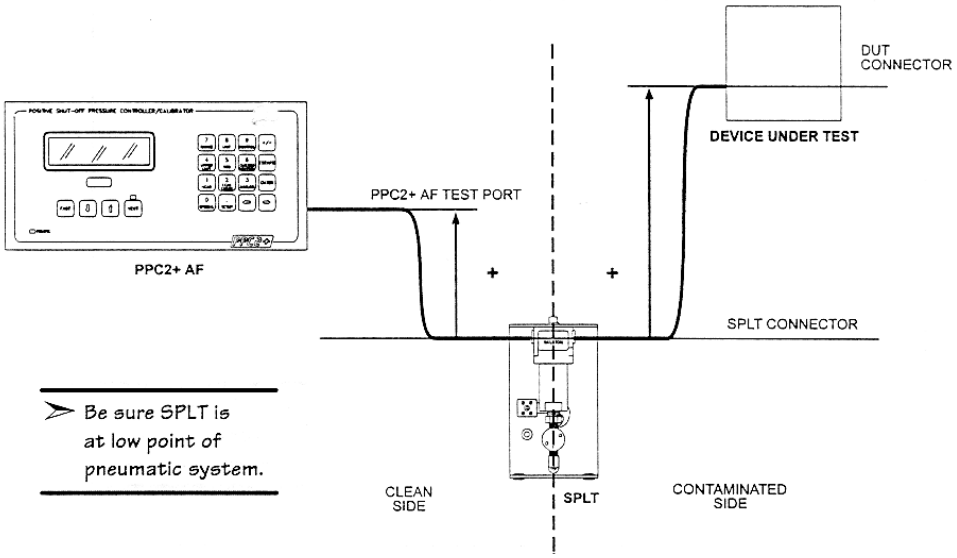
Proper SPLT operation is dependent on the gas flowing through it in the correct direction. Be sure to connect the SPLT to the device or system under test and the PPC2 AF following the connector port labels on the SPLT.

Connect the SPLT electrically to the PPC2 AF rear panel DRIVER connection and to the SPLT terminal blocs. See Appendix 9.2 for information on preparing the SPLT electrical cable and connection to the SPLT terminal blocs.

The SPLT must be mounted vertically with the purge valve at the bottom to perform properly. It must be at a lower point in the system than the PPC2 AF and/or the device under test. In operation, liquid contaminants collected from the device or system under test will be exhausted through the SPLT purge valve.

Liquid contaminants will be forcibly ejected from the SPLT purge tube. Provision for collecting the purged liquids should be considered when installing the SPLT.

Excessively dirty or wet filter elements can adversely affect pressure control.



PPC2 AF with SPLT and DUT

2.3.6 THE VENT CONNECTION (VENT PORT)

The PPC2 AF VENT connection is the system vent to atmosphere point used to set zero gauge pressure and obtain reference pressure transducer measurements of atmospheric pressure. Though a pressure hose can be connected to the VENT connection to direct the vented gas flow, a completely unobstructed connection to atmosphere must be obtained for PPC2 AF reference pressure measurements to operate normally.

The PPC2 AF VENT connection is **1/4 in. NPT female**.

Never plug, obstruct or connect a supply pressure to the PPC2 AF vent connection.

2.3.7 THE AUTOZERO CONNECTION (AUTOZERO PORT)

The PPC2 AF AUTOZERO connection is used for the AutoZero by Vacuum function and is not needed at start up. It should be left open to atmosphere.

2.4 POWER UP AND VERIFICATION

2.4.1 SWITCH POWER ON

Actuate the power switch on the PPC2 AF rear panel. Observe the front panel display as PPC2 AF initializes, error checks and goes to the main run screen (see Section 3.1.1).

PPC2 AF operating condition at power up is VENT valve closed, Hi reference pressure transducer active.

If the PPC2 AF fails to reach the main run screen, service is required. Record the sequences of operation and displays observed.

If the active range on power down was a Hi reference transducer range, the same range will be active on the next power up. If the active power down range was a Lo reference transducer range, range H3 will be active on power up. This is to protect the Lo reference transducer from accidental overpressure (see Section 3.1.2.5).

2.4.2 SET THE USER LEVEL (INITIAL START UP ONLY)

PPC2 AF's front panel interface provides the means to access all PPC2 AF data and functions including functions which, if used inadvertently or incorrectly, could change critical metrological and/or operational parameters. The USER LEVEL function (see Section 3.4.4.6) allows these areas to be password protected. The "low" security level protects only the most critical internal calibration data. It is recommended that this level be set on all PPC2 AF's even if no special security precautions are desired.

2.4.3 CHECK PROPER PRESSURE MEASUREMENT OPERATION

2.4.3.1 CHECKING ABSOLUTE PRESSURE MEASUREMENT

If the PPC2 AF is not vented, press the VENT direct pressure control key to vent it (see Section 3.1.2.2).

Press the UNIT function key (see Section 3.2.2). Select psi and then select absolute mode.

Using the RANGE function key to change ranges (see Section 3.2.1), observe the current value of atmospheric pressure displayed by each range. Check that these values agree within ± 0.2 psi (1.4 kPa). If they do not agree, PPC2 AF may need calibration or repair.

2.4.3.2 CHECKING GAUGE PRESSURE MEASUREMENT

If the PPC2 AF is not vented, press the VENT direct pressure control key to vent it (see Section 3.1.2.2).

Press the UNIT function key. Select psi and then select gauge mode.

Using the RANGE function key to change ranges, observe that zero psi, ± 0.01 psi is indicated for each range within 10 seconds. If it is not, PPC2 AF may need repair.

2.4.4 LEAK CHECK

If desired, perform a leak check of the test system (see Section 3.2.8).

2.4.5 PURGE

If the SPLT is included and installed in the test line, perform a purge of the system if it may be liquid contaminated and descending pressures will be controlled (see Section 3.2.8).

Operating the PPC2 AF connected to a system with liquid contaminants without taking proper precautions to purge the system and test line may cause contamination of the PPC2 AF that will require non-warranty service.

2.4.6 CHECK PROPER PRESSURE CONTROL OPERATION

Select a pressure range using the RANGE function (see Section 3.2.1).

Press the CONTROL function key and select "dynamic" (see Section 3.2.3).

Select1Vac under 1ControlRef of the SETUP menu if a vacuum supply is connected to the PPC2 AF EXHAUST port, otherwise, set 2Atm (see Sections 3.3.1).

Press ENTER, specify a target pressure within the current range to be set and press ENTER again (see Section 3.2.3).

PPC2 AF should set the target pressure and indicate "ready" (see Section 3.1.2.4) continuously in 30 to 60 seconds. If it does not, see Section 6.

2.5 SHORT TERM STORAGE

The following is recommended for short term storage of PPC2 AF:

- Vent the PPC2 AF test pressure.
- Turn the power "off" using the rear panel power switch.
- Shut-off or disconnect the pressure supply.
- Shut-off or disconnect the vacuum supply.

3. OPERATION

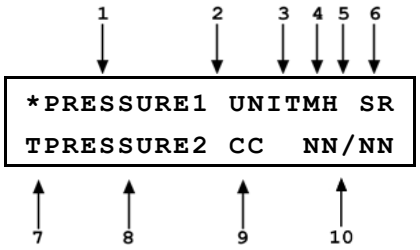
3.1 GENERAL/MANUAL OPERATION

PPC2 AF is designed to offer a balance between simple, straight forward operation and the availability of a wide variety of functions with a high level of operator discretion if desired. The local operator interface is through a 2 X 20 display, a 4 X 4 keypad and 4 direct pressure control keys.

3.1.1 THE MAIN RUN SCREEN

The PPC2 AF main run screen is its home display that is reached on power up and from which other functions and menus are accessed. It is the very top level of all menu structures.

The main run screen is where the operator works with PPC2 AF to set and read pressures. It provides complete information on the system's current configuration and operating status.



1. * Ready/Not Ready indication (See Section 3.1.2.4).

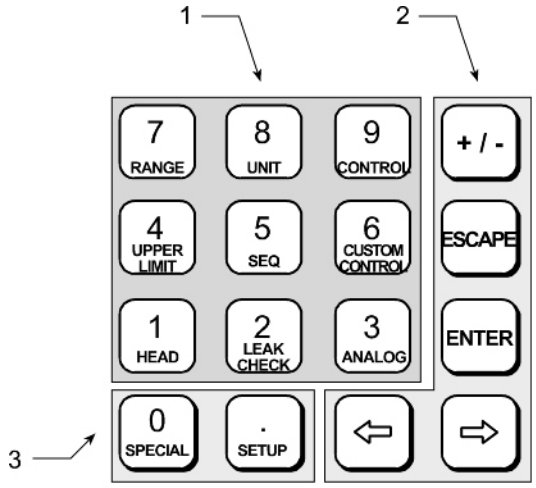
   * when Ready, ↑ or ↓ indication direction of pressure evolution if Not Ready.
2. **PRESSURE1:** Numerical value and sign of pressure currently measured by currently active transducer and range.
3. **UNIT:** Current unit of measure of pressure indication (see Section 3.2.2).
4. **M:** Pressure measurement mode: **g** for gauge, **a** for absolute (see Section 3.2.2).
5. **H:** Indicates if a head correction is applied. **H** if applied, blank if not (see Section 3.2.7).
6. **SR:** Indicates active reference transducer (**H** for high, **L** for low) and range (**1** = low, **2** = mid, **3** = hi) (see Section 3.2.1).
7. **T:** Indicates whether number following is target pressure (**T**), rate of change of pressure (**R**) or deviation from target value (**D**) (see Section 3.2.3).
   - Target pressure (**T**) will be indicated when:
     - Dynamic control is active and pressure is NOT READY.
     - Static control is active and valves are operating.
   - Deviation (**D**) will be indicated when:
     - Dynamic control is active and pressure is READY.
   - Rate of change (**R**) will be indicated when:
     - No control is active, i.e. control is suspended or system is vented.
     - Static control is active, and no valves are active.
8. **PRESSURE2:** Numerical sign and value of either target pressure, rate of change of pressure or deviation from target. Target value and deviation in the same pressure unit as the current unit in 3. above. Rate of change of pressure is in current unit per second (see Section 3.2.3).
9. **CC:** Pressure control mode (**S** for static, **D** for dynamic) with a (**C**) appended if custom control settings are in use. These characters flash when the system is controlling. In static mode, if control is active they flash even if no valve is operating, for example while inside the hold limit and waiting for stability. Characters flash while controlling pressure down to vent but not when vent valve is open (see Sections 3.2.3 and 3.2.6).
10. **NN/NN:** Used only when running a sequence. Indicates number of increment currently being worked on over total number of increments in the sequence or enter when "ready". Changes to a countdown time during count down when next increment of sequence is on timed delay rather than enter.

PPC2 AF has a screen saver function which causes the display to dim if no key is pressed for 10 minutes. Pressing a key restores full power to the display.

3.1.2 GENERAL OPERATING PRINCIPLES

3.1.2.1 MAIN KEYPAD LAYOUT AND PROTOCOL

The PPC2 AF has a 4 X 4 keypad for local operator access to direct functions, function menus and for data entry.



1. **The Function/Data keys** allow very commonly used functions to be accessed directly by a single keystroke when pressed from the main run screen. The name of the function is on the bottom half of the key (see Section 3.2). These keys enter numerical values when editing.
2. **The Menu/Data keys** provide access to function menus when pressed from the main run screen. The menu name is on the bottom half of the key. The SETUP menu is for more frequently used functions (see Section 3.3). The SPECIAL menu is for functions that are not generally used as a part of normal operation (see Section 3.4). These keys enter numerical values when editing.
3. **The Editing and Execution keys** are for causing execution, suspending execution, backing up in menus and editing entries.

Keypad

The ENTER key generally causes execution or forward movement in the menu tree. ENTER from the main run screen allows an automated pressure control command to be given.

The ESCAPE key moves back in the menu tree and/or causes execution to cease or suspend. Pressing ESCAPE repeatedly always eventually brings you back to the main run screen and from there will allow a momentary viewing of the PPC2 AF introduction screen.

The **+ / -** key changes a numerical sign when editing. It also toggles through multiple screens when available.

The ⇦ and ⇨ keys allow reverse and forward cursor movement when editing data entry.

Some screens go beyond the two lines provided by the display. This is indicated by a flashing arrow in the second line of the display. Use the ← and → arrow keys to move the cursor to access the lines that are not visible or directly enter the number of the desired menu choice if you know it.

3.1.2.2 DIRECT PRESSURE CONTROL KEYS

Direct Pressure Control Keys

The direct pressure control keys provide direct manual control of pressure increase, decrease and vent. They can be useful in adjusting pressure when automated pressure control to a target value is not needed.

The direct pressure control keys interrupt and override automated pressure control.

The VENT key causes the system to control pressure to near atmospheric pressure and then open the system vent valve (see Section 1.2.7). Vent valve open is indicated by lighting a red LED just above the VENT key. The vent valve will remain open until the VENT key is pressed again or pressure is changed by a direct pressure control key or an automated pressure control command. The VENT key also causes the purge function to execute when the PPC2 AF LEAK CHECK/PURGE function is active (see Section 3.2.8).

The ⬆ and ⬇ keys cause pressure to increase or decrease at the slow slew rate.

Pressing the FAST key while pressing an ⬆ or ⬇ key will cause the pressure increase or decrease speed to change from slow to fast.

3.1.2.3 AUTOMATED PRESSURE CONTROL

PPC2 AF automated pressure control provides automated adjustment and control of pressure to a user designated target value. This feature allows pressure values to be set simply and precisely by simple numerical entry. Pressing ENTER from the main run screen allows a pressure control target value to be entered and executed. Pressing ESCAPE or a direct pressure control key will cause pressure control to be interrupted.

PPC2 AF supports two pressure control modes, static and dynamic, to meet different pressure setting and controlling requirements. Pressure control parameters for each control mode are automatically adjusted to optimal values for each PPC2 AF range when the control mode is selected in that range (see Section 3.2.3). If desired, control parameters can be customized by the user using the CUSTOM CONTROL function (see Section 3.2.6).

Control parameters:

Target Value: The pressure setpoint specified by the operator.

Hold Limit: A symmetrical positive and negative limit around the target value.

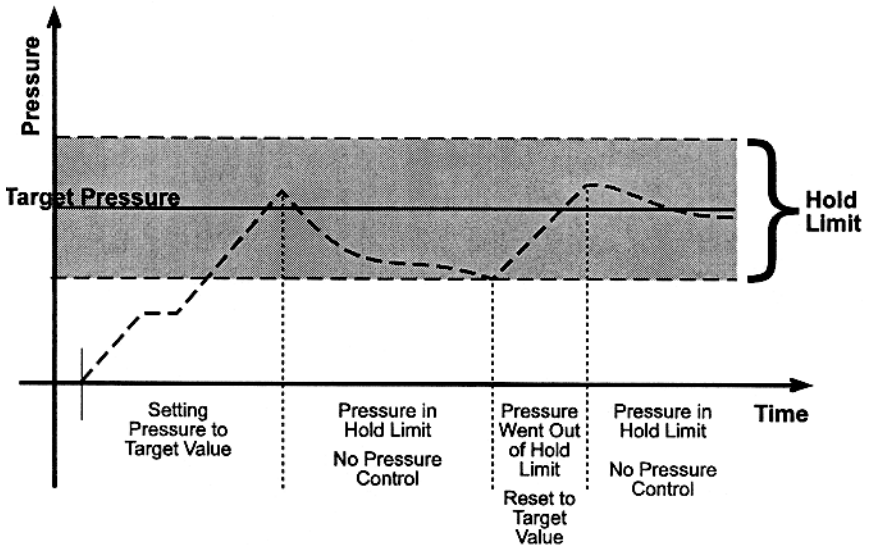
Stability Limit: A rate of change of pressure limit in units of pressure/second.

See Sections 3.1.2.3.1 and 3.1.2.3.2 for a detailed explanation of each control mode and its advantages, the default control parameters and the Custom Control options.

3.1.2.3.1 Static Control

Static control mode is designed to set the pressure near the target value and then stop controlling to allow pressure to stabilize naturally. The advantage of this control mode is that pressure can be measured without interference from a pressure control system. In a system without excessive leaks, the pressure stability achieved, especially at low pressures, may be greater than the stability with which the pressure control system can actively control pressure. Using static control to control pressures near the desired set point and then measuring back the stabilized pressure without interference of the control function, can allow control errors to be eliminated. However, the final pressure achieved will be different from the target value.

During static pressure control, the hold limit is active. If the pressure goes outside of the hold limit, a "not ready" condition will occur (see Section 3.1.2.4) and pressure will be readjusted to the target value (see Section 3.2.3 for default hold and stability limit values and Section 3.2.6 for setting the hold and stability limits).

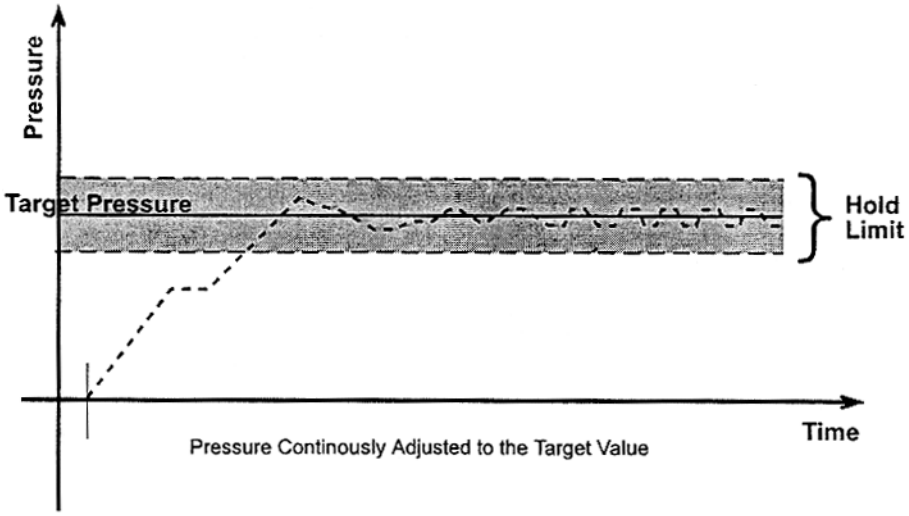


Static Pressure Control Operation

3.1.2.3.2 Dynamic Control

Dynamic control mode is designed to set the pressure to the target value and control continuously to keep pressure within the hold limit and as close to the target value as possible. The advantage of this control mode is that the final pressure achieved will be the same as the target value. However, unlike static control, in dynamic control, a control error will be included in the pressure achieved. The maximum value of the control error is equal to the hold limit. The average value of the control error is generally well inside the hold limit.

During dynamic pressure control, the hold limit is active. If the pressure goes outside of the hold limit, a "not ready" condition will occur (see Section 3.1.3.4; see Section 3.2.3 for default hold limit values and Section 3.2.6 for setting the hold limit).



Dynamic Pressure Control Operation

3.1.2.4 PRESSURE READY/NOT READY INDICATION

The far left character of the display provides a pressure "Ready/Not Ready" indication. This indication is intended to provide the user with a clear and objective criterion for determining when a valid pressure measurement can be made.

Ready/Not Ready indications are:

*** :** Pressure "ready".

↓ : Pressure "not ready" and decreasing.

↑ : Pressure "not ready" and increasing.

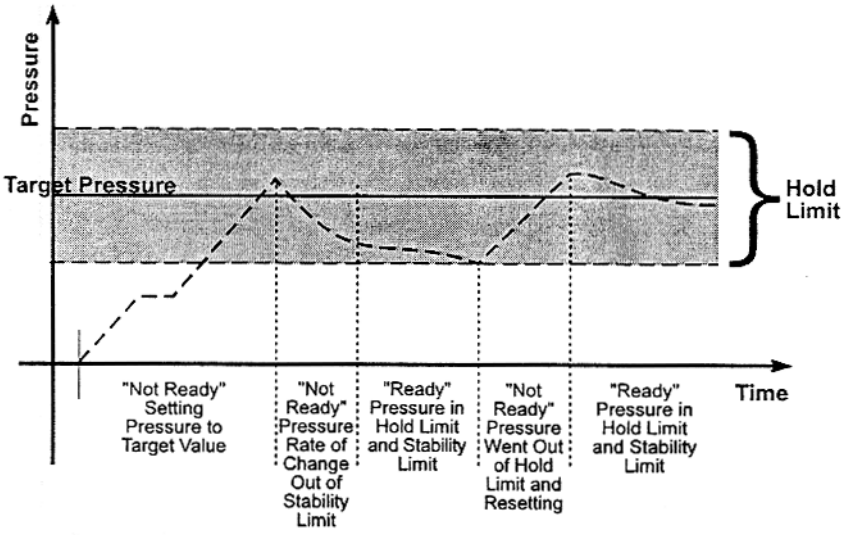
When pressure control is not active, a "ready" condition will occur any time no control valve is operating and the pressure rate of change is inside the stability limit. The stability limit is defined in terms of rate of change of pressure in current pressure units per second.

The determination of the "ready/not ready" condition is different for static and dynamic pressure control. Pressure Ready/Not Ready parameters are set by default when a control mode is selected and can be customized (see Sections 3.2.3 and 3.2.6).

3.1.2.4.1 Static Control Ready/Not Ready

When static pressure control mode is active a "ready" condition will occur when:

1. No control valve is operating.
2. The current measured pressure is inside the hold limit.
3. The rate of change of pressure is less than the current stability limit.

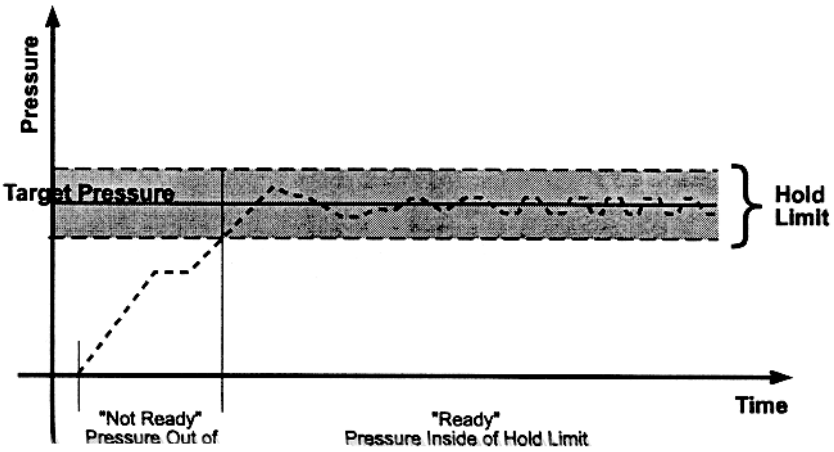


Ready/Not Ready Static Control Mode

3.1.2.4.2 Dynamic Control Ready/Not Ready

When dynamic pressure control mode is active a "ready" condition will occur when:

1. The current measured pressure is inside the hold limit.



Ready/Not Ready in Dynamic Pressure Control Mode

3.1.2.4.3 Ready/Not Ready When Automated Pressure Control is Not Active

When no automated pressure control is active, "ready" is indicated whenever the rate of change of pressure is less than the current stability limit.

3.1.2.5 MULTIPLE PRESSURE RANGES

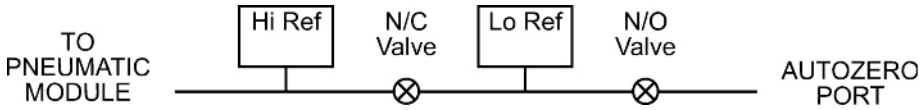
PPC2 AF has two reference pressure transducers each of which has three ranges for a total of six pressure ranges. This multiranging feature allows accuracy to be optimized for the range of pressure in which you are working. Generally, the best range to select (see Section 3.2.1) is that whose full scale is closest to, but not less than, the maximum pressure at which you need to work.

PPC2 AF handles all of the data and internal valving operations needed to make range changes occur transparently to the operator when the RANGE function is used to select a range. Ranges available can be viewed at any time but changing ranges can only occur when PPC2 AF is vented.

When ranges are changed, the upper limit is automatically changed to the default for that range or to the last upper limit that was set for that range (see Section 3.2.4). In addition, most other functions are range specific (see Section 3.2.1 below).

PPC2 AF has six ranges on two transducers. In general, user settings and operational adjustments are specific to the range currently in use, as if you had six instruments rather than one.

The PPC2 AF internal valving for handling of the two reference transducers is:



Valving – Hi and Lo Reference Transducers

RANGES AND IDENTIFICATION

The currently active reference transducer and range is continuously displayed in the upper right hand corner of the main run screen. Ranges available and main run screen indication are as follows:

REFERENCE TRANSDUCER AND RANGE NUMBER	RANGE (PSI) GAUGE/ABSOLUTE	MAIN RUN SCREEN INDICATION
Lo, 1 (Lo)	0/15	L1
Lo, 2 (Mid)	15/30	L2
Lo, 3 (Hi)	35/50	L3
Hi, 1 (Lo)	300/300	H1
Hi, 2 (Mid)	600/600	H2
Hi, 3 (Hi)	1 000/1 000	H3

All ranges start at zero in absolute mode and in gauge mode go negative by the current value of atmospheric pressure.

3.2 DIRECT FUNCTION KEYS

3.2.1 RANGE

- **PURPOSE**

To change the currently active pressure measurement range.

- **PRINCIPLE**

PPC2 AF uses a 1 000 psi (7 MPa) absolute transducer and a 50 psi (350 kPa) absolute transducer to measure reference pressures. In addition, each one of these transducers is triple ranged providing a total of six pressure ranges over the 1 000 psi pressure range of the PPC2 AF (see Section 3.1.2.5).

The RANGE function keys allows ranges to be selected including automated switching of transducers when necessary with built-in logic to prevent accidental overpressure of the low pressure transducer.

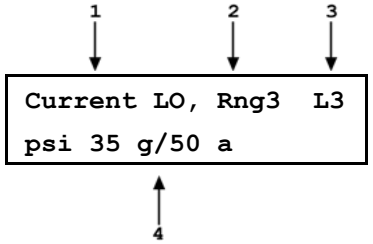
PPC2 AF functions and settings such as pressure unit of measure (UNIT) and control mode (CONTROL) are range specific. Only the HEAD function is not range specific (see Section 3.4.2). Changes made while in one range apply to that range only and will not affect the other ranges.

- **OPERATION**

Pressing the RANGE function key activates the range viewing and selecting function. Pressing the +/- key or the RANGE key again while in the RANGE functions steps through displays of available ranges, Lo to Hi. Pressing ENTER while in the RANGE function when PPC2 AF is vented makes the currently displayed range the active range. Pressing ESCAPE while in the range function returns to the main run screen with no range change having been made.

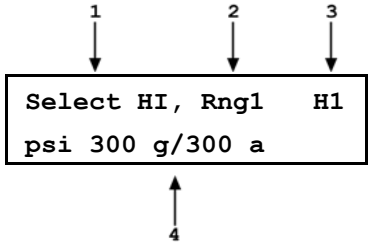
When the RANGE function key is first pressed, the current reference transducer and range being used are displayed, for example:

1. Identifies reference transducer in use (Lo or Hi).
2. Identifies range of that reference transducer currently in use (1, 2 or 3, Lo to Hi).
3. Abbreviated range designation.
4. Units of measure and pressure range for that transducer and range number when used in gauge (g) or absolute(a) mode.



Pressing the **+ / -** key or pressing the RANGE key again causes the screen to step through the other available ranges in sequence Lo to Hi, for example:

1. Identifies reference transducer (Lo or Hi).
2. Identifies range of number on that reference transducer (1, 2 or 3).
3. Abbreviated range designation.
4. Units of measure and pressure range for that transducer and that range when used in gauge (g) or absolute(a) mode.



Range limits are given in the pressure unit that is currently active for that range.

To protect against overpressure of the Lo pressure reference transducer and avoid accidentally exceeding range upper limits, the active range can only be changed when the system is vented. If ENTER is pressed while in the RANGE function when PPC2 AF is not vented, the display will indicate "Vent system fully to change range". Press ESCAPE or ENTER to reach the main run screen and vent using the VENT direct pressure control key. Once the system has fully vented, use the RANGE function to make the desired range change.

RANGE SPECIFIC FUNCTIONS AND SETTINGS

In general, PPC2 AF functions and settings are channel specific. They are set and stored for each range so that changing them when in one range does not change them in the other ranges and when you return to a range, you will find the settings you left.

The only functions and settings that are not range specific are:

Functions: HEAD, ANALOG

Setup Menu: 1ControlRef, 4Drivers

3.2.2 UNIT

❍ PURPOSE

To specify the pressure unit in which PPC2 AF displays pressure values.

See also Section 3.4.1.

❍ OPERATION

To change the pressure unit of measure, press the UNIT function key. The display is:

```
1psi   2kPa   3inHg
4inWa  5mmHg  6ft
```

Select the desired pressure unit. ENTER selects the unit and goes to measurement mode selection: 1gauge or 2absolute. Making the selection returns to the main run screen with the selected measurement unit and mode active.

If the pressure unit selected is inWa the reference temperature for water density must be specified. When inWa is selected as the unit, the next display is:

```
Select inWa ref temp
4°C    20°C    60°F
```

Select the desired reference temperature for water density using the ← or → key to move the cursor. ENTER returns to the main run screen with the inWa based on water density at the selected reference temperature as the pressure unit. The current inWa reference temperature can be viewed by observing the position of the cursor in the reference temperature screen.

No reference temperature selection is necessary for the unit mmWa as the only reference temperature commonly used for mmWa is 4° C.

See Section 9.3 for tables of the conversion factors used by PPC2 AF.

The choice of six units available under the UNIT function can be modified from a wider selection by the user. See Section 3.4.1.

3.2.3 CONTROL

❍ PURPOSE

To set the automated pressure control mode for the currently active range with default control parameters.

❍ PRINCIPLE

The CONTROL function allows the active control mode for the current range to be set to either static control or dynamic control (see Section 3.1.2.3). The control mode set is specific to the current range and will be maintained with that range when ranges are changed.

When the control mode is set using the CONTROL function, CONTROL parameters are set to system default parameters which have been determined to be those most suitable for the typical user to operate within PPC2 AF pressure control and measurement specifications (see SYSTEM DEFAULT CONTROL PARAMETERS below). If desired, control mode parameters can be customized by the user using the CUSTOM CONTROL function (see Section 3.2.6).

For a complete description of the operation and purpose of static and dynamic control modes, see Section 3.1.2.3.

❍ OPERATION

To select the control mode for the currently active range and set control parameters to the default control parameters, press the CONTROL function key from the main run screen. The display is:

```
Control mode:
1dynamic  2static
```

Selecting 1static or 2dynamic causes the selected pressure control mode to be activated with default control parameters and returns to the main run screen.

Control mode setting is range specific. A change in control mode made while in one PPC2 AF range does not affect the control mode setting in other ranges (see Section 3.2.1).

The current control mode is indicated by two characters in the middle of the bottom line of the main run screen (S for static and D for dynamic with C appended if custom control settings are in use). (See Section 3.1.1.)

In dynamic control mode, whenever the pressure is "ready" (inside the hold limit), the display of measured pressure is equal to the target pressure. This is because in dynamic control mode, when the pressure is "ready", it is assumed that the measured pressure equals the target pressure. This is not true when setting zero in absolute measure mode (see Section 3.2.3.1.2).

SYSTEM DEFAULT CONTROL PARAMETERS

	LO REFERENCE TRANSDUCER RANGE 1, 2, 3		HI REFERENCE TRANSDUCER RANGE 1, 2, 3	
	HOLD LIMIT	STABILITY LIMIT	HOLD LIMIT	STABILITY LIMIT
Static Mode	± 1% of F.S. of the active pressure measurement range	± 0.005% of F.S./sec of the active pressure measurement range.	± 1% of F.S. of the active pressure measurement range	± 0.005% of F.S./sec of the active pressure measurement range.
Dynamic Mode	± 0.0025 psi (35 Pa)	± 0.0025 psi (35 Pa)/sec	± 0.05 psi (350 Pa)	± 0.05 psi (350 Pa)/sec

3.2.3.1 EXECUTING AUTOMATED PRESSURE CONTROL COMMANDS

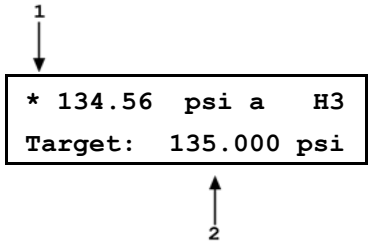
❍ PURPOSE

To use the automated pressure control functions of PPC2 AF to set target pressure values.

❍ OPERATION

To set a pressure press ENTER from the main run screen. The display is:

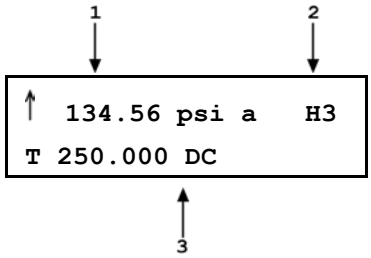
1. Ready/Not Ready indication, current pressure, units, measurement mode, range (regular first line of main run screen).
2. Entry field for target pressure to be set automatically. Comes up with last entry or zero if pressure measurement units have been changed, range has been changed, or system has been vented.



Use the numerical keys and editing keys to enter the target pressure value desired (see Section 3.2.3.1.2 for information on zero pressure commands).

Press ENTER to start pressure control to the target pressure and return to the main run screen. The main run screen is:

1. "Ready/Not Ready indication, current pressure, units, measurement mode, range (regular first line of main run screen).
2. Target pressure value (T) or pressure rate of change value (R) if in dynamic control and pressure is in ready condition.
3. Current control mode *flashing* to indicate that control is on.



A target pressure entry that exceeds the current upper limit (see Section 3.2.4 or that is out of range will not be accepted as the target value when ENTER is pressed.

Observe the *Ready/Not Ready* indication for indication of when ready conditions have been satisfied (see Section 3.1.2.4). PPC2 AF will continue controlling following static or dynamic control operation protocol (see Section 3.1.2.3) until automated pressure control is interrupted.

See Section 6 if PPC2 AF is unable to control pressure or appears to control pressure poorly.

For PPC2 AF to set pressures under atmosphere and/or to reliably set pressures under 2 psi (14 kPa) gauge other than zero gauge, a vacuum pump must be connected to the EXHAUST port (see Section 2.3.4) and PPC2 AF must be set up for control using a vacuum reference (see Section 3.3.1). Zero gauge pressure can always be set.

3.2.3.1.1 Interrupting Automated Pressure Control

Automated pressure control is interrupted by:

- Pressing ESCAPE.
- Pressing any direct pressure control key (see Section 3.1.2.2).
- Pressing any function key.

To start automated pressure control again, press ENTER and ENTER a target pressure value.

3.2.3.1.2 Automated Pressure Commands for Zero Pressure

Zero in gauge mode: A command for automated pressure control of zero when in gauge pressure measurement mode is interpreted in the same manner as if the VENT direct pressure control key had been pressed (see Section 3.1.2.2). A "ready" condition will occur when the vent valve has been opened and the pressure meets the current stability test.

Zero in absolute mode: Even with a vacuum pump connected to its reference EXHAUST, PPC2 AF cannot set absolute zero pressure due to internal restrictions and the continuous gas flow through its EXHAUST port. When a command for automated pressure control of zero when in absolute pressure measurement mode is given, PPC2 AF responds by reducing the pressure as far as possible using down fast pressure control. A "ready" condition will be indicated when the stability limit is reached with the control down fast remaining open.

Due to the manner in which PPC2 AF handles an automated pressure command for zero in absolute pressure measurement mode, a ready condition can occur at a pressure well outside of the hold limit. When setting zero in absolute measurement mode, the "ready" condition should not be used as an indication that the pressure is zero. "Ready" is an indication that the PPC2 AF has reduced the pressure as far as possible and that the pressure is now stable. The current displayed pressure should be used as the value of pressure applied to the device or system under test.

3.2.4 UPPER LIMIT

❍ PURPOSE

To set the upper limit pressure value for a pressure range.

❍ PRINCIPLE

The UPPER LIMIT function provides the capability to enter a maximum pressure not to be exceeded when using a specific range. Automated pressure control target values above the upper limit will not be accepted and direct pressure control keys will shut off when the upper limit is reached.

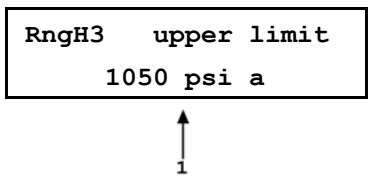
The UPPER LIMIT function is most often used to protect the device or system that the PPC2 AF is testing from accidental overpressure.

If no upper limit value is entered by the user, the upper limit for each range is set by default to 105 % of the active range for ranges L3 and H3 and to 115 % of the active range for all other ranges.

❍ OPERATION

When the UPPER LIMIT function key is pressed from the main run screen the display is:

1. Entry field to enter desired upper limit value.



Enter the desired upper limit value and PPC2 AF returns to main run screen with new upper limit value active.

Upper limit values are always specified in absolute pressure. Keep this in mind when setting upper limits for gauge measurement mode.

Upper limits are always specified in the current pressure unit. This creates an anomaly, in the case of altitude units, since the maximum pressure defined in MIL-STD 859A is roughly 179 kPaa (26 psia). This corresponds to an altitude of – 5 000m (- 16 480ft). Therefore, it is not possible to specify an upper limit in altitude that corresponds to a pressure greater than 179 kPaa (26 psia).

When the UPPER LIMIT has been exceeded, the display of current pressure flashes. Reduce pressure using direct pressure control keys or an automated pressure command to return to normal operation.

3.2.5 SEQ

- **PURPOSE**

To execute a programmed sequence of automated pressure control target values

- **PRINCIPLE**

The sequence function is intended to facilitate the execution of a series of pressure control target values such as is commonly needed when PPC2 AF is used to run a typical calibration sequence on a device or system being tested.

There are two types of sequences. Quick Sequence (see Section 3.2.5.1) allows quick definition and execution of a sequence in the current range and using all of the current settings (i.e. pressure units, control mode, control settings). File Sequence (see Section 3.2.5.3) allows execution of a preprogrammed sequence script including the PPC2 AF range to use, measurement mode, control mode, target values and other operational settings (see Section 3.3.3).

- **OPERATION**

When the SEQ function key is pressed from the main run screen, the display is :

```
Run sequence
1Quick  2File
```

Select the sequence type desired (see Sections 3.2.5.1 or 3.2.5.2).

3.2.5.1 SETTING UP/EDITING A QUICK SEQUENCE

- **OPERATION**

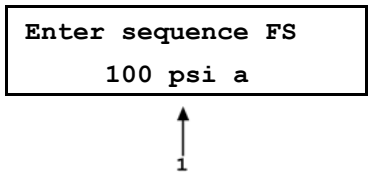
When 1Quick is selected from the SEQ function menu, the display is:

```
Run current quick
sequence    1Yes 2No
```

This selection provides the choice between running the quick sequence that is currently set up or changing the quick sequence set up. 1Yes will cause the currently defined quick sequence to run (see Section 3.2.5.3). 2No will go to the quick sequence set up/edit routine.

When 2No is selected from the Run Current Quick Sequence menu, the set-up/edit routine is accessed. The first display is:

1. Entry field for sequence full scale value. Recalls last entered value.

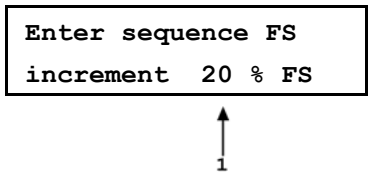


This entry determines the maximum pressure (furthest from zero) of the quick pressure sequence. Enter the desired sequence maximum pressure and press ENTER.

Sequence FS must be less than the pressure upper limit of the currently active pressure range (see Section 3.2.4).

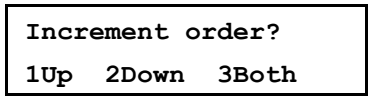
The next display is:

1. Entry field for sequence pressure increment in % of full scale. Recalls last entered value.



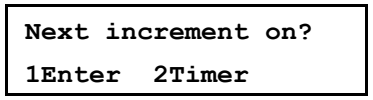
This selection determines the size of the pressure increment in terms of % of the full scale (FS) value entered in the previous screen. The sequence will be between zero and full scale in pressure steps of (full scale x increment %) starting from zero and ending with the uneven increment if applicable. Enter the desired pressure increment and press ENTER.

The next display is:



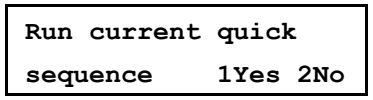
This selection determines the order in which the sequence increments will execute. 1Up will cause the sequence to execute between zero and the full scale value. 2Down will cause the sequence to execute between the full scale value and zero. 3Both will cause the sequence to execute from zero to full scale and back to zero.

After making the increment order selection the next display is:



This selection determines when, during running of the sequence, the pressure target value will change to the next value in the sequence. If 1ENTER is selected, the sequence will proceed to the next target value when ENTER is pressed. If 2Timer is selected, a timer will be started when a pressure ready condition is reached (see Section 3.1.2.4) and the sequence will continue to the next pressure control target value without operator intervention once the timer has expired. After selecting 2Timer, an additional screen is presented for entry of the timer value in seconds (minimum 1, maximum 999).

After making the next increment on selection the next display is:



Select 1Yes to run the quick sequence that has just been set up/edited (see Running a Quick Sequence below). Select 2No to setup/edit the current sequence. Press ESCAPE to back out of the SEQ function if desired.

3.2.5.2 SETTING UP/EDITING A FILE SEQUENCE

See Section 3.3.3.

3.2.5.3 RUNNING A SEQUENCE

❍ **OPERATION**

Selecting 1Yes in the Run current quick sequence menu causes the current quick sequence to execute.

Entering a valid sequence file number from the Run Sequence File # causes a file sequence to execute.

A Quick Sequence executes in the current range with the current settings. A File Sequence sets up the range and other settings as specified in the sequence file (see Sections 3.2.5 and 3.3.3.)

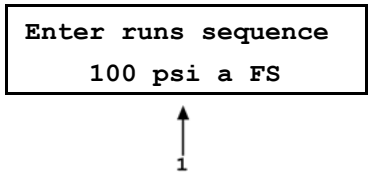
When initializing execution of a quick sequence, PPC2 AF checks: a) if the sequence full scale pressure exceeds the current upper limit; b) if PPC2 AF is in absolute measure mode, that the sequence does not contain negative values. If either of these conditions exists, an error message will be displayed and the sequence will not be run.

To run a file sequence that specifies a reference pressure transducer range other than the current range, PPC2 AF must be vented because the range cannot be changed when PPC2 AF is not vented.

To run a file sequence, the sequence file number selected must already have been setup using 3Sequence under the SETUP menu (see Section 3.3.3)

The first display is:

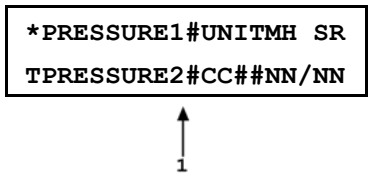
1. Maximum pressure of the sequence that is about to run.



This screen is offered as a means for the user to check, prior to execution, that the correct sequence is selected and that it does not exceed the range of the device or system being tested. Pressing ENTER causes sequence execution to proceed.

Pressure control will begin to set the first target value of the sequence (or vent will execute if the first increment is zero gauge pressure). The display is the Main Run Screen (see Section 3.1.1) with indication of the sequence progress:

1. Sequence increment that is currently being controlled/total increments in sequence. Changes to countdown time remaining during count down time following "ready" condition when sequence next increment is on timed delay rather than on ENTER.



Except for the bottom right hand corner, this display is identical to the normal main run screen (see Section 3.1.1). The bottom right corner provides information on sequence execution. This information updates as each sequence increment is executed.

If the sequence was set up with "Next increment on timed delay", execution will proceed automatically from increment to increment after a "ready" condition has occurred at the increment and the countdown timer has expired. If the sequence was set up with "Next increment on ENTER", ENTER must be pressed to continue to the next increment.

Regardless of whether the sequence was set up for next increment on time delay or on ENTER, pressing ENTER always causes the sequence to proceed to the next increment. This feature can be used to skip one or several increments if desired.

The display is:

```
Abort quick sequence
1Yes  2No
```

To interrupt the sequence, press ESCAPE or a direct pressure control key. Pressure control will immediately cease and the display will go to:

Selecting 1Yes causes the sequence to abort and returns to the main run screen. 2No causes the sequence to resume where it left off.

All Quick Sequences end with a VENT command after the last point. To avoid the VENT, ESCAPE after the last point.

3.2.6 CUSTOM CONTROL

PURPOSE

To customize the control parameters of the current automated control mode for the current range.

PRINCIPLE

Automated pressure control and the associated pressure ready/not ready condition are characterized by hold limit and stability limit parameters.(see Sections 3.1.2.3 and 3.1.2.4) which determine how PPC2 AF will control and under what conditions a "ready" indication will occur.

PPC2 AF provides system default values for the hold limit and stability limit parameters which have been determined to be those most suitable for the typical user to operate within PPC2 AF pressure control and measurement specifications. The default parameters are automatically set when the control mode is selected using the CONTROL function key (see SYSTEM DEFAULT CONTROL PARAMETERS below).

The CUSTOM CONTROL function allows the hold and stability limit parameters to be adjusted by the user. This can be used to increase control speed (time to "ready"), which usually decreases precision, or to increase precision which usually decreases control speed (see Section 3.1.2.4). For example, changing the dynamic pressure control hold limit in range 3 of the Hi reference pressure transducer from ± 0.02 psi to ± 0.1 psi will decrease the time it takes to set a pressure since the limit in which the pressure must be set has increased by a factor of five but it will also increase by a factor of five the possible control error included when ready is indicated.

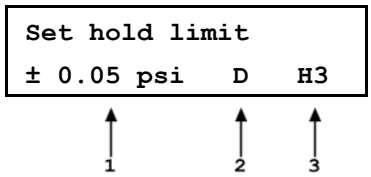
Adjusting default control parameters using the CUSTOM CONTROL function may result in control parameters that the PPC2 AF is unable to meet so that a "ready" condition never occurs. This does not indicate PPC2 AF malfunction, just that the control parameters need to be relaxed or set back to default parameters.

SYSTEM DEFAULT CONTROL PARAMETERS

	Lo Reference Transducer Range 1, 2, 3		Hi Reference Transducer Range 1, 2, 3	
	Hold Limit	**Stability Limit**	**Hold Limit**	**Stability Limit**
Static Mode	± 1 % of F.S. of the active pressure measurement range	± 0.005 % of F.S./sec of the active pressure measurement range.	± 1 % of F.S. of the active pressure measurement range	± 0.005 % of F.S./sec of the active pressure measurement range.
Dynamic Mode	± 0.0025 psi (35 Pa)	± 0.0025 psi (35 Pa)/sec	± 0.05 psi (350 Pa)	± 0.05 psi (350 Pa)/sec

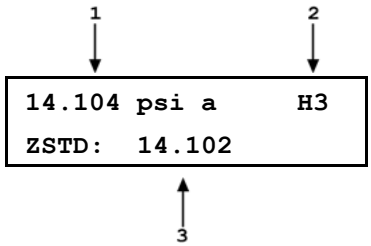
❍ OPERATION

To make custom control parameter settings, press the CUSTOM CONTROL key from the main run screen. The display is:



1. Entry field for setting the desired hold limit. Recalls the default hold limit or the last custom hold limit set for the currently active range.
2. Current control mode (S for static, D for dynamic).
3. Current reference transducer (H for high, L for Lo) and range (1, 2 or 3).

Enter the desired hold limit. The next display is:



1. Entry field for setting the desired stability limit. Recalls the default stability limit or the last custom stability limit for the currently active range.
2. Current control mode (S for static, D for dynamic).
3. Current reference transducer (H for high, L for Lo) and range (1, 2 or 3).

Enter the desired stability limit. The display returns to the main run screen with the custom control parameters active.

Custom control parameters are range and control mode specific. Changes made in one range and control mode are stored for that range and control mode and will be recalled when that range and control mode is returned to. Changes made in one range and control mode do not affect any other range and control mode.

When custom control parameters are active, a C is appended to the control mode indicating character (S for static, D for dynamic) in the middle of the bottom line of the main run screen.

3.2.6.1 TURNING-OFF CUSTOM CONTROL PARAMETERS

To return to default pressure control parameters for the active range and control mode, select the control mode using the CONTROL function (see Section 3.2.3).

3.2.7 HEAD

❍ PURPOSE

To cause a pressure value representing a difference in height to be added to the pressure measured by the PPC2 AF reference pressure transducer and to specify the applicable height and test gas.

❍ PRINCIPLE

PPC2 AF's reference pressure transducers measure gauge or absolute pressure at the height of the rear panel TEST port. Frequently, when performing a calibration or test, the device or system under test is at a different height than the PPC2 AF's TEST port. This difference in height, frequently called "head", can cause a significant difference between the pressure measured by the PPC2 AF at its TEST port height and the pressure actually applied to the device under test at a different height. In this case, it is useful to make a head correction to

the pressure measured by the PPC2 AF reference transducer in order to accurately predict the pressure actually applied at a different height.

PPC2 AF can accurately calculate the "head" pressure for nitrogen, helium and air as the test gas over its working pressure range. The HEAD function allows the height difference and test gas to be specified and causes the resulting head pressure to be added to the pressure measured at the TEST port.

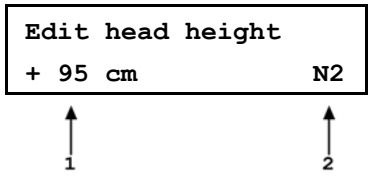
The HEAD function key is used to turn the head correction function on and off and to specify the height difference used to calculate the head pressure between the PPC2 AF TEST port and the device under test. The height units and the test gas are specified under 2Head of the SPECIAL menu (see Section 3.4.2).

Use of the HEAD function to assure in tolerance measurements is most important at low absolute pressures. Specifying the head height within ± 5 in. (12.5 cm) is adequate to assure that, even in the worst case, the uncertainty on the head correction will be insignificant relative to the tolerance on the measurement.

❍ OPERATION

To access the HEAD function, press the HEAD function key. The display is:

1. Entry field for head height.
2. Test gas currently specified for the head correction.



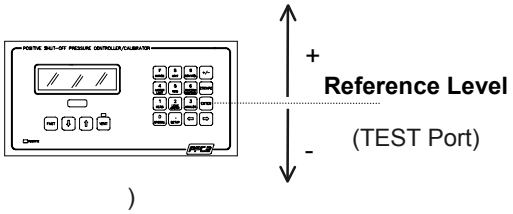
Entering a value of zero turns the HEAD function off. Entering a value other than zero turns the HEAD function on using the height entered. Pressing ESCAPE returns to the main run screen with no change to the current setting.

When the HEAD function is "on", it is indicated by "H" in the top line of the main run screen (see Section 3.1.1).

The HEAD function is not range specific. The HEAD "on" or "off" status remains the same as ranges are changed and edits made to the head specifications are independent of range.

To change units of height between inches and centimeters and to change the test gas species, use 2Head under the SPECIAL menu (see Section 3.4.2).

The reference height of the PPC2 AF reference pressure transducer is the middle of the PPC2 AF TEST port. The head height should be entered as a positive value if the device or system under test is higher than the PPC2 AF and negative if it is lower.



)

3.2.8 LEAK CHECK/PURGE

PURPOSE

The LEAK CHECK function key accesses two functions:

1. The LEAK CHECK function to check the pressurized connections and device or system under test for leaks (see Section 3.2.8.1).
2. The PURGE function to use the optional Self Purging Liquid Trap (SPLT) to collect and exhaust liquid contaminants from the device or systems under test before they reach the PPC2 AF.

PRINCIPLE

Leaks in the test system can have a detrimental effect on measurement accuracy and, when large enough, can cause the PPC2 AF to be unable to set and control pressures reliably. The LEAK CHECK function is provided as a means of checking and quantifying the leaks that may be present in the system.

PPC2 AF is designed to precisely set, control and measure gas pressures. Liquid contamination of the PPC2 AF internal pneumatic control module and reference pressure transducers can cause poor pressure control and interfere with accurate pressure measurement. Liquid contaminants that may be present in test devices or systems that are connected to the PPC2 AF are likely to make their way back to PPC2 AF's internal pneumatic system as the test device or system is pressurized and depressurized. To every extent possible, only clean hoses and connections should be used in connecting PPC2 AF to test devices or system and those devices and systems should be free of liquid contaminants. However, it is likely that PPC2 AF will need to be used to test some devices or systems that contain liquid contaminants. For this case, a Self Purging Liquid Trap (SPLT) accessory supported by a PURGE function is available.

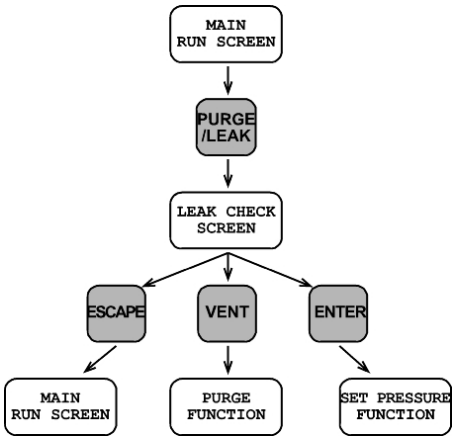
As the LEAK CHECK and PURGE functions are generally performed together at the beginning of a test and there are commonalities to the procedures, PPC2 AF's LEAK and PURGE functions are designed to operate together under a single LEAK CHECK function key.

OPERATION

To access the LEAK CHECK/PURGE function, from the main run screen press the LEAK CHECK function key. The function can be accessed directly at any pressure in any range. The first screen is the leak check screen (see Section 3.2.8.2).

3.2.8.1 LEAK CHECK/PURGE MENU AND FUNCTIONS FLOW CHART

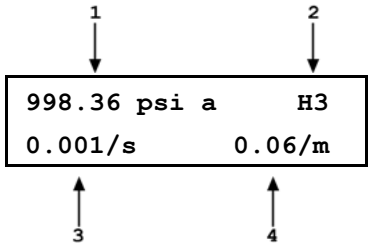
The flow chart of the LEAK CHECK/PURGE menu and functions is:



3.2.8.2 LEAK CHECK SCREEN FUNCTION

The leak check screen appears when the PURGE/LEAK CHECK function key has been pressed from the main run screen.

1. Current measured pressure and pressure units.
2. Active reference pressure transducer and range.
3. Current rate of change of pressure (leak rate) in current pressure units/second.
4. Current rate of change of pressure (leak rate) in current pressure units/minute (updated every 10 seconds).



This screen is for observing the current leak rate. Pressing ESCAPE returns to the main run screen.

Pressing VENT when in the leak check screen causes the PURGE function to execute (see Section 3.2.8.3).

Pressing ENTER when in the leak check screen goes to the set pressure screen (see Sections 3.2.3.1 and 3.2.8.4).

In general, the maximum acceptable leak rate for optimal PPC2 AF automated pressure control operation and to assure in tolerance measurements is ± 0.02 psi (140 Pa)/second or 1.2 psi (8.3 kPa/minute) when using range 1, 2 or 3 of the Hi reference pressure transducer and 0.001 psi (7 Pa)/second or 0.06 psi (420 Pa)/minute when using range 1, 2 or 3 of the Lo reference pressure transducer.

Changing the pressure in the test system causes adiabatic temperature changes in the gas that need to have dissipated before a valid leak measurement can be made. In general, a 0.5 to 1 minute wait, depending on the magnitude of the pressure change and the size of the total pressurized volume, is adequate to allow the adiabatic temperature change to dissipate and valid leak measurements to be made.

3.2.8.3 PURGE FUNCTION

For the purge function to operate, the Self Purging Liquid Trap (SPLT) must be correctly installed in the line connecting the PPC2 AF TEST port to the device or system under test. For information on SPLT installation see Section 2.3.5.1.

Pressing the VENT direct pressure control key (see Section 3.1.2.2) from the LEAK CHECK screen will cause the PURGE function to execute.

Execution of the PURGE function is automated and proceeds as follows:

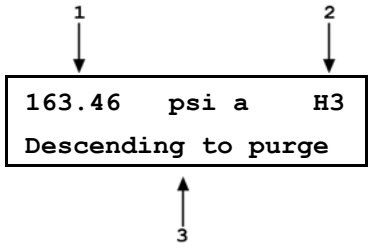
1. If current pressure is greater than 100 psi (700 kPa) gauge, pressure is controlled down to less than 100 psi (700 kPa) gauge.

Ideal pressure from which to execute PURGE function is 150psi (1MPa). Avoid executing PURGE function from pressures above 150psi (1MPa).

2. Pressure control stops and a 5 second wait occurs.
3. SPLT exhaust valve is opened.
4. Waits until pressure is less than 3 psi (20 kPa) gauge or 16 psi (110 kPa) absolute.
5. Vent valve is opened with SPLT exhaust valve left open.

When the PURGE function is initiated, if the current pressure is over 100 psi (700 kPa) gauge, the display is:

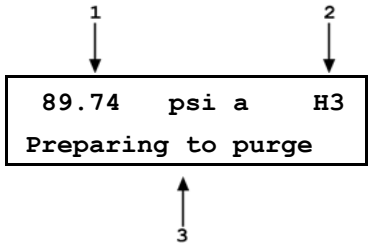
1. Current measured pressure and pressure units.
2. Current reference pressure transducer and range.
3. Indication that PPC2 AF is reducing pressure to the purge pressure of less than 100 psi (700 kPa) gauge.



Pressing ESCAPE at any time during purge routine execution causes the purge function to abort and returns to the leak check screen (see Leak Check Screen above).

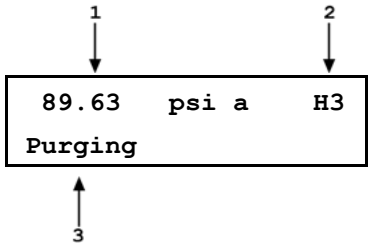
Once the current pressure is, or if the purge function was initiated, under 100 psi (700 kPa) gauge the display is:

1. Current measured pressure and pressure units.
2. Current reference pressure transducer and range.
3. Indication that PPC2 AF is preparing to open the SPLT exhaust valve.



After a five (5) second wait the display is :

1. Current measured pressure and pressure units.
2. Current reference pressure transducer and range.
3. Indication that PPC2 AF has opened the SPLT exhaust valve and is waiting for pressure to go to zero gauge. This indication flashes.



Once the pressure reaches less than 3 psi (20 kPa) gauge or 16 psi (110 kPa) absolute, PPC2 AF opens its internal vent valve and returns to the main run screen in its normal vented condition.

When the SPLT exhaust valve opens at pressure during the purge routine, any liquid contaminant collected will be released through the SPLT exhaust tube. If measurable amounts of liquid contamination are exhausted from the SPLT exhaust valve, it is recommended that the purge function be repeated until no noticeable amount of liquid contamination is observed exhausting from the SPLT exhaust valve.

The internal volume of the SPLT is about 20 cc. The SPLT will not operate effectively if the volume of liquid contaminants connected is greater than about 10 cc. Even if an SPLT is being used, precautions should be taken to reduce potential liquid contamination from the device or system under test as much as possible *before* making the test connection.

Do not plug the SPLT exhaust valve. The purge routine can not be completed with the SPLT exhaust valve plugged and the SPLT's protective function will not be effective.

If the SPLT is electrically connected to the PPC2 AF, its exhaust valve will always be open when the PPC2 AF vent valve is open. It may be closed manually using the DRIVER function (see Section 3.3.4.)

3.2.8.4 SETTING PRESSURES FOR LEAK CHECK/PURGE FUNCTION

The direct pressure control keys are active when in the LEAK CHECK screen and can be used to adjust pressure as desired (see Section 3.1.2.2) keeping in mind that the VENT key will cause the PURGE function to execute.

Pressing the ENTER key from the leak check screen will cause the regular set pressure screen for automated pressure control to appear (see Section 3.2.3.1). An automated pressure control command can then be executed. Press the LEAK CHECK function key when desired to resume LEAK CHECK/PURGE function.

3.2.8.5 TYPICAL USE OF THE LEAK CHECK/PURGE FUNCTION

The most common use of the LEAK CHECK/PURGE function is at the beginning of a test just after the device or system under test has been connected to the PPC2 AF TEST port. Generally, the purge process should be completed before leak checking is performed. This may not be the case when the PPC2 AF will be used to apply only ascending pressures.

To purge:

❶ Press the LEAK CHECK function key.

❷ Use the direct manual pressure control keys to set the desired leak check/purge pressure (generally full scale of the device or system under test).

❸ Wait for pressure to stabilize.

❹ Press the VENT key to cause the purge function to execute. Wait for purge function to execute completely. Observe whether any liquid contaminants exhaust from the SPLT exhaust valve.

❺ Repeat from ❶ until no noticeable amount of liquid contamination is observed in ❹.

To leak check:

❶ Press the LEAK CHECK function key.

❷ Use the direct manual pressure control keys to set the desired leak check pressure (generally full scale of the device or system under test).

❸ Wait for pressure to stabilize.

❹ Observe the leak rates displayed in the leak check screen to determine if the leak rate is within acceptable limits. If leak rate is not acceptable, identify source of leak, vent system and correct source of leak.

❺ Repeat from ❶ until leak rate observed in ❹ is acceptable.

The leak check function can also be used at any time during operation to check current leak rate and/or cause the purge routine to execute.

There is very little risk of contamination of PPC2 AF if it will be used to apply ascending pressures only to the device or system under test since flowing gas back to the PPC2 AF can be avoided. In this case, particularly if working with a significantly contaminated device or system under test, it may be preferable to not use the PURGE function until the end of the test after the last ascending pressure increment has been set. Also, be sure not to execute the PURGE function at pressure above 150 psi (1 MPa).

3.2.9 ANALOG

Function not implemented on PPC2 AF.

3.3 SETUP MENU KEY

❍ PURPOSE

The SETUP menu key accesses a menu of functions and features commonly used in setting up PPC2 AF for use.

❍ OPERATION

Press the SETUP key from the main run screen to access the SETUP menu. The display is:

```
1ControlRef  2Resltn
3Sequence    4Drivers
```

3.3.1 CONTROLREF

❍ PURPOSE

To specify whether a vacuum source or atmospheric pressure is connected to the PPC2 AF EXHAUST port.

❍ PRINCIPLE

The PPC2 AF exhaust (down) control valves and the output of the exhaust pressure regulator are connected to the PPC2 AF EXHAUST port (see Section 1.2.7).

In order for PPC2 AF to set pressures under atmospheric pressure, the EXHAUST port must be connected to vacuum. In addition, the pneumatic module pressure regulators assure a constant differential across the control valves of 3 psi (25 kPa) assuring predictable operation of the control valves. For the regulators to operate properly, there must be a minimum difference of 3 psi (25 kPa) between the pressure in the controlled volume and the supply pressure (in the case of the inlet regulator) or the exhaust pressure (in the case of the exhaust regulator). Applying a vacuum to the exhaust port lowers the pressure on the down side of the regulator to achieve the desired differential pressure.

Connecting a vacuum pump to the PPC2 AF EXHAUST port lowers the pressure on the down side of the exhaust pressure regulator. The ControlRef function is used to inform the PPC2 AF that a vacuum has been applied to the EXHAUST port so it can take this into consideration in its control routines.

❍ OPERATION

To access the ControlRef function, press the SETUP menu key and then 1ControlRef. The display is:

```
Control reference:
1Vacuum  2Atm
```

Make the appropriate selection, 1Vacuum if a vacuum supply is connected to the EXHAUST port and 2ATM if it is open to atmospheric pressure. The selection will be maintained until it is changed.

Pressure control near and under atmospheric pressure will not operate properly if ControlRef is not set correctly.

The ControlRef function setting is not range or control mode specific. The setting made in ControlRef setting will remain the same and apply across transducers and ranges as they are changed.

See Section 2.3.4 for information on vacuum pump requirements and connection.

3.3.2 RESLTN

❍ PURPOSE

To set the resolution with which the measured pressure is displayed on the main run screen.

❍ OPERATION

To access the Resltn function, press the SETUP menu key and then 2Resltn. The display is:

```
Pressure resolution:
     0.0010% FS
```

Enter the desired pressure display resolution in % FS of the currently active range. The display returns to the main run screen with the entered resolution setting active.

The system default pressure display resolution is 0.0010% FS.

The resolution setting is range specific. A resolution setting made in one range does not affect other ranges.

3.3.3 SEQUENCE

❍ PURPOSE

To create, store and edit the sequence files used by the SEQ function (see Sections 3.2.5 and 3.2.5.3).

❍ PRINCIPLE

The PPC2 AF FILE SEQUENCE function allows a sequence of automated pressure control targets in a specific range with predetermined control and operating parameters to be executed by recalling and running a sequence file. The files containing the information necessary to run a file sequence are created, stored and edited in 3Sequence of the SETUP menu.

Setting up a sequence file requires specifying:

- The reference transducer to be used (Hi, Lo).
- The range on the reference transducer (1, 2 or 3).
- The number of pressure targets in the sequence.
- The numerical value of each target pressure.
- The pressure units of measure and measurement mode (gauge or absolute).
- Whether a VENT function should be included at the end of the sequence.
- Whether sequence execution should continue from one pressure target to the next on operator pressing ENTER or automatically on a timer and, if on a timer, the timer duration.
- Pressure control mode to be used (static or dynamic).
- Whether to use custom control parameter settings and the value of those settings if custom control is selected.
- The file number under which the sequence definition should be stored.

OPERATION

Sequence file setup requires the user to specify a large number of parameters in a series of data entry screens described below. For a summary of the sequence definition requirements in the order they are edited, see PRINCIPLE above.

To access the Sequence file building function, press the SETUP menu key and then 3Sequence. The display is:

```
File sequence:
1Edit  2View
```

1Edit allows a sequence file to be edited.

2View allows a sequence file to be viewed only. If 2View is selected, the values shown in the following screens cannot be edited. The instructions below assume that 1Edit is selected.

When defining a sequence, the ESCAPE key can be used to back through the definition and reenter information until the numerical value of the pressure points is being defined. Then ESCAPE will go to a "Save As" screen in which the sequence as edited so far can be saved to a sequence file number. This allows information in the beginning of a sequence file to be edited without having to go through the entire sequence definition.

The next display is:

1. Entry field for the file number of the sequence to be edited.

```
Edit sequence:
        nn
```

1

Enter the desired sequence file number.

Up to 20 sequence files can be setup (address numbers 01 through 20).

The next selection determines the **reference transducer** that will be used:

1. Indication of the sequence file number that is currently being edited.

```
Use ref sensors
1Hi 2Lo Seq01
```

1

Select the reference transducer that is to be used when running this sequence.

The next selection specifies the **range** of the selected reference transducer that is to be used for this sequence:

```
Use rnge 1Rng1 2Rng2
3Rng3
```

Select the range (see Section 3.1.2.5) that is to be used when running this sequence.

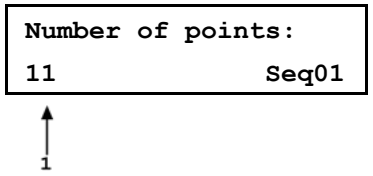
The next selections specify the **pressure unit and measurement mode** in which the sequence pressure points will be defined:

```
Select pressure unit
<Next Screen>  Seq01
```

Press ENTER to proceed to the pressure unit and measurement mode selection. These will operate in the same manner as when the UNIT function is used (see Section 3.2.2). To change the pressure units available, use PresU under the SPECIAL menu (see Section 3.4.1).

The next selection specifies the **number of pressure points** in the sequence, including zeros:

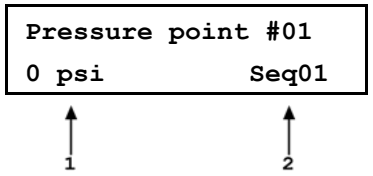
1. Entry field to edit the total number of points in the sequence including zero.



Enter the total number of points in the sequence.

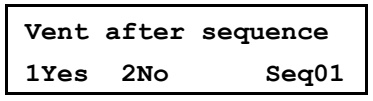
Next, the **numerical values of the pressure points** in the sequence are specified:

1. Number of the point in the sequence whose value is currently being edited.
2. Entry field for the numerical value of the target pressure of this pressure point (pressure unit and measure mode are set below).



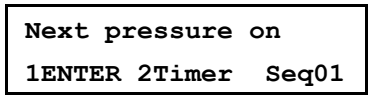
Enter the numerical value of the target pressure for that point. The display repeats until the total number of points specified above has been defined.

The next selection defines **how the test will end**, at the last target value or vented:



Selecting 1Yes will cause a VENT command to execute after the last point of the sequence has been completed. Selecting 2No will cause the sequence to end at the last point.

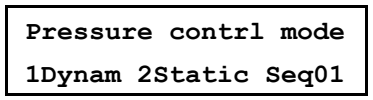
The next selection defines **how the sequence will proceed from one pressure point to the next**:



If 1ENTER is selected, when the sequence is executed, PPC2 AF will wait at each pressure point until ENTER is pressed before proceeding to the next point.

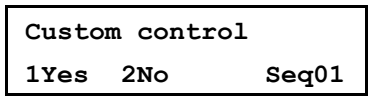
If 2Timer is selected, when the sequence is executed, PPC2 AF will start a timer when a "ready" condition is reached at a pressure point. When the time expires, the sequence will proceed automatically to the next pressure point. If dwell is selected, the dwell time in seconds, minimum 1 and maximum 99, is entered in the next screen.

After defining how the sequence will proceed from one pressure point to the next, the **control mode** is specified:



Enter the desired pressure control mode for the sequence (see Section 3.1.2.3 for a description of the control modes).

The option of **customizing the control mode parameters** for the control mode selected is then offered:

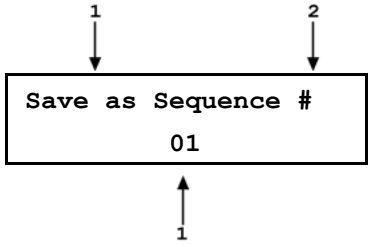


If 1Yes is selected, screens will be presented allowing the control hold limit and stability limit to be adjusted (see Sections 3.2.3 and 3.2.6).

If 2No is selected, the control parameters will be the default control parameters for the range and control mode specified for this sequence (see Sections 3.2.3 and 3.2.6).

Definition of the file sequence is now complete and the **"save as"** choice is offered:

1. Enter the desired sequence number or press ENTER if the desired number is already displayed.



Pressing ESCAPE, at “save as”, allows all changes to be abandoned.

3.3.4 DRIVERS

- **PURPOSE**

To control the output signals of PPC2 AF's 8 channel, 12 V external drivers.

- **PRINCIPLE**

PPC2 AF external drivers are available to drive peripheral equipment in a PPC2 AF system, for example, solenoid valves. The driver electrical connections are available from a rear panel connector

See Section 9.1 for driver specifications and pin-outs.

- **OPERATION**

To access the driver control function press 3drivers under the SETUP menu.

The display is:

```
Extern Drivers:   1
2  3  4  5  6  7  8
```

Pressing the keypad numerical key driver number turns that driver on and off with either a momentary or a toggled response (see immediately below). An active driver is indicated by * immediately following the driver number.

Pressing ENTER while in the Extern Drivers menu causes a menu to appear that allows selection of whether the driver actuation by pressing the driver number will be 1momentary or 2toggle.

The PPC2 AF PURGE function uses external driver #8 (see Sections 3.2.8, 9.1, 9.2).

3.4 SPECIAL MENU KEY

The SPECIAL menu key accesses a menu of functions that are less commonly used or not normally used in regular operation.

Press the SPECIAL menu key to access the SPECIAL menu.

The display is:

```
1PresU  2Head   3Cfg
4Internal      5Diag
```

3.4.1 PRESU

❍ PURPOSE

To select the pressure units that will be available for selection from the UNIT function key.

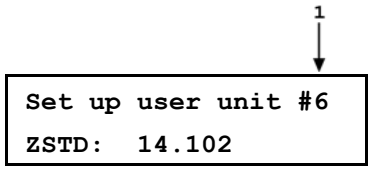
❍ PRINCIPLE

The UNIT function key (see Section 3.2.2) makes available a choice of six default pressure units. However, PPC2 AF supports many additional commonly used units. These units can be made available for active selection by customizing the unit function using 1PresU under the SPECIAL menu key. This allows PPC2 AF to offer a very wide selection of units while simplifying day to day operation. The typical user will customize the UNIT function key to support his/her six most commonly used units.

❍ OPERATION

To customize the UNIT function key, from the main run screen press the SPECIAL menu key and then select 1PresU. The display is:

1. Entry field to select which unit position (1 - 6) of the UNIT function key menu is to be changed.



Enter the number of the unit position that you would like to change. The display becomes:

Select the category of the pressure unit that you would like to select (SI units include all units based on SI such as mmHg), then select the desired unit from the unit menu.

The units available are:

1SI	2OTHER	3ALTITUDE
1Pa	1psi	1feet
2kPa	2psf	2meters
3MPa	3inHg	
4mbar	4inWa	
5bar	5kcm2	
6mmHg		
7mmWa		

See Section 9.3 for the pressure unit conversion factors used by PPC2 AF.

3.4.2 HEAD

PURPOSE

To specify the length unit of measure for head height entry in the HEAD function and the test gas type used for head pressure calculations (see Section 3.2.7).

OPERATION

From the main run screen, press the SPECIAL menu key and the select 2Head. The display is:

```
Head height unit
1in      2cm
```

Select the desired head height unit. The next display is:

```
1N2     2He     3Air
```

Select the type of gas that is being supplied to PPC2 AF. The characteristics of the gas selected will be used by PPC2 AF in calculating head pressures.

3.4.3 CONFIG

PURPOSE

To run an automated routine that readjusts internal pressure control characteristics.

OPERATION

See Section 5.1.1.

3.4.4 INTERNAL

PURPOSE

To set, adjust, maintain and diagnose various aspects of PPC2 AF's internal operation.

OPERATION

To access the internal selections press 4Internal under the SPECIAL menu. The display is:

```
1AutoZ 2Cal  3Remote
4Date  5Reset 6Level
7Atm   8Maint
```

Select the internal function desired. For a detailed description of each internal function see Sections 3.4.4.1 to 3.4.4.8.

Some screens go beyond the two lines provided by the display. This is indicated by a flashing arrow in the second line of the display. Use the ⇦ and ⇨ arrow keys to move the cursor to access the lines that are not visible or directly enter the number of the desired menu choice if you know it.

3.4.4.1 AUTOZ

PURPOSE

To change the offset (zero) of the Lo and Hi reference pressure transducers relative to a reference value.

OPERATION

See Section 5.2.

3.4.4.2 CAL

To calibrate the PPC2 AF Hi and Lo reference pressure transducers and barometer.

- **PRINCIPLE**

See Sections 5.3 and 5.4.

- **OPERATION**

See Sections 5.3 and 5.4.

3.4.4.3 REMOTE

- **PURPOSE**

To configure the PPC2 AF communication ports including COM1 and COM2.

- **PRINCIPLE**

The PPC2 AF has two RS-232 communications ports referred to as COM1 and COM2. COM1 is for communicating with a host computer (refer to Section 4), and COM2 is reserved for connecting an external device, e.g. a multimeter, RPM, etc.. These ports can be set up through the PPC2 AF front panel.

- **OPERATION**

To access the port configurations press 3Remote under 4Internal of the SPECIAL menu. Select COM1 or COM2 to view and edit that port's settings.

- **COM1 AND COM2**

The COMx ports can be set for the specific settings required by the user. These settings are baud, parity, length and stop bit. The available options are:

Baud: 300, 600, 1200, 2400, 4800, 9600

Parity: NONE, ODD or EVEN

Length: 7 or 8

Stop Bit: 1 or 2

The default is "2400, E, 7,1" for COM1 and COM2.

The user can also specify one or two termination characters as well as define these characters. These are referred to as "Term1" and "Term2". These define the characters that mark the end of commands that are sent to the PPC2 AF as well as mark the end of replies sent back to the host computer. The PPC2 AF typically will use the "Term1" character to mark the end, and will ignore the "Term2" character. These characters can be any decimal number from 1 to 255. The default for these are "13" (carriage return) and "10" (line feed) and usually should not be changed.

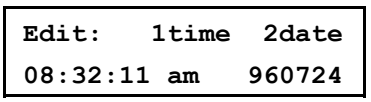
3.4.4.4 DATE

- **PURPOSE**

To view and edit the PPC2 AF time and date.

- **OPERATION**

To access the date function press 4Date under 4Internal of the SPECIAL menu. The display is:



The time runs.

Select 1time to edit the time. Editing is by hours, then minutes, by pressing ENTER at each entry. Seconds go to zero when minutes are entered.

Select 2date to edit the date. The date must be specified in YYMMDD format.

The PPC2 AF date and time are set to United States Mountain Standard Time in the final test and inspection process at the factory. If desired, used the date function to set your local time and date.

3.4.4.5 RESET

❍ **PURPOSE**

To reset various PPC2 AF settings to default or factory values.

PPC2 AF stores its user definable settings in non-volatile memory. The reset menu allows the user to selectively or completely reset these settings to factory defaults. This clears out any settings that the user has set up, and should be done only to restore the PPC2 AF to a known state. PPC2 AF will restart after any type of reset is selected.

❍ **OPERATION**

To access the reset choices press 5Reset under 4Internal of the SPECIAL menu. The display is:

```
1units  2all  3com
4seq     5cal
```

3.4.4.5.1 Reset – units

❍ **PURPOSE**

Sets the six pressure units selectable from the UNIT function to (1psi is selected as the active unit):

```
1psi    2kPa    3inHg
4inWa   5mmWa   6ft
```

See Sections 3.2.2 and 3.4.1.

3.4.4.5.2 Reset – all

❍ **PURPOSE**

Performs the functions of the Units and System resets, as well as:

- Dynamic generation hold reset to default values.
- Dynamic generation stability reset to default values.
- Static generation hold reset to default values.
- Static generation stability reset to default values.
- Display resolution reset to 0.001 %FS.
- Upper limits set to default values.
- Generation mode set to dynamic.
- Range 3 of the high pressure transducer (H,3) selected as the range.
- Clear out the user generation config and use the factory set config.
- The head correction is disabled, the units are set to meters, and the gas is set to N_2.
- The gauge mode tare value is reset to zero.

3.4.4.5.3 Reset - com

Resets communications port settings: COM1 and COM2 set to 2400,E,7,1 using **<CR>** and **<LF>** as the terminating characters.

3.4.4.5.4 Reset – seq

❍ **PURPOSE**

Clears all of the user defined file and quick sequences.

See Sections 3.2.5 and 3.3.3.

3.4.4.5.5 Reset – cal

❍ **PURPOSE**

Use caution with this reset as critical calibration data may be deleted.

This will clear the user calibrations information, which will affect the calibration of the unit.

Clears the user defined reference pressure calibrations. Sets PA/PM to 0 and 1.

Clears the user defined barometer calibration. Sets PA/PM to 0 and 1.

Clears the PA(z)net and PA(z)tare values.

Reset the as received and as left user calibration values.

3.4.4.6 LEVEL

❍ **PURPOSE**

To set user protection levels to deny access to certain functions and to edit the password required for changing user levels.

❍ **PRINCIPLE**

PPC2 AF's front panel user interface provides the means to access all PPC2 AF data and functions including internal calibration data, special diagnostic functions and privileged factory functions. Certain PPC2 AF functions, if used inadvertently or by an unqualified operator may cause erroneous readings and behavior. For these reasons, depending upon the application in which PPC2 AF is being used, it may be desirable to restrict access to certain functions for certain users. The user level function provides a means of restricting access to certain functions. Three different levels of security are available. Once set up, changing the security level requires password entry.

❍ **SECURITY LEVELS**

The security levels are structured to support typical levels of operation as follows:

None This level is intended for use only by the system manager and/or calibration facility. It allows access and editing in all areas including critical metrological information and system diagnostic and maintenance functions.

Low This level of security is designed to protect the specific metrological information and system diagnostic and maintenance functions of the system. It is intended for an advanced operator performing many different tasks.

Medium This level of security is designed to protect specific metrological information in the system and to assure that, from a metrological standpoint, calibrations are all performed under the same conditions.

High This level of security is designed to protect all operating parameters. It is intended to minimize operator choices, for example to perform repeated identical calibrations under consistent conditions.

It is recommended that all users set at least the low user level to avoid accidental changes to reference pressure transducer calibration data (see Section 2.4.2).

Specifically, the security levels prevent execution of the following functions:

FUNCTION	LOW	MEDIUM	HIGH
RANGE key			X
UPPER LIMIT key			X
SEQ key, Run current sequence, 2No			X
CUSTOM CONTROL key			X
HEAD key			X
SETUP menu, 1ControlRef			X
SETUP menu, 2Resltn			X
SETUP menu, 3Sequence, 2Edit			X
SETUP menu, 4Drivers			X
SPECIAL menu, 1PresU			X
SPECIAL menu, 2Head		X	X
SPECIAL menu, 3Config			X
SPECIAL menu, 4Internal, 1AutoZ, 2 Edit	X	X	X
SPECIAL menu, 4Internal, 1AutoZ, 3 Run			X
SPECIAL menu, 4Internal, 2Cal, 2Edit	X	X	X
SPECIAL menu, 4Internal, 2Cal, 3Run		X	X
SPECIAL menu, 4Internal, 3Remote			X
SPECIAL menu, 4Internal, 4Date, 1Time	X	X	X
SPECIAL menu, 4Internal, 4Date, 2Date	X	X	X
SPECIAL menu, 4Internal, 5Reset, 1units		X	X
SPECIAL menu, 4Internal, 5Reset, 2all	X	X	X
SPECIAL menu, 4Internal, 5Reset, 3Com		X	X
SPECIAL menu, 4Internal, 5Reset, 4seq		X	X
SPECIAL menu, 4Internal, 5Reset, 5cal	X	X	X
SPECIAL menu, 5Diag	X	X	X

OPERATION

PPC2 AF is delivered with no active password and access to the User Level menu is open. User levels cannot be changed until a password is created and, once a password is created, entry of the password is required to access the User Level menu.

To access the User Level function, press 6level, under 4internal of the SPECIAL menu. If no password yet exists or if the correct password has been entered. The display is:

```
1change user level
2edit password
```

The first selection "change user level" will bring up the "restriction" menu:

```
Restriction: 1none
2low 3medium 4high
```

You can then select the current restriction level, or ESC back to the RUN screen.

The second selection "edit password" displays the user password and allows it to be edited.

```
Password:  pppppp
0 disables password
```

Passwords can be up to six numbers in length and cannot start with a zero.

If '0' is entered, then the password is made inactive and the user will not be required to enter a password to get into the user level menu. This is the factory default with a security level of 1none.

If there is an active password, the PPC2 AF password entry screen will appear. The user must enter the user defined password or the factory **secondary** password before proceeding any further:

```
PPC2 AF SN#nnnn-xx
Password:  pppppp
```

The first field "*nnnn*" is the serial number of the PPC2 AF, followed by a second field "*xx*" that represents the number of times that a **secondary** password has been used. This second field increments each time a **secondary** password is used. The third field is where the user enters the password.

The factory secondary password is available in case the user's password has been misplaced. It can be obtained by contacting Customer Service. The factory secondary password is different for all PPC2 AF's and changes each time it is used.

Once the correct user or **secondary** password is entered, the User Level menu will appear:

```
1change user level
2edit password
```

The first selection "change user level" will bring up the "restriction" menu:

```
Restriction: 1none
2low 3medium 4high
```

You can then select the current restriction level, or ESC back to the RUN screen.

```
Password:  pppppp
0 disables password
```

The second selection "edit password" displays the user password and allows it to be edited.

If '0' is entered, then the password is made inactive and the user will not be required to enter a password to get into the user level menu. This is the factory default with a security level of 1none.

3.4.4.7 ATM

- **PURPOSE**

To view the current atmospheric pressure measurement made by the barometer board atmospheric sensor.

- **PRINCIPLE**

PPC2 AF has an independent barometric sensing board. The atmospheric pressure measurements made by the barometer board are used only for dynamic compensation of atmospheric pressure when using an absolute reference pressure transducer to make gauge pressure measurements. Thus, the barometer board is used only to measure changes in atmospheric pressure between opportunities to measure atmospheric pressure directly with the reference pressure transducers.

See Section 1.2.6.

- **OPERATION**

To view the current reading of the barometer board press 7Atm under 4Internal of the SPECIAL menu. The display is in the current pressure units in absolute measure mode.

3.4.4.8 MAINT

❍ **PURPOSE**

To view the PPC2 AF log of recorded errors.

❍ **OPERATION**

To view the log of recorded errors press 8Maint under 4Internal of the SPECIAL menu.

PPC2 AF recorded operating errors can be viewed by pressing ENTER to step through them.

3.4.5 DIAG

❍ **PURPOSE**

Allows access to advanced functions that view low level PPC2 AF data and allows editing of manufacturer calibration and operational settings that affect PPC2 AF operation.

Users should not access this function without special instructions. Access to these functions is tracked by PPC2 AF to deter undesired use.

❍ **OPERATION**

See Section 5.5.

NOTES

4. REMOTE OPERATION

4.1 OVERVIEW

Most of the PPC2 AF front panel functions can also be executed by commands from a remote computer. The host computer can communicate to the PPC2 AF using the PPC2 AF COM1 RS232 port.

4.2 INTERFACING

Sending a command to the PPC2 AF will place it into remote mode. The remote indicator in the lower left hand corner of the PPC2 AF front panel will light when the PPC2 AF is in remote mode. It will also flicker when a command is received. The menus usually accessed from the front panel will become locked out while in remote. The 'ESCAPE" key will return the PPC2 AF to local operation unless the "REMOTE" command was sent to the unit, which locks out keypad operation.

Most remote commands will return a reply within 500 ms. You **must** wait for this reply before issuing another command to the PPC2 AF. This insures that the PPC2 AF has completed the command. The following commands take more than 500 ms to reply:

PR, PRR, SR, ATM, RATE Up to 2.0 seconds to allow a new measurement.

RESET Up to 12 seconds to reset the data and restart the PPC2 AF.

4.2.1 RS232 INTERFACE

The PPC2 AF COM1 RS232 interface is located on the back of the unit. It is a 9 pin male DB-9F connector configured as a DCE device. Data is transmitted out of the unit using pin 2, and is received on pin 3. This allows a normal "pin to pin" DB-9M to DB-9F RS232 cable to be used to connect to a DTE host. Handshaking is not required or supported.

4.2.1.1 COM1

PPC2 AF COM1 DB-9F PIN DESIGNATIONS		
PIN #	**FUNCTION**	**DESCRIPTION**
2	TxD	This pin transmits serial data from the PPC2 AF to the host.
3	RxD	This pin accepts serial data from the host computer.
5	Grn	This pin is the common return for the TxD and RxD signals.

IBM PC/XT DB-9F CONNECTIONS		IBM PC/XT DB-9M TO PPC2 AF DB9F CONNECTION	
DB-25M	**DB-9F**	**DB-9M**	**DB-9F**
2	3	3	3
3	2	2	2
7	5	5	5

4.2.1.2 COM2

The PPC2 AF COM2 RS232 interface is located on the back of the unit. It can be used to allow the Host computer to communicate with another device through the PPC2 AF. This allows the user to use one Host COM port to communicate with the PPC2 AF and an additional RS-232 device. Refer to the "#" remote command for details.

It is a 9 pin female DB-9F connector configured as a DTE device. Data is transmitted out of the unit using pin 3, and is received on pin 2. This allows a normal "pin to pin" DB-9M to DB-9F RS232 cable to be used to connect to a DCE device. Handshaking is not required or supported.

List of PPC2 AF COM2 DB-9F pin designations:

PPC2 AF COM2 DB-9F PIN DESIGNATIONS		
PIN #	**FUNCTION**	**DESCRIPTION**
2	TxD	This pin transmits serial data from the PPC2 AF to a device.
3	RxD	This pin accepts serial data from the external device.
5	Grn	This pin is the common return for the TxD and RxD signals.

4.3 COMMANDS

All PPC2 AF commands are ASCII strings. All commands must be terminated with the correct terminating characters (see Section 3.4.4.3). The default terminating characters are **<CR><LF>**. The user **must** wait for the PPC2 AF to reply before sending another command. All replies from the PPC2 AF are ASCII and are terminated with the designated terminating characters.

4.3.1 COMMAND LIST

#	Send a command string out of the PPC2 AF COM2 port.
ABORT	Stop pressure generation.
ATM	Read the current atmospheric pressure
COM*n*(=)	Read or set the configuration of the COM1 or COM2 port.
DATE(=)	Read or set the current date.
DF=	Decrease the pressure quickly.
DP=	Decrease the pressure a given amount.
DRV	Read or set the status of an external valve drivers.
DS	Decrease pressure slowly.
ERR	Read the last error message.
HEAD(=)	Read or set the head settings.
HS(%)(=)	Read or set the current control hold limit.
IF=	Increase the pressure quickly.
IP=	Slowly increase the pressure a given amount.
IS=	Increase the pressure slowly.
LOCAL	Returns control to the PPC2 AF front panel.
MEM	Read the power up memory test status.
MODE(=)	Read or set the current pressure control mode.
PCAL*d,r*(=)	Read or set the user reference pressure transducer calibration information.
PR	Read the next PPC2 AF pressure.
PRR	Read the next PPC2 AF pressure and rate.
PS=	Set a new target pressure & start a pressure generation cycle.
PSF=	Set a new target pressure & use only the fast speed to reach the target.
PSS=	Set a new target pressure & use only the slow speed to reach the target.
RANGE	Read or set the active range of the PPC2 AF.
RATE	Read the next available rate of pressure change.
READYCK(=)	Read or set a flag that is cleared by a “Not Ready” condition.
REMOTE	Enable remote local lockout operation.
RES	Read or set the pressure display resolution for the current transducer and range.
RESET	Reset the PPC2 AF to the default pressure control parameters.
RETURN	Start a new generation using the current target.
SAVECAL	Save changes made to the user calibration of the reference pressure transducer.
SN	Read the serial number of the PPC2 AF.
SR	Read the next available pressure ready status.
SS%(=)	Read or set the stability required for a ready condition (% F.S./ s).
STAT	Read the pressure generation status.
TIME(=)	Read or set the current time of day.
TP	Read the current target pressure.
UCOEF(=)	Convert a pressure in Pascal to pressure in the current units.
UL(=)	Read or set the upper limit for the current range.
UNIT(=)	Read or set the pressure unit for the current transducer and range.
VAC(=)	Read or set the exhaust reference status flag.
VENT(=)	Read, execute or abort a vent process.
VER	Read the PPC2 AF software version.

4.3.2 ERROR MESSAGES

The PPC2 AF will always reply to a command. If the command is incorrect or contains invalid data, an error number will be returned in the form “ERR# n” where n is an integer number that represents a specific error. This allows for easy error trapping by the host computer. Here is a list of the possible errors numbers and the error description for each:

REPLY	DESCRIPTION
ERR #0	"OK"
ERR #2	"Text argument is too long"
ERR #3	"User defined coefficient cannot be 0"
ERR #4	"External device not detected"
ERR #5	"External device improperly configured"
ERR #6	"Numeric argument missing or out of range"
ERR #7	"Missing or improper command argument(s)"
ERR #8	"External device timeout error"
ERR #9	"Unknown command"
ERR #11	"Command missing argument"
ERR #12	"System overpressured"
ERR #13	"Text detected in numeric field"
ERR #14	"User unit not defined"
ERR #18	"Command not yet available"
ERR #21	"User device not defined"
ERR #22	"Pressure is not stable"
ERR #23	"Option not available or installed"
ERR #25	"Transducer out of calibration"
ERR #26	"COM port failed to initialize"
ERR #27	"Internal device#1 timeout error"
ERR #28	"Internal device#2 timeout error"

The user may retrieve the error message for a previous command error by using the “ERR” command.

4.3.3 COMMAND SUMMARY

#	
Purpose:	To allow the host PC to communicate with a device connected to the PPC2 AF COM2 port.
Syntax:	"#xx"
Arguments:	xx: The string to send out of the COM2 port. It must be less than 40 characters long.
Remarks:	The PPC2 AF COM2 port can be used to communicate to another RS-232 device (such as another PPC2 AF). This allows the user to use one COM port or IEEE port on the host computer to communicate with the PPC2 AF and another device. A carriage return and a line feed (<CR><LF>) are added to the string. After this command is issued, the PPC2 AF will reply back the first string received by the PPC2 AF COM2 port that is terminated with a carriage return. Line feeds are discarded. This will discontinue when the next command is sent to the PPC2 AF. There is no reply from this command other than this. Prior to using this command, you must ensure that the PPC2 AF COM2 port is correctly set up to communicate with the device. Refer to the "COM2=" command. This assumes that a second PPC2 AF's COM1 port is connected to the PPC2 AF COM2 port. This example gets the version of the second PPC2 AF:
Example:	Command: "#VER" Reply: "DH INSTRUMENTS, INC PPC2 AF VER1.00"
See Also:	None.

ABORT	
Purpose:	Stops an active pressure generation. All control valves are closed. The exhaust and transducer valves are not affected.
Remarks:	This command has no affect if the PPC2 AF is not generating or holding a pressure. Otherwise, it will cancel the current generation or hold cycle.
Example:	Command: "ABORT" Reply: "ABORT"
See Also:	None.

ATM	
Purpose:	Reads the current internal ambient pressure.
Syntax:	"ATM"
Arguments:	
Remarks:	The atmospheric pressure will be returned in the current pressure units (always absolute). This measurement is followed by the units.
Example:	Command: "ATM"
See Also:	3.4.4.7

COM*N*(=)	
Purpose:	Read or set the configuration of the COM1 or COM2 port.
Syntax:	"COMn=baud,parity,data,stop" "COMn"
Arguments:	n: The COM port '1' or '2' baud: The baud rate. This may be '300', '600','1200','2400','4800', '9600' or '19200' parity: The data parity. This may be 'O' for odd, 'E' for even, or 'N' for none. stop: The number of stop bits. This may be '1' or '0'
Defaults:	"COM1=2400,E,7,1" "COM2=2400,E,7,1"
Remarks:	The COM1 port is used to communicate to the PPC2 AF. When the COM1 port configuration of the PPC2 is changed, the command reply will be sent at the old COM1 settings, but all subsequent communications will be accomplished at the new COM1 settings. The COM2 port can be used to communicate with additional devices.
Example:	Command: "COM1=9600,N,8,1" Reply: "9600,N,8,1"
Errors:	ERR# 7: Missing or improper command argument(s)
See Also:	3.4.4.3

DATE(=)	
Purpose:	Read or set the PPC2 AF date.
Syntax:	"DATE=yymmdd "DATE"
Arguments:	yymmdd: The date in the numerical only format year-month-day with no spaces.
Remarks:	The PPC2 AF has an internal real time calendar clock. It is used for date stamping calibrations.
Example:	Command: "DATE=960221" Reply: "960221"
Errors:	ERR# 7: Missing or improper command argument(s)
See Also:	3.4.4.4

DF=	
Purpose:	Decrease the pressure quickly.
Syntax:	"DF=*n*"
Arguments:	'0' Closes the fast down valves. '1' Opens the fast down valves.
Remarks:	Opening the fast down valves will cause the pressure to decrease quickly.
Example:	Command: "DF=1" Reply: "DF=1"
Errors:	ERR# 6:The *n* argument is a '0' or a '1'
See Also:	1.2.7

DP=	
Purpose:	Decrease the pressure a given amount using the slow speed.
Syntax:	"DP=*n*"
Arguments:	*n* The decrease in pressure desired (current pressure units). This can be from 0 to 2 % FS of the current transducer range.
Remarks:	The slow speed will be used for a calculated amount of time (up to 5 seconds) to create the desired change. The PPC2 AF will not attempt to control the pressure to a target, so the change in pressure will be approximate.
Example:	Command: "DP=10" Reply: "10.00 kPa a"
Errors:	ERR# 6: The *n* argument is not within given limits.
See Also:	None.

DS=	
Purpose:	Decrease the pressure slowly.
Syntax:	"DS=*n*"
Arguments:	*n* *'0'* Closes the slow down valve. *'1'* Opens the slow down valve.
Remarks:	Opening the slow down valve will cause the pressure to decrease slowly.
Example:	Command: "DS=1" Reply: "DS=1"
Errors:	ERR# 6: The *n* argument is a '0' or a '1'
See Also:	1.2.7

DRV*n* (=)	
Purpose:	Read or set the status of an external solenoid valve.
Syntax:	"DRV*n*=*x*" "DRV*n*"
Arguments:	*n* The valve to operate on. This can be from 1 to 8. *x* The state to change the valve to. '0' to de-activate it. '1' to activate it.
Remarks:	The PPC2 AF can control up to eight external valves. Valve driver #8 is reserved for the external SPLT valve.
Example:	Command: "DRV3" Reply: "DRV3=1"
Errors:	ERR# 6: The *n* or *x* arguments are not within given limits.
See Also:	3.3.4

ERR	
Purpose:	Read the last error message.
Syntax:	"ERR"
Remarks:	The "ERR" command finds out more details about an error that has occurred. If the user receives an "ERR# nn" reply, the "ERR" command returns a brief description about the last error number that was replied.
Example:	Command: "ERR" Reply: "Missing or improper command argument(s)"
See Also:	4.3.2

HEAD(=)	
Purpose:	Read or set the head settings.
Syntax:	"HEAD=h,u,g" "HEAD" "HEAD=0,cm,N2"
Arguments:	*h* The height of the test in relation to the PPC2 AF. This will be positive if the test is above the PPC2 AF, or negative if below the PPC2 AF. This value can be between -9999 and 9999. Setting this value to '0' will disable the head correction. *u* The height units. This must be "in" or "cm". *g* The gas type. This must be "N2", "Air" or "He".
Remarks:	The PPC2 AF can make a head correction to allow it to display the pressure at the test instead of the pressure at the PPC2 AF.
Example:	Command: "HEAD=10,cm,N2" Reply: "10, cm, N2"
Errors:	ERR# 6: The arguments are not within given limits.
See Also:	3.2.7

HS(%)(=)	
Purpose:	Read or set the control hold limit.
Syntax:	"HS" "HS%" "HS=*n*" "HS%=*p*"
Arguments:	*n:* The hold limit in the current pressure units. *p:* The hold limit in %FS of the current active range.
Remarks:	The hold limit can be read and set as a pressure or as a percent of the range. If this command is used to set the hold limit, the PPC2 AF will then use CUSTOM control settings.
Example:	Command: "HS=5" Reply: "5.000 kPa"
Errors:	ERR# 6 The provided argument was invalid.
See Also:	3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6

IF=	
Purpose:	Increase the pressure quickly.
Syntax:	"IF=*n*"
Arguments:	*n* *'0'* Closes the fast up valve. *'1'* Opens the fast up valve.
Remarks:	Opening the fast up valve will cause the pressure to increase quickly. Care must be used, as the pressure will not stop increasing until the valve is closed, or the upper limit is passed.
Example:	Command: "IF=1" Reply: "IF=1"
Errors:	ERR# 6: The *n* argument is a '0' or a '1'
See Also:	"UL" command, 1.2.7

IP=	
Purpose:	Increase the pressure a given amount using the slow speed.
Syntax:	"IP=*n*"
Arguments:	*n* The increase in pressure desired (current pressure units). This can be from 0 to 2% FS of the current transducer range.
Remarks:	The slow speed will be used for a calculated amount of time (up to 5 seconds) to create the desired change. The PPC2 AF will not attempt to control the pressure to a target, so the change in pressure will be approximate.
Example:	Command: "IP=10" Reply: "10.00 kPa a"
Errors:	ERR# 6: The *n* argument is not within given limits.
See Also:	None.

IS=	
Purpose:	Increase the pressure slowly.
Syntax:	"IS=*n*"
Arguments:	*n* *'0'* Closes the slow up valve. *'1'* Opens the slow up valve.
Remarks:	Opening the slow up valve will cause the pressure to increase slowly. Care must be used, as the pressure will not stop increasing until the valve is closed, or the upper limit is passed.
Example:	Command: "IS=1" Reply: "IS=1"
Errors:	ERR# 6: The *n* argument is a '0' or a '1'.
See Also:	"UL" command, 1.2.7

LOCAL	
Purpose:	Returns control to the PPC2 AF front panel.
Syntax:	"LOCAL"
Remarks:	The REMOTE command can lock the front panel out completely. The user can return to local operation by sending the LOCAL command. or by powering the PPC2 AF off.
Example:	Command: "LOCAL" Reply: "LOCAL"
See Also:	"REMOTE" command

MEM	
Purpose:	Read the status from the power up memory test.
Syntax:	"MEM"
Remarks:	The PPC2 AF system memory stores the user settings (units, resolution, generation settings) and retains them when the unit if off. On power up, this memory is checked. If this memory is corrupted, all user settings are reset to default (as if the "RESET" command was executed), and the MEM status will be set to reflect this.
Example:	Command: "MEM" Reply "MEM=0" The memory was found to be corrupted on power up, and all user setting were reset to factory defaults. "MEM=1" The memory was found to be OK on power up
See Also:	"RESET" command, 3.4.4.5

MODE(=)	
Purpose:	Read or set the control mode.
Syntax:	"MODE" "MODE=*n*"
Arguments:	*n:* '0' for static pressure control. '1' for dynamic pressure control.
Remarks:	The control mode & control mode settings are selected with the MODE command. When the control mode is set, control parameters go to default parameters for that range. The mode setting is range specific.
Example:	Command: "MODE=1" Reply: "MODE=1"
Errors:	ERR# 6 The argument is invalid.
See Also:	3.1.2.3, 3.1.2.4, 3.2.3 , 3.2.6

PCALd,r(=)	
Purpose:	Read or set the user reference pressure transducer calibration information.
Syntax:	"PCAL*n,xx = adder, mult, Tare, CalDate*" "PCAL*n,xx*" "PCAL*n,xx* = 0.0, 1.0, 0.0, 800101"
Arguments:	*n:* The transducer range. '1' for the low, '2' for the medium '3' for the high range of the selected transducer. *xx:* The transducer. 'Hi' for the high pressure, 'Lo' for the low pressure. *adder:* The transducer calibration adder from -10 000 to 10 000 Pa. *mult:* The transducer calibration multiplier from 0.9 to 1.1. *Tare:* The transducer PA(z)tare (Pa). *CalDate:* The date of the last calibration in the format "YYMMDD".
Remarks:	The user defined pressure calibration information for the specified transducer (Hi or Lo pressure) and transducer range (low, medium, or high) can be access with this command Using this command will overwrite the current calibration, so caution must be used. Changes made using this command will take affect immediately, but must be made permanent by executing the "SAVECAL" command before the unit is powered down. If this is not done, the changes will be lost if the unit is powered down.
Example:	Command: "PCALo,2=.3, 1.000021, 1.4,960101" Reply: "0.30 Pa, 1.000021, 1.40 Pa, 960101"
Errors:	ERR# 6: One of the arguments is out of range.
See Also:	5.4

PR	
Purpose:	Read the next available pressure.
Syntax:	"PR"
Arguments:	
Remarks:	The next available pressure value for the active transducer (Lo or Hi) and range is read in the current pressure units. The data returned also contains ready information, and the pressure units. The reply field is always 20 characters long. The first 3 characters of the reply are reserved for the ready status (R or NR). The ready status is covered in the "SR" command. The pressure measurement value and pressure units are right justified in this field. After receiving this command, the PPC2 AF will reply back with the data once a new pressure measurement cycle is complete. This can take up to 1.5 seconds.
Example:	Command: "PR" Reply: "R 1936.72 kPa a"
Errors:	
See Also:	"SR" command, 3.1.2.3, 3.1.2.4

PRR	
Purpose:	Read the next available pressure and rate.
Syntax:	"PRR"
Arguments:	ready: 'R' if the current pressure ready criteria has been met, 'NR' if the criteria has not been met. (see the "SR" command) pressure The measured pressure for the selected transducer and range in the current pressure units. This is followed by the current pressure units. rate The measured rate for the selected transducer and range in the current pressure units per second. This is followed by the current pressure units. atm The ambient pressure measured by the PPC2 AF internal barometer in the current pressure units (but always absolute). This is followed by the current pressure units. After receiving this command, the PPC2 AF will reply back with the data once a new pressure measurement cycle is complete. This can take up to 1.5 seconds.
Remarks:	The next available ready condition, pressure rate of pressure change, and ambient pressure for the active transducer (Lo or Hi) and range is read in the current pressure units. Each data field is separated by a comma, and is returned in the following order: ready, pressure UNITS, rate UNITS/s, atm UNITS
Example:	Command: "PRR" Reply: "R,2306.265 kPa a,0.011 kPa/s,97.000 kPa a"
See Also:	"SR" command

PS=	
Purpose:	Set a new target pressure and start a new pressure generation cycle.
Syntax:	"PS=*n*"
Arguments:	*n:* The target pressure in the current pressure units.
Remarks:	The PPC2 AF will generate the given target pressure using the current generation settings & mode. Generation will continue until a new target pressure is set, the PPC2 AF goes into LOCAL mode, or an "ABORT" command is executed. If the given target is '0' and the pressure units are gauge, the PPC2 AF will vent. The "PR", "PRR", "STAT", or "SR" command can be used to monitor the progress of the generation.
Example:	Command: "PS=1000" Reply: "1000.00 kPa a"
See Also:	"PR", "PRR", "STAT", and "SR" commands, 3.1.2.3, 3.2.3

PSF=	
Purpose:	Set a new target pressure and use just the fast speed to generate the pressure.
Syntax:	"PSF=*n*"
Arguments:	*n:* The target pressure in the current pressure units.
Remarks:	The PPC2 AF will generate the given target pressure using just the fast speed, and will stop generating when the pressure has reached or passed the given target. The system will not attempt to hold the pressure. The "PR", "PRR", "STAT", or "SR" command can be used to monitor the progress of the generation.
Example:	Command: "PSF=1000" Reply: "1000.00 kPa a"
Errors:	
See Also:	"PR", "PRR", "STAT", and "SR" commands

PSS=	
Purpose:	Set a new target pressure and use just the slow speed to generate the pressure.
Syntax:	"PSS=*n*"
Arguments:	*n:* The target pressure in the current pressure units.
Remarks:	The PPC2 AF will generate the given target pressure using just the slow speed, and will stop generating when the pressure has reached or passed the given target. The system will not attempt to hold the pressure. The "PR", "PRR", "STAT", or "SR" command can be used to monitor the progress of the generation.
Example:	Command: "PSS=1000" Reply: "1000.00 kPa a"
See Also:	"PR", "PRR", "STAT", and "SR" commands

RANGE	
Purpose:	Read or change the range and active transducer of the PPC2 AF.
Syntax:	"RANGE" "RANGE=*n*,*XX*" "RANGE=3,HI"
Arguments:	*n:* '1' for the low range of the selected transducer. '2' for the mid range of the selected transducer. '3' for the high range of the selected transducer. *XX:* 'Lo' for the low pressure transducer. 'Hi' for the high pressure transducer.
Remarks:	The range and active transducer must be selected before making changes to settings that are dependent on the range. Each of the 2 transducers has 3 separate ranges. You must specify both the range and the transducer. The system MUST BE VENTED to switch transducers. The reply is the current or the new range value in psi.
Example:	Command: "RANGE" Reply: "1000 psia"
Errors:	ERR# 6: Invalid *n* or *XX* argument. ERR# 22: System must be vented for the requested operation.
See Also:	3.1.2.5, 3.2.1

RATE	
Purpose:	Read the next available pressure rate of change.
Syntax:	"RATE"
Remarks:	The next available pressure rate of change in the current pressure units per second is returned. After receiving this command, the PPC2 AF will reply back with the data once a new pressure measurement cycle is complete. This can take up to 1.5 seconds.
Example:	Command: "RATE" Reply: "0.01 kPa/s"
See Also:	None

READYCK (=)	
Purpose:	Read or set the ready check flag.
Syntax:	"READYCK" "READYCK=1"
Remarks:	The internal ready check flag is cleared whenever the PPC2 AF reaches a Not Ready (NR) condition. The "READYCK" command will return the status of this flag. This flag can only be set by sending the "READYCK=1" command while the PPC2 AF is in a Ready condition. You can then use "READYCK" command at a later time to determine if a Not Ready (NR) condition has occurred since. If a not ready ("NR") has occurred, the reply will be "READYCK=0". Otherwise, the reply will be "READYCK=1".
Example:	Command: "READYCK=1" Reply: "READYCK=1" (if PPC2 AF condition is Ready) "READYCK=0" (if PPC2 AF condition is Not Ready)
Errors:	ERR# 6: Argument is not a '0' or a '1'.
See Also:	"SR" command, 3.1.2.4

REMOTE	
Purpose:	Lock out the front panel controls.
Syntax:	"REMOTE"
Remarks:	The PPC2 AF goes into remote whenever communications take place. The user can return to local operation by pressing the ESC key. The REMOTE command locks out the front panel completely. The only way to unlock the front panel is by using the LOCAL command, or by powering the PPC2 AF off.
Example:	Command: "REMOTE" Reply: "REMOTE"
See Also:	"LOCAL" command

RES(=)	
Purpose:	To read or set the pressure display resolution for the current transducer and range.
Syntax:	"RES" "RES=*n*" "RES=0.001 %FS"
Arguments:	*n:* The pressure display resolution in %FS of the current range (0.0001 to 1 %FS).
Remarks:	The pressure display resolution is defined as %FS of the selected transducer range. The setting is separate for each range, and will change as the range is changed.
Example:	Command: "RES=.01" Reply: "0.01 %FS"
Errors:	ERR# 6 The argument is invalid.
See Also:	3.3.2

RESET	
Purpose:	Reset the user's settings to factory defaults.
Syntax:	"RESET"
Remarks:	The PPC2 AF has user settings (units, resolution, control modes, etc.) that can be reset to factory defaults. Calibrations and sequences will not be affected. The remote "RESET" command corresponds to the local "Reset-all." (See Section 3.4.5.2) The PPC2 AF also will restart as if the power was cycled OFF and then ON. The reset cycle takes about 10 seconds to complete. During this period, remote communications cannot take place.
Example:	Command: "RESET" Reply: "RESET"
See Also:	3.4.4.5.2

RETURN	
Purpose:	Start a new generation using the current target pressure.
Syntax:	"RETURN"
Remarks:	The "RETURN" command will start a new pressure generation using the current settings and target pressure. Generation will continue until a new target pressure is set, the PPC2 AF goes into LOCAL mode, or an "ABORT" command is executed.
Example:	Command: "RETURN" Reply: "1000.00 kPa a"
Errors:	ERR# 6 The current target pressure is invalid.
See Also:	"PS=", "TP" commands

SAVECAL	
Purpose:	To save changes made to the PPC2 AF calibration.
Syntax:	"SAVECAL"
Remarks:	The PPC2 AF calibration can be changed using the "PCAL" command. After the necessary calibration changes have been made, the "SAVECAL" command should be used to save these changes to non-volatile memory.
Example:	Command: "SAVECAL" Reply: "SAVECAL"
See Also:	"PCAL*d*,*r(*=*)*" Command

SN	
Purpose:	To read the serial number of the PPC2 AF.
Syntax:	"SN"
Remarks:	The PPC2 AF is serialized. The serial number can be read using this command.
Example:	Command: "SN" Reply: "SN"
See Also:	None.

SR	
Purpose:	Read the next available ready status.
Syntax:	"SR"
Remarks:	The current ready status can be read using this command. If the reply is "NR", then the pressure is Not Ready within the limits defined by the control mode and current hold and stability settings. If the reply is "R" then the pressure meets the ready criteria. The status is replied when the next pressure measurement is finished.
Example:	Command: "SR" Reply: "NR"
See Also:	"PR", "PRR","HS", "SS" Commands, 3.1.2.4

SS(%)(=)	
Purpose:	Read or set the current stability limit.
Syntax:	"SS" "SS%" "SS=*n*" "SS%=*p*"
Arguments:	*n:* The stability limit in the current pressure units. *p:* The stability limit in %FS of the current active range.
Remarks:	The stability limit can be read and set as a pressure or as a percent of the range. If this command is used to set the stability limit, the PPC2 AF will then use CUSTOM control settings.
Example:	Command: "SS=.1" Reply: "0.10 kPa/s"
Errors:	ERR# 6 The argument was invalid.
See Also:	3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6

STAT	
Purpose:	Read the pressure generation status.
Syntax:	"STAT"
Remarks:	The generation cycle status can be checked using this command. The reply is a numeric code which references a specific generation action: 0 The system is not generating or holding a pressure. 1 A new generation is preparing to start. 2 Quick ramping to the target. 4 Quick pulsing to the target. 8 Slow ramping to the target. 16 Slow pulsing to the target. 32 Reached the target, will re-adjust as needed to stay ready. 64 Quick ramping to a vent condition. 128 Vented with the exhaust valve open. 256 Quickly decreasing the pressure to reach a hard vacuum.
Example:	Command: "STAT" Reply: "32"
See Also:	"PS=" command

TIME(=)	
Purpose:	Read or set the PPC2 AF time.
Syntax:	"TIME=hh:mmXX" "TIME"
Arguments:	*hh:mm* The time in a 12 hour format using a colon delimiter. *XX:* "am" or "pm"
Remarks:	The PPC2 AF has an internal real time clock. It is used for date stamping calibrations and log data.
Example:	Command: "TIME=12:52PM" Reply: "12:52pm"
Errors:	ERR# 7: Missing or improper command argument(s).
See Also:	3.4.4.4

TP	
Purpose:	To read the current target pressure.
Syntax:	"TP"
Remarks:	The current target pressure is replied in the current pressure units.
Example:	Command: "TP" Reply: "1000.00 kPa a"
See Also:	"PS=" Command, 3.1.2.3

UCOEF(=)	
Purpose:	To convert a pressure in Pascal to the current pressure units.
Syntax:	"UCOEF" "UCOEF=*n*"
Arguments:	*n:* The pressure (Pa) to convert.
Remarks:	The PPC2 AF handles all pressure values internally in Pascal. This command allows the user to convert pressures. If a pressure is not given, 1 Pa is assumed. The reply includes the current pressure units.
Example:	Command: "UCOEF=100" Reply: "0.10000000 kPa"
See Also:	None

UNIT(=)	
Purpose:	Read or set the pressure display unit.
Syntax:	"UNIT=*unit*" "UNIT=*unitg*" "UNIT=*unita*" "UNIT=*unit, ref*" "UNIT=*unitg, ref*" "UNIT=*unita, ref*" "UNIT"
Arguments:	*unit:* The text corresponding to the pressure unit. *ref:* The optional unit reference temperature only if the unit is "InWa".
Remarks:	This command determines what unit is used to display pressure measurements. Refer to the UNIT section of the manual for a detailed list of the units. The unit text must be followed by an 'a' if an absolute unit is desired, else a gauge unit will be assumed. The unit text can optionally be followed by a 'g' to specify a gauge unit also. There can be a space between the unit text and the 'a' or the 'g'. If the unit specified is "InWa", an optional second argument "*ref*" can be set. The "ref" can be 4, 20, or 60 corresponding to InWa at 4°C, 20°C or 60°F. If this second argument is not given when the unit is "InWa", then the reference temperature will be at 20°C. The fifth character of the reply will always be 'a' for an absolute unit, or 'g' for a gauge unit. White spaces will proceed this character if needed. The temperature reference will be added to the reply only if the unit is "InWa".
Example:	Command: "UNIT=KPA A" Reply: "kPa a" Command: "UNIT=INWA, 4" Reply: 'inWag, 4dC"
Errors:	ERR# 7: The *unit* is invalid. ERR#102: The *ref is invalid (if given)*.
See Also:	3.4.1, 9.3

UL(=)	
Purpose:	Read or set an upper limit for the current transducer and range.
Syntax:	"UL" "UL=*n*"
Arguments:	*n:* The upper limit pressure in the current pressure units. This value is always in absolute units if the transducer is absolute, or gauge units if the transducer is gauge.
Remarks:	The PPC2 AF has an upper limit for each range of each transducer. New targets can not be greater that this value. If the pressure does exceed the upper limit, the pressure display will flash, and the unit will stop generating. Manual increases in pressure will not be allowed as long as the pressure is above the upper limit. Decreases in pressure will be allowed. This feature should always be used to prevent accidental over pressure of a device under test.
Example:	Command: "UL=1000" Reply: "1000.00 kPa a"
See Also:	3.2.4

VAC(=)	
Purpose:	Read or set the vacuum status.
Syntax:	"VAC" "VAC=*n*" "VAC=0"
Arguments:	*n:* '0' if the PPC2 AF exhaust port is open to atmosphere. '1' if the PPC2 AF exhaust port is connected to a vacuum pump.
Remarks:	The PPC2 AF must be informed if a vacuum pump is being used.
Example:	Command: "VAC=1" Reply: "VAC=1"
See Also:	3.3.1

VENT(=)	
Purpose:	Read, execute or abort a vent process.
Syntax:	"VAC" "VAC=*n*"
Arguments:	*n:* '1' to start a vent process. '0' to abort a vent process and close the exhaust valve.
Remarks:	The PPC2 AF vents by generating close to atmosphere, and then opening the exhaust valve. This command will return a '0' if the exhaust valve is closed, or a '1' if the exhaust valve is open. Because of this, a reply to a "VENT=1" will always be a "VENT=0" unless the unit is already vented.
Example:	Command: "VENT=1" Reply: "VENT=0"
See Also:	3.1.2.2

VER	
Purpose:	Read the PPC2 AF version.
Syntax:	“VER”
Remarks:	The software version of the PPC2 AF can be read. This is useful for checking presence of the PPC2 AF and for reference purposes.
Example:	Command: “VER” Reply: “DH INSTRUMENTS, INC PPC2 AF Ver1.00 ”
See Also:	None

NOTES

5. MAINTENANCE, ADJUSTMENTS AND CALIBRATION

PPC2 AF was designed for maintenance free operation. No maintenance is required other than:

- Rezeroing of reference transducers as needed (see Section 5.2).
- Automated adjustment of pressure controlling parameters as needed (see Section 5.1.1).
- Adjustment of the on-board barometer as needed (see Section 5.3).
- Regular reference transducer calibration (see Section 5.4).

This section provides information on maintenance, adjustment and calibration procedures, certain repair functions and recommended overhaul procedures.

PPC2 AF is a sophisticated pressure setting and measuring instrument with advanced on-board features and functions. Before assuming that unexpected behavior is caused by system defect or breakdown, the operator should use this manual and other training facilities to become thoroughly familiar with PPC2 AF operation. For rapid assistance in specific situations, see Section 6.

PPC2 AF is covered by a limited 5 year warranty. Unauthorized service or repair during the warranty period is undertaken at the owner's risk and may cause damage that is not covered under warranty and/or may void the warranty (see Section 9.4).

5.1 MAINTENANCE

5.1.1 PNEUMATIC CONTROL MODULE CONFIGURATION

PURPOSE

To run an automated routine that allows PPC2 AF to readjust automated pressure control coefficients to take into account changes in the characteristics of its pressure control hardware over time.

PRINCIPLE

PPC2 AF uses hardware specific factory configuration coefficients in the pressure control algorithms used for automated pressure control. Changes in the pressure control elements (valves, orifices and pressure controllers) over time can cause pressure control performance to deteriorate as the factory configuration values become less valid. The configuration routine automatically retunes the factory configuration coefficients to take into account small changes in performance.

Use of the Cfg function should be considered a maintenance function used only when PPC2 AF pressure control has deteriorated noticeably as evidenced by *changes* in the time required to set a pressure, overshoot when setting a pressure and/or hunting around the target value in dynamic control mode.

The Cfg function is only designed to compensate for the small changes in pressure control hardware that may occur with normal wear over time. Major changes to the pressure control hardware such as replacing a valve or pressure controller normally require a complete recharacterization of the pneumatic module.

❍ **OPERATION**

Poor control can also be caused by excessive leaks and restrictions in the test line. These problems should be eliminated before determining whether or not to run the Cfg function.

Before running a user Config, remove any external volume, plug the test port, and connect a supply pressure of 1 100 psia to the rear panel SUPPLY port. No vacuum source is needed.

To run the Cfg function, press 3Cfg under the SPECIAL menu.

The display warns the user that pressure will increase to roughly 3 400 kPa (500 psi). Press ENTER to continue.

```
CAUTION:  About to
set  3378.43 kPa  a
```

PPC2 AF will then pulse and set pressures around mid scale pressure, and "CFG" will flash in the lower left corner of the display. After about ten minutes, the user will be asked whether or not to save the new configurations. If the Cfg function ran completely and without incident, select 1Yes. Selecting 2No returns to the main run screen with no change to the internal pressure control parameters.

```
Save New Config
1Yes  2No
```

The effect of the Cfg function can be eliminated and control coefficients returned to factory defaults using RESET ALL (see Section 3.4.4.5.2).

5.1.2 REPAIRS

PPC2 AF is covered by a limited 5 year warranty. Unauthorized service or repair during the warranty period is undertaken at the owner's risk and may cause damage that is not covered under and/or may void the warranty (see Section 9.4).

See Section 5.1.5 Illustrated Parts Breakdown for part number and figures referred to in the repair procedures.

5.1.2.1 FUSE REMOVAL AND REPLACEMENT

See Figure .4.

Remove all power.

1. With a small flat screw driver remove fuse holder.
   1.1. Remove bottom fuse and replace with spare, top fuse. (100589)
      1.1.1. If there is no spare fuse use a new one, try to rotate spare into use.
   1.2. The spare should also be replaced, but is not mandatory.
2. Slide fuse holder back into position.

5.1.2.2 FRONT PANEL REMOVAL AND REPLACEMENT

See Figures .1, .7 and .9.

Remove electrical power and shut off pressure prior to executing this procedure.

1. Remove top panel (fig 7)
2. Remove front panel.
   2.1. Remove ribbon cable P/N 401278 (W5) (fig 1)
   2.2. Remove the four (4) mounting nuts P/N 100970-Z (fig 1).
   2.3. Remove front panel assembly from instrument
3. Remove keypad interface board
   3.1. Remove the ribbon cable at the interface board P/N 401093 (fig 9).
   3.2. Remove mounting screws P/N 100984-Z (fig 9).
4. Remove display
   4.1. Remove standoff P/N 100171 (fig 9)
   4.2. Remove mounting screws P/N 100970-Z (fig 9)
5. Replace front panel assembly
6. Reassemble in reverse order as disassembly.

5.1.2.3 DISPLAY REMOVAL AND REPLACEMENT

Remove electrical power and shut off pressure prior to executing this procedure.

1. Remove top panel (fig 7)
2. Remove front panel.
   2.1. Remove ribbon cable P/N 401278 (W5) (fig 1)
   2.2. Remove the four (4) mounting nuts P/N 100970-Z (fig 1).
   2.3. Remove front panel assembly from instrument
3. Remove keypad interface board
   3.1. Remove the ribbon cable at the interface board P/N 401093 (fig 9).
   3.2. Remove mounting screws P/N 100984-Z (fig 9).
4. Remove and replace display
   4.1. Remove standoff P/N 100171 (fig 9)
   4.2. Remove mounting screws P/N 100970-Z (fig 9)
5. Reassemble in reverse order as disassembly.

5.1.2.4 REAR FITTING REMOVAL AND REPLACEMENT

Electric shock hazard exists when performing this procedure. Following the outlined procedure exactly is required. Disconnect power and pressure prior to any disassembly.

1. Remove adaptor fittings from rear panel fittings (fig 11)
2. Remove top and bottom panels. (fig 7)
3. Remove rear panel. (fig 4)
   3.1. Disconnect two (2) ribbon cables P/N 401278 (W4), (W3) (fig 1) at rear panel board P/N 40168 (fig 4).
   3.2. Disconnect fan motor cable at position P3 (fig 1).
   3.3. Disconnect AC power leads (three each) from rear of power entry/filter module P/N 102417 (fig 4).

   Annotate wire position on power entry module using wire color code.

   3.4. Remove five (5) mounting screws securing the rear panel to the instrument (fig 11).
   3.5. Remove rear panel.
4. Remove and replace fitting to be replaced (figs 2, 3, 5 and 6).
5. Reassemble in reverse of disassembly.

When reattaching the AC power leads to the power entry/filter module, ensure the leads are connected to the correct pins. Attaching the earth lead to the live AC connector will result in damage to the instrument and possible electric shock.

5.1.2.5 POWER SUPPLY REMOVAL

See Figures .8, .7 and .1.

Remove all power and pressure connections prior to any disassembly.

1. Remove top and bottom covers (fig. 7)
2. Remove left side panel (fig. 1)
   2.1. Loosen eight allen screws on top and bottom side (101010-Z).
   2.2. Slide the side up off the rails (100260).

   Notice that there are two power supplies (12 V and + 5, 15 V). Remove only the defective part.

3. Remove connecting cables (fig. 8)
   3.1. one connector on ether end of power supply.

   Remember to mark cables so they go back to the correct power supply.

4. Remove power supply (fig. 8)
   4.1. Remove four screws holding the power supply (100550-Z).
5. Install new or repaired part.
6. Reassemble unit using this instructions as a guide.

5.1.2.6 BAROMETER BOARD REPLACEMENT

See Figures .1 and .7.

Remove all power and pressure prior to disassembly.

1. Remove top (fig. 7)
2. Remove two allen screws at diagonal corners on board (fig. 1) (ENG400461)
3. Carefully pull board out from connector.

Be careful not to damage pins on connector J1.

4. Install new board.
5. After re-assembly, power up the PPC2 AF.
6. The temperature coefficients must be input.
   6.1. SPECIAL, DIAG, CALIB, TEMP,
   6.2. Type in Addr. and Multi. if needed.
   6.3. ENTER, type in Amb Pres Coef:
   6.4. ENTER
7. A pressure adder and multiplier may be used if desired.
   7.1. SPECIAL, INTERNAL, CAL, EDIT, BAROMETER
   7.2. ENTER, type in PA and PM, ENTER.

5.1.2.7 COOLING FAN REMOVAL AND REPLACEMENT

See figures 7, 4 and 1.

Remove all power and pressure connections prior to any disassembly.

1. Remove top and bottom covers (fig. 7)
2. Remove left side panel (fig. 1)
   2.1. Loosen eight allen screws on top and bottom side (101010-Z).
   2.2. Slide the side up off the rails (100260).
3. Remove connecting cable (fig. 1)
   3.1. One connector on circuit board (P3).
   3.2. Push grommet down through slotted hole.
4. Remove cooling fan.
   4.1. Remove four screws holding the fan in place. (100970-2)(fig. 4)
5. Install new fan.
6. Reassemble PPC2 AF.

5.1.2.8 SUPPLY PRESSURE RELIEF VALVE REMOVAL AND REPLACEMENT

See Figures 1, 2, 3 and 7.

Remove all power and pressure prior to any disassembly.

1. Remove top and bottom covers (fig. 7)
2. Disconnect fittings (102491, 101985 and bulk head nut).
3. Remove pressure relief valve from assembly.
   3.1. Disconnect fittings on valve to use on new valve if part is to be replaced.
4. Install new or repaired part.
5. Reassemble PPC2 AF.

Leak check unit prior to use.

5.1.2.9 RELOADING EMBEDDED SOFTWARE INTO FLASH MEMORY

1. The PPC2 AF has flash memory, which means that when an upgrade is required or for some reason the embedded software is corrupted it can be reloaded with the help of a PC.
2. If new versions of software are to come **DH Instruments** will send the FLASH instructions along with the new software.
3. If the embedded software is suspect of a problem, write down all symptoms and call **DH Instruments** technical service. If indeed a new FLASH is required instructions and all required software will be provided.

5.1.3 OVERHAUL

If calibration of the reference pressure transducers is included as part of the overhaul procedure, the calibration procedure must be performed last as other overhaul procedures may affect reference transducer calibration.

Any or all of the following items may be included as part of a system maintenance overhaul:

1. Verify operation of supply pressure relief valve.
2. Disassemble pneumatic module filters and clean filter elements. Replace if necessary.
3. Clean front panel.
4. Clean threads of rear panel fittings. Check for damage and replace if necessary.
5. Check that rear panel cooling fan operates when PPC2 AF is on.
6. Check that internal screws, bolts and nuts are tight.
7. Check that the gas flow through exhaust port when not controlling pressure is between 500 sccm (test port at atm) and 1.5 slm.
8. Verify that internal barometer reads atmospheric pressure within +/- 0.15 psi of reference transducer range L1, L2 and/or L3.
9. Perform calibration of reference pressure transducers if necessary.
10. Perform system leak and operational check.

5.1.4 SELF PURGING LIQUID TRAP (SPLT)

5.1.4.1 MAINTENANCE

The maintenance of the SPLT consists of cleaning or replacing the internal coalescing filter. A dirty filter should be rinsed with a degreasing agent to remove oil and particulate matter. A filter with physical damage should be replaced.

Removing and Installing the SPLT Filter

See Section 5.1.5 for part number and figures referred to in the filter replacement procedure.

See Figure .10.

Remove power and pressure connections prior to disassembly.

1. Disconnect pressure tubing to the SPLT.
2. Disconnect power leads to the solenoid.
3. Remove 2 screws on top of bracket (102530).
4. Unscrew top of SPLT (102501).
5. Remove filter; clean cavity (102502).
6. Install new filter.
7. Re-assemble SPLT.

5.1.4.2 REPAIR

5.1.4.2.1 SPLT Exhaust Valve Removal and Replacement

See Figure .10

1. Disconnect pressure tubing to the SPLT.
2. Disconnect power leads to the solenoid valve (102514).
3. Remove solenoid valve from SPLT body (102502).
4. Remove fittings (102516, 100321) and drain tube (101392-Z) from solenoid valve.
5. Install fittings (102516, 100321) and drain tube (101392-Z) onto new solenoid valve.
6. Reinstall solenoid valve onto SPLT body (101502).

5.1.4.3 OVERHAUL

Any or all of the following items may be included as part of SPLT maintenance overhaul:

1. Clean or change filter (see Section 5.1.4.1).
2. Clean internal portions of SPLT body using a degreasing agent.
3. Check solenoid power leads.
4. Check tightness of fittings on SPLT exhaust solenoid valve.
5. Check drain tube and replace as necessary.

5.1.5 ILLUSTRATED PARTS BREAKDOWN

5.1.5.1 PARTS LISTS

5.1.5.1.1 Main Assembly

See Section 5.1.5.2 Figure .1.

PART NUMBER	DESCRIPTION	# REQUIRED
100550-Z	Allen screw, M3 X 5	6
100969-Z	Lock washer	6
100970-Z	Nut, M3	5
101010-Z	Allen screw, M3 X 8	14
102464-Z	Washer	19
400913-01	Micro-board	1
401278 (W3)	Interconnecting cable	1
401278 (W4)	Interconnecting cable	1
401278 (W5)	Interconnecting cable	1
ENG400461	Barometer board	1
100260	Slide rails	9
100768	PPC2 AF enclosure	1
100792	Handle	1
102386	Female stud, M3 X 20	8
401267	Pneumatic assy.	1
401269	PPC2 AF driver board	1
401274	Front panel assy.	1
401275	Rear panel assy.	1
401308	Power supply housing	1

5.1.5.1.2 Pneumatic Schematic

See Section 5.1.5.2 Figure .2.

PART NUMBER	DESCRIPTION	# REQUIRED
100314	Cross connector	2
100318	Adaptor	2
100326	Tee connector	1
100355	2 micron filter	2
100817	Volume cylinder	1
100851	50 psia transducer	1
100856	1000 psia transducer	1
100898	Flow controller	1
100899	Flow controller	1
100931	Adaptor	4
101406	Adaptor	2
101487	Tee connector	1
101490	Elbow connector	1
101527	Bulkhead connector	4
101981	Union connector	3
101983	Reducer adaptor	1
101985	Union	1
101987	Adaptor	3
102174	Bulkhead connector	1
102189	Adaptor	3
102192	Seal	1
102194	Solenoid valve	1
102194	Solenoid valve	3
102196	Tee connector	1
102273	Union connector	3
102280	Pressure plug	1
102394	O-ring	18
102488	Solenoid valve	2
102489	Solenoid valve	1
102490	Pressure relief valve	1
102491	Adaptor	2
102525	Reducer connector	1
102526	Reducer connector	2
122511	Union connector	18
122529	Pressure manifold	2

5.1.5.1.3 Pneumatic Assembly

See Section 5.1.5.2 Figures .3, .5 and .6.

PART NUMBER	DESCRIPTION	# REQUIRED
100969-Z	Lock washer	10
100971-Z	Lock washer	4
100972-Z	Hex nut	4
101000-Z	Screw, M3 X 6	4
101005-Z	Screw, M3 X 10	4
102398-Z	Screw, 6-32 X 1/4	6
102566-Z	Screw, 6-32 X 1/4	4
401276 (W2)	Valve cable	1
100314	Cross connector	3
100318	Adaptor	2
100326	Tee connector	1
100355	2 micron filter	2
100817	Volume cylinder	1
100851	50 psia transducer	1
100856	1000 psia transducer	1
100898	Flow controller	1
100899	Flow controller	1
100931	Adaptor	4
101032	Screw, 1/4-20 X 1 1/4	4
101033	Screw, 1/4-20 X 1	8
101406	Adaptor	2
101487	Tee connector	1
101490	Elbow connector	1
101527	Bulkhead connector	4
102174	Bulkhead connector	1
102189	Adaptor	3
102192	Seal	1
102194	Solenoid valve	4
102196	Tee connector	1
102280	Pressure plug	1
102394	Viton O-ring	18
102488	Solenoid valve	2
102489	Solenoid valve	2
102490	Pressure relief valve	1
122508	Valve housing	1
122509	Valve bracket	1
122511	Union connection	18
122529	Pressure manifold	2

5.1.5.1.4 Rear Panel Assembly

See Section 5.1.5.2 Figures .4, .11 and .12.

PART NUMBER	DESCRIPTION	# REQUIRED
100632-Z	Crimp terminal	31
100970-Z	Nut, M3	4
100482	RS-232 socket	4
100589	Fuse, slo-blo 1A/250V	2
100985	Screw, M3 X 20	4
101469	Rubber grommet	1
102169	Fan power connector	1
102337	Cooling fan	1
102338	Fan guard	1
102417	Power entry module	1
102476	Gasket	2
122518	Rear panel	1
401268	Rear micro board	1
100997-Z	Screw, M3 X 10	5

5.1.5.1.5 Electronic Chassis (Power Supplies)

See Section 5.1.5.2 Figure .8.

PART NUMBER	DESCRIPTION	# REQUIRED
100550-Z	Screw, M3 X 5	12
102464-Z	Washer	12
401277 (W1)	Main wire harness	1
102030	Power supply, +5V, +-15V	1
102236	Power supply, 12V	1
122514	Mounting bracket	2

5.1.5.1.6 Front Panel Assembly

See Section 5.1.5.2 Figure .9.

PART NUMBER	DESCRIPTION	# REQUIRED
100970-Z	Hex nut, M3	2
100984-Z	Phillips screw, M3 X 6	2
102464-Z	Lock washer	4
100171	Female stud, M3 X 10	2
100528	Female stud, M3 X 6	4
100739	Washer	4
102066	Alpha-Numeric display	1
122517	Front panel overlay	1
122555	Front panel	1
401093	Key pad interface board	1

5.1.5.1.7 SPLT Assembly

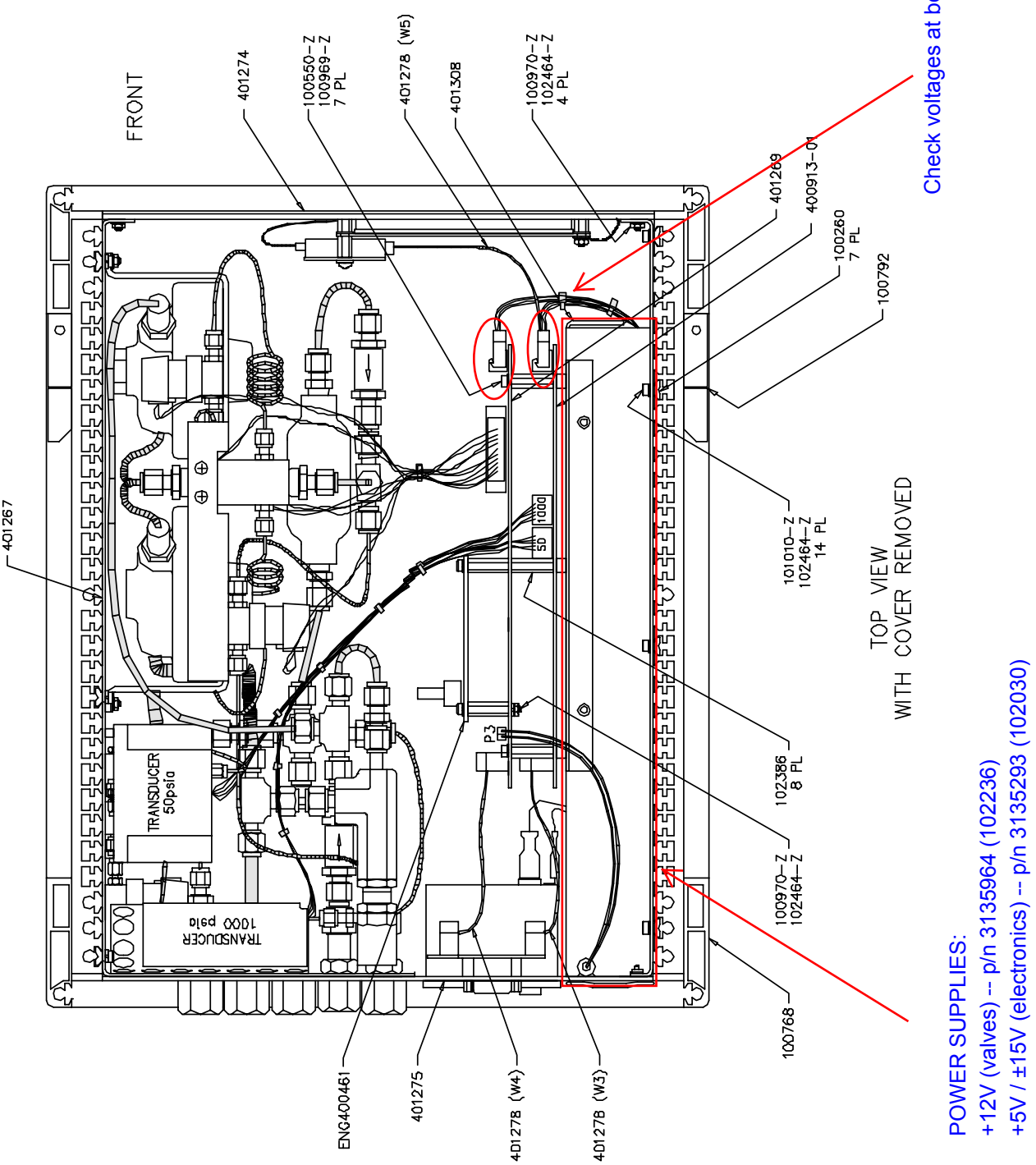
See Section 5.1.5.2 Figure .10

PART NUMBER	DESCRIPTION	# REQUIRED
100970-Z	Hex nut, M 3	1
101392-Z	Vent tube, 1/8 in. O.D.	1
102088-Z	Split lock washer	2
102464-Z	Split lock washer	1
122461-Z	Label	1
122587-Z	Label	1
100321	Elbow adaptor	1
101008	Allen screw, M3 X 20	1
101468	Rubber grommet	6
102501	Liquid trap	1
102502	Filter	1
102514	12 VDC solenoid valve	1
102516	Reducer, adaptor	1
102528	Terminal block	1
102530	Allen screw, 1/4-20 X 1/2	2
122541	Mounting bracket	1

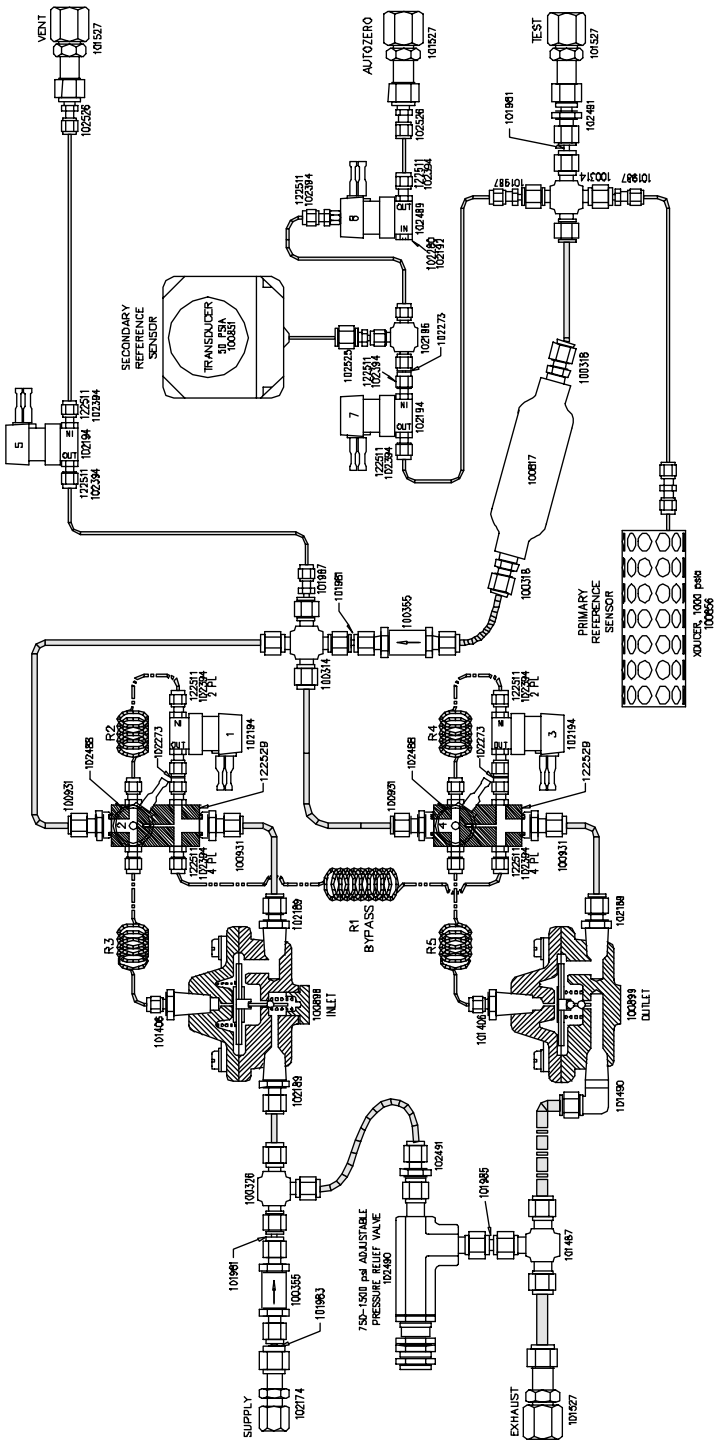
5.1.5.2 FIGURES

This section provides figures describing various subassemblies of the PPC2 AF. For associated parts lists see Section 5.1.5.1. For additional information on PPC2 AF subassemblies and their locations see Section 1.2.

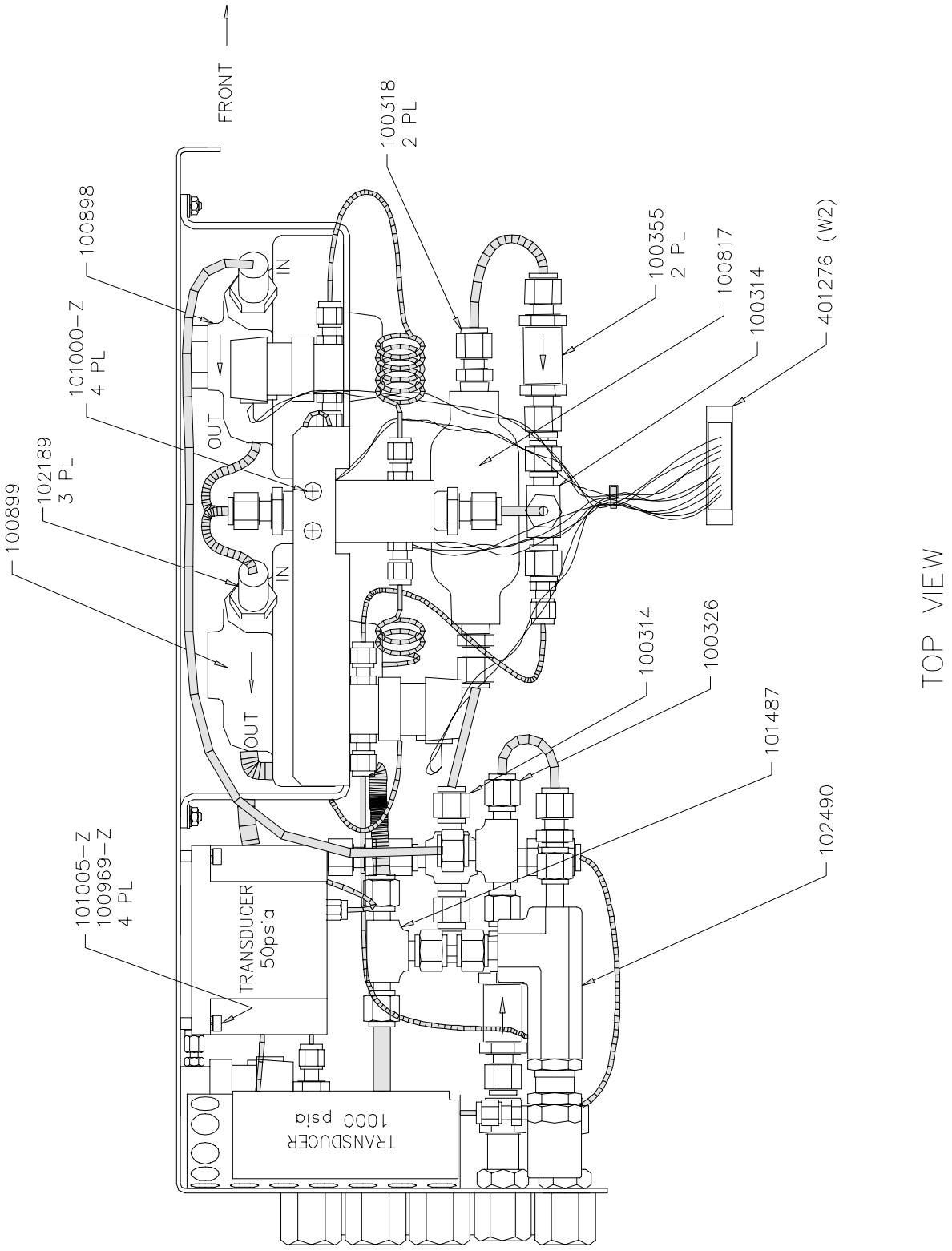
5.1.5.2.1 General Assembly (Top View) - Figure 1



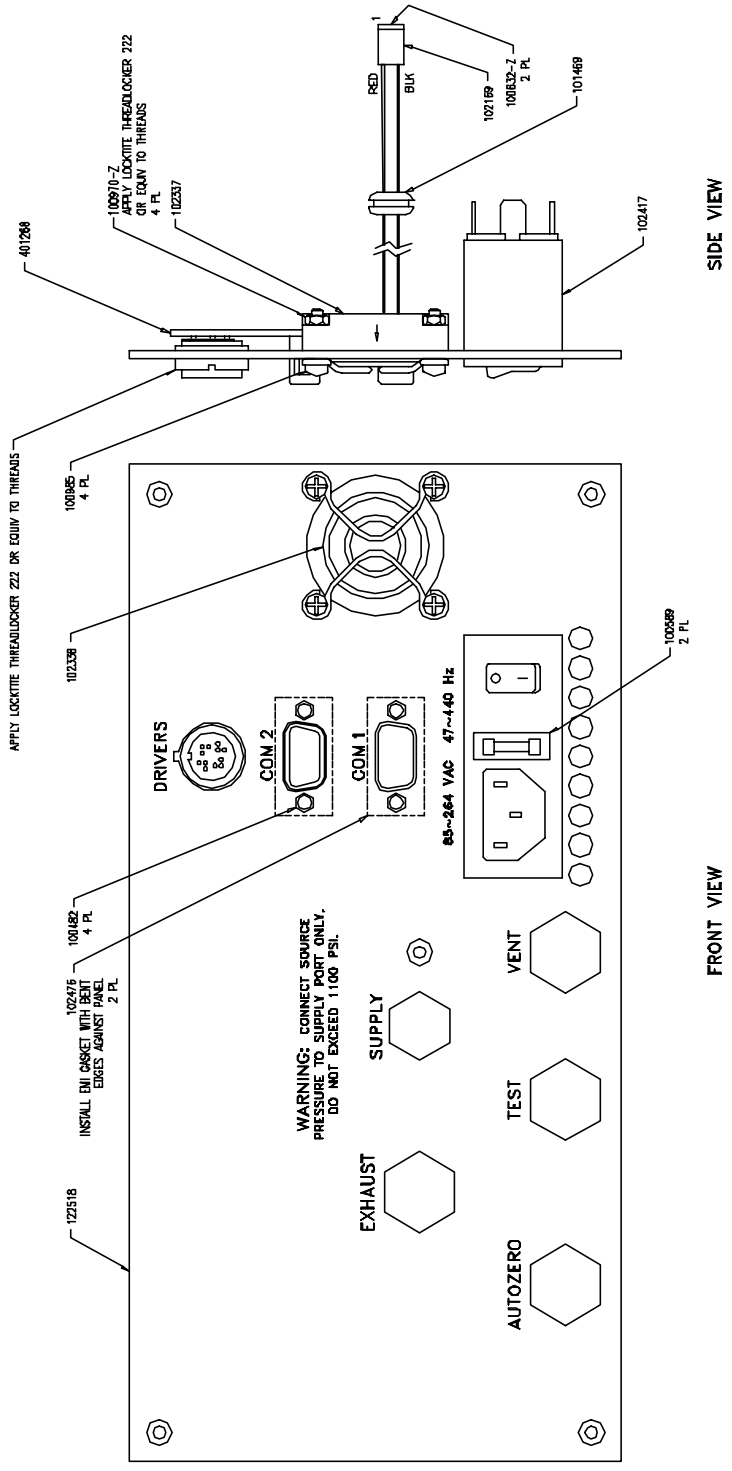
5.1.5.2.2 Pneumatic Schematic (Conceptual) - Figure 2



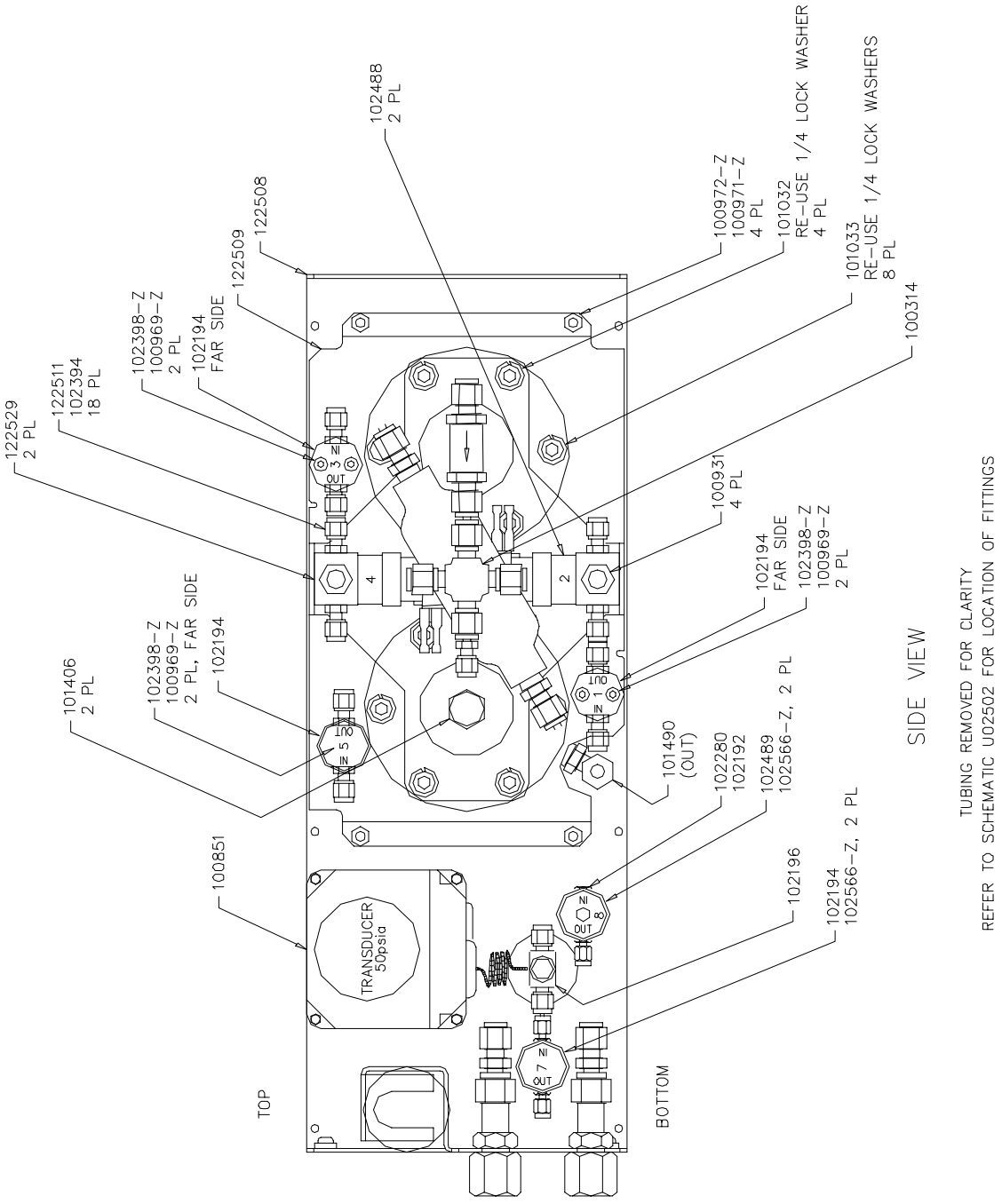
5.1.5.2.3 Pneumatic Schematic (Top View) - Figure 3



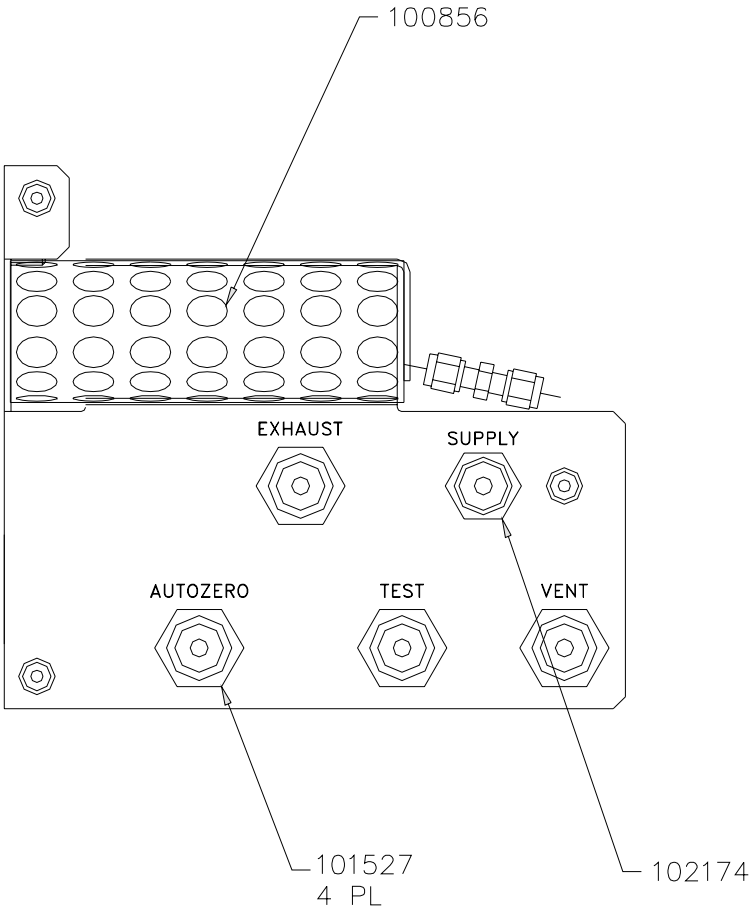
5.1.5.2.4 Rear Panel (Front View) - Figure 4



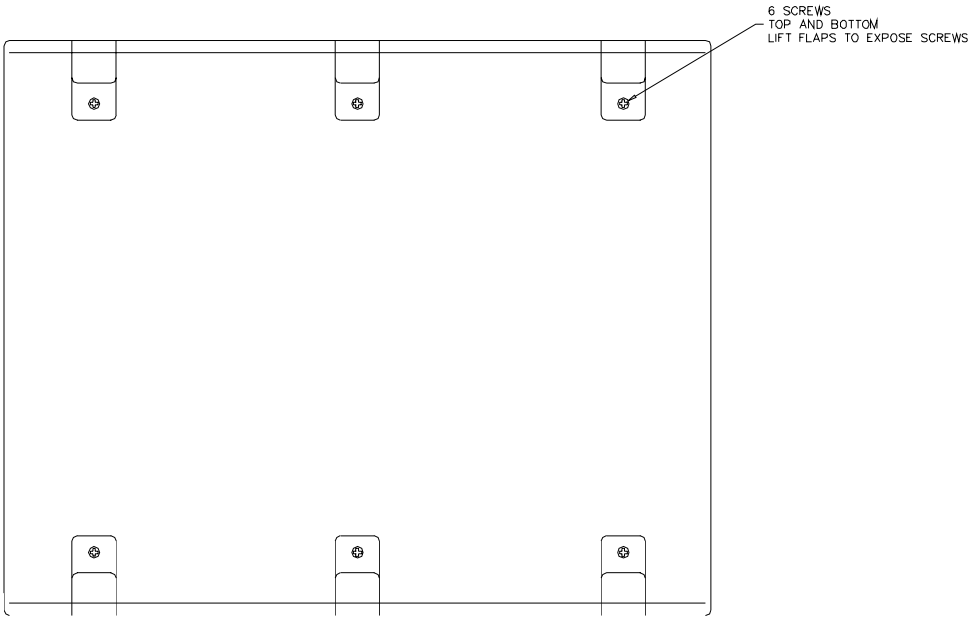
5.1.5.2.5 Pneumatic Schematic (Side View) - Figure 5



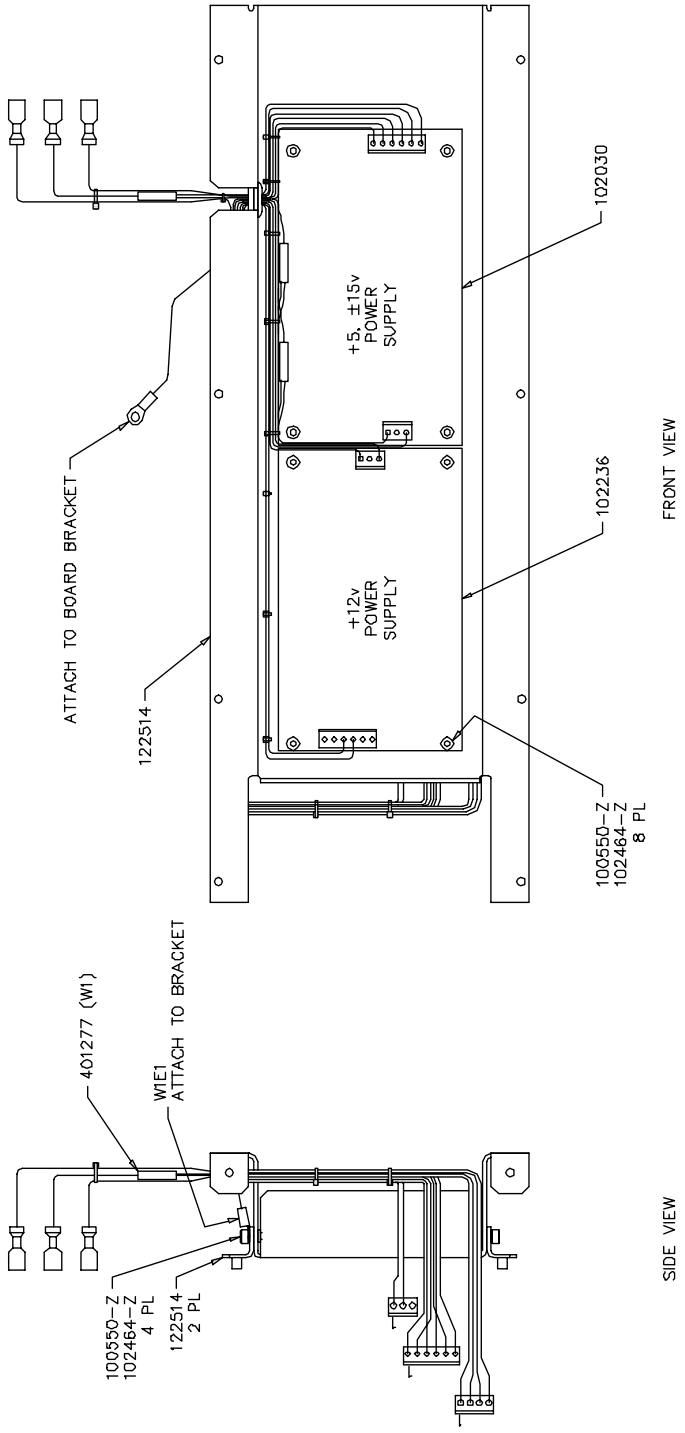
5.1.5.2.6 Rear Panel (Rear View) - Figure 6



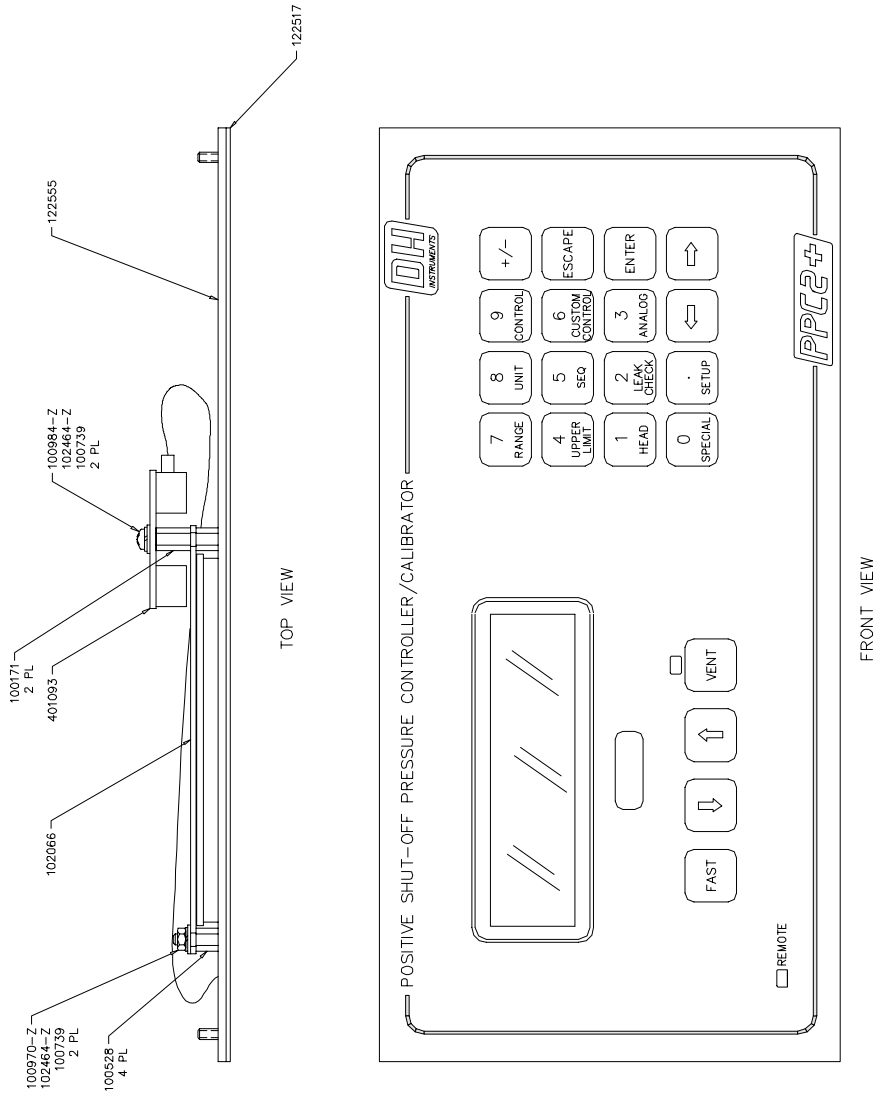
5.1.5.2.7 Bottom Panel (Top View) - Figure 7



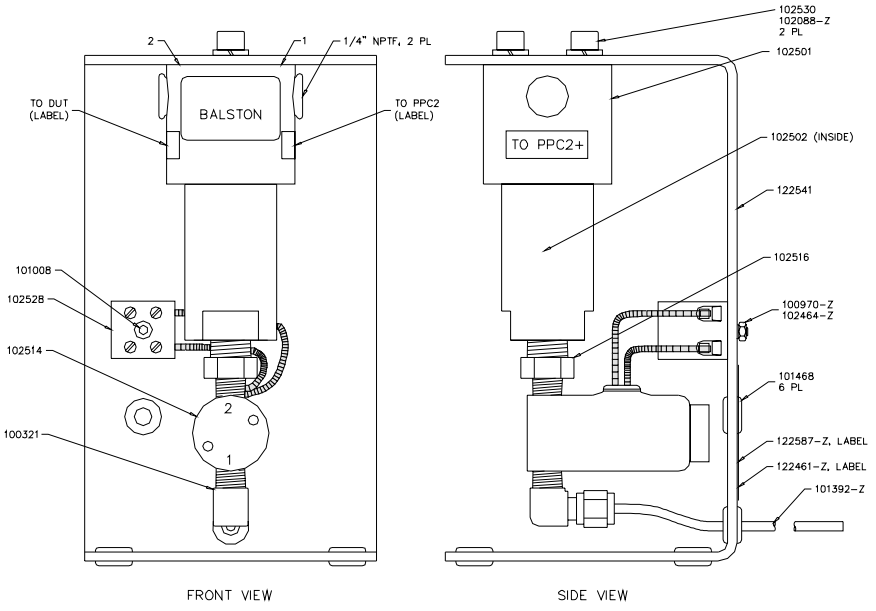
5.1.5.2.8 Electronic Chassis (Front and Side Views) - Figure 8



5.1.5.2.9 Front Panel (Front and Top Views) - Figure 9



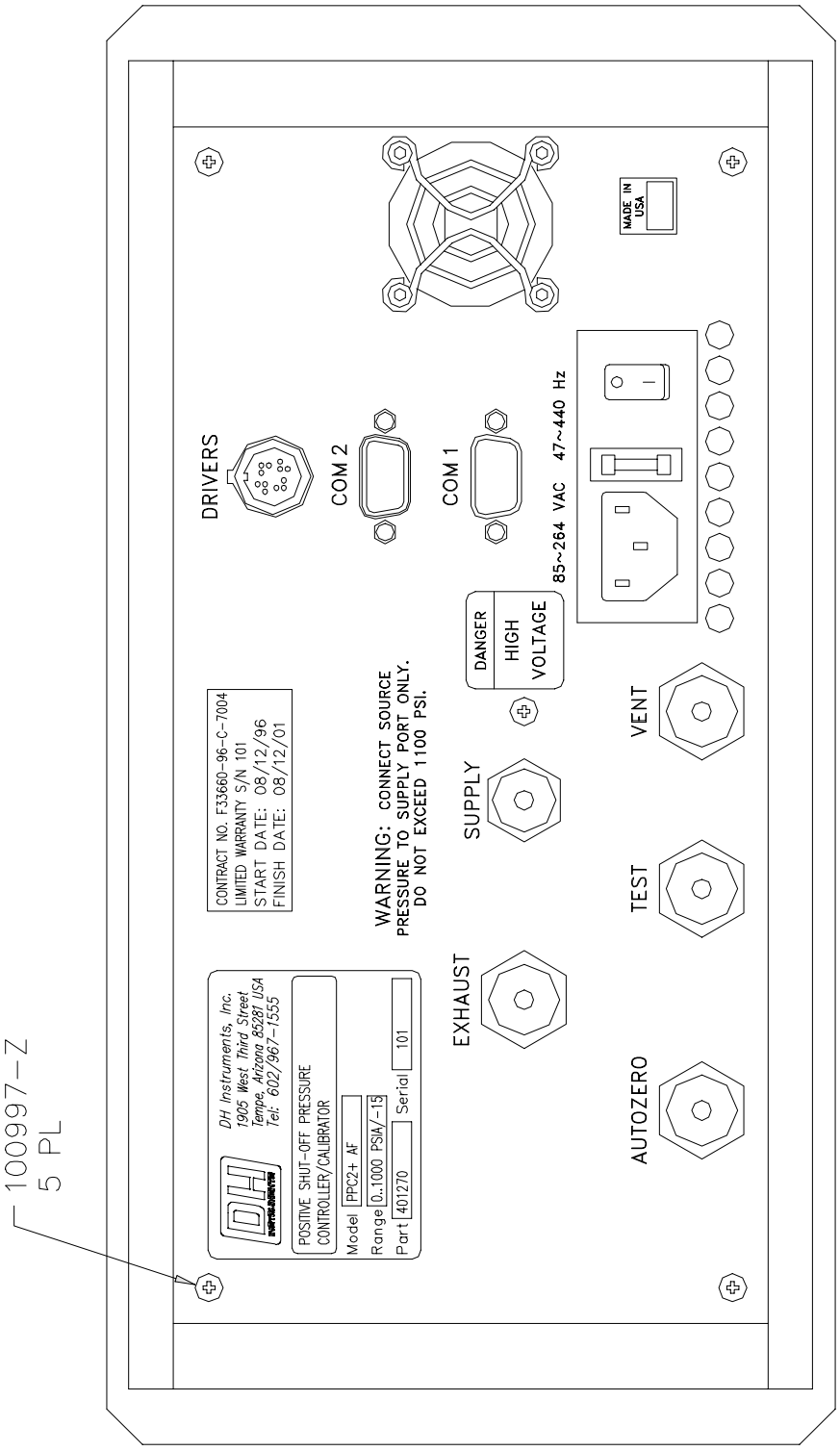
5.1.5.2.10 SPLT (Front and Side Views) - Figure 10



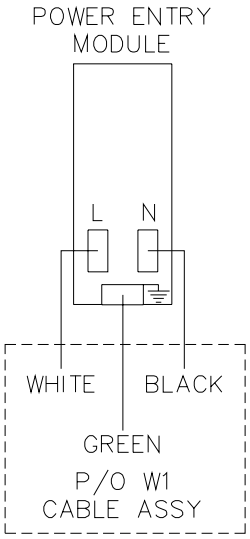
NOTES: UNLESS OTHERWISE SPECIFIED;

1. SEAL NPT CONNECTIONS USING TEFLON TAPE

5.1.5.2.11 Full Rear Panel (Front View) - Figure 11



5.1.5.2.12 Power Entry Module - Figure 12



5.2 AUTOZERO OF REFERENCE TRANSDUCERS

PURPOSE

To change the offset (zero) of the Lo and Hi reference pressure transducers relative to a reference value.

PRINCIPLE

The main component of drift over time of the PPC2 AF reference pressure transducers is zero drift or offset, independent of span. The autozero routines (AutoZ) allow the Lo and Hi reference transducers to be rezeroed relative to a reference between recalibrations. This allows the measurement accuracy specification to be maintained with less frequent full calibrations.

The autozero routines use changes over time in the difference between a reference transducer and a stable zero reference to correct the reference transducer for zero drift. The "natural" reference transducer disagreement with the zero reference [PA(z)tare] is determined at the time the reference transducer is calibrated. Between calibrations, the autozero routine measures the current disagreement between the reference transducer and its zero reference [PA(z)raw]. The difference between the current disagreement and the "natural" disagreement [PA(z)net = PA(z)raw - PA(z)tare] represents the reference transducer's zero drift and is added to PA to compensate for zero drift(see Section 5.4.1 PRINCIPLE, PA/PM Coefficients).

The Lo reference transducer (50 psia) is autozeroed relative to a vacuum applied to the PPC2 AF AUTOZERO port. The Hi reference transducer (1 000 psia) is autozeroed at atmospheric pressure relative to the Lo reference transducer.

The AutoZ function supports the automated routines used to apply the reference zero pressure to the reference transducer and performs the calculations and data handling necessary to update and maintain the autozero values.

TO ASSURE MAINTENANCE OF PPC2 AF REFERENCE TRANSDUCER MEASUREMENT SPECIFICATIONS, IT IS RECOMMENDED THAT THE AUTOZERO ROUTINES BE EXECUTED AT LEAST EVERY SIXTY DAYS OR WHEN THE SYSTEM HAS BEEN EXPOSED TO TEMPERATURE CHANGES EXCEEDING ± 20 ºC (36 ºF).

PA(z) Calculations:

PA(z)	**=**	**Reading of reference transducer at zero reference pressure with no AutoZ value applied**	**-**	**Zero reference value**
PA(z)tare	**=**	**PA(z) determined just after calibration.**		
PA(z)raw	**=**	**PA(z) determined between calibrations**		
PA(z)net	**=**	**PA(z)raw**	**-**	**PA(z)tare**

In regular operation, PA(z) net is subtracted from PA:

Reference transducer pressure	**=**	**(Uncorrected pressure • PM)**	**+**	**(PA - Pa(z)net)**

(See Section 5.4.1 Principle, PA/PM Coefficients)

❍ OPERATION

To access the autozero, press 1AutoZ under 4Internal of the SPECIAL menu. The display is:

```
Autozero
1View   2Edit   3Run
```

Selecting 1View allows the currently used values of PA(z)net and PA(z)tare (see Principle above) with the date that the PA(z)net was determined to be viewed. Values for each range are stepped through by pressing ENTER repeatedly. (See Section 5.2.3)

Selecting 2Edit allows the value of PA(z) net to be changed. (See Section 5.2.3)

Selecting 3Run leads to running the autozero sequence. (See Sections 5.2.1 and 5.2.2) The display is:

```
Autozero ref sensor
1Hi     2Lo
```

Select 1Hi to run the autozero routine for the Hi (1 000 psia) reference transducer (see Section 5.2.1 Hi ref by comp at atm).

Select 2Lo to run the autozero routine for the Lo (50 psia) reference transducer (see Section 5.2.2 Lo ref by vacuum).

Access for editing autozero values independently of the automated autozero routines is provided in 2Cal of 4Internal under the SPECIAL menu. Running the PA(z)tare autozero routine or editing and activating PA(z)tare values causes the value of PA(z) net to go to zero. (See Section 5.4.4.5)

5.2.1 HI REF (BY COMP AT ATM)

❍ PURPOSE

To automatically rezero (offset) the Hi reference pressure transducer (see Section 3.4.4.1).

❍ PRINCIPLE

The autozero routine for the Hi reference pressure transducer uses the Lo reference pressure transducer as a stable reference value against which to measure zero drift. This is valid since the reference transducer zero drift is proportional to the transducer full scale and the full scale of the Hi reference transducer is 20 times greater than the full scale of the Lo reference transducer.

The Hi and Lo reference transducer readings are compared at atmospheric pressure and the difference between the two is measured. The difference found [PA(z)raw], less the "natural" difference [PA(z)tare], represents the zero drift since the last calibration of the Hi reference transducer [PA(z)net]. The "natural" difference [PA(z)tare] is the difference found between the two reference pressure transducers just after they have been calibrated.

OPERATION

The autozero by comparison at atmosphere routine builds in a three minute wait to allow the reference transducers to stabilize. For best results, a one hour wait with the PPC2 AF idle and at stable temperature before running the autozero routine is recommended.

To run the autozero routine for the Hi reference transducer select 1AutoZ under 4Internal of the SPECIAL menu. Then display is:

```
Autozero
1View       2Run
```

Select 2Run. The display is:

```
Autozero ref sensor
1Hi         2Lo
```

Select 1Hi. The display is:

```
Autozero Hi ref?
1000 psia
```

Press ENTER to confirm that you want to run the autozero routine on the Hi reference transducer (whose range is 1 000 psia). The next display is:

```
Hi ref autozero
by comp at atm
```

Press ENTER to confirm that the autozero routine used will be the comparison between the Hi and Lo reference transducers at atmosphere. The next display is:

```
ENTER when autozero
port clear & vented
```

Assure that the AUTOZERO port on the rear panel of PPC2 AF is unobstructed and exposed to atmospheric pressure. Once this has been verified, press ENTER. The next display is:

```
14.0233
seeking autozero
```

The current pressure (in current pressure units) is displayed with "seeking autozero" flashing while PPC2 AF operates internal valves to connect the Hi and Lo reference transducers together and to the AUTOZERO port and runs a pressure stability test. When the stability test has been met the next display is:

```
Collecting autozero
Wait 180 seconds
```

The 180 counts down to zero as PPC2 AF collects readings from the two reference transducers:

The next display is:

```
                    1
                    |
                    v
New PAzNet  -59   Pa
Old PAzNet  -11   Pa
                    ^
                    |
                    2
```

1. New value of PA(z)net based on the PA(z)raw just measured.
2. Value of PA(z)net currently in use.

If the autozero routine is being run as part of the calibration, the final result will be new and old PA(z)tare, not PA(z)net (see Section 5.4.4.5).

Pressing ENTER causes New PAzNet to replace the PAzNet value currently in use (Old PAzNet).

Pressing ESCAPE returns to the autozero menu without changing the current value of PA(z)net. Old PAzNet remains active and New PAzNet is lost.

PA(z)net = PA(z)raw - PA(z)tare (see Section 3.4.4.1.)

AUTOZERO BY COMPARISON AT ATMOSPHERE ERRORS

1. For autozero to proceed when "seeking autozero", stability of ± 0.000 15 psi (1 Pa)/second as measured by the Lo reference pressure transducer must be met. If the stability test is not met within 60 seconds, then "Autozero error: ATM, stability timeout" will be displayed. Press ESCAPE or ENTER to return to the autozero menu. Correct the source of instability and retry.

2. If the value of PA(z)net resulting from the current autozero routine exceeds ± 0.15 % of full scale of the Hi reference pressure transducer (1.5 psi, 100 kPa), the PA(z)Net value determined will be displayed with the message, "ERROR: data rejected". A PA(z)net greater than ± 0.15 % F.S. is assumed to indicate improper autozero conditions, faulty calibration of the Lo and/or Hi reference transducer or damage to a reference transducer. Press ENTER or ESCAPE from this error to return to the autozero menu.

3. If the value of PA(z)net resulting from the current autozero routine exceeds ± 0.015 % but is less than ± 0.15 % of full scale of the Hi reference pressure transducer (0.15, 10 kPa to 1.5 psi, 100 kPa), the PA(z)Net value determined will be displayed with the message, "WARNING: high value". A PA(z)net greater than 0.015 % F.S. may indicate improper autozero conditions, faulty calibration of the Lo and/or Hi reference transducer or damage to a reference transducer. Press ENTER to proceed to the "New PAzNet/ Old PAzNet" screen or ESCAPE to return to the autozero menu.

The autozero by comparison at atmosphere routine is always run in range H3 but the results are used to readjust PA(z)net for all the ranges of the Hi pressure reference transducer.

5.2.2 LO REF (BY VACUUM)

PURPOSE

To automatically rezero (offset) the Lo reference pressure transducer (see Section 3.4.4.1).

PRINCIPLE

The autozero routine for the Lo reference pressure transducer uses the pressure present at a specific point in the rate of change of pressure curve of the low pressure reference transducer as it goes down from atmosphere in response to the application of vacuum as a repeatable reference point.

The Lo reference transducer is isolated at atmospheric pressure from the AUTOZERO port by a solenoid valve (see Section 1.2.7). A vacuum is applied to the AUTOZERO port. The Lo reference transducer autozero isolation valve is opened applying the vacuum to the Lo reference transducer. The transducer's response to the application of vacuum under these controlled conditions is a repeatable rate of change of pressure curve. In subsequent applications of vacuum, at the same rate of change of pressure point, the same pressure is applied. This point is not assumed to be accurate in the absolute sense; it is a repeatable baseline against which to measure zero drift over time.

The pressure indicated by the Lo reference transducer at the repeatable pressure point is recorded. The value recorded [PA(z)raw], less the "natural" reading at that point [PA(z)tare], represents the zero drift since the last calibration of the Lo reference transducer [PA(z)net]. The "natural" reading [PA(z)tare], is the pressure indicated by the Lo reference transducer at the repeatable pressure point just after the Lo reference transducer has been calibrated.

OPERATION

The quality of the autozero by vacuum results are highly dependent upon use of the correct hardware and proper execution. For best results, follow these recommendations closely:

1. *Use the 1/4 in. Male X KF16 adaptor (Part No. 102519) to make the vacuum connection to the PPC2 AF AUTOZERO port.*

2. *Use a large diameter vacuum hose to connect the PPC2 AF AUTOZERO port to the vacuum source.*

3. *When instructed to apply vacuum to autozero port, be sure to apply less than 5 Pa (0.00075 psi, 40 millitorr) to the AUTOZERO port. Use a vacuum gauge with accuracy of at least ± 10 % to measure the vacuum.*

To run the autozero routine for the Lo reference transducer select 1AutoZ under 4Internal of the SPECIAL menu. Then display is:

```
Autozero
1View   2Edit   3Run
```

Select 3Run. The display is:

```
Autozero ref sensor
1Hi       2Lo
```

Select 2Lo. The next display is:

```
Autozero Lo ref?
50 psia
```

Press ENTER to confirm that you want to run the autozero routine on the Lo reference transducer (whose range is 50 psia). The next display is:

```
Lo ref autozero
by vacuum
```

Press ENTER to confirm that the autozero routine used will be the application of vacuum to the AUTOZERO port. The next display is:

```
ENTER when autozero
port clear & vented
```

Assure that the AUTOZERO port on the rear panel of PPC2 AF is unobstructed and exposed to atmospheric pressure.. Once this has been verified, press ENTER. PPC2 AF operates internal valves to trap atmospheric pressure on the Lo reference transducer and isolate it from the AUTOZERO port. The next display is:

```
Stabilizing
Wait 180 seconds
```

The 180 counts down to zero to provide a three minute stabilization period for the Lo reference transducer. The next display is:

```
ENTER when autozero
port at vacuum
```

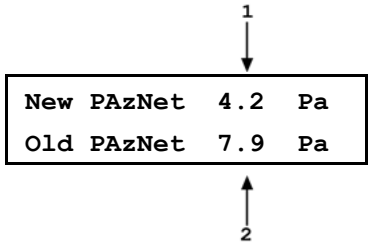
Apply vacuum of 5 Pa (0.00075 psi, 40 millitorr) or less to the AUTOZERO port. Once the vacuum is achieved, press ENTER.

When ENTER is pressed, the autozero Lo reference transducer isolation valve opens and the display is:

```
14.0372   psi a
Seeking autozero
```

The current pressure (in current pressure units) is displayed while PPC2 AF seeks the reference rate of change of pressure point. When the reference rate of change of pressure has been achieved the display is:

1. New value of PA(z)net based on the PA(z)raw just measured.
2. Value of PA(z)net currently in use.



If the autozero routine is being run as part of the calibration, the final result will be new and old PA(z)tare, not PA(z)net (see Section 5.4.4.5).

Pressing ENTER causes New PAzNet to replace the PAzNet value currently in use (Old PAzNet).

Pressing ESCAPE returns to the autozero menu without changing the current value of PA(z)net. Old PAzNet remains active and New PAzNet is lost.

PA(z)net = PA(z)raw - PA(z)tare (see Section 3.4.4.1)

AUTOZERO BY VACUUM ERRORS

1. For autozero to proceed when "seeking autozero", a pressure rate of change of less than - 0.2 Pa/second as measured by the Lo reference pressure transducer, must have been established. If the rate of change test is not met within 300 seconds, then "Autozero error: vacuum rate timeout" will be displayed. Press ESCAPE or ENTER to return to the autozero menu. Correct the leak or other problem with vacuum source and retry.

2. If the value of PA(z)net resulting from the current autozero routine exceeds ± 0.15 % of full scale of the Lo reference pressure transducer (0.075 psi, 0.5 kPa), the PA(z)Net value determined will be displayed with the message, "ERROR: data rejected". A PA(z)net greater than ± 0.15 % F.S. is assumed to indicate improper autozero conditions, faulty calibration or damage to the Lo reference transducer. Press ENTER or ESCAPE from this error to return to the autozero menu.

3. If the value of PA(z)net resulting from the current autozero routine exceeds ± 0.015 % but is less than ± 0.15 % of full scale of the Hi reference pressure transducer (0.0075 psi, 0.05 kPa), the PA(z)Net value determined will be displayed with the message, "WARNING: high value". A PA(z)net greater than ± 0.015 % F.S. may indicate improper autozero conditions, faulty calibration or damage to the Lo reference transducer. Press ENTER to proceed to the "New PAzNet/ Old PAzNet" screen or ESCAPE to return to the autozero menu.

The autozero by vacuum routine is always run in range L3 but the results are used to readjust PA(z)net for all the ranges of the Lo pressure reference transducer.

5.2.3 VIEWING AND EDITING AUTOZERO VALUES

❍ PURPOSE

To view and edit autozero information.

❍ OPERATION

Viewing Autozero Information

To view current autozero information use 1View of 1AutoZ of 4Internal under the SPECIAL menu. Then select the reference transducer (Hi or Lo) for which you desire to view the information. After selecting the reference transducer, pressing ENTER steps through displays of autozero information for each range.

The information displayed includes:

- *autozero date:* The date at which the last autozero function was executed or autozero values were edited [YYMMDD].
- *PA(z)net:* The currently used value of PA(z)net [Pa].
- *PA(z)tare:* The currently used value of PA(z)tare [Pa].

Editing Autozero Information (PA(z)net)

To edit the value of PA(z)net use 2Edit of 1AutoZ of 4Internal under the SPECIAL menu. Then select the reference transducer (hi or lo) for which you desire to edit the information. After selecting the reference transducer pressing ENTER steps through each range identifying the range in one display and presenting the information to be edited in the next screen.

After the last range of the selected reference transducer has been displayed, if PA(z)net for any range has been edited, a display giving the choice of whether to activate the edited value or not is presented. Selecting 1Yes causes the edited value to be implemented. Selecting 2No returns to the reference transducer choice without implementing edits.

The PA(z) date is changed automatically to the current date using the PPC2 AF internal calendar when an edit of PA(z)net is activated or when the autozero routine is executed.

Editing Autozero Information (PA(z)tare)

The determination of PA(z)tare is considered part of the calibration process of the PPC2 AF and the value of PA(z)tare is considered to be calibration data. Therefore, running the PA(z)tare routine and editing of PA(z)tare are included in the calibration function, not the autozero function (see Section 5.4.4.5).

To edit the value of PA(z)tare use 2Edit of 2Cal of 4Internal under the SPECIAL menu. Then select the reference transducer (hi or lo) and range (1, 2 or 3) for which you desire to edit information. After selecting the reference transducer and range, pressing ENTER displays the calibration date and range full scale and then steps through the current values of PA, PM and PA(z)tare. These values can be edited.

If any value is edited, a display giving the choice of whether to activate the edited value or not is presented. Selecting 1Yes causes the edited value to be implemented. Selecting 2No returns to the reference transducer choice without implementing edits.

5.3 ADJUSTMENT OF BAROMETER

PURPOSE

To adjust the output of the on-board barometer (see Section 1.2.6).

PRINCIPLE

The on-board barometer output can be adjusted using PA and PM values in the same manner as for the reference pressure transducers (see Section 5.4.1 Principle, PA/PM Coefficients)

OPERATION

To edit the values of PA and PM for the barometer, use 2Edit of 2Cal of 4Internal under the SPECIAL menu. Then select 1Barometer. Pressing ENTER steps through displays of the calibration date [YYMMDD] and PA/PM [Pa]. Edit these values as desired. Pressing ENTER after the last screen activates the values.

To view the current atmospheric pressure measurement made by the barometer board use 7Atm under 4Internal of the SPECIAL menu (see Section 3.4.4.7).

5.4 CALIBRATION OF REFERENCE TRANSDUCERS

5.4.1 PRINCIPLE

PPC2 AF has two reference pressure transducers that are used as the source of accurate pressure measurement for the system. Each transducer has three ranges as follows:

REFERENCE TRANSDUCER AND RANGE NUMBER	RANGE (PSI) GAUGE/ABSOLUTE	MAIN RUN SCREEN INDICATION
Lo, 1(Lo)	0/15	L1
Lo, 2(Mid)	15/30	L2
Lo, 3(Hi)	35/50	L3
Hi, 1(Lo)	300/300	H1
Hi, 2(Mid)	600/600	H2
Hi, 3(Hi)	1 000/1 000	H3

To calibrate a range, pressures from a standard are applied to the reference transducer at ascending and descending pressures over the range. The transducer readings relative to the pressure standard are recorded at each point and then adjustments are made to fit the pressure readings to the standard. Fitting the readings means performing a linear regression to arrive at the lowest value of the residuals of errors of the transducer relative to the standard. The transducer readings are adjusted using a user setable PA (an adder or offset) and PM (a multiplier or span set) (see PA/PM Coefficients below).

The adjustment process is performed independently on each range for each pressure transducer to arrive at the optimal fit for each range. This technique allows improved accuracy for individual ranges lower than the transducer full range by taking into account specific transducer performance characteristics, in particular localized non-linearity and excursion dependent hysteresis.

The calibration process of a reference pressure transducer has a second step which is the experimental determination of the value of PA(z)tare (see Setting PA(z)tare below) to allow the Autozero function to accurately reset the offset between calibrations (see Section 3.4.4.1).

PPC2 AF supports an on-board calibration routine to step the operator through performing the complete reference transducer calibration procedure including applying the necessary pressures to each range, determining PA(z)tare, automatically calculating new PA/PM values, previewing the results of the new calibration and activating the results of the new calibration (see Section 5.4.4). The option of performing the calibration without using the on-board calibration routine is also available (see Section 5.4.5).

PA/PM Coefficients

The coefficients used to adjust transducer readings are designated PA (an adder or offset) and PM (a multiplier or span set). The coefficients affect the transducer reading following:

Corrected reading = (uncorrected reading • PM) + PA

PA is expressed in units of pressure (always the SI unit, Pa).

PM is dimensionless.

There are individual PA/PM values for each of PPC2 AF's six ranges. The current PA/PM values used can be viewed in the calibration function (see Section 5.4.6). PA/PM values are automatically edited when the on-board reference transducer calibration function is used and the results are activated (see Section 5.4.4). PA/PM values can also be edited directly under the calibration function (see Section 5.4.5).

The PA/PM values used by the on-board calibration function and accessible under SPECIAL, 4Internal, 2Cal are the user PA/PM values. These values are set at the factory on a new PPC2 AF to have no effect (PA = 0, PM = 1). Thus, their change over time can be used as a measure of the evolution over time of the reference pressure transducer calibration. PA/PM values are also available under SPECIAL, 4Internal, 5Diag, 2Calib. These are the factory PA/PM values and should not be changed by the user.

As editing PA/PM values will change the calibration of the reference pressure transducers, they should only be edited by qualified personnel as part of the calibration process. Care should be taken to avoid accidental editing (see Section 2.4.2). For recalibration, only the user PA/PM in SPECIAL, 4Internal, 2Cal menu should be used. The factory PA/PM in SPECIAL, 4Internal, 5Diag, 2Calib should not be altered.

Setting PA(z)tare

Setting PA(z)tare is necessary for the AutoZ function that "rezeros" the reference transducers between calibrations to function properly (see Section 5.2).

Setting PA(z)tare is procedurally identical to running the AutoZ function but the result is changes to the PA(z)tare value rather than the PA(z)net value. The PA(z)tare setting procedure occurs automatically as part of the on-board reference pressure transducer calibration procedure. It can also be run separately under SPECIAL, 4Internal, 2Cal.

As the PA(z)tare must reflect the "natural" error between the reference transducer reading and the zero reference pressure at the time the reference transducer is calibrated, the PA(z)tare function should not be executed between calibrations. Only the AutoZ function should be used to "rezero" the reference transducer between calibrations (see Section 5.2).

Order of Operations

Given certain interdependence of reference pressure transducer measurements it is important that the calibration and determination of PA(z)tare be performed in a certain order as follows:

1. Calibrate the range or ranges to be calibrated on the Lo reference transducer.
2. Determine PA(z)tare of the Lo reference transducer.
3. Calibrate the range or ranges to be calibrated on the Hi reference transducer.
4. Determine PA(z)tare of the Hi reference transducer.

This order is required because a) the PA(z)tare value of a reference transducer must reflect the "natural" error of the transducer after the transducer has been calibrated (see Section 5.2) and b) the PA(z)tare of the Hi reference transducer is determined relative to the Lo reference transducer.

As Received/As Left Data

Frequently, calibration reports require that as received and as left data be reported. The necessary information to report as received and as left data on the calibration of PPC2 AF reference pressure transducers can be obtained in several ways.

When the PPC2 AF on-board calibration procedure is used, as received data for each point is displayed as the calibration points are being taken and can be recorded at that time. As left data for any range that has been calibrated can be viewed in the Cal function (see Section 5.4.6).

In addition, knowledge of pressures applied, associated transducer readings and PA/PM and PA(z) net values can be used to calculate as received/as left values. For example, reversing PA/PM on the as left reference transducer readings provides the transducer readings with PA = 0 and PM = 1. Then applying the as received PA/PM and PA(z)net values to the readings calculates "as received" readings (the readings that the transducer would have made with the old PA/PM and PA(z)net).

It is recommended that "as received" values of PA/PM and PA(z)net be recorded for each range prior to running the calibration. The current PA/PM can be viewed under SPECIAL, 4Internal, 2Cal, 1View. PA(z)net's current value can be viewed under SPECIAL, 4Internal, 1AutoZ, 1View.

5.4.2 EQUIPMENT REQUIRED

1. **Gas operated piston gauge (deadweight tester):** able to set absolute pressures at 20 % increments in the range to be calibrated.

   It is not necessary that the calibration pressure standard used apply precisely the nominal pressure value requested for a calibration point as long as the exact value of the applied pressure is known. Best results will be obtained if the pressure actually applied is within ± 2 % of F.S. of the range being calibrated from the nominal increment. On the Lo reference pressure transducer, a piston gauge able to set absolute pressures relative to a vacuum reference must be used and the zero psia point should be set using the lowest accurate pressure point of the piston gauge. On the Hi reference pressure transducer, if desired, a gauge pressure piston gauge combined with an accurate barometer can be used to determine the absolute pressures applied. In that case, atmospheric pressure can be used as the zero point and the barometers reading as the pressure applied by the standard.

2. **Vacuum pump, vacuum gauge and connecting hardware:** Needed only if the Lo reference transducer is being calibrated for performing the setting PA(z)net procedure (see Section 5.2.2 for hardware specifications).

5.4.3 SET-UP AND PREPARATION

To set-up and prepare the PPC2 AF for calibration of a reference transducer:

1. Set the PPC2 AF on a stable surface near the calibration standard at as close as possible to the calibration standard's reference height. Consider the connections that may need to be made to the rear panel and access to the front panel display and keypad.
2. Connect a pressure supply greater than the maximum pressure to be applied during the calibration to the PPC2 AF rear panel SUPPLY port (1/8 in. NPT F).
3. If the calibration will include pressures under atmospheric pressure, connect a vacuum pump to the PPC2 AF rear panel EXHAUST port (1/4 in. NPT F). There will be a constant bleed of gas through the EXHAUST port so the vacuum pump should be self-venting or disconnected when "off".
4. If the Lo reference pressure transducer is to be calibrated, install a 1/4 in. NPT M X KF16 adaptor (P/N 102519, provided with PPC2 AF accessories) on the PPC2 AF rear panel AUTOZERO port and leave room for connecting and disconnecting the vacuum line. Leave this port open to atmosphere.

5. Connect the calibration standard output to the PPC2 AF rear panel TEST port (1/4 in. NPT F).
6. Set PPC2 AF to desired pressure unit (see Section 3.2.2) and be sure "head" correction is off (see Section 3.2.7).

NEVER apply pressure to the TEST port without having a pressure supply equal to or greater than the applied pressure connected to the supply port and NEVER cause a sudden external change in pressure as damage to internal PPC2 AF components could result. (See Section 2.3.5) It is recommended when using a piston gauge to calibrate PPC2 AF, that the PPC2 AF direct pressure control keys (see Section 3.1.2.2) be used to change the pressure rather than the piston gauge valves. The piston gauge vernier can be used for fine pressure adjustment.

5.4.4 ON-BOARD REFERENCE TRANSDUCER CALIBRATION FUNCTION

5.4.4.1 OVERVIEW

The on-board reference transducer calibration function is provided to simplify the calibration process by prompting the user through the procedure, automatically calculating new calibration coefficients and activating those coefficients if desired.

The calibration function handles the calibration of the Hi and Lo reference pressure transducers independently. When calibrating a reference transducer, any combination of its three ranges can be calibrated/not calibrated.

Calibration can also be performed without using the on-board calibration function (see Section 5.4.5).

❍ **SUMMARY OF ON-BOARD CALIBRATION FUNCTION OPERATION**

The on-board calibration proceeds as follows:

1. Select reference transducer to be calibrated (Hi or Lo) (see Section 5.4.4.2).
2. Decide whether to calibrate Rng3 of the selected reference transducer (see Section 5.4.4.3). If yes, calibrate it. (see Section 5.4.4.4).
3. Decide whether to calibrate Rng2 of the selected reference transducer. If yes, calibrate it, if no decide what PA/PM (see Section 5.4.1) will be used for it.
4. Decide whether to calibrate Rng1 of the selected reference transducer. if yes, calibrate it, if no decide what PA/PM will be used for it.
5. Run the autozero routine to set PA(z)tare (see Section 5.4.4.5).
6. Preview the new calibration data if desired (see Section 5.4.4.6).
7. Activate results of the calibration process if desired (see Section 5.4.4.7.).

The complete procedure for one reference transducer including all three ranges requires about 2 hours to complete.

Aborting a calibration: The calibration process involves extensive sequential operations during which data is taken. If the process is aborted, the data taken will be lost and the process will have to be repeated. To avoid accidental loss of data, PPC2 AF protects against accidentally aborting the process. It is not possible to abort using ESCAPE only. The intent to abort and abandon data must be confirmed by specific key entry.

Be sure no "head" correction is active before running.

5.4.4.2 SELECTION OF REFERENCE TRANSDUCER (HI, LO) TO CALIBRATE

❍ **OPERATION**

From the main run screen select SPECIAL menu, 4Internal, 2Cal, 3Run, 1Reference. The display is:

```
Run ref sensor cal
1Hi          2Lo
```

Select the reference transducer desired and press ENTER on confirmation screen or ESCAPE to change selection. Go to Section 5.4.4.3.

When calibrating both the Lo and Hi reference transducer the Lo reference transducer should be calibrated first as it will be used as the reference for setting PA(z)tare on the Hi reference transducer (see Section 5.4.1).

5.4.4.3 SELECTION OF RANGE TO CALIBRATE AND ASSIGNMENT OF PA/PM

❍ **PRINCIPLE**

After having selected the reference transducer to calibrate (Hi or Lo) the opportunity to calibrate/not calibrate, each range (Hi, Mid, Lo) of the selected reference transducer is offered. Any combination of calibrate/not calibrate ranges is possible:

Summary of PA/PM Assignment Rules

If a range is calibrated, PA/PM will be recalculated for that range from the calibration data just collected (see Section 5.4.1 Principle, PA/PM Coefficients).

If a range is not calibrated the option is offered to retain the old PA/PM or apply the PA/PM of a higher range that has been calibrated as part of the current calibration procedure. This feature makes it easy to calibrate the Hi range only and assure that the Mid and Lo ranges will be consistent with it if they are not calibrated. It also makes it possible to calibrate ranges individually without interfering with the calibration of another range.

❍ **OPERATION**

Following selection and confirmation of the reference transducer to be calibrated, the display is:

```
Cal Rng3(Hi) of
Hi ref? 1Yes 2No
```

Press 1Yes to proceed with the calibration of Rng3(Hi) (see Section 5.4.4.4).

Press 2No to refuse calibration of Rng3(Hi). From the confirmation screen that follows press ESCAPE to return to the "Cal Rng3(Hi)" screen or press ENTER to continue. The PA/PM of Rng3(Hi) will be unaltered by this calibration procedure. The next display is:

```
Cal Rng2(Hi) of
Hi ref? 1Yes 2No
```

Press 1Yes to proceed with the calibration of Rng2(Mid) (see Section 5.4.4.4).

Press 2No to refuse calibration of Rng2(Mid). From the confirmation screen that follows press ESCAPE to return to the "Cal Rng2(Mid)" screen or press ENTER to continue. If Rng3(Hi) was calibrated as part of this procedure, the option to use the new Rng3(Hi) PA/PM or to retain the old PA/PM for Rng2(Mid) is offered. If Rng2(Mid) is not calibrated as part of this procedure, the PA/PM of Rng2(Mid) will be unaltered by this calibration procedure. The next display is:

```
Cal Rng1(Hi) of
Hi ref?  1Yes  2No
```

Press 1Yes to proceed with the calibration of Rng1(Lo) (see Section 5.4.4.4).

Press 2No to refuse calibration of Rng1(Lo). From the confirmation screen that follows press ESCAPE to return to the "Cal Rng1(Lo)" screen or press ENTER to continue. The option to use the new PA/PM of any higher range that has been calibrated as part of this procedure or to retain the old PA/PM for Rng1(Lo) is offered. If Rng1(Lo) is not calibrated as part of this procedure, the PA/PM of Rng1(Lo) will be unaltered by this calibration procedure.

Following Rng1(Lo):

- If no range has been calibrated the display returns to the "Run cal" screen (see Section 5.4.4.2).
- If any range has been calibrated, the next step in the calibration procedure is the determination of PA(z)tare for the reference transducer being calibrated. Go to 5.4.4.5 Setting PA(z)tare.

5.4.4.4 RUNNING THE CALIBRATION OF A RANGE

❍ **PRINCIPLE**

Running the calibration of a range requires applying absolute pressures in 20 % F.S. ascending and descending points starting and ending at zero (see Sections 5.4.2.and 5.4.3).

Summary of Calibrate a Range Sequence

The running of calibration of a pressure range using the on-board calibration sequence proceeds as follows:

1. Prompt announces reference transducer (Hi or Lo) and range (1, 2 or 3) being calibrated and the number of the next calibration point (1 to 11). Press ENTER to continue.
2. Display of PPC2 AF measured pressure, current calibration point number and instruction of calibration pressure to set. Apply calibration pressure and press ENTER to continue.
3. Display of PPC2 AF measured pressure, current calibration point number and 180 second countdown for stabilization. Wait 180 seconds until count down ends.
4. Display requesting "ENTER standard pres." with entry field for the pressure applied by the pressure calibration standard and current calibration point number. Edit the pressure applied by the calibration standard and press ENTER.
5. Display of "ENTER to take point", PPC2 AF measured pressure and current calibration point number. Observe the PPC2 AF measured pressure and the pressure calibration standard. When ready, press ENTER to take the PPC2 AF reading for this calibration point.
6. Display of RESULTS screen for the calibration point. Indicates recorded PPC2 AF pressure reading, calibration standard and calibration point number. Press ENTER to accept the results or ESCAPE to reenter the calibration standard pressure and repeat the PPC2 AF reading.
7. Go to 1. above for the next calibration point.

For information on making changes during the running of a calibration see Backing Up in the Calibration, Repeating Points, Aborting below.

❍ **OPERATION**

See Section 5.4.3. before beginning a calibration process.

The basic calibration sequence repeats for each point, 1 through 11. The first screen of each point provides a reminder of the range and reference transducer being calibrated and indicates the point that is about to be executed:

```
Cal Rng3, Hi ref
Point 3
```

Press ENTER to proceed with the point. The next screen provides a display of current pressure as measured by the reference transducer and range being calibrated using the current PA/PM and PA(z)net and an instruction of the pressure to be applied by the calibration standard for the point:

```
14.50  psi a  Pt1
Set  200    psi  a
```

It is not necessary that the pressures applied be equal to the nominal pressure value requested for the point as long as the exact value of the applied pressure is entered. Best results will be obtained if the pressure actually applied is within ± 2 % of F.S. of the range being calibrated from the nominal increment. On the Lo pressure reference transducer, the zero psia point should be set using the lowest accurate pressure point of the piston gauge being used as a standard.

Apply the requested pressure using direct pressure control keys (see Section 3.1.2.2) and press ENTER when ready. The next screen provides a 180 second countdown to allow full stabilization of the system and reference transducer at the set pressure:

```
199.97   psi a Pt1
wait 180 seconds
```

The 180 counts down to zero. During the countdown time, maintain the pressure constant. When the countdown completes, the screen prompts for entry of the pressure applied by the calibration standard:

1. Entry field for entering the exact value of the pressure applied by the calibration standard. Comes up with the nominal pressure for this calibration point.

```
ENTER standard pres.
 200  psi  a    Pt1
```

1

Enter the exact pressure applied by the calibration standard. The next screen displays the current reading of the reference transducer and range being calibrated and prompts for ENTER to log the reading:

1. Current reading of the reference transducer and range being calibrated.

```
ENTER to take point
199.97  psi a    Pt1
```

1

When ENTER is pressed, the reading is taken from the reference transducer and range being calibrated and the RESULT screen is presented:

```
199.97  psi a    Pt1
200   std   RESULT
```

Observe and check the values recorded for that point. Press ENTER to accept the results and proceed, press ESCAPE to make changes (see Backing Up in the Calibration, Repeating Points, Aborting below).

The RESULT display is the only opportunity offered to record "as received" data for the reference transducer and range being calibrated. If you want a record of as received data without having to perform calculations after the calibration, record each result screen as it is presented.

When the RESULT screen is accepted by pressing ENTER, execution proceeds to the next calibration point. Go to the first screen of OPERATION above.

After the last point (Pt11) of calibration of the current range has been completed, execution proceeds with selection of the next range to calibrate. Go to Section 5.4.4.3.

After the last point (Pt11) of calibration of the Lo (1) range has been completed, execution proceeds to the determination of PA(z)tare for the reference transducer being calibrated. Go to Section 5.4.4.5.

Backing Up in the Calibration, Repeating Points, Aborting

When executing pressure calibration points, pressing ESCAPE from any of the calibration screens before the "ENTER standard pres." screen goes to the previous screen. Pressing ESCAPE from the first screen, goes to the "RESULT" screen for the previous point.

Pressing ESCAPE from any of the screens after the "ENTER standard pres." screen returns to the "ENTER standard pres." screen.

Pressing ESCAPE from the "ENTER standard pres." screen goes to a prompt asking whether to repeat the previous point. Pressing ESCAPE from that screen, goes to the ABORT calibration option.

5.4.4.5 SETTING PA(Z)TARE

❍ PRINCIPLE

PA(z)tare must be set as part of the calibration process for the PPC2 AF AutoZ function to operate properly to allow "rezeroing" between calibrations (see Section 3.4.4.1, 5.4.1 Principle Setting PA(z)tare). Therefore, the determination of PA(z)tare is included as a required step in the on-board calibration function.

❍ OPERATION

The PA(z)tare function directly follows the running of the last range of the calibration of the reference transducer being calibrated.

Operation of the PA(z)tare function is identical to the AutoZ function except that at the end of the routine, old and new PA(z) tare are displayed rather than PA(z)net. The procedure is different for the Hi and Lo reference transducers. Go to 5.2.1 Hi ref or 5.2.2 Lo ref depending on which transducer is being calibrated for a description of the PA(z)tare procedure.

5.4.4.6 PREVIEWING CALIBRATION DATA

❍ PRINCIPLE

The Preview option is offered to allow the results of the calibration just completed to be viewed prior to saving the results of the new calibration by overwriting the previous calibration information.

The preview allows viewing of each range's new PA/PM and PA(z)tare if they will be changed by the new calibration. It also allows viewing of the "as left" data that will result for any range that was actually calibrated, if the calibration is activated (see Section 5.4.4.7). "As left" data shows the pressures applied by the standard and the corresponding reference transducer readings having applied the new PA/PM resulting from the calibration (see Section 5.4.1. Principle, PA/PM Coefficients).

❍ OPERATION

Once the PA(z)tare procedure is complete, the Preview option is offered.

```
Hi ref cal complete
Preview 1Yes  2No
```

Press 2No to proceed to activating calibration results (see Section 5.4.4.7).

Press 1Yes to preview. The display is:

```
Preview Hi ref cal
1Rng1  2Rng2  3Rng3
```

Select the range to be previewed.

If no changes have been made to the range selected, the prompt "This range not calibrated" will be displayed.

If the PA/PM of the range selected have been changed by carry over of the PA/PM from another range, the new PA/PM and PA(z)tare can be previewed.

If the range selected has been calibrated, the new PA/PM and PA(z)tare can be previewed along with displays of "as left" data showing the calibration pressure applied by the standard and reference transducer reading using the new PA/PM at each point.

To leave the preview function and proceed to activation of calibration results, press 2No in the "Preview?" screen.

5.4.4.7 ACTIVATING CALIBRATION RESULTS

❍ **OPERATION**

The display is:

```
Hi ref cal complete
Activate?  1Yes  2No
```

Press 1Yes to activate the results of the current calibration procedure including changing of PA/PMs, recording of as left data if available and changing the recorded calibration date. An activate screen will appear momentarily before returning to the "Run cal" screen.

Press 2No to go to the abort calibration procedure.

Reference Transducer Calibration Without Using the On-Board Transducer Calibration Function.

❍ **PRINCIPLE**

5.4.5 THE REFERENCE PRESSURE TRANSDUCERS CAN BE CALIBRATED WITHOUT USING THE ON-BOARD CALIBRATION FUNCTION. THIS REQUIRES:

1. Applying pressure with a calibration standard and recording the pressures measured by PPC2 AF.
2. Calculating new PA/PM values and entering them.
3. Setting PA(z)tare for the calibrated reference pressure transducer.

Before proceeding to calibrate a reference pressure transducer without using the on-board calibration routine, sections 5.4.1 to 5.4.4 should be reviewed thoroughly.

❍ **OPERATION**

The following provides a recommended procedure for calibrating a range of a reference transducer:

1. Set-up and prepare the PPC2 AF for calibration (see Sections 5.4.2 and 5.4.3).
2. From the main run screen, using the RANGE function key, select the reference transducer and range to be calibrated (see Section 3.2.1).
3. Under SPECIAL, 4Internal, 2Cal, 1View, 2Ref, read and record the current values of PA/PM.
4. Under SPECIAL, 4Internal, 1AutoZ, 1View, read and record the current value of PA(z)net.
5. Run the calibration pressures for the range recording the pressure applied by the standard and the PPC2 AF reading at each calibration point. The data recorded is the "as received" data for this calibration.

6. Enter the calibration pressure and PPC2 AF readings into a spreadsheet. Calculate the "non-corrected" PPC2 AF readings by backing out the PA, PM and PA(z)net recorded in 2. and 3. above following:

non-corrected reading = (corrected reading - PA - Pa(z)net)/PM

7. Perform a linear regression to find the offset and slope that best fits the non-corrected PPC2 AF readings to the calibration standard pressures. The offset is the new value of PA, the slope is the new value of PM.
8. Under SPECIAL, 4Internal, 2Cal, 2Edit, 2Ref, write the new values of PA/PM and the new calibration date for the reference transducer and range calibrated.
9. Under SPECIAL, 4Internal, 2Cal, 3Run, 2PA(z)tare, set the PA(z)tare for the reference transducer and range calibrated by running PA(z)tare.
10. Calculate as "left data" for the calibration if desired following:

as left reading = (non-corrected reading • new PM) + new PA

5.4.6 VIEWING REFERENCE TRANSDUCER CALIBRATION INFORMATION

❍ OPERATION

The data pertaining to a reference transducer calibration can be viewed using SPECIAL, 4Internal, 2Cal, 1View and then selecting the reference transducer and range.

Calibration data that can be viewed includes the current values of:

- Calibration Date
- PA
- PM
- PA(z)Tare
- As left calibration points if the last calibration for this reference transducer and range was performed using the on-board calibration function.

To view the current value of PA(z)net, use SPECIAL, 4Internal, 1AutoZ, 1View.

As left calibration data points are only available for ranges whose calibration was included in the last calibration sequence. For example, if only Rng1 is calibrated there will be no as left data for Rng2 and Rng3, even if there was data previously.

5.5 DIAGNOSTIC FUNCTION

The PPC2 AF diagnostic menu allows access to advanced functions that allow the user to view low level data and to edit manufacturer calibration settings that alter the operation of the PPC2 AF. Users should not access this menu without instruction from DH Instruments or full knowledge of these functions. This section assumes a high level of familiarity with the fundamentals of the PPC2 AF. Access to these functions is tracked by the PPC2 AF to deter access.

5.5.1 MODE

The Diagnostic code is a decimal number that represents a bit field used to enable specific diagnostic modes in the PPC2 AF. Most of these modes enable the PPC2 AF to print specialized data out of the COM1 port as events occur. This allows data logging using a host computer. These diagnostic modes can be 'ORed' together to allow multiple modes at the same time. Too many modes at once can cause garbled data, so this is not the usual usage. Here is a summary of these modes:

MODE = 1

KEY:	Key press & release data.
RATIO:	The New calc Ratio, slope, and pressure slope was calc at the start of each generation.
PCALC:	The pressure, up & dn offsets, common time, and up & dn normalized slopes, up & dn slope & fast down slope.
SETTLING:	When a settle cycle starts.
SETTLED:	When a settle cycle is done.
GEN_STATUS:	The generation status:
	1 A new generation is preparing to start
	2 Quick ramping to the target
	4 Quick pulsing to the target.
	8 Slow ramping to the target.
	16 Slow pulsing to the target.
	32 Reached the target, will re-adjust as needed to stay ready.
	64 Quick ramping to a vent condition.
	128 Vented with the exhaust valve open.
	256 Quickly decreasing the pressure to reach a hard vacuum.
	512 The system is not generating or holding a pressure.
METHOD:	The starting status (see GEN_STATUS), pressure, deltaP, and Slow ramp time away from target."
FASTP:	The pres, deltaP, pulse period, and fast slope.
SLOWP:	Pres, deltaP, offsetPulse, mainPulse, pulseDir, upTrim, dnTrim, pulseAtten.

MODE = 2

Echoes before each slow pulse.

SLOWP:	Pres, deltaP, upPulse, dnPulse, pulseDir, upTrim, dnTrim, pulseAtten.

MODE = 4

Echoes for each new reference measurement.

P/R:	Pres, Rate

MODE = 16

Echo the slope (cnts/v) and zero (v) of the ambient pres & ambient temp autocal cycle.

MODE = 32

Echoes the special front panel display modes DISP COUNTS or DISP PERIODS if these display modes are enabled (from the diag menu).

MODE = 64

Echoes the pneumatic table to curve interpolation data.

CURVE: Table Index, ratio, pres, rate, normalized pres, normalized rate.

MODE = 128

Echoes the low level pulse data.

PULSE: offset pulse, main pulse, offset period, main period, prescale, offset valve, main pulse valve

MODE = 256

Echoes the head calc data (if enabled).

HEAD: head calc, air density, gas density, height

MODE = 512

Echoes the user config data as it runs.

CFG: rate, direction, speed, sample#

Echoes the user config results.

CFG_RESULTS: avg rate, min, max, dir, speed

5.5.2 CALIB

The calibration functions of this selection are intended for factory use only. Use user calibration functions to perform calibrations (see Sections 5.3 and 5.4).

Allows editing of PPC2 AF reference pressure transducer, barometer, timebase, and temperature factory calibrations & settings. All changes are permanent.

5.5.2.1 DUCER

The PPC2 AF allows selection of the current range (unit must be vented) and editing of the factory adder and multiplier for the current range of the reference pressure transducer. The factory calibration of the barometer can also be edited. Adder and multipliers are calculated as:

Meas = (Meas · multiplier) + adder

5.5.2.2 TBASE

The internal timebase reference for the transducer period measurement can be edited here.

5.5.2.3 TEMP

The ambient pressure temperature measurement calibration and coef can be edited here. The coef is applied as:

AmbPres = AmbPres + ((Temp - 20) x Coef)

5.5.3 DISP

The PPC2 AF can be set to display low level measured data to aid in troubleshooting. These following display modes will replace the normal pressure display screen that appears on power up. You can return to the normal display mode by selecting 'norm' in this menu, or by pressing the ESC key while viewing the display screen. These other display modes are available:

counts: Displays the ambient pressure and ambient temperature counts. These values can be from 0 to 8 191. These will represent the internal voltage reference and ground while auto calibrating.

The first count's value is the 'X' joystick

The second is the 'Y' joystick.

The third is the ambient pressure.

The fourth is the ambient temperature.

volts: Displays the ambient pressure and temperature voltage measurements. These represent the internal voltage references while auto calibrating.

periods: The Internal pressure transducers produce frequencies that are pressure and temperature dependent. This selection displays the high and low pressure and transducer temperature frequency periods (us).

The first number is the high transducer pressure measurement period.

The second number is high transducer temperature measurement period.

The third number is the low transducer pressure measurement period.

The fourth number is the low transducer temperature measurement period.

5.5.4 RELAY

Internal relays are used to switch the measurements inputs from the normal measurements lines to the internal voltage references while auto calibrating. These can be manually switched to determine how the PPC2 AF is functioning. This along with the DISP modes can assist in troubleshooting.

This menu can also be accessed directly from the display run screen by pressing the +/- key if the display is not in the norm mode.

5.5.4.1 AMBIENT

The ambient relays menu can switch the ambient pressure and temperature inputs to ground, or the internal voltage reference. The relays will stay in this position until the next auto calibration.

5.5.4.2 ANALOGOPT

Not available.

5.5.5 VALVE

The state of the internal valves can be viewed or changed in this menu. Pressing the 1 through 8 buttons will toggle the state of the associated valve. Pressing the ENTER key will give the option to choose toggle or momentary operation. The 8 valve can only be opened if the 5 valve is currently open.

5.5.6 TEST

This selection allows testing of the COM1 and the COM2 ports. The COM1 and COM2 ports must be looped back for this test. The loop back test connector must have pin2 and pin3 connected together. This loops back the TX into the RX port.

5.5.7 LOG

The error and over pressure log can be viewed. Each log screen has the log description which appears and a second screen accessed by pressing the +/- key that has the date and time of the log entry. The ENTER key increments to the next Log.

6. TROUBLESHOOTING

PPC2 AF is a sophisticated pressure setting and measuring instrument with advanced on-board features and functions. Before assuming that unexpected behavior is caused by system defect or breakdown, the operator should use this manual and other training facilities to become thoroughly familiar with PPC2 AF operation. This troubleshooting guide is intended as an aid in identifying the reason for PPC2 AF behavior and determining whether the behavior is due to normal operation or an internal or external problem.

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Will not power up.	Blown fuse.	Replace fuse (5.1.2.1).
There is a leak through the EXHAUST port.	Normal flow through bypass of internal pressure controllers when pressure supply is connected.	None necessary if flow rate is normal (5.1.3).
Measured pressure display has too much/not enough resolution.	Resolution setting needs to be changed.	Use Res function to change resolution setting (3.3.2).
The pressure units selectable under the PRESSURE function key are not the ones you want.	UNIT function needs to be customized.	Use PresU function to customize the PRESSURE function (3.4.1)
Front panel keys seem to be disabled.	"Remote" command has been sent from a host computer.	Send "local" command from host computer or cycle PPC2 AF power.
Valve driver #8 seems to be operating erratically.	Driver #8 is used by the automated purge function	Don't use driver #8 other than to support an SPLT (3.2.8, 9.1, 9.2)
Front panel display is dim	Screen saver option has activated.	Press any key to resume full screen power.
Cannot access certain functions.	User levels have been set that restrict access to certain functions.	Change user level or consult system manager (3.4.4.6).
Displays "FATAL ERROR" or "FATAL FAULT".	Encountered unresolved internal software conflict.	Cycle power to clear. Please record conditions leading up to event including the numbers displayed when enter is pressed and report to *DHI* Technical Service.
There is a C next to the D or S control mode character on the bottom line of the display and it won't go away.	The custom control function has been used.	Reset control parameters to default by selecting a control mode using the CONTROL function (3.2.3, 3.2.6)
Pressure display is flashing.	Current upper limit of active range has been exceeded.	Correct overpressure condition. Change UL and/or active range if needed (3.2.4, 3.2.1).
A "ready" indication is never achieved.	Control parameter settings are too tight and/or existing conditions will not allow "ready".	Adjust control parameters or correct other conditions (3.1.2.4, 3.2.6).

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Will not set pressure.	Pressure and/or vacuum supply incorrectly connected or not adequate.	Correct pressure and/or vacuum supply (2.3.3, 2.3.4).
Disagreement between Hi and Lo reference transducer or between transducer ranges appears excessive.	Difference is actually in tolerance and represents “natural” disagreement..	Compare differences observed to tolerances on reference transducer measurements (1.3.2)
Disagreement between measurements made by different ranges at the same pressure is not zero but an autozero routine was just executed.	Readings by different ranges at the same pressure can disagree even after a valid autozero.	Check that disagreement between ranges is within tolerance (1.3.2, 5.2).
Will not set pressure.	Target exceeds UL range.	Check UL (3.2.4) and range (3.2.1).
Will not set pressure.	There is a very large leak in the test system or TEST port is not connected.	Correct leak.
Poor pressure control at low pressures.	ControlRef not properly set to reflect pressure conditions at EXHAUST port.	Set ControlRef properly (3.3.1).
Poor pressure control at pressures under atmosphere or inability to reach pressures under atmosphere.	Vacuum supply is incorrectly connected, is not low enough or is unstable.	Correct vacuum supply (2.3.4, 3.3.1).
Poor pressure control characterized by "hunting" around target.	Pneumatic control module needs to be reconfigured.	Reconfigure control module (5.1.1)
Poor pressure control characterized by control stopping completely near the target pressure.	Control mode is set to static rather than dynamic.	Set control mode to dynamic (3.1.2.3, 3.2.3)
Poor pressure control characterized by excessive overshooting and/or undershooting, inability to "lock-on" target.	There is a restriction in the test connection between the PPC2 AF and the test.	Remove the restriction to allow free flow between the PPC2 AF and the test.
	A filter in the PPC2 AF, the SPLT or an accessory is dirty and causing a restriction.	Clean and dry or replace the filter element (5.1.3).
Poor pressure control characterized by excessive pressure noise at control point and/or hunting around target.	Excessive leak present in system.	Correct internal or external leak (3.2.8, 5.1.2).
Poor pressure control characterized by minor overshooting.	Some overshooting is part of normal operation to speed up operation.	Check whether overshooting is within normal limits (3.1.2.3).
Poor pressure control characterized by very slow slew rate.	Test volume is beyond normal limits.	Reduce test volume if slew rate is unacceptable (1.3.3)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Poor pressure control.	Unstable or incorrect pressure supply.	Connect regulated pressure supply set to correct supply pressure (2.3.3).
Won't AutoZero at vacuum, ERROR: data rejected.	Vacuum supply is not low enough; Lo reference transducer isolation valve leaks or reference transducer needs to be recalibrated.	Assure that vacuum supply is correct, check reference transducer calibration coefficients (5.2, 2.3.4, 5.4).
Poor pressure control and measurement.	The PPC2 AF and/or the connection to the test system is contaminated with liquids.	Purge and clean affected systems (3.2.8, 5.1.3).
Apparent inaccurate pressure control/measure and little or no response from reference transducer:	Reference transducer destroyed by overpressure.	Isolate failure and have repaired as needed.
Apparent inaccurate pressure measurement/control and "H" is displayed on top line of screen.	An unplanned "head" correction is active or head height or gas is incorrect.	Remove or change "head" correction (3.2.7).
Apparent inaccurate pressure measurement/control.	Incorrect pressure units and/or measurement mode (gauge or absolute).	Set desired pressure units and/or measurement mode. Consider reference temperature if unit is inWa (3.2.2).
	Reference transducer calibration coefficients have been altered.	Check and correct calibration coefficients if needed (5.4).
Will not vent.	System is vented but does not indicate zero because measurement mode is absolute.	Check measurement mode setting and current value of atmospheric pressure if absolute (3.2.2).
	VENT port is plugged.	Open VENT port to atmosphere.
	Vent valve not operating.	Have unit serviced.

NOTES

7. PREPARTION FOR SHIPMENT OR LONG TERM STORAGE

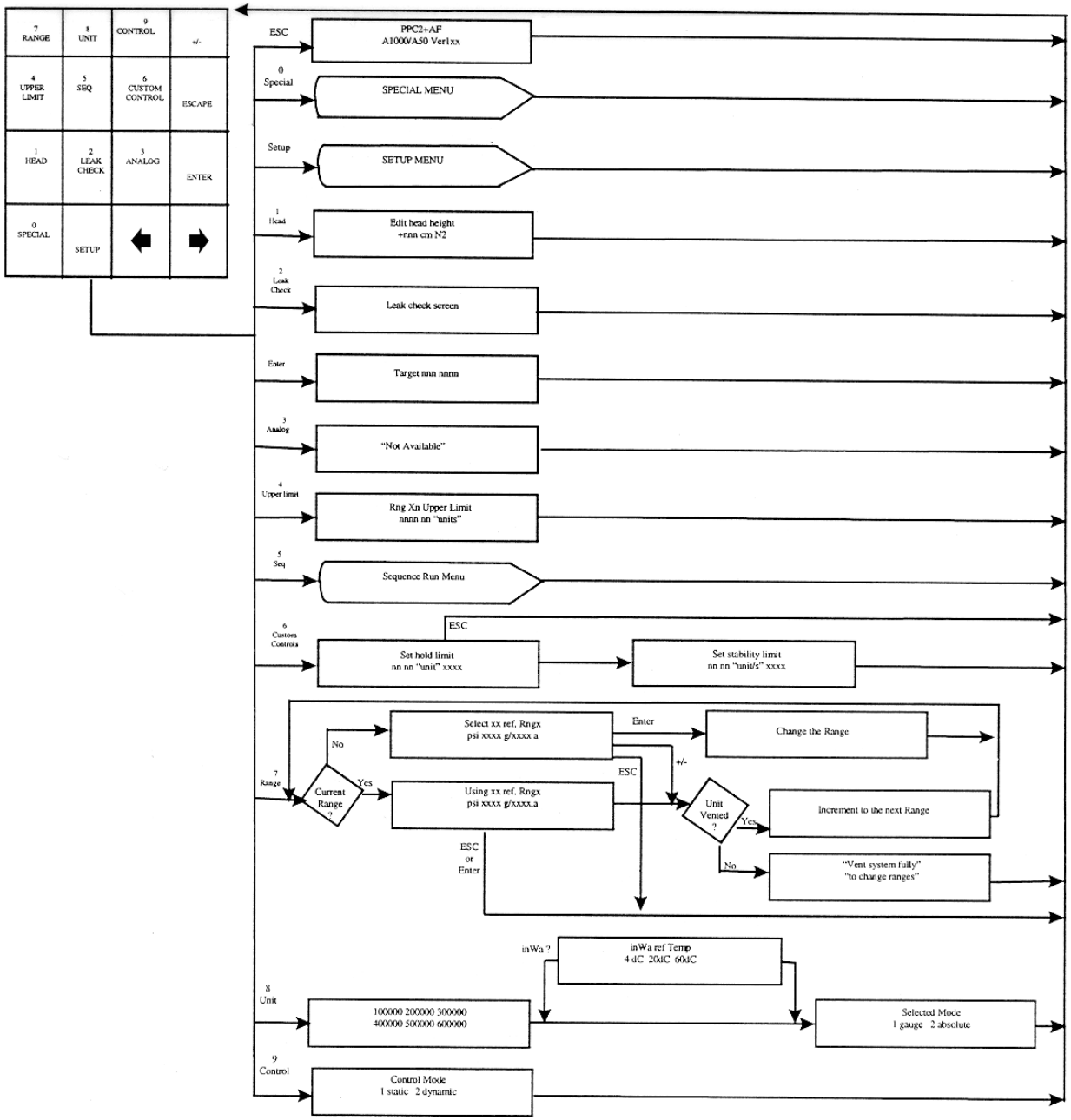
To prepare PPC2 AF for shipment or long term storage:

- Disconnect electrical supply and cable.
- Disconnect all rear panel pressure connections. Clean and cap ports.
- Remove rubber feet caps and retract legs if extended.
- Place PPC2 AF in protective plastic bag.
- Place PPC2 AF front panel down in the custom shipping and storage container in which it was delivered.
- Stow accessories and documents in container cut outs.
- Close and latch container.

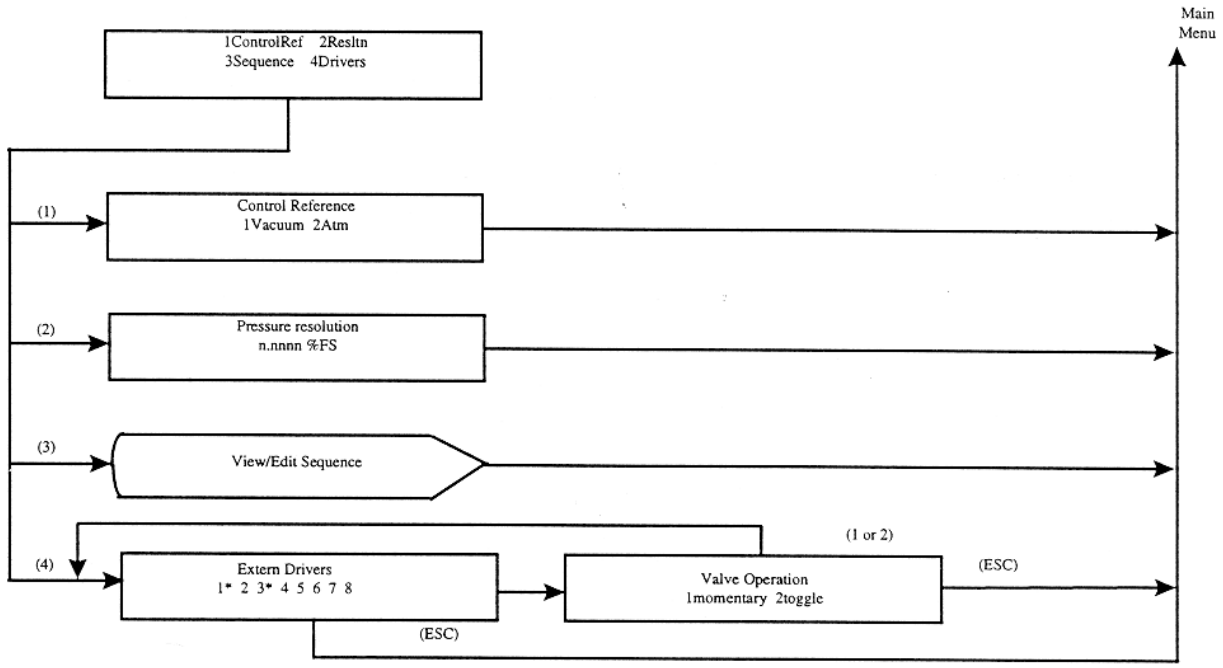
NOTES

8. MENU TREE

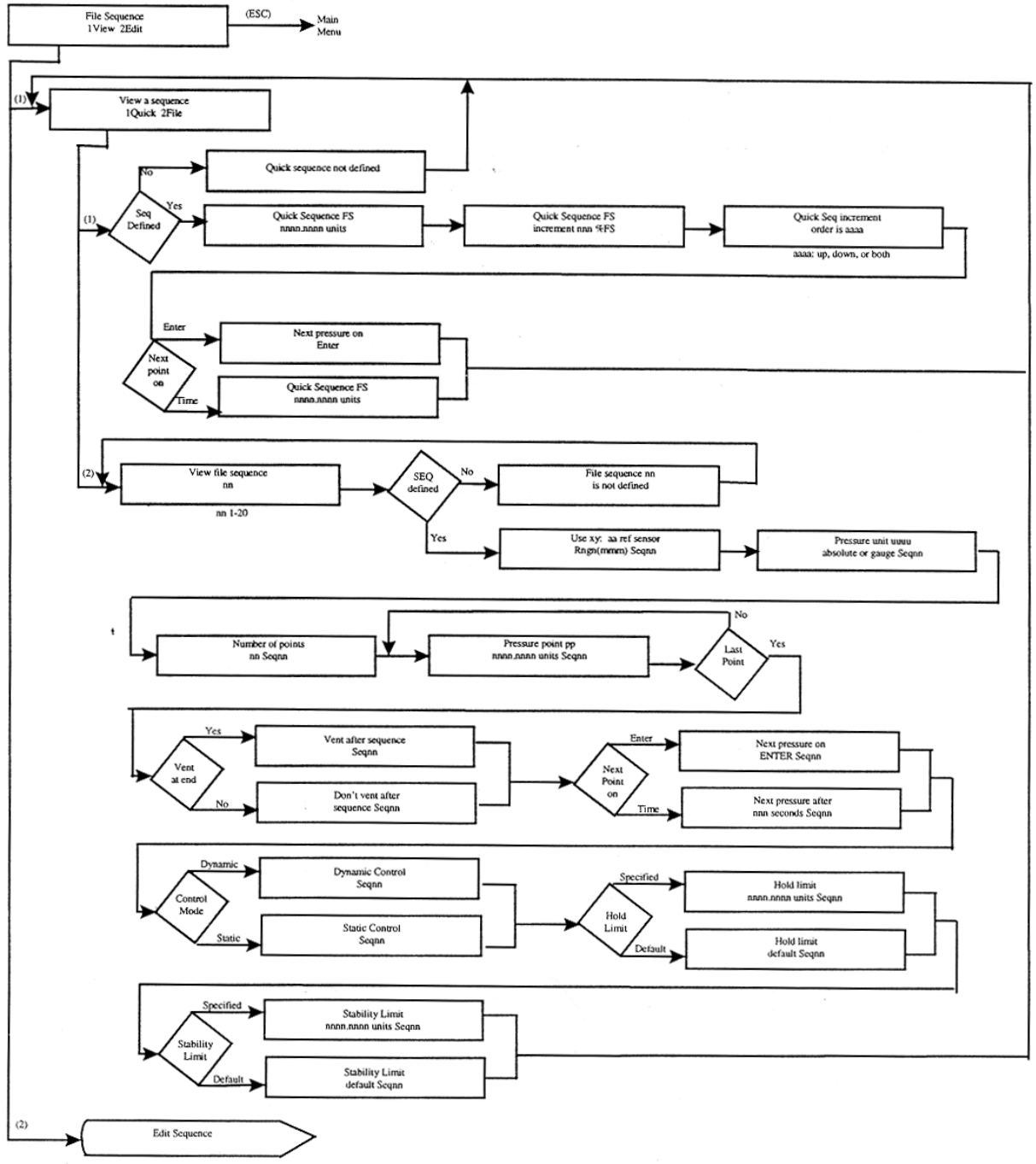
8.1 FUNCTION KEYS



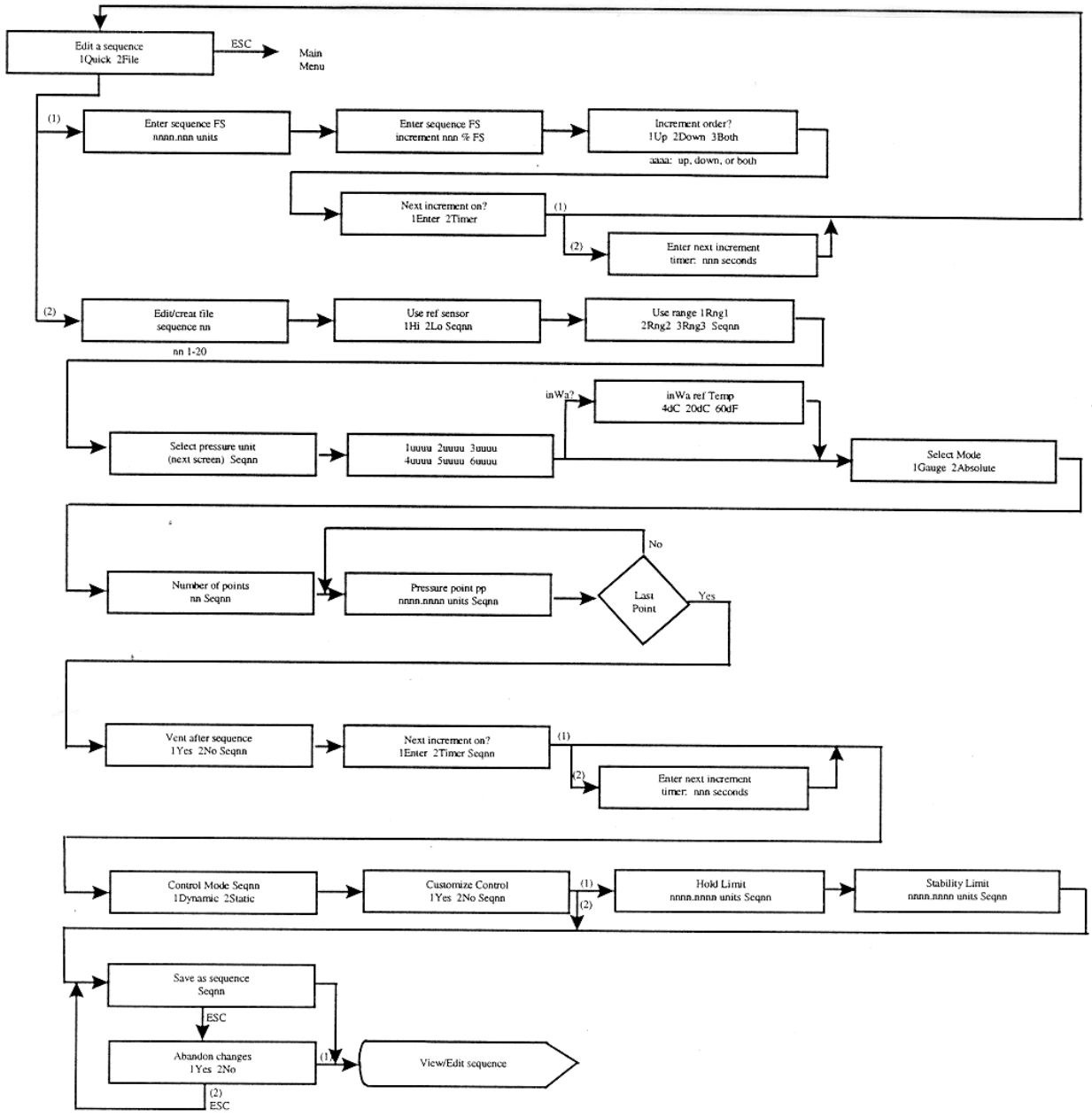
8.2 SETUP MENU



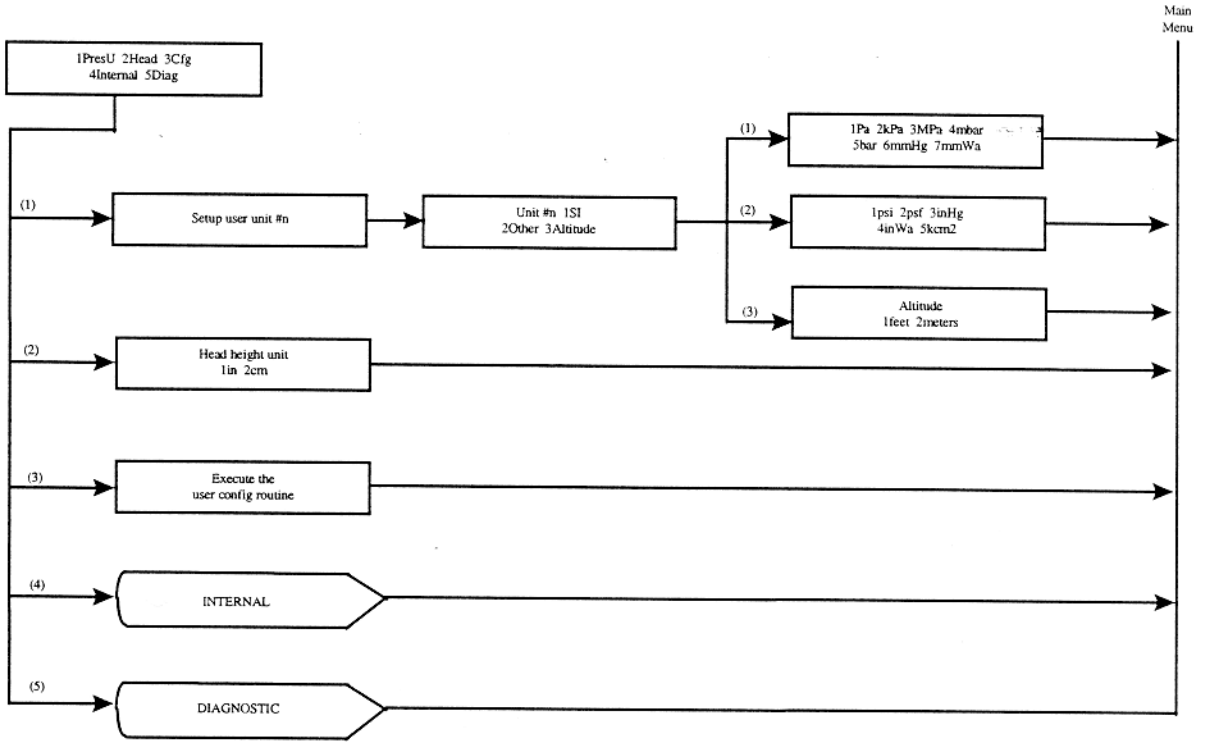
8.3 VIEW/EDIT SEQUENCE MENU



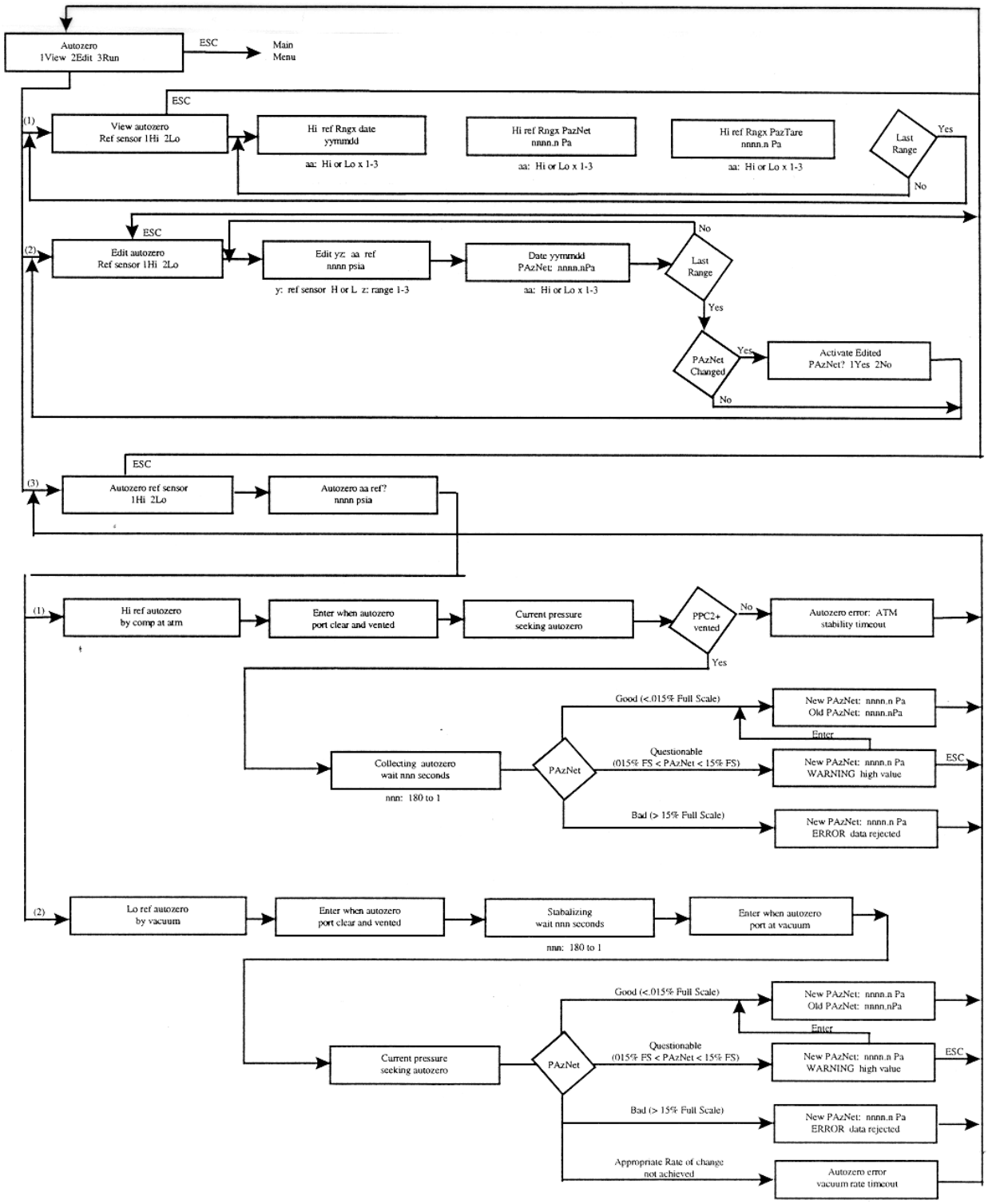
8.4 EDIT SEQUENCE MENU



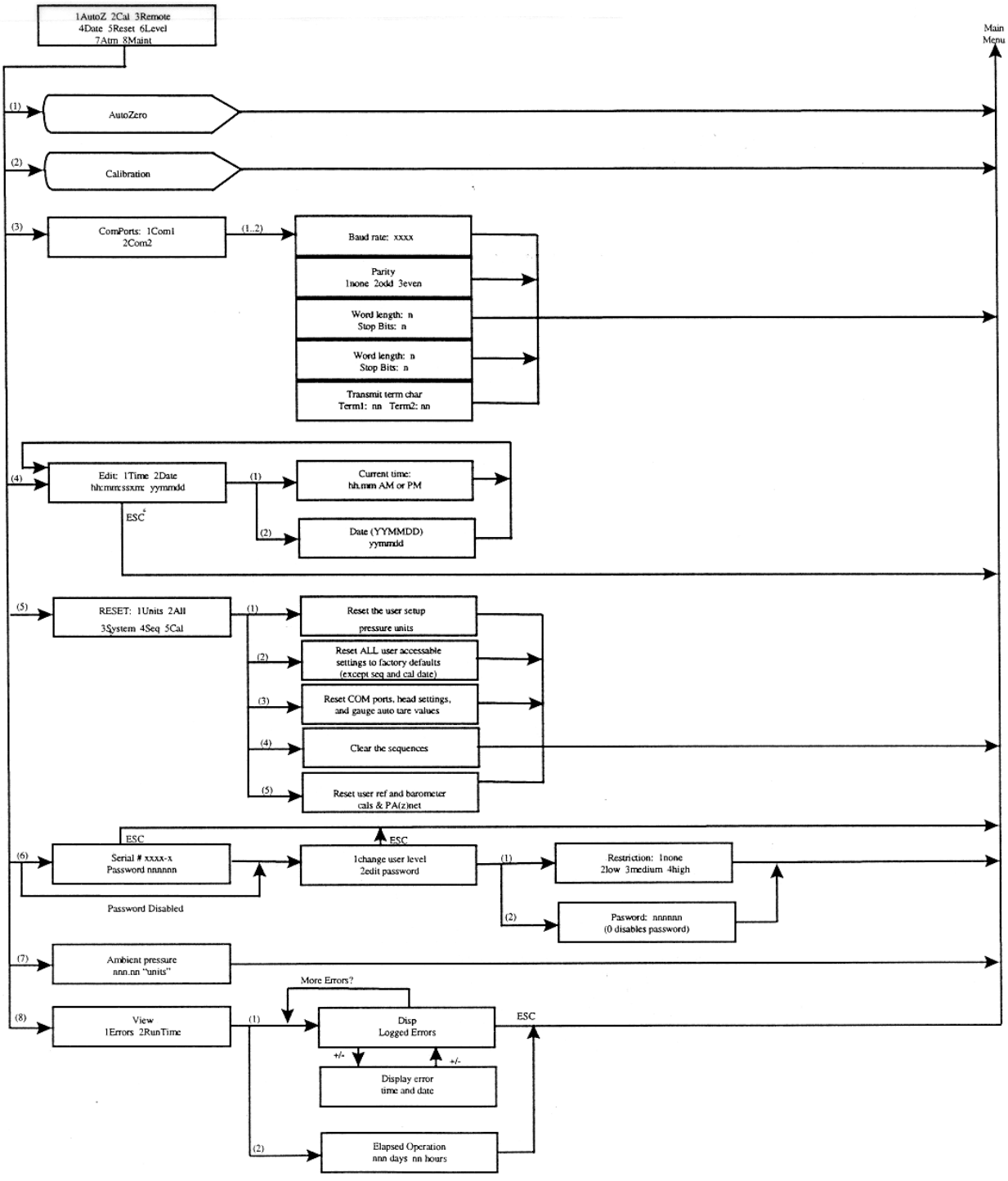
8.5 SPECIAL MENU



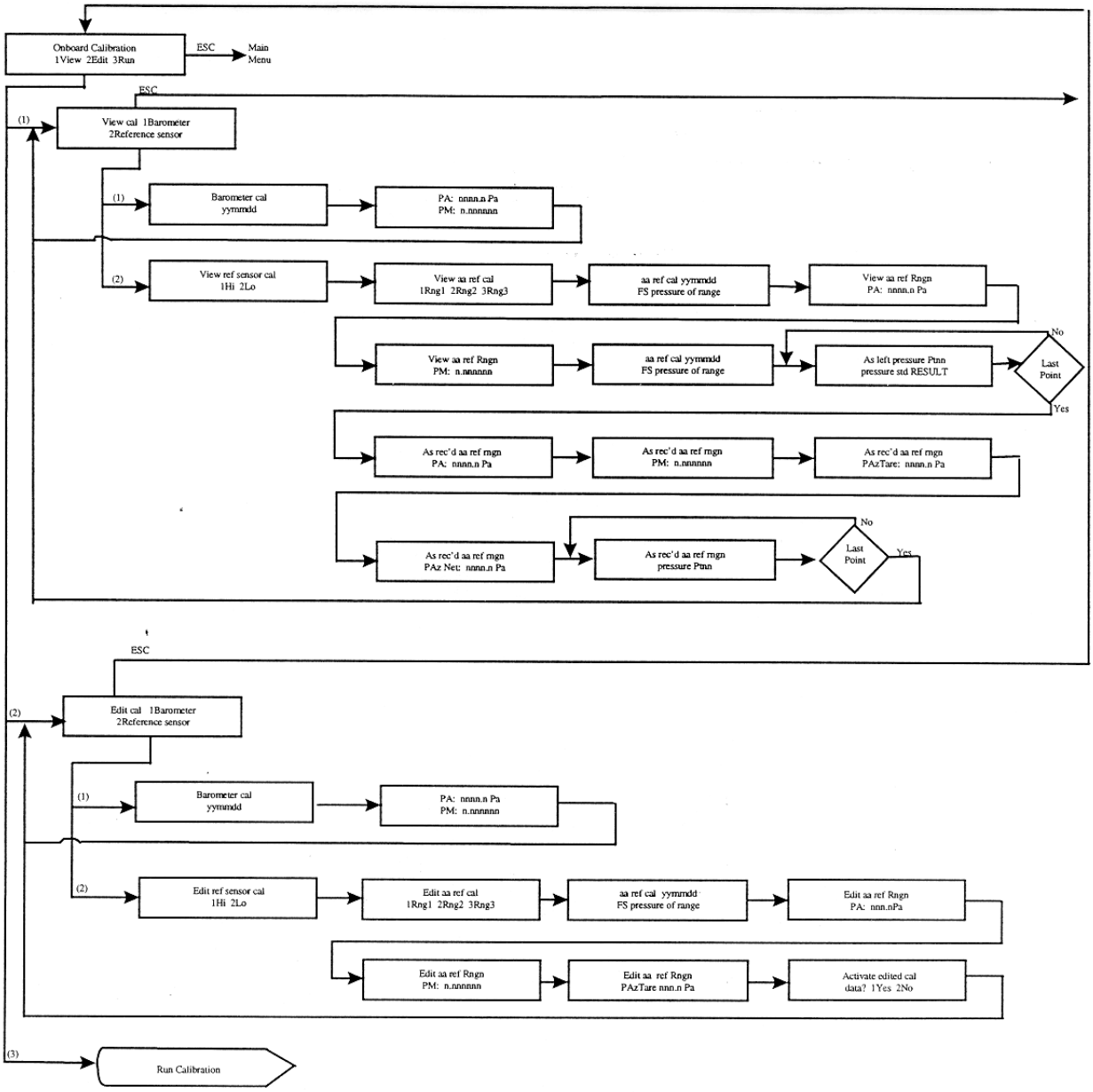
8.6 AUTOZERO MENU



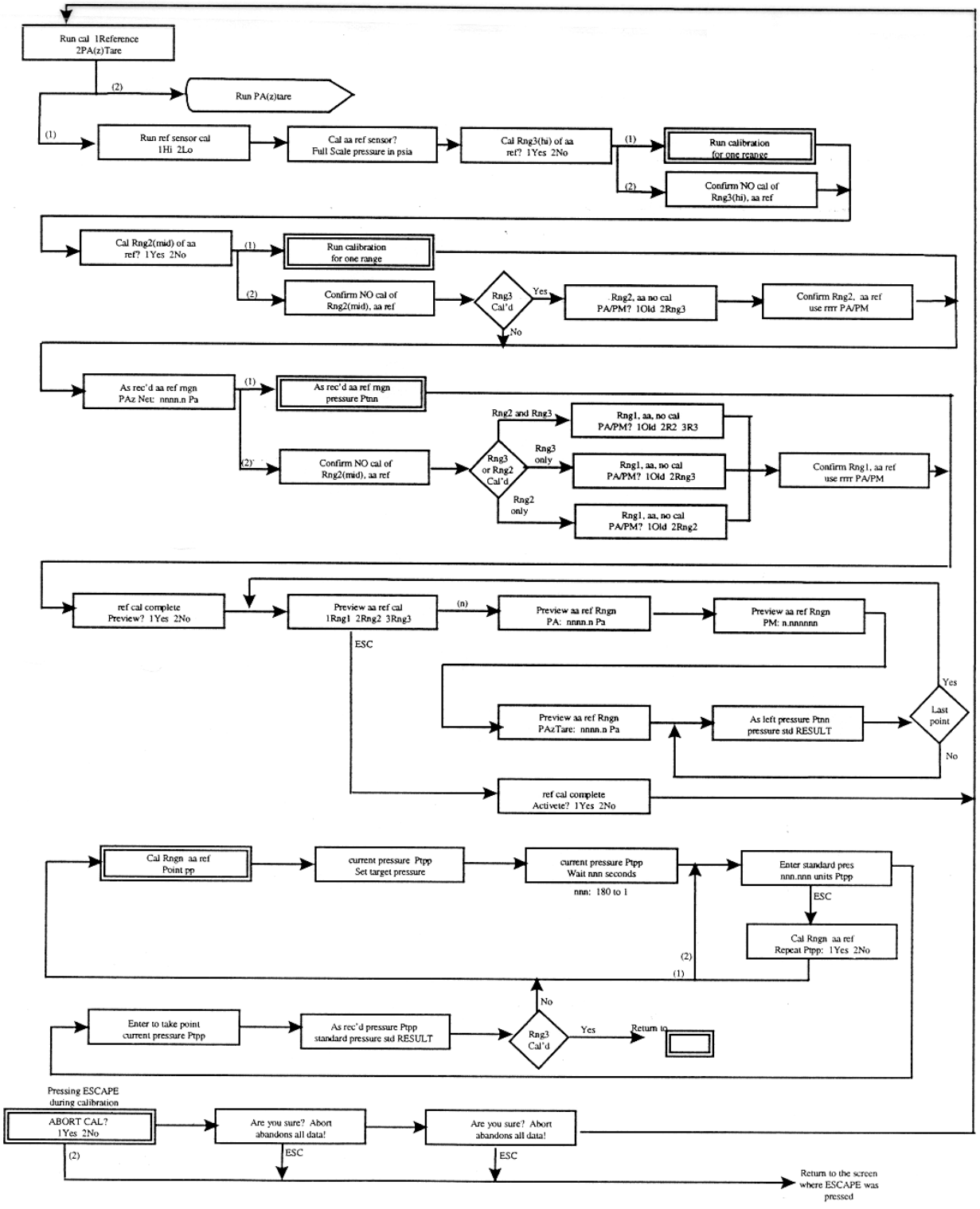
8.7 INTERNAL MENU



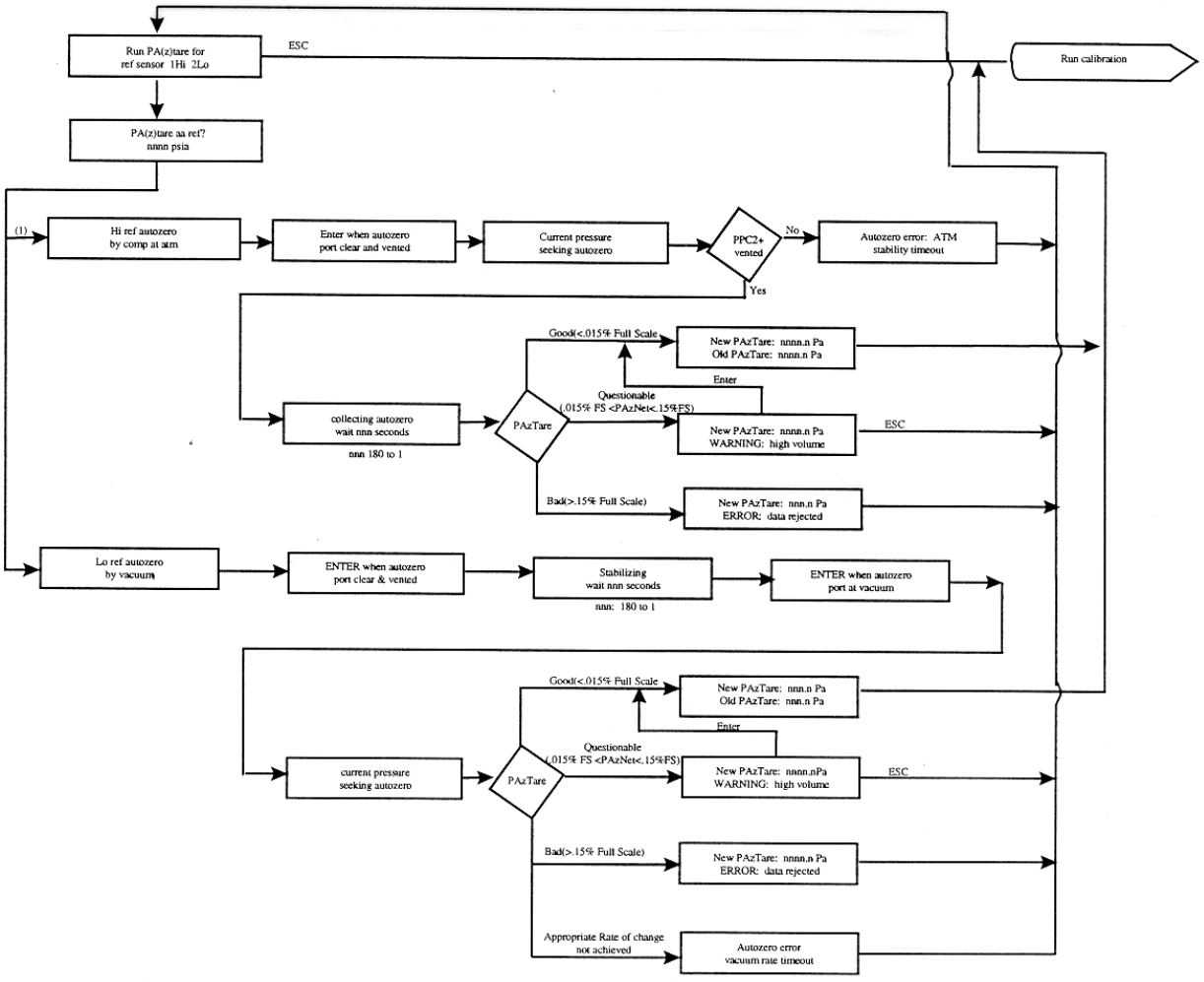
8.8 CALIBRATION MENU



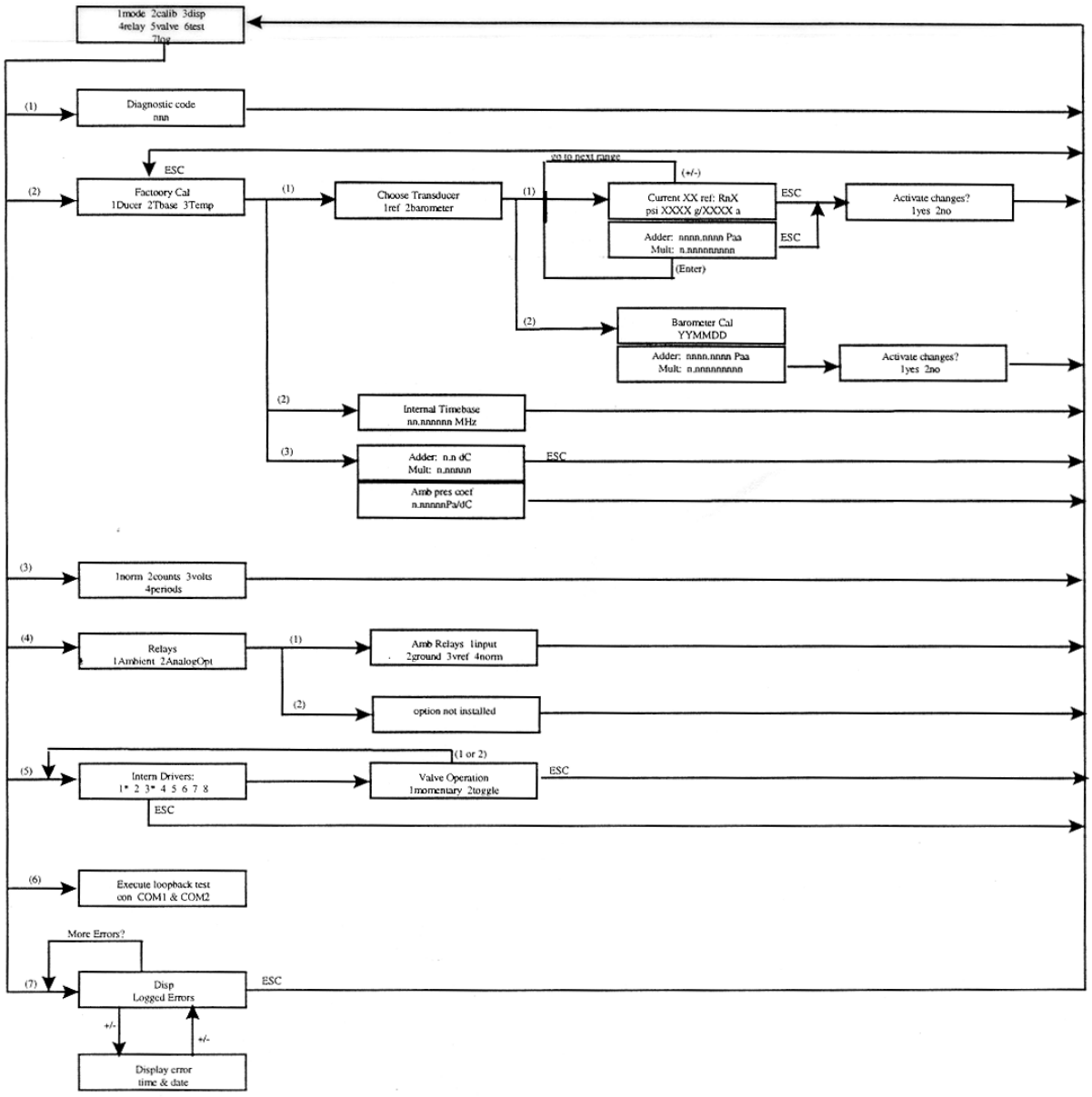
8.9 RUN CALIBRATION MENU



8.10 RUN PA(z) TARE MENU



8.11 DIAGNOSTICS MENU



NOTES

9. APPENDIX

9.1 DRIVERS

The PPC2 AF drivers option provides eight open collector drivers for operating external valves, solenoids, indicators, etc. When operating from the setup-driver screen (see Section 3.3.4), pressing enter will allow the operating mode of the drivers to be set. The two modes of operation are Momentary and Toggle. A momentary driver will change state while the corresponding driver number on the keyboard is being pressed. In toggle mode the driver state will toggle each time the corresponding key is pressed.

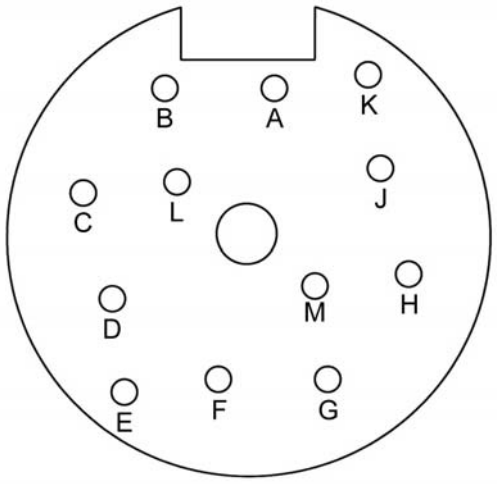
Each output can sink 500 mA at 12V. However, the total output of all the activated drivers cannot exceed one Amp. Therefore, if multiple drivers are being activated please refer to the following chart as a guide.

# OF ACTIVE DRIVERS	MAX CURRENT PER OUTPUT
1	500 mA
2	400 mA
3	275 mA
4	200 mA
5	160 mA
6	135 mA
7	120 mA
8	100 mA

The male connector (P/N 102478) for the DRIVERS port is supplied with the PPC2 AF accessories.

The following table and figure should be used as reference when building a cable to utilize the drivers port.

EXTERNAL DRIVERS		
PIN	DESCRIPTION	
A	D1	Driver #1 (Open Collector)
C	D2	Driver #2 (Open Collector)
E	D3	Driver #3 (Open Collector)
G	D4	Driver #4 (Open Collector)
M	D5	Driver #5 (Open Collector)
J	D6	Driver #6 (Open Collector)
K	D7	Driver #7 (Open Collector)
L	D8	Driver #8 (Open Collector)
B		Drivers (+ 12 V)
D		Drivers (+ 12 V)
F		Drivers (+ 12 V)
H		Drivers (+ 12 V)



9.2 SPLT CABLE AND CONNECTIONS

In order to take advantage of the automatic purging feature of the PPC2 AF (see Section 3.2.8), the SPLT valve must be connected to the PPC2 AF's external driver #8. This can be accomplished by soldering two 24 gauge wires of desired length to the 12 pin connector provided with the accessories. Connect one wire to pin L and the other to pin B. Attach the other end of these wires to the terminal block on the SPLT.

Polarity is not significant to the operation of the purge valve.

9.3 UNIT CONVERSION

9.3.1 PRESSURE

PPC2 AF performs all internal calculations in SI units. Numerical values input or output in other units are converted to SI immediately after entry and back to other units just before output as needed.

The tables below provide the conversion coefficients used by PPC2 AF to convert numerical values expressed in SI units to corresponding values expressed in other units.

TO CONVERT FROM Pa To		MULTIPLY BY
Pa	*Pascal*	1.0
mbar	*millibar*	1.0 E-02
kPa	*kilo Pascal*	1.0 E-03
bar	*bar*	1.0 E-05
mmWa @ 4°C	*millimeter of water*	1.019716 E-01
mmHg @ 0°C	*millimeter of mercury*	7.50063 E-03
psi	*pound per square inch*	1.450377 E-04
psf	*pound per square foot*	1.007206 E-06
inWa @ 4°C	*inch of water*	4.014649 E-03
inWa @ 20°C	*inch of water*	4.021732 E-03
inWa @ 60°F	*inch of water*	4.018429 E-03
inHg @ 0°C	*inch of mercury*	2.953 E-04
kcm^2	*kilogram force per centimeter square*	1.019716 E-05
ft	*feet of altitude*	see **Altitude Note** below
m	*meter of altitude*	see **Altitude Note** below

Altitude Note: Quantities expressed in units of altitude follow MIL-STD-859A “Static Pressure, p, in Inches of Mercury for Values of Pressure Altitude, H, in Geopotential Feet.” MIL-STD-859A provides tables of pressure in inches of mercury as a function of altitude in feet. PPC2 AF uses a set of equations to model the pressure/altitude relationship. The worst case deviation between the MIL-STD-859A table and the calculated pressure is 0.0001 inches of mercury (0.3 Pa). The pressure quantity expressed in inches of mercury is converted to Pascal following the table above. For altitude expressed in meters, meters are converted to feet using 1 m = 3.28084 ft.

9.4 WARRANTY STATEMENT (FOR DELIVERIES UNDER F33660-96-C7004)

PPC2 AFs delivered to the United States Government under contract F33660-96-C7004 are covered by a limited, 5 year worldwide warranty. The warranty start and finish dates are marked on each unit.

The Contractor warrants that the unit is free from defects in material, workmanship, manufacturing, and design and will perform to, or exceed, specifications, if operated and maintained properly for five (5) years commencing 45 days after delivery. The warranty does not cover damage due to misuse, use in unintended applications or acts of God.

Failed units shall be repaired or replaced, at the contractor's discretion, within two weeks of receipt at the Contractor's Warranty Service Center.

A failed unit shall be returned to the contractor's warranty service center at the Government's expense and returned to the owner at the Contractor's expense. Air freight shall be employed for shipments over 300 miles unless a faster means is available.

The Contractor reserves the right to invoice at published commercial hourly rates and replacement part prices for time, materials and shipping costs expended diagnosing and repairing repairs not covered by warranty.

CONTRACTOR WARRANTY SERVICE CENTERS			
COMPANY	**ADDRESS**	**TELEPHONE, FAX & EMAIL**	**NORMAL SUPPORT REGION**
DH Instruments, Inc.	4765 East Beautiful Lane Phoenix AZ 85044-5318 USA	Tel 602.431.9100 Fax 602.431.9559 cal.repair@dhinstruments.com	Worldwide
Minerva I.P.&M. B.V.	Handelsweg 13 Postbus 76-1270 AB Huizen NETHERLANDS	Tel 31/35.52.54.997 Fax 31/35.52.64.560 info@minervaipm.com	European Union
Nippon CalService, Inc.	2-9-1 Sengen, Tsukuba-Shi Ibaraki Prefecture 305 JAPAN	Tel 0298.55.8778 Fax 0298.55.8700 n-calservice@ohtegiken.co.jp	Japan/Asia
DH Products Technical Service Division	National Institute of Metrology Heat Division Pressure & Vacuum Lab NO. 18, Bei San Huan Donglu Beijing 100013 PR CHINA	Tel 010.64291994 ext 5 Tel 010.64218637 ext 5 Fax 010.64218703 cxcen@mx.cei.gov.cn	Peoples Republic of China

Units not delivered under F33660-96-C7004 are covered by DHI's standard commercial warranty.