PPC2+™

Operation and Maintenance Manual

⚠ High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

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ABOUT THIS MANUAL

Manual Conventions

This manual is intended to provide the user with the basic information necessary to operate a PPC2+ pressure controller/calibrator. It also includes a great deal of additional information provided to allow you to optimize its use and take full advantage of its many features and functions.

Before using the manual, take a moment to familiarize yourself with the table of contents structure: Sections 1, 2 and 3 should be read by all first time PPC2+ users. Section 3 is most important for those using the local front panel interface but should be read over by all users to familiarize themselves with general PPC2+ operating principles. Section 4 is for remote operation from an external computer. Section 5 provides maintenance and calibration information. Section 6 is a quick troubleshooting guide. Use it to troubleshoot unexpected PPC2+ behavior based on the symptom of that behavior.

For those of you who "don't read manuals", go directly to Section 2.3 to set up your PPC2+ and then go to Section 2.4 for power-up and verification. This will get you running quickly with a minimal risk of causing damage to yourself or your new PPC2+. THEN… when you have questions or start to wonder about all the great features you might be missing, get into the manual!

PPC2+ BG0002 has a separate manual with model specific information. If you are using a PPC2+ BG0002, use this manual in conjunction with the PPC2+ BG0002 Operation and Maintenance Manual.

Certain words and expressions have specific meaning as they pertain to PPC2+. The Glossary Section is useful as a quick reference for exact definition of specific words and expressions as they are used in the manual.

(CAUTION) is used in manual to identify user warnings and cautions.

(NOTE) is used in the manual to identify operating and applications advice and additional explanations.

[ ] indicates direct function keys (e.g., **[RANGE]**).

< > indicates PPC2+ screen displays (e.g., **<1yes>**).

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

PPC2+ is a stand-alone, microprocessor driven, pressure controller/calibrator intended to apply and measure accurate values of gas pressure for the calibration and testing of pressure measuring instruments. It has been designed to provide very high performance combined with maximum versatility and ease of use.

PPC2+ measures pressures using one or two high accuracy reference pressure transducers (RPTs) and an on-board barometer. Pressures control is achieved by a pneumatic module based on solenoid valves and differential pressure regulators.

PPC2+ 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 RS-232 or IEEE-488 interface.

PPC2+ models are available to measure and control pressure in ranges up to 0 to 1 500 psi (0 to 10 MPa) in both gauge and absolute measurement modes.

1.2 SPECIFICATIONS

1.2.1 GENERAL SPECIFICATIONS

Power Requirements:	85 to 264 VAC, 50/60 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 in. H x 12.6 in. W x 15.8 in. D (18 cm x 32 cm x 40 cm)
Microprocessor:	Motorola 68302, 16 MHz
Communication Ports:	RS-232 (COM1), RS-232 (COM2), IEEE-488
Pressure Ranges:	Up to six pressure ranges from 0 to 5 psi (33 kPa) to 0 to 1 500 psi (10 000 kPa) using one or two reference pressure transducers and a barometer
Operating Medium:	Any clean, dry, non-corrosive gas
Pressure Connections:	Supply: 1/8 in. NPT F Test(+): 1/4 in. NPT F Test(-): 1/4 in. NPT F (with gauge RPT only) Vent: 1/4 in. NPT F Exhaust: 1/4 in. NPT F Atm Ref: Pass through
Pressure Limits:	Maximum Working Test Pressure: Range H3+5 % Maximum Test Pressure without Damage: Range H3+10 % Recommended Supply Pressure: Range H3+10 % Maximum Supply Pressure without Damage: If Range H3>1 000 psi (7 000 kPa): 2 000 psi (14 000 kPa) If 300 psi (2 000 kPa) <Range H3 ≤ 1 000 psi (7 000 kPa): 1 400 psi (9 600 kPa) If Range H3 ≤ 300 psi (2 000 kPa): 500 psi (3 500 kPa)

1.2.2 PRESSURE MEASUREMENT SPECIFICATIONS

PPC2+ measures pressures in **gauge** and **absolute** mode in up to six ranges using one (**<3 ranges>**) or two (**<6 ranges>**) Reference Pressure Transducers (RPTs) and a barometer.

All RPTs with ranges over 30 psi (200 kPa) are of the absolute pressure type using an evacuated, permanently sealed reference. Absolute RPTs can measure both absolute and gauge pressure. Gauge pressures with an absolute RPTs are defined by offsetting atmospheric pressure with dynamic compensation for atmospheric changes using the on-board barometer. Gauge RPTs cannot measure absolute pressure.

Table 1. Reference Pressure Transducer (RPT) Designations and Ranges

	US UNITS VERSION (psi)						SI UNITS VERSION (kPa)					
RPT Designation	Range1 (Lo)		Range2 (Mid)		Range3 (Hi)		Range1 (Lo)		Range2 (Mid)		Range3 (Hi)	
	Absolute	Gauge	Absolute	Gauge	Absolute	Gauge	Absolute	Gauge	Absolute	Gauge	Absolute	Gauge
A1500	500	500	1 000	1 000	1 500	1 500	3 000	3 000	6 000	6 000	10 000	10 000
A1000	300	300	600	600	1 000	1 000	2 000	2 000	4 000	4 000	7 000	7 000
A0500	150	150	300	300	500	500	1 000	1 000	2 000	2 000	3 500	3 500
A0300	100	100	200	200	300	300	600	600	1 200	1 200	2 000	2 000
A0200	50	50	100	100	200	200	400	400	800	800	1 400	1 400
A0100	30	15	60	50	100	100	200	100	400	300	700	700
A0050	15	0	30	15	50	35	100	0	200	100	350	250
A0030	10	-5	20	5	30	15	60	-40	120	20	200	100
A0023	7	-8	15	0	23	8	50	-50	100	0	160	60
A0015	5	-10	10	-5	15	0	30	-70	60	-40	100	0
G0030	NA	10	NA	20	NA	30	NA	60	NA	120	NA	200
G0015	NA	5	NA	10	NA	15	NA	30	NA	60	NA	100

1.2.2.1 REFERENCE PRESSURE TRANSDUCER (RPT) SPECIFICATIONS

ALL VALUES ARE ± FS OF THE ACTIVE RANGE UNLESS OTHERWISE INDICATED.

Warm Up Time: None required

Resolution: To 1 ppm, user settable by individual range

Temperature Effect: Fully compensated with active independent temperature measurement from -20 to 100 °C
± 0.005 % maximum temperature effect in normal ambient 15 to 35°C operating range

Acceleration Affect: ± 0.008 % /g maximum, worst axis
Allows operation at ± 20° from reference plane without significant effect

Precision[1]*:* ± 0.005 %

Stability:

	90 day	1 year
Gauge Mode (w/Autozero):	0.003 %	0.009 %
Absolute Mode (w/Autozero):	0.003 %	0.009 %
Absolute Mode (w/out Autozero):	0.006 %	0.015 %

Measurement Accuracy[2]*:*

	90 day	1 year
Gauge Mode (w/Autozero):	0.008 %	0.012 %
Absolute Mode (w/Autozero):	0.008 %	0.012 %
Absolute Mode (w/out Autozero):	0.010 %	0.017 %

1 Measurement Precision: Combined linearity, hysteresis, repeatability of measurements made by the reference pressure transducer.

2 Measurement Accuracy: Maximum deviation of the reference pressure transducer indication from the true value of measured pressure including precision, stability, temperature effect and calibration standard accuracy of ± 0.0035 % of reading.

NOTE: When using an absolute reference pressure transducer for gauge mode measurements in a gauge range of < 30 psi (200 kPa), add ± 0.001 psi (8 Pa) to the measurement specification to take into account the resolution of the on-board barometer.

1.2.2.2 ON-BOARD BAROMETER

The barometric sensor is NOT used as a source of absolute accuracy. It is used ONLY to measure changes in atmospheric pressure to provide dynamic compensation of the RPTs atmospheric pressure offset when using an absolute RPT to make gauge pressure measurements.

1.2.3 PRESSURE CONTROL SPECIFICATIONS

All values are ± FS of the active range unless otherwise indicated.

*Modes and Ready (**<*>**)*

Indication:
- Static: Sets pressure within hold limit and stops active control until hold limit is exceeded
  Pressure is **Ready (<*>)** when within hold limit and stability test is met
- Dynamic: Sets pressure within hold limit and continuously adjusts as close as possible to target
  Pressure is **Ready (<*>)** when within hold limit

Control Parameters: Hold limit, stability limit (optimum values set by default, can be customized independently for each measurement range)

Table 2. Default Pressure 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 % FS of the active pressure range	± 0.005 % FS/sec of the active pressure range	± 1 % FS of the active pressure range	± 0.005 % FS/sec of the active pressure range.
DYNAMIC MODE	± 0.005 % FS of the active pressure range or ± 2 ppm of range H3, whichever is larger	± 0.005 % of the active pressure range	± 0.005 % FS of the active pressure range	± 0.005 % FS of the active pressure range

Control Precision[1]*:* ± 0.001 % (with 30:1 maximum ratio between highest and lowest range)

Normal Test Volume: Lo (max range < 300 psi): 100 to 1 000 cc (500 cc optimal)
Hi (max range ≥ 300 psi): 0 to 500 cc (250 cc optimal)

Control Speed: Slew Rate (0 to Controller FS) in Optimal Volume with No Control: 10 to 30 seconds

Pressure Setting (Typical Time To Ready (<*>) Indication in Dynamic Mode): 20 to 30 seconds (lower for low, higher for high ranges) Reduced by increasing hold limit

Minimum Control Pressure: Gauge Mode: None when EXHAUST at vacuum
Absolute Mode: 0.2 % FS of range H3, will also set zero absolute (see Section 3.2.3.1).

***Delivered** Pressure Accuracy*[2]*:*

	90 day	*1 year*
Gauge Mode:	0.010 %	0.013 %
Absolute Mode (w/Autozero):	0.010 %	0.013 %
Absolute Mode (w/out Autozero):	0.012 %	0.018 %

1 Control Precision: Minimum useable hold limit in dynamic control mode.

2 Delivered Pressure Accuracy: Maximum deviation from the true value of pressure applied to the device under test in dynamic control mode with default control limits and assuming measurement accuracy as in Section 1.2.2.1. In static control mode, control errors can be eliminated making accuracy of delivered pressure the same as measurement accuracy.

1.2.4 ANALOG INPUT SPECIFICATION

Table 3. Analog Input Specifications

MEASUREMENT RANGE	DISPLAY RESOLUTION	A/D RESOLUTION	ACCURACY (+/- % FS)
0 to 100 mV	0.001	0.014	0.05
0 to 5 V	0.001	0.7	0.03
0 to 10 V	0.001	0.14	0.03
4 to 20 mA	0.001	0.003	0.05

24 V Power Source: Four channels, each output independently can sink 250 mA at 24 V, but maximum output of all four channels must not exceed 250 mA.

NOTES

2. INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 REMOVING FROM PACKAGING

PPC2+ is delivered in a custom corrugated container with high density polyethylene inserts to hold it in place; or in the optional molded medium density polyethylene shipping case with a custom foam insert for holding the PPC2+ and SPLT (if included).

Remove the PPC2+ and its accessories from the shipping container 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.

A standard PPC2+ includes all items indicated in Table 4.

Table 4. PPC2+ Packing List

DESCRIPTION	PART NO.
PPC2+ Pressure Controller/Calibrator	FAM0002
Calibration Certificate	550100
Test Report	550103
Accessories:	401357 or 401357-CE
Operation and Maintenance Manual	550091
Power Cord (7.5 ft.)	100770 or 100770-CE
(6) Rubber Feet Caps	400203
General Accessories Disk (Important: Includes system support software and documentation.)	102987

2.2 SITE REQUIREMENTS

The PPC2+ 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+ can also be mounted in a standard 19-in. rack mount using the optional rack mount kit.

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

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

The Self Purging Liquid Trap (SPLT), if used, should 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 pressure supply** of clean, dry, non-corrosive gas at maximum PPC2+ range (H3) +10 % to be connected to the SUPPLY port. Lower gas pressure supply 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 with displacement of at least 3 cfm (90 lm) if control of pressures under 3 psi (20 kPa) gauge is desired.

2.3 INITIAL SETUP

2.3.1 PREPARING FOR OPERATION

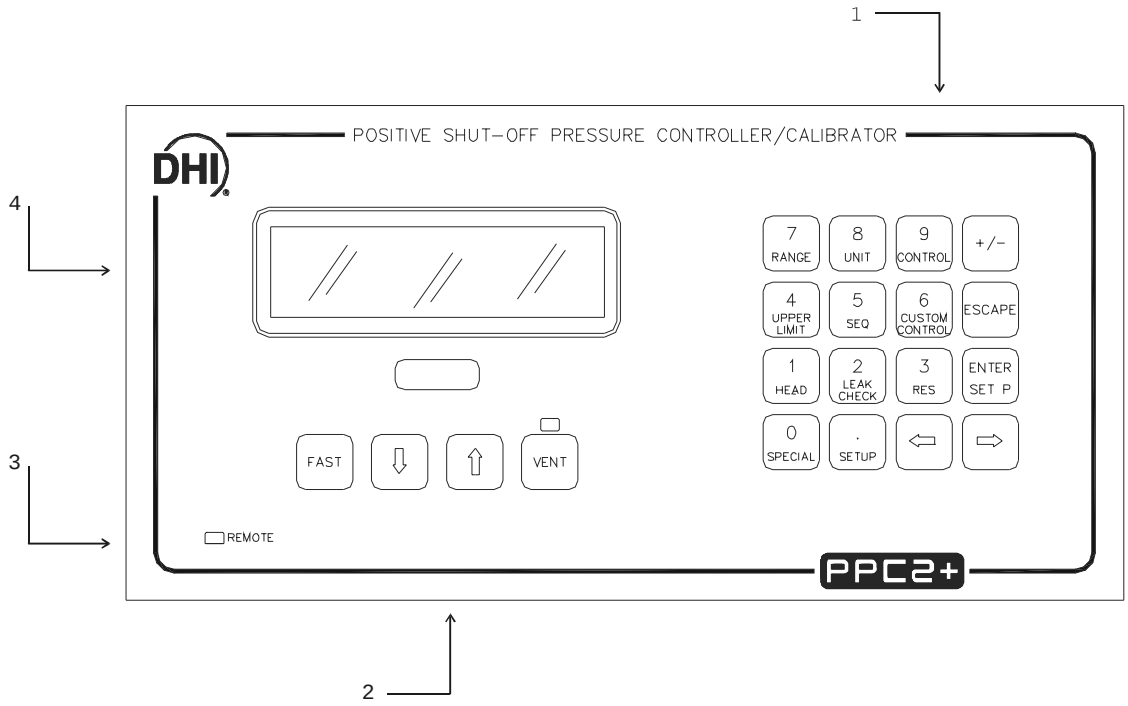
To prepare PPC2+ for check out and operation:

- Remove the plastic caps from the PPC2+ 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.
- Familiarize yourself briefly with the front and rear panel (see Section 2.3.2).

2.3.2 FRONT AND REAR PANELS

2.3.2.1 FRONT PANEL

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

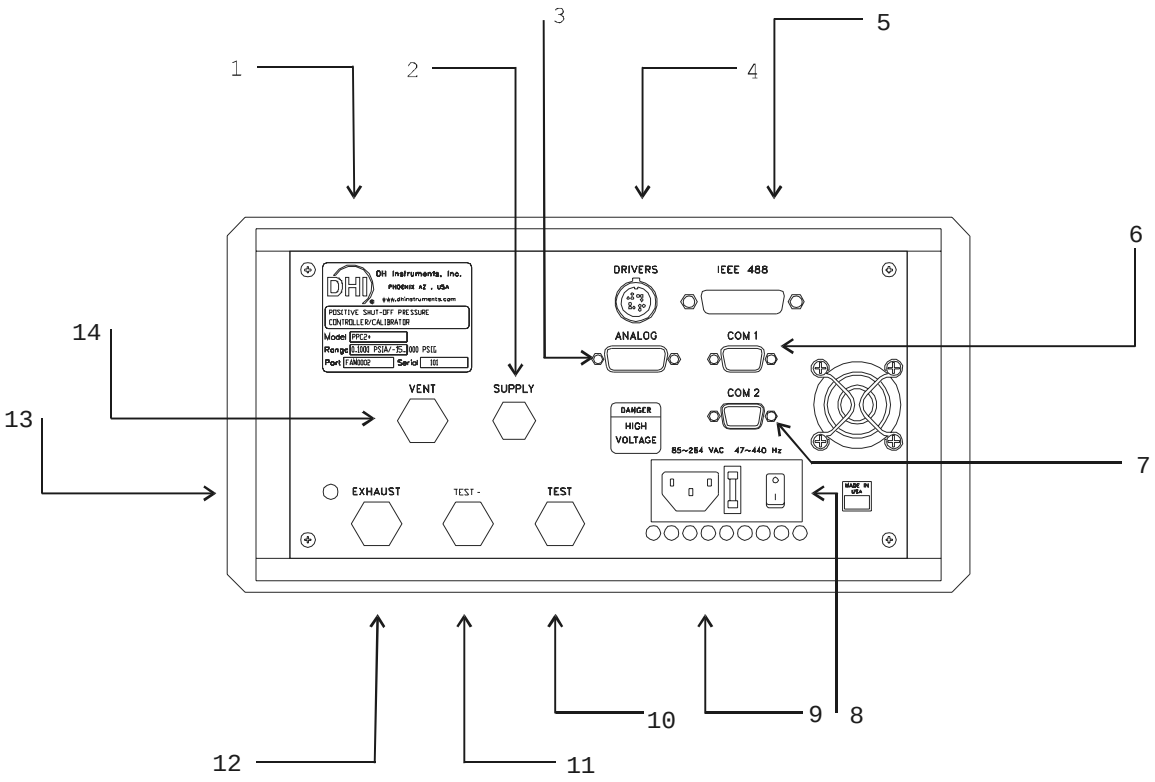


1. Multi-Function Keypad
2. Direct Pressure Control Keys
3. Remote Indicator
4. Display

Figure 1. Front Panel

2.3.2.2 REAR PANEL ASSEMBLY

The rear panel assembly provides pressure connections, communications interfaces, the power ON/OFF module and product labeling. Pressure fittings are internally secured to prevent loosening when making and breaking connections.



1. Label, Product
2. Pressure Connection, SUPPLY
3. Analog Option Connector
4. Drivers Option Connector
5. IEEE-488 Connector
6. COM1 Connector
7. COM2 Connector
8. Power Switch
9. Fuse
10. Pressure Connection, TEST
11. Pressure Connection, TEST(-) (models with gauge RPT only)
12. Pressure Connection, EXHAUST
13. Pass Through, ATM REF
14. Pressure Connection, VENT

Figure 2. Rear Panel Assembly

2.3.3 POWER CONNECTION

- Check that the PPC2+ 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.

2.3.4 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+. The PPC2+ SUPPLY connection is **1/8 in. NPT female**.

The supply pressure should be equal to the maximum PPC2+ range +10 %. Lower gas pressure sources can be used but should exceed the maximum desired test output pressure by 10 to 20 %.

⚠ *Never connect a pressure supply greater than 20 % over the maximum range (H3) of the PPC2+ model you are using.*

2.3.5 CONNECTING A VACUUM PUMP (EXHAUST PORT)

For PPC2+ to set pressures under atmosphere and/or to reliably set pressure under 3 psi (20 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+ EXHAUST port.*

⚠ *To avoid building up pressure on the EXHAUST port and/or the vacuum pump, the vacuum source should either be continuously ON or should bypass to atmosphere when the vacuum source is OFF. This is because when a supply pressure is applied to the PPC2+ SUPPLY port and the PPC2+ is NOT in the vent ON condition, there is a constant gas exhaust through the PPC2+ EXHAUST port to which the vacuum source will be connected.*

To assure optimum pressure control when changing the pressure applied to the EXHAUST port from vacuum to atmosphere or vice-versa, be sure to change the control reference setting if the setting is NOT in AUTO mode (see Section 3.3.1).

2.3.6 CONNECTING TO THE DEVICE UNDER TEST (TEST AND TEST(-) PORTS)

If you are using a SPLT, see Section 2.3.6.1 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+. The PPC2+ TEST connection is **1/4 in. NPT female.**

If PPC2+ is equipped with a gauge RPT (GXXXX), it has a TEST port **and** a TEST(-) port. The TEST(-) port is connected to the **low** side of the gauge RPT. This connection is normally left open to atmosphere. It can also be connected to the low side of a differential device that is being calibrated or tested. With very low pressure devices, this will enhance the calibration results by helping assure that PPC2+ and device under test reference ports are at the same pressure.

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. 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 damage to the PPC2+ may result.

NEVER connect a pressure supply to the TEST(-) port. The pressure applied to this port should be maintained at atmospheric pressure ± 3 psi (20 kPa). Exceeding these limits may damage the RPT.

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

Minimizing the length of the test connection tubing will enhance control performance and reduce pressure setting time. For normal operation, the total volume of the device or system under test including connecting tubing should be less than 1 000 cc (60 in^3) up to 300 psi (2 000 kPa) and less than 500 cc (30 in^3) over 300 psi (2 000 kPa).

Minimizing the length of the test connection tubing will enhance control performance and reduce pressure setting time. For normal operation, the total volume of the device or system under test including connecting tubing should be less than 1 000 cc (60 in^3) up to 300 psi (2 000 kPa) and less than 500 cc (30 in^3) over 300 psi (2 000 kPa).

PPC2+ pressure control will not operate properly if there are excessive leaks in the test system. In general, the maximum acceptable leak rate for optimal PPC2+ automated pressure control operation and to assure in tolerance measurements with default pressure control parameters is ± 1 % of active range FS/minute. In DYNAMIC CONTROL mode, to handle higher test system leak rates, increase the hold limit using CUSTOM CONTROL (see Section 3.2.6).

PPC2+ pressure control may be adversely affected if the test connection tubing is too restrictive. For optimum results, the inner diameter of the connecting hose should be > 0.07 in. (1,75 mm).

2.3.6.1 INSTALLING THE SPLT

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

The SPLT is installed in the test connection line at a low point between PPC2+ and the device or system under test. See the SPLT manual for more complete instructions on SPLT installation.

2.3.7 THE VENT CONNECTION (VENT PORT)

The PPC2+ VENT connection is the system vent to atmosphere point used to set zero gauge pressure as well as to 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 maintained for PPC2+ reference pressure measurements to operate normally.

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

⚠ NEVER plug, obstruct or connect a supply pressure to the PPC2+ vent connection.

2.3.8 THE ATM REF PASS THROUGH (UNLABELED)

The ATM REF pass through is connected to the on-board barometer and to the valve that opens the Lo RPT (if present) to atmosphere when it is not in use. The ATM REF pass through assures that the Lo RPT and on-board barometer are truly subject to atmospheric pressure rather than to the pressure inside the PPC2+ case which may be slightly different from ambient pressure.

⚠ Do not plug or obstruct the ATM REF pass through as this may adversely affect GAUGE mode operation on an absolute transducer and autozeroing of an absolute Lo RPT.

2.4 POWER-UP AND VERIFICATION

2.4.1 SWITCH POWER ON

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

PPC2+ operating condition at power-up is VENT valve closed unless the pressure measured by the RPT was within 3 psi (20 kPa) of atmospheric pressure.

If the PPC2+ 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 CHECK PROPER PRESSURE MEASUREMENT OPERATION

2.4.2.1 CHECKING ABSOLUTE MODE PRESSURE MEASUREMENT

If the PPC2+ has an absolute RPT (designated AXXXX), check that it operates properly in **absolute** mode.

If the PPC2+ is not vented (vent LED OFF), press the **[VENT]** direct pressure control key to vent the PPC2+ (VENT LED ON) (see Section 3.1.2.2).

Using the **[RANGE]** function key to change ranges if necessary (see Section 3.2.1) select a range of the absolute RPT.

Press the **[UNIT]** function key and select **<absolute>** mode. Change the pressure unit if desired (see Section 3.2.2).

Observe the current value of atmospheric pressure. Check that the value agrees with the local value of atmospheric pressure. Repeat this process for all the ranges on both RPTs if the PPC2+ has two absolute RPTs. Check that the values of atmospheric pressure measured by the different ranges agree with each other within PPC2+ measurement tolerances (see Section 1.2.2). If they do not agree within tolerances, PPC2+ may need calibration or repair.

2.4.2.2 CHECKING GAUGE MODE PRESSURE MEASUREMENT

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

Press the **[UNIT]** function key and select **<gauge>** mode. Change the pressure unit if desired (see Section 3.2.2).

Observe that, within ten seconds, zero is indicated. It is normal for PPC2+ to indicate a value other than zero for up to ten seconds when first entering **gauge** mode.

Using the **[RANGE]** function key to change ranges, observe that zero is indicated for each range within 10 seconds. It is normal for PPC2+ to indicate a value other than zero when vented when **gauge** mode is first entered or ranges are changed. After about ten seconds, the VENT LED should flash and zero should be indicated. If this does not occur, check that the AUTOZERO function is ON (see Section 3.4.1). If AUTOZERO is ON and display will not zero when vented, PPC2+ may need repair.

2.4.3 LEAK CHECK

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

2.4.4 PURGE

If the SPLT is included and installed in the test line, perform a purge of the Device Under Test (DUT). This will rid the DUT of contaminated liquids and enable descending pressures to be controlled (see Section 3.2.8).

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

2.4.5 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).

Press **[ENTER]**. Specify a target pressure within the active range and press **[ENTER]** again (see Section 3.2.3).

PPC2+ should set the target pressure and indicate **Ready *(<*>)*** (see Section 3.1.2.4) continuously in 15 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+:

- Vent the PPC2+ 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.

NOTES

3. OPERATION

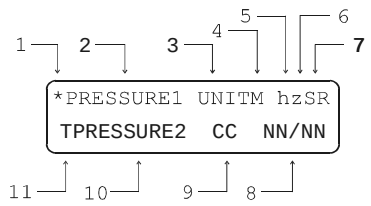
3.1 GENERAL/MANUAL OPERATION

PPC2+ 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 four direct pressure control keys.

3.1.1 MAIN RUN SCREEN

The PPC2+ 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+ 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 **<↓>** indicating direction of measured pressure evolution if not ready.
2. PRESSURE1: Numerical value and sign of pressure measured by active RPT and range.
3. UNIT Current unit of measure of pressure indication (see Section 3.2.2).
4. **<M>** Pressure measurement mode: **<g>** gauge, **<a>** absolute (see Section 3.2.2).
5. Indicates whether a head correction is applied. **<h>** if applied, **< >** (blank) if not (see Section 3.2.7).
6. Indicates whether the autozero function is ON or OFF. **<z>** if ON; **< >** (blank) if OFF (see Section 3.4.1).
7. **SR:** Indicates active RPT (**<H>** for high, **<L>** for low) and range (**<1>** = low, **<2>** = mid, **<3>** = hi) (see Section 3.2.1).
8. Used only when running a sequence. Indicates number of current increment over total number of increments in the sequence or **[ENTER]** when **ready**. Changes to countdown time during count down when next increment of sequence is on timed delay rather than enter.
9. Pressure control mode (**<S>** for static, **<D>** for dynamic) with a **<C>** appended if custom control settings are in use. These control indicator characters flash when the system is controlling. In static mode, if control is active they flash even if NO valve is operating (e.g., 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. **PRESSURE2:** Numerical sign and value of either target pressure **<T>**, rate of change of pressure **<R>** or deviation from target **<D>**. Target value and deviation are in the same pressure unit as the current unit in Step 3 of this section. Rate of change of pressure is in current unit per second (see Section 3.2.3).

11. Indicates whether the number following is target pressure **<T>**, rate of change of pressure **<R>** or current deviation from target value **<D>**) (see Section 3.2.3).
    Target pressure **<T>** is indicated when:
    - Dynamic control is active and pressure is Not Ready (**<↑>** or **<↓>**)
    - Static control is active and control valves are operating.

    Deviation **<D>** is indicated when:
    - Dynamic control is active and pressure is Ready (**<*>**).

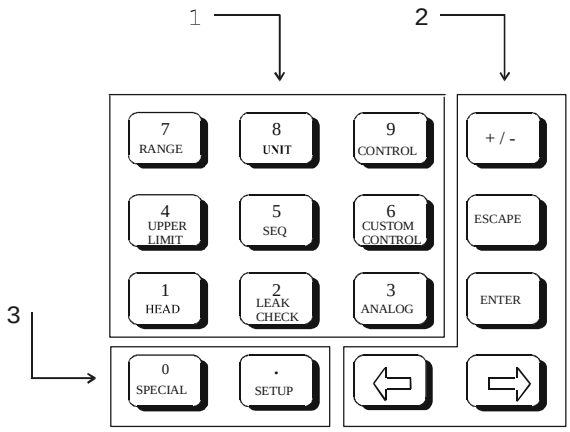
    Rate of change **<R>** is indicated when:
    - No control is active (e.g., control is suspended or system is vented.)
    - Static control is active, and NO valves are active.

PPC2+ 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. The screen saver time can be changed or screen saving can be completely suppressed (see Section 3.4.4).

3.1.2 GENERAL OPERATING PRINCIPLES

3.1.2.1 MAIN 4 X 4 KEYPAD LAYOUT AND PROTOCOL

The PPC2+ 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 Editing and Execution keys are for causing execution, suspending execution, backing up in menus and editing entries.
3. **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 day to day operation (see Section 3.4). These keys enter numerical values when editing.

Figure 3. Keypad Layout

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

Pressing 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+ introduction screen.

Pressing the **[+/-]** key changes a numerical sign when editing. It also toggles through multiple screens when available.

Pressing the **[←]** and **[→]** keys allow reverse and forward cursor movement when editing data entry. They also allow the target pressure value to be jogged up and down while controlling or when editing target value.

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. Press the [←] and [→] keys to move the cursor to access the lines that are not visible or directly enter the number of the hidden menu choice if you know it.

3.1.2.2 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.

Pressing the **[VENT]** key causes PPC2+ to control pressure to near atmospheric pressure and then open the system vent valve (see Section 5.8.1.7). 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, another direct pressure control key is pressed, or an automated pressure control command is given. Pressing the **[VENT]** key also causes the purge function to execute when the PPC2+ LEAK CHECK/PURGE function is active (see Section 3.2.8).

The PPC2+ BG0002 VENT sequence differs from other PPC2+ models due to the use of a TEST(+)/TEST(-) bypass valve. See the PPC2+ BG0002 Operation and Maintenance Manual, Section 3.3.2 PRINCIPLE.

Pressing 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.

Figure 4. Direct Pressure Control Keys

3.1.2.3 AUTOMATED PRESSURE CONTROL

PPC2+ 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+ supports two pressure control modes to meet different pressure setting and controlling requirements: **static** and **dynamic**. Pressure control parameters for each **control** mode are automatically set to optimal default values for each PPC2+ range when the **control** mode is selected in the active 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 within which the controlled pressure is to be maintained.
- **Stability Limit:** A rate of change of pressure limit in units of pressure/second used as a criterion for the Ready **(<*>**)/Not Ready (**<↑>** or **<↓>**) condition in static control or when automated control is not active.

See Section 3.1.2.3, Static Control and Dynamic Control for a detailed explanation of each **control** mode and its advantages, the default control parameters and the Custom Control options.

A series of pressure control target values can be programmed at one time include other preset operating parameters using the SEQUENCE function (see Section 3.2.5).

Static Control

Static control mode is designed to set the pressure near the target value and then cease active control to allow pressure to stabilize naturally. The advantage of this **control** mode is that pressure can be set and/or 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 (**<↑>** or **<↓>**) 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 to user defined values).

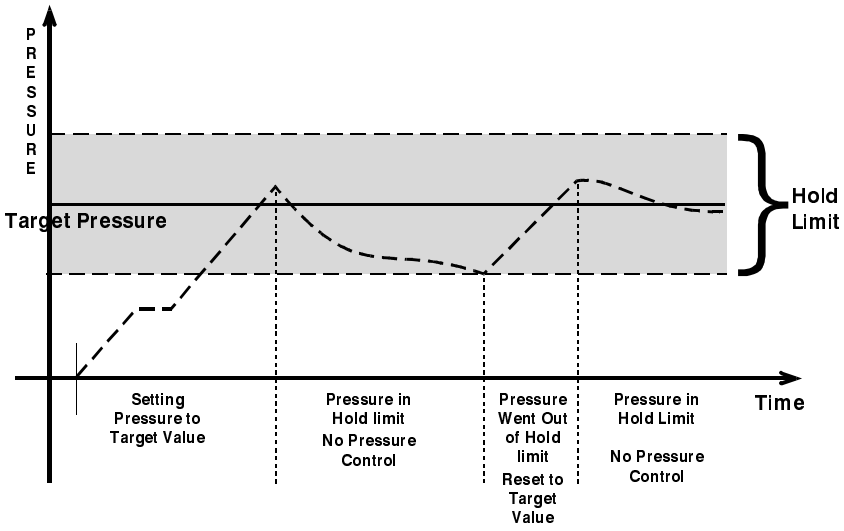


Figure 5. Static Pressure Control Operation

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 (**<↑>** or **<↓>**) condition will occur. See Sections 3.1.2.4 and 3.2.3 for default hold limit values. See Section 3.2.6 for setting the hold limit.

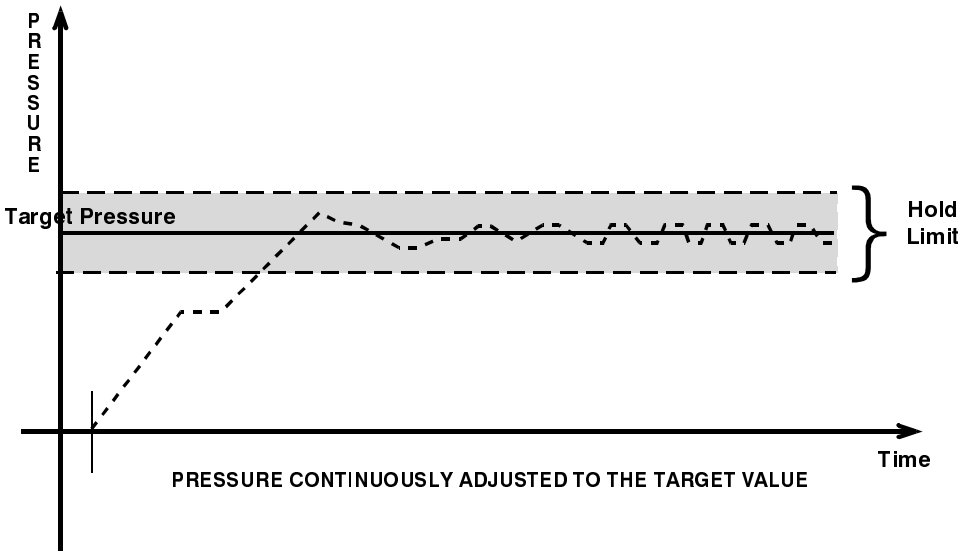


Figure 6. Dynamic Pressure Control Operation

3.1.2.4 PRESSURE READY (<*>)/NOT READY (<↑> OR <↓>)

The far left character of the main run screen provides a pressure Ready (**<*>**)/Not Ready (**<↑>** or **<↓>**) 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 (**<↑>** or **<↓>**) 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.

When pressure control is active: The criteria for determining the **Ready (<*>)/Not Ready (<↑> or <↓>)** condition depend on whether the current **control** mode is static or dynamic. Pressure **Ready (<*>)/Not Ready (<↑> or <↓>)** parameters are set by default when a **control** mode is selected and or can be customized if desired (see Sections 3.2.3 and 3.2.6).

Static Control Ready (<*>)/Not Ready (<↑> or <↓>)

When static pressure control mode is active a **Ready (<*>)** condition will occur when:

- NO control valve is operating.
- The current measured pressure is inside the hold limit.
- The rate of change of pressure is less than the current stability limit.

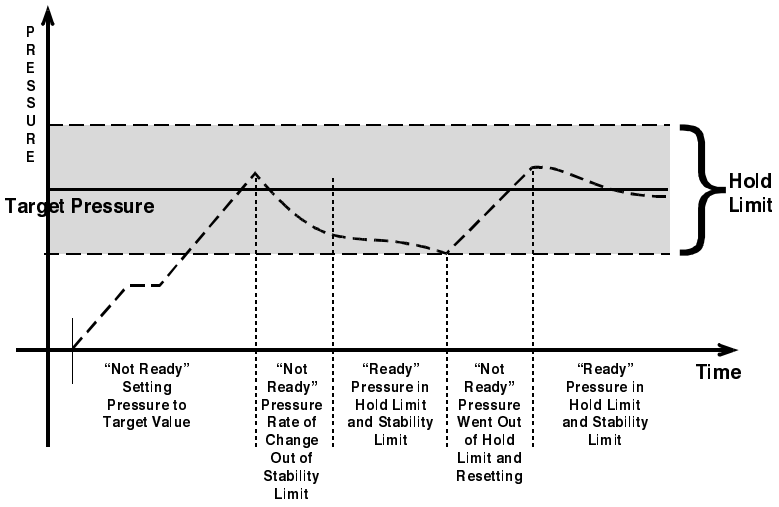


Figure 7. Ready (**<*>**)/Not Ready (**<↑>** or **<↓>**) Static Control Mode

Dynamic Control Ready (<*>)/Not Ready (<↑> or <↓>)

When **dynamic pressure control** mode is active, a **Ready (<*>)** condition will occur when:

- The current measured pressure is inside the hold limit.

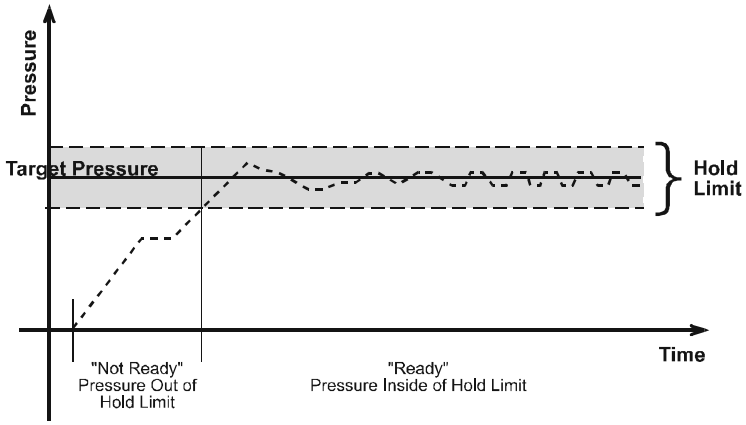


Figure 8. Ready (**<*>**)/Not Ready (**<↑>** or **<↓>**) in Dynamic Pressure Control Mode

Ready (<*>)/Not Ready (<↑> or <↓>) 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+ has one or two reference pressure transducers (RPT) each of which has three ranges for a total of three or six pressure ranges. This multi-ranging 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 greater than, the maximum pressure of the device or system under test.

PPC2+ 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+ 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 and settings are range specific (see Section 3.2.1).

Each PPC2+ has three or six ranges. 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+ internal pneumatic layout for handling two RPTs if two RPTs are present is:

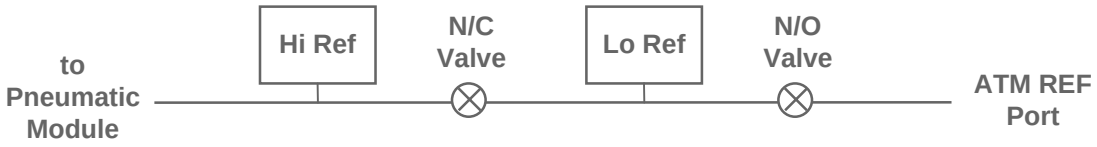


Figure 9. Hi and Low RPT Pneumatic Circuit

Ranges and Identification

The currently active reference transducer and range is continuously displayed in the upper right hand corner of the main run screen and most other screens. See Table 1 for a complete listing of the RPTs available and their ranges.

Hi RPT: The RPT in a single RPT PPC2+ or the RPT with the highest maximum range in a dual RPT PPC2+ is referred to as the Hi RPT.

Lo RPT: The RPT with the lower maximum range in a dual RPT PPC2+ is referred to as the Lo or secondary RPT.

Range 1, 2 or 3: The three ranges of an RPT are referred to as 1 = lo range, 2 = mid range, 3 = hi range.

Table 5. PPC2+ Range Identification Summary

REFERENCE PRESSURE TRANSDUCER AND RANGE	DESIGNATION	DISPLAY SYMBOL *
Lo RPT, Lo range	Lo, 1	L1
Lo RPT, Mid range	Lo, 2	L2
Lo RPT, Hi range	Lo, 3	L3
Hi RPT, Lo range	Hi, 1	H1
Hi RPT, Mid range	Hi, 2	H2
Hi RPT, Hi range	Hi, 3	H3

* The display symbol is included in the upper, right hand corner of most PPC2+ menu displays as a convenient indicator of active range.

3.2 DIRECT FUNCTION KEYS

3.2.1 RANGE

- **PURPOSE**

  To view and/or change the pressure measurement range.

- **PRINCIPLE**

  Each PPC2+ has three or six ranges (see Section 3.1.2.5).

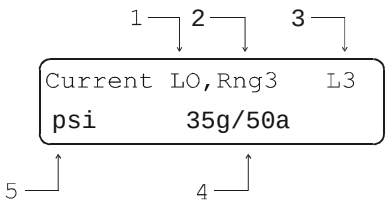
  Pressing the **[RANGE]** function key allows the ranges to be viewed and selected, including automated switching of RPTs when necessary, with built-in logic to prevent accidental overpressure of the Lo RPT if present.

  PPC2+ functions and settings such as pressure unit of measure (UNIT), **control** mode (CONTROL) and upper limit (UPPER LIMIT) are range specific. Changes made while in one range apply to that range only and will not affect the other ranges. Only the HEAD function is not range specific (see Section 3.2.7).

❍ OPERATION

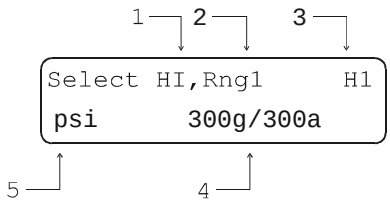
Pressing the **[RANGE]** function key activates the range viewing and selecting function. Pressing the **[+/-]** key or the **[RANGE]** key again while in the RANGE functions steps through displays of available ranges: Lo to Hi. Pressing **[ENTER]** while in the RANGE function when PPC2+ is vented will cause the currently displayed range to become 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 active reference pressure transducer (RPT) and range are displayed. For example:



1. Identifies RPT currently in use (**<Lo>** or **<Hi>**).
2. Identifies current range (**<1>**, **<2>** or **<3>**) of the RPT currently in use.
3. Range designator.
4. Full scale pressure value in the current units for the RPT and range number when used in gauge **<g>** or absolute **<a>** mode. If the RPT is a gauge-only RPT, there is no absolute **<a>** range indicated.
5. Units of measure (the units of measure currently active for this range).

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 RPT (**<Lo>** or **<Hi>**).
2. Identifies range of the RPT (**<1>**, **<2>** or **<3>**).
3. Range designator.
4. Full scale pressure value in the active units of measure for the RPT and range number when used in gauge **<g>** or absolute **<a>** mode. If the RPT is a gauge-only RPT, there is no absolute **<a>** range indicated.
5. Units of measure (the units of measure currently active for the range).

Range full scale 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+ is NOT vented, the display will indicate <Vent system fully to change range>. Pressing the [VENT] key will cause PPC2+ to vent and then return to the RANGE function when the VENT is complete.

3.2.1.1 RANGE SPECIFIC FUNCTIONS AND SETTINGS

In general, PPC2+ functions and settings are range 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. When you return to a range, you will find the settings you left.

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 and **measurement** mode in which PPC2+ displays pressure values.

See also Section 3.4.3.

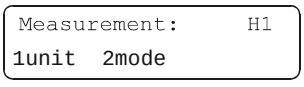
❍ **PRINCIPLE**

PPC2+ allows the pressure measurement unit and mode to be changed. Internally, PPC2+ always operates in Pascal (Pa), the SI unit of pressure. Values of pressure are represented in other units by the application of conversion factors to convert from Pa (see Section 7.3).

RPTs designated AXXXX intrinsically measure absolute pressure relative to an evacuated and sealed reference. These can also be used to measure in **gauge** mode by the subtraction of atmospheric pressure. PPC2+ supports extensive on-board logic and measurements to assure the precise atmospheric compensation of absolute RPTs to deliver gauge measurements (see Section 3.4.1). This allows simple, one step switching between gauge and absolute measurement modes by the operator without special procedures or hardware. RPTs designated GXXXX intrinsically measure gauge pressure and can be used in **gauge pressure measurement** mode only.

❍ **OPERATION**

To change the pressure unit and/or the **measurement** mode, press the **[UNIT]** function key. The display is:

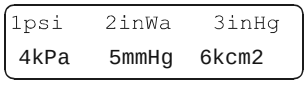


Select **<1>** to change pressure units or **<2>** to change **measurement** mode. If a **measurement** mode change is not currently possible (if the active RPT is gauge only or if the current pressure unit is an altitude unit which can only be absolute), the **<2mode>** selection is not offered.

If **<2mode>** was selected the next screen offers the choice between **<1gauge>** and **<2absolute>**. Making a selection returns to the main run screen with the selected **measurement** mode active.

If **<1unit>** was selected from the measurement screen, the units screen is presented.

The cursor will be on the number corresponding to the active unit for the active range. To change the pressure unit for the active range, select the desired unit. Pressing **[ENTER]** activates the unit and returns to the main run screen.



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 the desired reference temperature for water density using the **[←]** or **[→]** key to move the cursor. Pressing **[ENTER]** returns to the main run screen with 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.

There are two possible default pressure unit screens (one US and one SI) depending on whether the PPC2+ has been factory set as US or SI. Whether the PPC2+ is set up as US or SI is indicated by the right two characters on the top line of the PPC2+ introduction screen which can be viewed by pressing [ESCAPE] from the main run screen or when powering up PPC2+. For an SI PPC2+, the default units are: <1kPa>, <2Pa>, <3MPa>, <4bar>, <5mbar>, <6mmWa>.

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

The pressure measurement unit selected is range specific. When in a given range, all functions and settings will be represented in the current measurement unit for that range. However, certain internal and/or metrological functions (e.g., RPT calibration coefficients) are always represented in Pa regardless of the current range unit. In addition, when the current unit is an altitude unit, the range and upper limit indications are in kPa if the unit is meters (m) and psi if the unit is feet (ft).

See Section 7.3 for tables of the conversion factors used by PPC2+.

The default pressure units available under the UNIT function depend on whether the PPC2+ has been set up as an SI or US version (indicated by SI or US at top right of introduction screen). The choice of six units available under the UNIT function can be modified from a wider selection by the user (see Section 3.4.3). The units available under the UNIT function can be reset to default by pressing [SPECIAL] and selecting <4Internal>, <5Reset>, <2units> (see Section 3.4.4.5).

3.2.3 CONTROL

❍ PURPOSE

To set the automated **pressure control** mode for the currently active range and activate default control parameters.

❍ PRINCIPLE

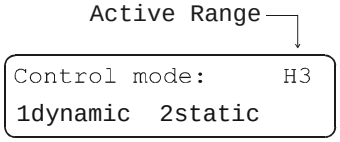
The CONTROL function allows the **active control** mode for the current range to be set to either static control or dynamic control (see Section 3.1.2.3). The **control** mode set is specific to the active range and will be maintained with that range when ranges are changed.

When the **control** mode is set using the CONTROL function, CONTROL parameters are set to system default parameters. The default control parameters have been determined to be those most suitable for the typical user to operate within PPC2+ pressure control and measurement specifications (see Section 3.2.3.1). If desired, **control** mode parameters can be customized 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:



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+ 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 3.2.3.2, Automated Pressure Commands for Zero Pressure).

3.2.3.1 SYSTEM DEFAULT CONTROL PARAMETERS

Table 6. Lo or Hi Reference Transducer Range 1, 2, 3

	HOLD LIMIT	STABILITY LIMIT
STATIC MODE	± 1 % FS of the active pressure measurement range	± 0.005 % FS/sec of the active pressure measurement range.
DYNAMIC MODE	± 0.005 % FS of the active range or ± 2 ppm FS of range H3, whichever is larger	± 0.005 % FS/sec of the active pressure measurement range

PPC2+ BG0002 default control limits are different from standard PPC2+ model default control limits. See the PPC2+ BG0002 Operation and Maintenance Manual.

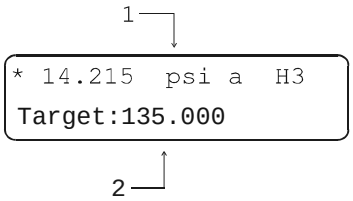
3.2.3.2 EXECUTING AUTOMATED PRESSURE CONTROL COMMANDS

❍ **PURPOSE**

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

❍ **OPERATION**

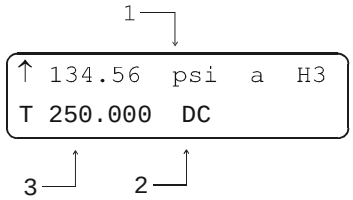
To set a pressure, press **[ENTER]** from the main run screen. The display is:



1. Ready (**<*>**)/Not Ready (**<↑>**) or **<↓>**) indication, current pressure, units, measurement mode, range (regular first line of main run screen).
2. Entry field for target pressure value 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 3.2.3.2.2) for information on zero pressure commands. Also, the **[←]** and **[→]** keys can be pressed to *jog* the current target pressure value displayed down or up by the current pressure control hold limit.

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 (**<↑>** or **<↓>**) indication, current pressure, units, measurement mode, range (regular first line of main run screen).
2. Current control mode indicator: Flashes when automated pressure control is ON. **<D>** for dynamic control, **<S>** for static control with **<C>** added if custom control parameters are in use.
3. Target pressure value **<T>** when controlling and in Not Ready (**<↑>** or **<↓>**) condition; pressure rate of change value **<R>** when in static control mode and waiting for stability; current deviation from the target value **<D>** when in dynamic control mode and Ready (**<*>**) condition.

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

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 and the buzzer will sound. The minimum and maximum in range target will be set.

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

For PPC2+ to set pressures under atmosphere and/or to reliably set pressures under 3 psi (20 kPa) gauge other than zero gauge, a vacuum pump must be connected to the EXHAUST port (see Section 2.3.5) and PPC2+ must be set up for control using a vacuum reference (see Section 3.3.1). Zero gauge pressure can always be set.

Pressing the [←] and [→] editing keys on the 4 x 4 keypad can be used while controlling to *jog* the pressure control target value down or up by the current hold limit. These keys also *jog* the target value when in the ENTER target value screen.

Interrupting Automated Pressure Control

Automated pressure control is interrupted by:

- Pressing **[ESCAPE]**: Suspends control and remains in main run screen.
- Pressing any direct pressure control key (see Section 3.1.2.2): Suspends control and executes direct pressure control.
- Pressing any function key: Suspends control and goes to the selected function.
- Pressing **[ENTER]**: Suspends control and goes to ENTER target pressure value screen.

To resume automated pressure control, press **[ENTER]** and insert a target pressure value.

Automated Pressure Commands for Zero Pressure

Zero in gauge mode: A command for automated pressure control to a target value 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: When attempting to set a target pressure of zero in **absolute measurement** mode, PPC2+ opens its down control valves fully and closes a bypass interrupt valve to interrupt the natural flow of gas out the EXHAUST port through its pressure regulators once pressure is under 3.5 psia (25 kPa). However, even with a vacuum pump connected to its EXHAUST port, there is a limit to how low the pressure in PPC2+ can be pulled down. This is a function of the quality of the vacuum pump used, the characteristics of the volume connected to the TEST port and PPC2+'s internal restrictions. When a command for automated pressure control to a target value of zero is given when in **absolute pressure measurement** mode, PPC2+ 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 and the control down fast valve will remain open keeping the vacuum pump connected to the PPC2+ pneumatic module and TEST port. When pressure control is suspended or a non-zero pressure target is executed, the bypass interrupt valve is opened.

⚠ Due to the manner in which PPC2+ 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 interpreted to mean that the pressure is zero within the hold limit. Ready (<*>) is an indication that the rate of change of pressure inside PPC2+ has reached the current stability limit. The current displayed pressure should be used as the value of pressure applied to the device or system under test.

When PPC2+ is given a command to set zero in absolute measurement mode, the rate of change of pressure will decrease as the pressure decreases and the rate will eventually be near zero when the vacuum pump has pulled down the pressure in the PPC2+ and the test volume as far as possible. To make best use of the Ready (<*>)/Not Ready (<↑> or <↓>) indication when setting zero in absolute measurement mode, set the stability limit (see Section 3.2.6) to a value that represents the rate of change of pressure expected when the vacuum pump connected to the EXHAUST port has reduced pressure as far as possible.

3.2.4 UPPER LIMIT

❍ PURPOSE

To set the upper limit pressure value for a **pressure range** and **measurement** mode.

❍ PRINCIPLE

The UPPER LIMIT function allows the setting of a maximum pressure not to be exceeded when using a specific range and **measurement** mode. 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.

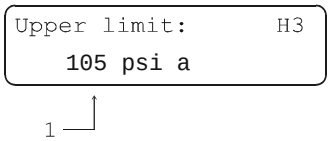
Upper limit settings are specific to each range and **measurement** mode *(***gauge** *or* **absolute***).*

The UPPER LIMIT function is most often used to protect the device or system connected to the PPC2+ TEST port from accidental overpressure.

If no upper limit value is entered by the user, the upper limit for each range and measurement mode is set by default to 105 % of each range and measurement mode for ranges L3 and H3 and to 115 % of each range and measurement mode 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+ returns to the main run screen with a new upper limit value active.

When the UPPER LIMIT has been exceeded, the display of current pressure flashes and a buzzer sounds for 3 seconds every 2 seconds. Reduce pressure using direct pressure control keys or an automated pressure command to return to normal operation.

Upper limit values are specific to each range and measurement mode. Be careful not to assume that the upper limit set in one measurement mode will apply to the other. For example, if you set 17 psi as the upper limit in absolute mode, the upper limit will not be (17 psia - atmospheric pressure) in gauge mode. The gauge mode upper limit for that range will still be the default limit or another limit that has been set in gauge mode.

Upper limits are always specified and displayed in the current pressure unit except for altitude units. When in altitude units, upper limits are expressed in kPa if the altitude unit is meters (m) and psi if the altitude unit is feet (ft).

PPC2+ has UPPER and LOWER limits, not just an UPPER LIMIT. See the PPC2+ BG0002 Operation and Maintenance Manual.

3.2.4.1 OVERPRESSURE FUNCTION

In addition to the UL function, PPC2+ has an **overpressure function.** This function executes when the maximum RPT range is exceeded by 25 %. The function causes all pressure control to be interrupted and disabled, changes the range to H3 and causes the display to flash. The overpressure function also logs the time and date of the overpressure condition to assist in incident diagnosis. To recover from an overpressure condition, cycle PPC2+ power.

3.2.5 SEQ

❍ **PURPOSE**

To execute a programmed sequence of automated pressure control target values: Either a **<quick sequence>** to run in the current range with all current settings or a **<file sequence>** specifying the range and settings to use.

❍ **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+ 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 (e.g., pressure units, **control** mode, control settings).
- File Sequence (see Section 3.2.5.2) allows execution of a preprogrammed sequence script including the PPC2+ range to use, **measurement** mode, **control** mode, target values and other operational settings.

❍ **OPERATION**

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

```
Run a sequence:   H3
1quick  2file
```

Select the sequence type desired. See Section 3.2.5.1 for quick sequence or Section 3.2.5.2 for file sequence set ups. See Section 3.2.5.3 for running a sequence.

3.2.5.1 SETTING UP/EDITING A QUICK SEQUENCE

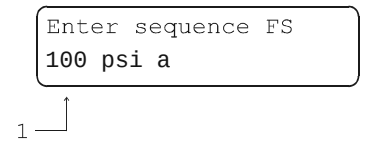
❍ **OPERATION**

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. Selecting **<1Yes>** will cause the currently defined quick sequence to run (see Section 3.2.5.3). Selecting **<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:

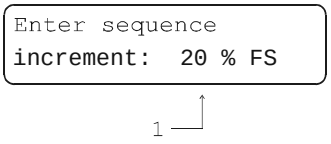


1. Entry field for sequence full scale value. Recalls value last entered.

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 or an error will occur when attempting to run the sequence (see Section 3.2.4). To run a sequence including a pressure greater than the current upper limit, increase the upper limit before running the sequence or change to a higher range if available.

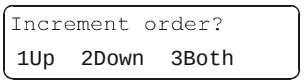
The next display is:



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

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 run 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:

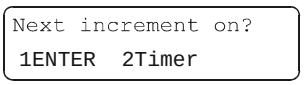


This selection determines the order in which the sequence increments will execute. Selecting **<1Up>** will cause the sequence to execute starting at zero and going to the full scale value.

Selecting **<2Down>** will cause the sequence to execute starting at the full scale value and going to zero.

Selecting **<3Both>** will cause the sequence to execute from zero to full scale and back to zero.

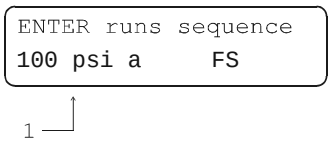
After making the increment order selection the next display is:



This selection determines under what conditions, when the sequence is run, 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 whenever, and only whenever, **[ENTER]** is pressed.

If **<2Timer>** is selected, a timer will be started each time a pressure Ready (**<*>**) condition is achieved (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:



1. Indication of maximum (furthest from zero) pressure included in the sequence which is about to run.

Press **[ENTER]** to run the quick sequence that has just been set up/edited (see Section 3.2.5.3). Press **[ESCAPE]** to return to the main run screen without running a sequence.

3.2.5.2 SETTING UP/EDITING A FILE SEQUENCE

Setting up and editing file sequences is done by pressing **[SETUP]** and selecting **<3Sequence>** (see Section 3.3.3).

3.2.5.3 RUNNING A SEQUENCE

- **PURPOSE**

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 # menu 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).

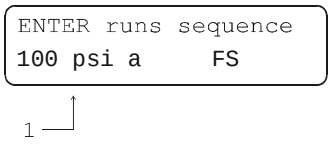
When initializing execution of a quick sequence, PPC2+ checks: a) if the sequence full scale pressure is within the current upper limit; b) if PPC2+ is in absolute measure mode, that the sequence does not contain negative values. If either condition is not met, an error message will be displayed and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

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

To run a file sequence, the sequence file number selected must already have been setup by pressing [SETUP] and selecting <3Sequence> (see Section 3.3.3).

OPERATION

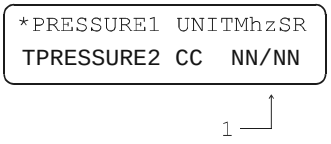
The first display is:



1. Indication of maximum (furthest from zero) pressure included in the sequence which 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 **[ESCAPE]** returns to the main run screen without sequence execution. 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 or a vent command). The display is the Main Run Screen (see Section 3.1.1) with indication of the sequence progress:



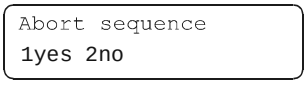
1. Indication of sequence increment that is currently being controlled/total increments in sequence. Changes to ENTER or countdown time remaining once Ready (**<*>**) condition has been reached at target value.

Except for the bottom right hand corner, the sequence run 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>**. Press **[ENTER]** 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.

To interrupt the sequence, press **[ESCAPE]**. 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. Selecting **<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, press [ESCAPE] after the last point.

3.2.6 CUSTOM CONTROL

- **PURPOSE**

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

- **PRINCIPLE**

Automated pressure control and the associated pressure Ready (**<*>**)/Not Ready (**<↑>** or **<↓>**) condition are characterized by hold limit and stability limit parameters which determine how PPC2+ will control and under what conditions a Ready (**<*>**) indication will occur (see Sections 3.1.2.3 and 3.1.2.4).

PPC2+ provides system default values for the hold limit and stability limit parameters for each range which have been determined to be those most suitable for the typical user to operate within PPC2+ pressure control and measurement specifications. The default parameters are automatically set each time the **control** mode is selected using the **[CONTROL]** function key (see Table 7).

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 (**<*>**)), usually by decreasing control 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 from its default value of ± 0.005 % FS of the current range to ± 0.01 % FS of the current range will decrease the time required to set a pressure (achieve a Ready (**<*>**) condition) since the limit in which the pressure must be set has increased by a factor of two but it will also increase by a factor of two the maximum possible control error included when Ready (**<*>**) is indicated.

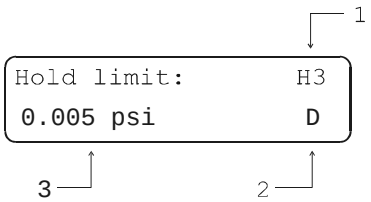
Adjusting default control parameters using the CUSTOM CONTROL function may result in control parameters that the PPC2+ is unable to meet so that a Ready (<*>) condition never occurs. This does not indicate PPC2+ malfunction, just that the control parameters need to be relaxed or set back to default parameters.

Table 7. 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 % FS of the active pressure range	± 0.005 % FS/sec of the active pressure range	± 1 % FS of the active pressure range	± 0.005 % FS/sec of the active pressure range.
DYNAMIC MODE	± 0.005 % FS of the active pressure range or ± 2 ppm of range H3, whichever is larger	± 0.00 % of the active pressure range	± 0.005 % FS of the active pressure range	± 0.005 % FS of the active pressure range

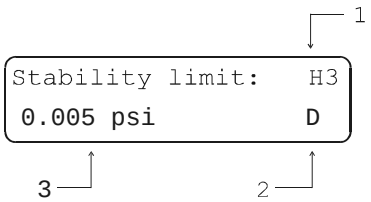
❍ OPERATION

To set custom control parameters, press the **[CUSTOM CONTROL]** key from the main run screen. The display is:



1. Current reference transducer (**<H>** for high, **<L>** for Lo) and range (**<1>**, **<2>** or **<3>**).
2. Current control mode (**<S>** for static, **<D>** for dynamic).
3. 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.

Enter the desired hold limit. The next display is:



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

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

To reset default control parameters for a range and control mode, select the control mode using the CONTROL function while in that range.

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+ reference pressure transducer.

- **PRINCIPLE**

PPC2+'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+'s TEST port. This difference in height, frequently called **head**, can cause a significant difference between the pressure measured by the PPC2+ at its TEST port height and the pressure actually applied to the device under test which is at a different height. In this case, it is useful to make a head correction to the pressure measured by the PPC2+ RPT at its test port in order to accurately predict the pressure actually applied at a different height.

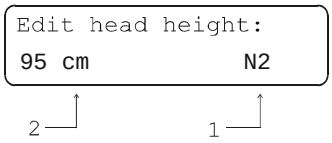
PPC2+ can accurately calculate **head** pressures for nitrogen, helium and air as the test gas over its working pressure range. The HEAD function allows the height difference to be specified and causes the resulting head pressure to be added to the pressure measured at the TEST port.

The **[HEAD]** function key is used to turn the head correction function ON and OFF and to specify the height difference between the PPC2+ TEST port and another height. The height units and the test gas are specified under by pressing **[SPECIAL]** and selecting **<2Head>** (see Section 3.2.7).

Use of the HEAD function to assure in tolerance measurements is most important in low absolute pressure ranges. Specifying the head height within ± 12 in. (30 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. Test gas currently specified for the head correction.
2. Entry field for head height.

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 head setting.

⚠ The HEAD function is *NOT* range specific. The HEAD ON or OFF status remains the same as ranges are changed. Edits made to the head specifications are independent of range.

When the HEAD function is ON (head value ≠0). It is indicated by <h> in the top line of the main run screen (see Section 3.1.1). When the HEAD function is OFF, the <h> is not shown.

To change units of head height between inches and centimeters and to change the test gas species, press [SPECIAL] and select <2Head> (see Section 3.2.7).

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

3.2.8 LEAK CHECK/PURGE

❍ **PURPOSE**

The **[LEAK CHECK]** function key accesses two functions:

- The LEAK CHECK function to assist in checking the pressurized connections and device or system under test connected to the PPC2+ TEST port for leaks (see Section 3.2.8.2).
- 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+ (see Section 3.2.8.3).

- **PRINCIPLE**

  Leaks in the test system can have a detrimental effect on measurement accuracy and, when large enough, can cause the PPC2+ 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+ is designed to precisely set, control and measure gas pressures. Liquid contamination of the PPC2+ 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+ TEST port are likely to make their way back to PPC2+'s internal pneumatic system as the test device or system is pressurized and depressurized by PPC2+. To every extent possible, only clean hoses and connections should be used in connecting PPC2+ to test devices or system and those devices and systems should be free of liquid contaminants. However, in the event that PPC2+ will need to be used to test some devices or systems that contain small amounts of liquid contaminants, a Self Purging Liquid Trap (SPLT) accessory supported by the PURGE function is available.

  As the LEAK CHECK and PURGE functions are generally performed together at the beginning of a test and there are commonalties to the procedures, PPC2+'s LEAK and PURGE functions are designed to operate together under the 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 flowchart of the LEAK CHECK/PURGE menu and functions is shown in Figure 10.

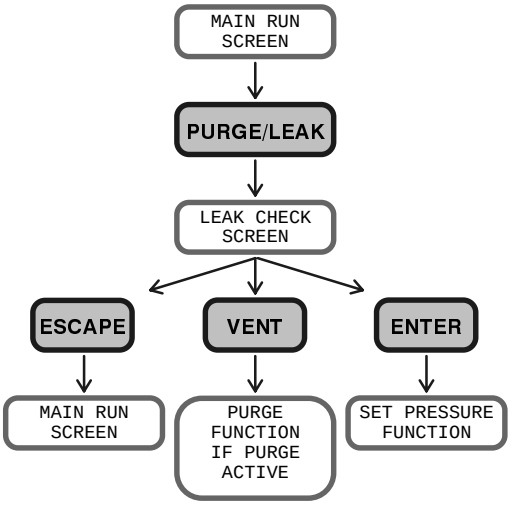
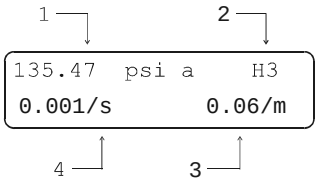


Figure 10. Leak Check/Purge Menu Flow Chart

The PURGE function must have been enabled by pressing [SPECIAL] and selecting <4Internal>, <8Purge> (see Section 3.4.4.8) for the PURGE function to execute. If the PURGE function has not been enabled, the [VENT] direct pressure control key will behave normally from the leak check screen.

3.2.8.2 LEAK CHECK SCREEN

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/minute (updated every 10 seconds).
4. Current rate of change of pressure (leak rate) in current pressure units/second.

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

If the PURGE function is enabled (see Section 3.4.4.8), 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+ automated pressure control operation and to assure in tolerance measurements with default pressure control parameters is 1 % of current range FS/minute. In dynamic control mode, to handle higher test system leak rates, increase the hold limit using CUSTOM CONTROL (see Section 3.2.6).

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 PURGE function must be enabled by pressing [SPECIAL] and selecting <4Internal>, <8Purge> (see Section 3.4.4.8) and an optional Self Purging Liquid Trap (SPLT) must be correctly installed in the line connecting the PPC2+ TEST port to the device or system under test (see Section 2.3.6.1).

The PURGE function makes use of the PPC2+ valve driver option. Valve driver number 8 is used to actuate the SPLT exhaust valve. The SPLT exhaust valve Is actuated when performing the PURGE function and in the background every time the PPC2+ vent valve is opened. When making use of valve drivers, note that when the PURGE function is enabled, valve driver number 8 will be actuated independently of valve driver commands.

If the PURGE function is enabled (see Section 3.4.4.8), 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.

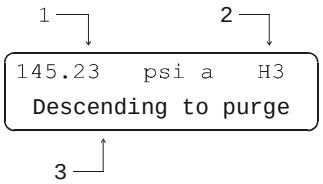
Execution of the PURGE function is automated and proceeds as follows:

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

The purge function should be executed from roughly full scale of the device or system under test or < 150 psi (1 MPa), whichever is lower. Avoid executing the PURGE function from pressures above 150 psi (1 MPa).

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

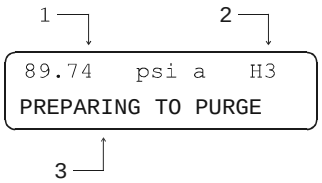
When the PURGE function is initiated, if the current pressure is over 100 psi (700 kPa) gauge, the display is:



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

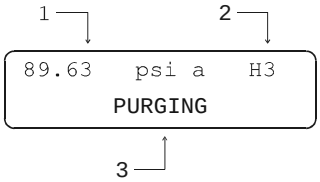
Pressing [ESCAPE] at any time during purge routine execution causes the purge function to abort and returns to the leak check screen (see Section 3.2.8.2).

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+ is waiting 5 seconds and preparing to open the SPLT exhaust valve. Indication flashes.

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+ 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+ 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 collected is greater than about 10 cc. The SPLT is designed to protect the PPC2+ against only *residual* liquid contamination. 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 connection to the PPC2+ TEST port.

⚠ 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+, its exhaust valve will always be open when the PPC2+ 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 if PURGE is enabled (see Section 3.4.4.8).

Pressing the **[ENTER]** key from the leak check screen will cause the regular set pressure screen for automated pressure control to appear (see Section 3.2.3.2). An automated pressure control command can then be executed.

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+ TEST port. Generally, the purge process should be completed before leak checking is performed. This may not be the case when the PPC2+ will be used to apply only ascending pressures.

To purge:

- Press the **[LEAK CHECK]** function key.
- Use the direct manual pressure control keys to set the desired purge pressure (generally full scale of the device or system under test or 150 psi (1 MPa), whichever is lower).
- Wait for pressure to stabilize.
- 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.
- Repeat from all steps until no noticeable amount of liquid contamination is observed exhausting from the SPLT exhaust valve.

To leak check:

- Press the **[LEAK CHECK]** function key.
- Use the direct manual pressure control keys to set the desired leak check pressure (generally full scale of the device or system under test).
- Wait for pressure to stabilize.
- 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 the source of the leak, vent system and eliminate the leak if possible.
- Repeat from all steps until leak rate observed in 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 to PPC2+ if it will be used to apply ascending pressures only to the device or system under test since flowing gas back to the PPC2+ 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

❍ **PURPOSE**

To select the current measurement range of the optional analog input function. This key has no function if the analog input function is not present in the PPC2+.

❍ **PRINCIPLE**

The PPC2+ is available with an analog input option that allows the user to measure up to four external voltage or current sources. Four ranges of measurement are provided:

- 0 to 100 mV.
- 0 to 5 V.
- 0 to 10 V.
- 4 - 20 mA.

The selected range is effective on all of the inputs together. The measurement is available on the PPC2+ front panel or remotely.

❍ **OPERATION**

To access the ANALOG function, press the **[ANALOG]** function key from the main run screen. If the PPC2+ is equipped with the analog input option, the display is:

Input range: 1:100 mV

2:5V 3:10V 4:4-20 mA

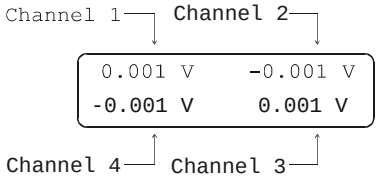
The cursor is on the number of the currently active measurement range. Make the desired selection. The display returns to previous screen with the new analog measurement range active.

The electrical connections to the analog input option are made at a connector on the PPC2+ rear panel (see Section 7.2).

3.2.9.1 VIEWING ANALOG MEASUREMENTS

To view the current reading of the four channels of the optional analog input press the **[+/-]** key from the main run screen.

The display is:



The displayed values update about every 0.75 seconds. To return to the main run screen from the analog input display screen press **[+/-]** or **[ESCAPE]**.

The unit indication is V for the 0 to 5 and 0 to 10 V ranges; mV for the 0 to 100 mV range and mA for the 4 to 20 mA range.

Whenever the PPC2+ is first turned ON or the analog input option range is changed and/or every 30 minutes of operation (see Section 5.4) the analog function performs an auto-calibration cycle. This cycle completes in about 10 seconds during which analog measurements are interrupted and the analog value fields display dashes.

3.3 SETUP MENU KEY

❍ **PURPOSE**

The **[SETUP]** menu key accesses a menu of functions and features commonly used in setting up PPC2+ 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 PPC2+ should automatically determine whether a vacuum source or atmospheric pressure is connected to its EXHAUST port or to manually set the EXHAUST port condition.

❍ PRINCIPLE

The PPC2+ exhaust (down) control valves and the output of the exhaust pressure regulator are connected to the PPC2+ EXHAUST port (see Section 5.8.1.7).

The response of the pneumatic module used to control pressure, particularly when controlling pressure near and under atmospheric pressure, changes depending on whether the EXHAUST port is connected to a vacuum source or left open to atmosphere. To use the proper pressure control algorithms, PPC2+ must know the condition of the exhaust port.

The ControlRef function allows the PPC2+ to know whether its exhaust port is at vacuum or atmospheric pressure. An independent exhaust pressure sensor measures the pressure present at the EXHAUST port. Normally, the exhaust sensor output is used automatically by PPC2+ to determine the exhaust port condition. If desired, this automatic determination can be overridden and the exhaust port condition set manually.

The ControlRef function allows setting of whether the EXHAUST port condition will be determined automatically using the exhaust sensor or set manually. It also allows viewing of the current status of the EXHAUST port.

The normal condition of the ControlRef function is <1auto>. In this condition, the operator need not be concerned with informing the PPC2+ of EXHAUST port pressure conditions as PPC2+ will determine the existing condition automatically. The other settings are normally used only for special applications or trouble shooting. Pressure control near and under atmospheric pressure will not operate properly if ControlRef is not set correctly.

❍ OPERATION

To access the ControlRef function, press **[SETUP]**, and select **<1ControlRef>**. The display is:

```
Control ref:1auto
2vac  3atm  4view
```

Make the appropriate selection.

Selecting **<1auto>** sets the PPC2+ to determine the EXHAUST port condition automatically using its internal exhaust sensor. This is the normal control ref setting.

Selecting **<2vac>** sets the PPC2+ to assume that a vacuum supply is connected to the EXHAUST port.

Selecting **<3atm>** sets the PPC2+ to assume that the EXHAUST port is open to atmospheric pressure.

Selecting **<4view>** allows viewing of the current EXHAUST port condition assumed by PPC2+ and how it was determined.

Before connecting a vacuum pump or vacuum source to the PPC2+ EXHAUST port. See Section 2.3.5 for information on vacuum connection requirements and precautions.

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

3.3.2 Resltn

- **PURPOSE**

To set the resolution with which measured pressures are displayed.

- **OPERATION**

To access the resolution function, press **[SETUP]**, and select **<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 Section 3.2.5).

- **PRINCIPLE**

The PPC2+ 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 by pressing **[SETUP]** and selecting **<3Sequence>**.

Setting up a sequence file requires specifying:

- The sequence file number to be created or edited.
- The RPT to be used (Hi, Lo).
- The range on the RPT (1, 2 or 3).
- The pressure units of measure and **measurement** mode (gauge or absolute).
- The number of pressure targets in the sequence.
- The numerical value of each target pressure.
- 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 of this section.

To access the Sequence file building function, press **[SETUP]** and select **<3Sequence>**. The display is:

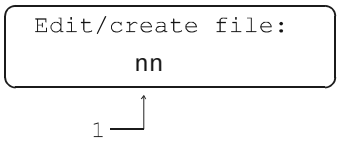
```
File sequence
1Edit    2View
```

Selecting **<1view>** allows sequence file characteristics to be viewed only.

Selecting **<2edit>** allows a sequence file to be edited or created. The instructions below assume that **<2edit>** has been 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 targets has been 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:

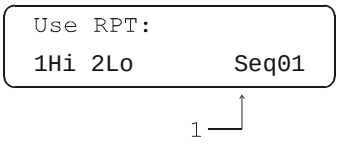


1. Entry field for the file number of the sequence to be edited.

Enter the desired sequence file number.

Up to 30 sequence files can be setup (address numbers 01 through 30).

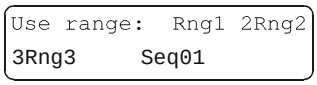
The next selection determines the **RPT** that will be used:



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

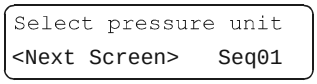
Select the RPT that is to be used by this sequence.

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



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

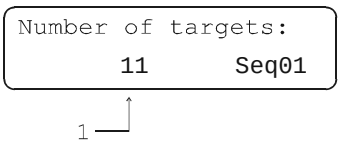
The next selections specify the **pressure unit and measurement mode** in which the sequence pressure target pressures will be defined:



If the RPT selected for the sequence is a gauge RPT (GXXXX) the measurement mode selection will not be offered as gauge RPTs can only measure in gauge mode.

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, press **[SPECIAL]** and select **<3PresU>** (see Section 3.4.3).

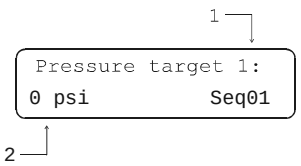
The next selection specifies the **number of pressure targets** in the sequence, including zeros and vents:



1. Entry field to edit the total number of targets in the sequence including zeros and vents.

Enter the total number of targets in the sequence.

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



1. Number of the target in the sequence whose value is currently being edited.
2. Entry field for the numerical value of the target pressure.

Enter the numerical value of the target pressure or press the **[VENT]** direct pressure control key to cause a VENT command to execute. The display repeats, incrementing through the target numbers until the total number of targets specified has been defined.

The next selection defines **how the sequence will end**, by venting after the last target **<1yes>** or at the last target **<2no>**:

```
Vent after sequence:
1yes  2no       Seq01
```

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

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

```
Next pressure on:
1ENTER 2timer   Seq01
```

If **<1ENTER>** is selected, when the sequence is executed, PPC2+ will wait at each pressure target until **[ENTER]** is pressed before proceeding to the next target.

If **<2Timer>** is selected, when the sequence is executed, PPC2+ will start a timer when a Ready (**<*>**) condition is reached at a pressure target. Each time the timer expires, the sequence will proceed automatically to the next pressure target. 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 target to the next, the **control mode** is specified:

```
Pressure control mode:
1dynamic2static  Seq01
```

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

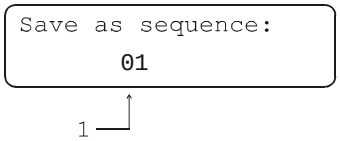
The option of **customizing the control mode parameters** for the **control** mode selected is then offered:

```
Custom control:
1Yes  2No       Seq01
```

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. Entry field for sequence file address number under which to save this sequence.

Enter the desired sequence file number or press **[ENTER]** if the desired file 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+'s 8 channel, 12 V external drivers.

- **PRINCIPLE**

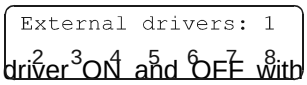
PPC2+ external drivers are available to drive peripheral equipment in a PPC2+ system, for example, solenoid valves or the optional Self Purging Liquid Trap (SPLT). The driver electrical connections are available from a rear panel connector

See Section 9.1 for driver specifications and pin-outs.

- **OPERATION**

To access the driver control function press **[SETUP]** and select **<4drivers>**.

The display is:



Pressing the keypad numerical key driver number turns that driver ON and OFF with either a momentary or a toggled response (see next paragraph). An active driver is indicated by **<*>** immediately following the driver number.

Pressing **[ENTER]** while in the External drivers menu causes a menu to appear that allows selection of whether the driver actuation by selecting the driver number will be **<1momentary>** or **<2toggle>**.

The PPC2+ PURGE function makes use of the valve driver option. Valve driver number 8 is used to actuate the SPLT exhaust valve. The SPLT exhaust valve Is actuated when performing the PURGE function and in the background every time the PPC2+ vent valve is opened. When making use of valve drivers, note that when the PURGE function is enabled, valve driver number 8 will be actuated independently of user initiated valve driver commands (see Section 3.2.8.3).

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:

```
1AutoZ 2Head3 PresU
4Internal
```

In PPC2+ BG0002, the [SPECIAL] menu key includes a selection <5Valves>. See the PPC2+ BG0002 Operation and Maintenance Manual.

3.4.1 AUTOZ

- **PURPOSE**

To change the offset (zero) of the Lo and Hi reference pressure transducers relative to a reference value in order to compensate for RPT zero drift between full recalibrations.

To assure operation within "with autozero" measurement accuracy specifications (see Section 1.2.2), it is recommended that AutoZ be run (the value of ZOFFSET updated) at least every 30 days or when PPC2+ has been exposed to temperature changes exceeding ± 20 °C (36 °F).

- **PRINCIPLE**

How AutoZ Works

The main component of the change over time of the PPC2+ RPTs is zero drift or offset, independent of span. Rezeroing PPC2+ RPTs relative to a more stable reference between recalibrations allows higher measurement accuracy specifications to be maintained with less frequent full calibrations. The PPC2+ autozero function (AutoZ) provides full on-board support for the rezeroing process to simplify its application by the user.

The autozeroing function uses four parameters:

1. **ZSTD:** The value of the autozero pressure as indicated by the reference autozero device.

   For *absolute RPTs in **absolute measurement** mode*, the autozero pressure is always atmospheric pressure and the ZSTD value can be supplied either a) by manual entry; b) automatically from a **DHI** RPM connected to the PPC2+ COM2 port or; c) automatically from a Lo absolute RPT if one is available.

   For *gauge RPTs or absolute RPTs in **gauge measurement** mode*, the autozero pressure is always zero (atmospheric pressure) which is supplied by definition when the RPT is vented to atmosphere.

2. **ZCURERR:** The difference between ZSTD and the RPT indication at the autozero pressure *at some time after the calibration of the RPT* (ZCURERR = RPT w/out AutoZ - ZSTD).

3. **ZNATERR**: The difference between ZSTD and the RPT indication at the autozero pressure *just after the RPT has been calibrated*. This is referred to as the **natural error** at the autozero pressure. Because no RPT is perfectly linear and ZSTD is not perfectly accurate, the disagreement between the RPT reading and ZSTD at the autozero pressure is unlikely to ever be zero (except for gauge RPTs for which the zero point is **forced** at calibration).

4. **ZOFFSET**: ZCURERR corrected for ZNATERR, represents the drift of the RPT relative to the reference (ZOFFSET = ZCURERR - ZNATERR). The current RPT reading, adjusted by ZOFFSET, is the **autozeroed** RPT reading (e.g., the RPT reading corrected for zero drift since it was calibrated). For an absolute RPT used in **gauge** mode, ZOFFSET also includes the value of atmospheric pressure that is being subtracted to arrive at gauge pressure.

The AutoZ function manages the determination, storage and application of ZNATERR and ZOFFSET individually for each PPC2+ range and **measurement** mode.

AutoZ ON/OFF

The AutoZ function can be turned ON and OFF. When AutoZ is ON, the ZOFFSET is always applied to the pressure measured by PPC2+. When AutoZ is OFF, ZOFFSET is not applied (except for an absolute RPT in **gauge** mode for which ZOFFSET is the current value of atmospheric pressure which is always subtracted to achieve gauge pressure).

Gauge Mode with an Absolute RPT, Dynamic Compensation for Atmospheric Pressure

PPC2+ allows gauge pressure measurements with an absolute RPT by calculation, subtracting the value of atmosphere (tare) from the RPT's absolute measurement to arrive at a gauge value. The appropriate tare value changes with the natural evolution of atmospheric pressure at a given location. For this reason, the value of the tare is redetermined each time the RPT is known to be exposed to atmospheric pressure (e.g., the PPC2+ is vented and the pressure is stable). However, if atmospheric pressure changes significantly between opportunities to redetermine the tare, for example if running an extensive test that does not include returns to a vented condition, the changes in atmospheric pressure during that time will not be taken into account and a significant zero offset in the gauge pressure indications could result.

To minimize zero errors due to the evolution of atmospheric pressure between taring opportunities when using an absolute RPT in **gauge measurement** mode, PPC2+ dynamically compensates the atmospheric tare value. PPC2+'s on-board barometer measures atmospheric pressure independently from the RPT. Between opportunities to update the tare value (vented conditions), the difference between the on-board barometer reading at the time of the last tare value and the current on-board barometer reading is used to compensate the tare value. This value is called ATMOFFSET. This technique, which relies only on the resolution and short term stability of the on-board barometer, rather than its absolute accuracy, allows gauge measurements with an absolute RPT with an additional uncertainty due to possible changes in atmospheric pressure limited to ± 0.001 psi (8 Pa).

When using an absolute RPT to make low gauge mode measurements, the limit in resolution of the on-board barometer used for dynamic compensation for atmospheric pressure may cause significant distortion of the results. For best results when using an absolute RPT in gauge mode under 20 psi (150 kPa) turn the AutoZ function OFF (see Section 3.4.1) to eliminate the effect of the dynamic compensation system and vent PPC2+ often to keep the atmospheric tare value current.

Recommendations for the Use of the AutoZ Function

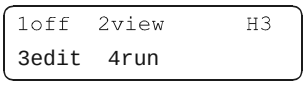
The AutoZ function provides a powerful and easy to use tool for improving the measurement accuracy specifications of a PPC2+ and reducing the calibration recall interval by compensating for zero drift between full recalibrations. The following simple recommendations will help assure that you use this feature to best advantage.

- Always leave AutoZ ON when operating in the **gauge measurement** mode. The only exception is when using an absolute RPT in **gauge** mode at pressures under 20 psi (150 kPa) (see note above).
- Always leave AutoZ ON when operating in the **absolute measurement** mode if ZNATERR was set properly at calibration and the AutoZ routine using a valid atmospheric reference has been run regularly.
- Execute the run AutoZ routine only when a reference whose accuracy is known to be significantly better than that of the PPC2+ RPT is available. Keep range ratios in mind when comparing accuracy. A ± 0.01 % FS barometer is roughly 10 times more accurate than an ± 0.01 % FS 150 psi (1 MPa) RPT range because the RPT/barometer range ratio is 10:1.
- Though this may not be practical and generally is not necessary, the best reference with which to run AutoZ is a gas operated piston gauge applying atmospheric pressure to the PPC2+ test port. The best day to day reference is a properly calibrated, barometric range, **DHI** RPM1, RPM2 or RPM3 interfaced directly to the PPC2+ COM2 port.
- Allow the PPC2+ to stabilize at atmospheric pressure and ambient temperature for 5 to 10 minutes before running AutoZ.

❍ **OPERATION**

The AutoZ function and values are range AND mode (gauge or absolute) specific. Gauge RPTs (GXXXX) have no ZNATERR and no independent AutoZ routine as they autozero transparently to the user whenever the PPC2+ is vented.

To access the PPC2+ AutoZ function press **[SPECIAL]** and select **<1AutoZ>**. The display is:



Selecting **<1off> (or <1on>)** is for changing the AutoZ status for the current range and **measurement** mode from ON to OFF or vice versa. Selecting **<1off>** turns OFF the AutoZ function for the current range and mode (see AutoZ ON/OFF of this section).

AutoZ ON is indicated by a <z> in the main run screen, top line, third character from the right. When AutoZ is OFF, the character is blank.

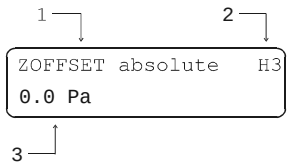
Selecting **<2view>** allows the current value of ZOFFSET for the current range and mode to be viewed.

Selecting **<3edit>** allows the value of ZOFFSET for the current range and **measurement** mode to be edited.

Selecting **<4run>** allows the routine for determination and activation of ZOFFSET by measurement of ZSTD to be executed.

3.4.1.1 VIEW AUTOZ

To view the current ZOFFSET for the current range and **measurement** mode press **[SPECIAL]** and select **<1AutoZ>**, **<2view>**. The display is:



1. Current measurement mode.
2. Current range.
3. Display field of current value of ZOFFSET

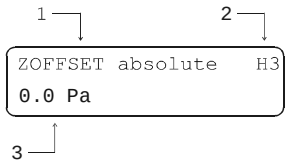
ZOFFSET should be zero when the PPC2+ is new or has just been calibrated. ZOFFSET should be roughly equal to atmospheric pressure for an absolute RPT operating in gauge mode.

The value of ZOFFSET is always displayed and entered in Pascal (Pa) as PPC2+'s internal operations are in Pa.

3.4.1.2 EDIT AUTOZ

The edit AutoZ function should be used with great caution as entering inappropriate values and turning ON AutoZ may result in incorrect autozeroing and out of tolerance measurements. In normal operation, the value of ZOFFSET should be changed using the run AutoZ function (seen Section 3.4.1.3). The only expected use of edit AutoZ is to set ZOFFSET to zero after a calibration of PPC2+ RPTs. Before editing ZOFFSET. See Sections 3.4.1, PRINCIPLE and 5.2.6).

To edit the current ZOFFSET for the current range and **measurement** mode, press **[SPECIAL]** and select **<1AutoZ>**, **<3edit>**. The display is:



1. Current measurement mode.
2. Current range.
3. Edit field for value of ZOFFSET

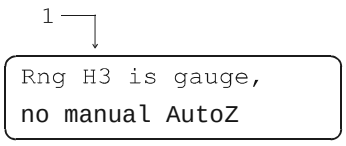
The value of ZOFFSET is always displayed and entered in Pascal (Pa).

3.4.1.3 RUN AUTOZ

Run AutoZ is the function by which the current RPT reading is compared to ZSTD and a new value of ZOFFSET representing RPT zero drift is determined (see Section 3.4.1, PRINCIPLE, How AutoZ Works).

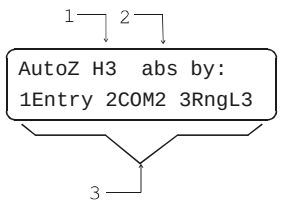
To access run AutoZ, press **[SPECIAL]** and select **<1AutoZ>**, **<4run>**.

If the measurement mode of the current range is gauge, run AutoZ occurs transparently to the user whenever AutoZ is ON and the PPC2+ is in the vented condition. The display is:



1. Indication of current range.

If the measurement mode of the current range is absolute the display is:



1. Current range.
2. Current measurement mode.
3. Selection of source of ZSTD for ZOFFSET determination.

Selecting **<1Entry>** allows the value of ZSTD to be entered from the front panel keypad.

Selecting **<2COM2>** allows the value of ZSTD to be read automatically from an RPM interfaced with PPC2+'s COM2 communications port.

Selecting **<3RngL3>** is available only if the current RPT is a Hi absolute RPT and there is a Lo absolute RPT. Allows the value of ZSTD to be read automatically from the Lo RPT.

Allow the PPC2+ to stabilize at atmospheric pressure and ambient temperature for 5 to 10 minutes before running AutoZ.

If running AutoZ results in values of ZOFFSET that are greater than ± 0.01 % FS of the current PPC2+ measurement range, the PPC2+ and/or the source of ZSTD may be out of tolerance or the AutoZ process may have been faulty. Before activating a new ZOFFSET greater than ± 0.01 % FS of the current PPC2+ range, check to be sure that both the PPC2+ and the source of ZSTD were in good working order, properly vented to stable atmospheric pressure, at the same height, and reading in the same pressure units when AutoZ was run.

When the run AutoZ selection is made, if a HEAD correction is currently active (see Section 3.2.7) the head correction will be disabled to avoid "autozeroing" the head value.

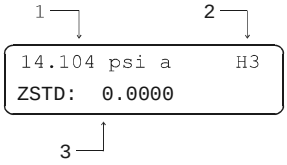
The value of ZOFFSET will not be exactly equal to the difference between the current reading and ZSTD if ZNATERR is not zero (see Section 3.4.1, PRINCIPLE, How AutoZ Works).

The value of ZOFFSET is always displayed and entered in Pascal (Pa).

Run AutoZ by Entry

AutoZ by entry allows the value of ZSTD (See Section 3.4.1, PRINCIPLE, How AutoZ Works) to be entered manually. This provides a simple way of autozeroing relative to an independent reference device such as a house barometer that does not interface directly with PPC2+.

To access run AutoZ by entry press **[SPECIAL]** and select **<1AutoZ>**, **<4run>**, **<1Entry>**. The display is:



1. Pressure reading, units and mode of the active RPT range.
2. Active range indicator.
3. Entry field for the value of ZSTD.

Enter the value of ZSTD in the current units. The next display is:

The new ZOFFSET is the ZOFFSET calculated from this execution of run AutoZ.

Press **[ENTER]** to activate the new ZOFFSET and return to the main run screen.

Press **[ESCAPE]** to maintain the old ZOFFSET and return to the main run screen.

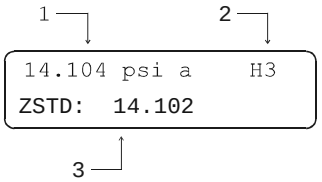
The value of ZOFFSET is always displayed and entered in Pascal (Pa).

The value of ZSTD is entered in the current pressure units.

Run AutoZ by COM2

AutoZ by COM2 allows the value of ZSTD (see Section 3.4.1, PRINCIPLE, How AutoZ Works) to be read automatically from a **DHI** RPM1, RPM2 or RPM3 connected by RS-232 interface to the PPC2+ COM2 port.

To access run AutoZ by COM2 press **[SPECIAL]** and select **<1AutoZ>**, **<4run>**, **<2COM2>**. The display is:



1. Pressure reading, units and mode of the active RPT range.
2. Active range indicator.
3. Pressure reading of the RPM connected to PPC2+'s COM2 port.

When Ready (**<*>**), press **[ENTER]**. The next display is:

```
Old ZOFFSET:  0.0 Pa
New ZOFFSET:  13.8 Pa
```

The new ZOFFSET is the ZOFFSET calculated from this execution of run AutoZ.

Press **[ENTER]** to activate the new ZOFFSET and return to the main run screen.

Press **[ESCAPE]** to maintain the old ZOFFSET and return to the main run screen.

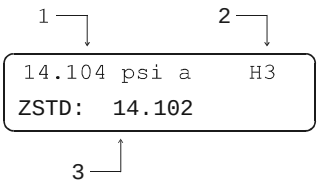
For PPC2+ to communicate with an RPM connected to it's COM2 port, the PPC2+ and the RPM RS-232 interfaces must be set up properly (see Section 3.4.4.3). If the PPC2+ is unable to locate an RPM on COM2 when running AutoZ by COM2, after 6 seconds it will time out and display <RPM not detected>.

The value of ZOFFSET is always displayed and entered in Pascal (Pa).

Run AutoZ by RngL3

The AutoZ by RngL3 choice is only available if the current RPT is an absolute, Hi RPT and there is an absolute Lo RPT in the PPC2+. Run AutoZ by RngL3 allows AutoZ to be run on a Hi RPT range using Lo RPT range 3 (L3) as the source of ZSTD (see Section 3.4.1, PRINCIPLE, How AutoZ Works).

To access run AutoZ by RngL3 press **[SPECIAL]** and select **<1AutoZ>**, **<4run>**, **<3RngL3>**. The display is:



1. Pressure reading, units and mode of the active Hi RPT range.
2. Active range indicator.
3. Pressure reading of Lo RPT range 3 (L3).

When, press **[ENTER]**. The next display is:

```
Old ZOFFSET:  0.0 Pa
New ZOFFSET:  13.8 Pa
```

The new ZOFFSET is the ZOFFSET calculated from this execution of run AutoZ.

Press **[ENTER]** to activate the new ZOFFSET and return to the main run screen.

Press **[ESCAPE]** to maintain the old ZOFFSET and return to the main run screen.

⚠ If you are running AutoZ on the Hi and Lo RPTs of a PPC2+ and using run AutoZ by RngL3 to autozero the Hi RPT, be sure to run AutoZ on the Lo RPT first.

⚠ Before running AutoZ by Lo RPT, be sure that range L3 of the Lo RPT is correctly calibrated and autozeroed.

The value of ZOFFSET is always displayed and entered in Pa.

3.4.2 HEAD

- **PURPOSE**

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

- **OPERATION**

From the main run screen, press **[SPECIAL]** and select **<2Head>**. The display is:

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

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

```
Gas type:
1N2 2He 3Air
```

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

3.4.3 PresU

❍ **PURPOSE**

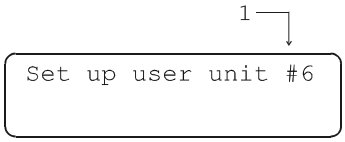
To customize the selection of pressure units that will be available for selection from the **[UNIT]** function key.

❍ **PRINCIPLE**

The **[UNIT]** function key makes available a choice of six default pressure units (US or SI units depending on whether the PPC2+ has been factory set as US or SI) (see Section 3.2.2). PPC2+ also supports many commonly used units other than those included in the default set up. These units can be made available for active selection by customizing the UNIT function using by pressing **[SPECIAL]** and selecting **<3PresU>**. This allows PPC2+ 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.

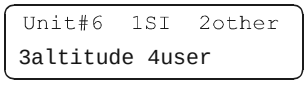
❍ **OPERATION**

To customize the **[UNIT]** function key, from the main run screen press **[SPECIAL]** and select **<3PresU>**. 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:



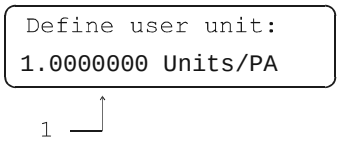
Select the desired pressure unit category (SI units include units *based* on SI such as mmHg), then select the desired unit from the unit menu.

The units available are listed in Table 8.

Table 8. UNIT Function - Available Units

<1SI>	<2other>	<3altitude>	<4user>
<1Pa>	<1psi>	<1feet>	
<2kPa>	<2psf>	<2meters>	
<3MPa>	<3inHg>		
<4mbar>	<4inWa>		
<5bar>	<5kcm2>		
<6mmHg>			
<7mmWa>			

If **<4user>** was selected, the user unit must be defined. The display is:



1. Entry field.

Enter the number of user units per Pascal (Pa) in the entry field. Pressing **[ENTER]** defines the user unit and returns to the Set up unit # screen.

See Section 7.3 for the pressure unit conversion factors used by PPC2+.

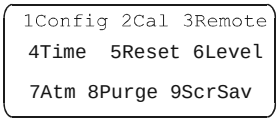
3.4.4 INTERNAL

- **PURPOSE**

To view, set, adjust, and maintain various aspects of PPC2+'s internal operation.

- **OPERATION**

To access the internal selections press **[SPECIAL]** and select **<4Internal>**. The display is:



Select the internal function desired. For a detailed description of each internal function. See Sections 3.4.4.1 to 3.4.4.9.

Some screens, such as the SPECIAL, 4Internal menu go beyond the two lines provided by the display. This is indicated by a flashing arrow in the second line of the display. Press the [←] and [→] arrow keys to move the cursor to access the lines that are not visible or directly enter the number of the hidden menu choice if you know it.

3.4.4.1 CONFIG

- **PURPOSE**

To run an automated routine that readjusts internal pressure control characteristics. This function is considered part of PPC2+ maintenance and is therefore covered in the maintenance section of this manual (see Section 5.5).

- **OPERATION**

See Section 5.5.

3.4.4.2 CAL

- **PURPOSE**

  To calibrate the PPC2+ Hi and Lo reference pressure transducers and adjust the on-board barometer. This function is considered part of PPC2+ maintenance and is therefore covered in the maintenance section of this manual (see Section 5.2).

- **PRINCIPLE**

  See Sections 5.2, 5.3, and 5.4.

- **OPERATION**

  See Sections 5.2, 5.3, and 5.4.

3.4.4.3 REMOTE

- **PURPOSE**

  To configure the PPC2+ communication ports including COM1, COM2 and the IEEE-488 interface.

- **PRINCIPLE**

  The PPC2+ has two RS-232 communications ports referred to as COM1 and COM2 and an IEEE-488 (GPIB) interface. Communication with a host computer is accomplished using either COM1 or the IEEE-488 interface. COM2 is reserved for connecting an external device (e.g., a multimeter, RPM, etc.). The configuration of all the communication ports can be set up through the PPC2+ front panel.

- **OPERATION**

  To access the port configurations and **remote program command** mode, select **<3Remote>** under **<4Internal>** of the SPECIAL menu. Select **<COM1>**, **<COM2>** or **<IEEE>** to view and edit that port's settings. Select **<format>** to select the remote programming command format to use (see FORMAT of this section).

  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, 1 200, 2 400, 4 800, 9 600
  - **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+ as well as mark the end of replies sent back to the host computer. The PPC2+ 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.

IEEE-488

The IEEE-488 port's primary address can be set from 1 to 31 in this screen. The factory default value is 10. Secondary addressing is not used or supported. This address must not conflict with the address of any other devices on the same IEEE-488 bus.

The receiving terminating character must be a line feed and EOI. Carriage returns are ignored if received. The PPC2+ sends a line feed and asserts the EOI line to terminate a reply. These settings are fixed to agree with IEEE Std. 488. If you change the address, the IEEE interface will reset (PON) and become idle.

Format

The PPC2+ has two different syntax formats available for the remote program commands. The **classic** format is compatible with previous PPC products and is the default format. The **enhanced** format follows the syntax, format, and status reporting features of IEEE Std 488.2. The details of each are covered in Section 4.3. Selecting a format resets the IEEE interface and puts it into an idle state.

3.4.4.4 TIME

- **PURPOSE**

To view and edit the PPC2+ internal time and date settings.

- **OPERATION**

To access the time function press **[SPECIAL]** and select **<4Internal>**, **<4Time>**. The display is:

```
Edit:  1time  2date
08:32:11 am   970724
```

Select **<1time>** to edit the time. Edit hours, then minutes, then am/pm 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+ date and time are set to United States Mountain Standard Time in the final test and inspection process at the factory. If desired, use the date function to set your local time and date.

3.4.4.5 RESET

❍ **PURPOSE**

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

PPC2+ 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 used only to restore the PPC2+ to a known state. PPC2+ will go through its reboot sequence after any type of reset is executed.

⚠ *PPC2+ reset functions will change current settings to factory defaults. These may include settings vital to PPC2+ operation and affecting the calibration of the reference pressure transducers. Reset functions should be used only by qualified personnel with knowledge of reset consequences. Reset functions should never be used "experimentally".*

❍ **OPERATION**

To access the reset function press **[SPECIAL]** and select **<4Internal>**, **<5Reset>**. The display is:

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

Reset - Sets

❍ **PURPOSE**

Sets most general system operating parameters back to default values. Does not affect calibration coefficients or remote interfaces.

- Returns each range unit of measure to the first of six available (see Section 3.2.2).
- Returns **measurement** mode to the **RPT** mode (A or G) (see Section 3.2.2).
- Range to H3 (see Section 3.2.1).
- Head settings to 0 cm and Nitrogen (see Section 3.2.7).
- Automated pressure control parameters to defaults (see Section 3.1.2.3).
- All upper limit values to defaults (see Section 3.2.4).
- Pressure display resolution to 0.001 % FS (see Section 3.3.2).
- **Control** mode to dynamic (see Section 3.1.2.3).
- COM ports and IEEE-488 settings (see Section 3.4.4.3).
- Purge disabled (see Section 3.4.4.8).
- Autozero enabled (see Section 3.4.1).

- Control Ref to auto (see Section 3.3.1).
- Screen saver to 10 minutes (see Section 3.4.4.9).

Reset - Units

❍ **PURPOSE**

Sets the six pressure units available under the UNIT function to the SI or US default selections depending on whether the PPC2+ has been factory set for SI or US.

See Sections 3.2.2 and 3.4.3.

Reset - Seq

❍ **PURPOSE**

- Clears all of the user defined file and quick sequences. See Sections 3.2.5 and 3.3.3.
- Sets user level control configuration to factory defaults. See Sections 3.4.4.1 and 5.5.

Reset - Cal

❍ **PURPOSE**

⚠ The reset - cal function will delete RPT calibration coefficients changing the PPC2+ calibration.

Clears all user values affecting the calibration of RPTs and the on-board barometer including:

- Sets all user RPT PA/PM values to 0 and 1 (see Section 5.2).
- Sets user on-board barometer PA/PM to 0 and 1 (see Section 5.3).
- Sets all ZNATERR values back to zero (see Section 5.2.6).
- Sets all ZOFFSET values back to zero (see Section 3.4.1).

Reset - All

❍ **PURPOSE**

⚠ The reset - all function will clear and delete large amounts of user defined information including critical calibration data.

Combines all resets in one global reset command that clears the entire user section of non-volatile memory. These include:

- Reset - sets (see Section 3.4.4.5.1).
- Reset - units (see Section 3.4.4.5.2).
- Reset - seq (see Section 3.4.4.5.3).
- Reset - cal (see Section 3.4.4.5.4).
- Reset - Com1, Com2 and IEEE-488 interface to defaults (see Section 3.4.4.3).

There is no reset type that affects the user level protection settings (see Section 3.4.4.6).

3.4.4.6 LEVEL

❍ **PURPOSE**

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

❍ **PRINCIPLE**

PPC2+'s front panel user interface provides the means to access all PPC2+ user defined data, settings and functions including calibration data. Inadvertent, uninformed or unauthorized altering or deleting of data, settings and functions could require extensive reconfiguration by the user and might cause invalid readings and behavior. For these reasons, depending upon the application in which PPC2+ 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. Four different levels of security are available.

Access to changing security levels can be left open, or be protected by a password.

Security Levels

The security levels are structured to support typical operating environments 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.

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 the PPC2+ is operated using consistent operational parameters.

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.

⚠ PPC2+ is delivered with the security level set at low to avoid inadvertent altering of critical internal settings but with access to changing security levels unrestricted. It is recommended that the low security level be maintained at all times. If there is a risk of unauthorized changing of the security level, changing authority should be password protected (see OPERATION of this section).

The security levels are structured to support typical levels of operation as shown in Table 9.

Specifically, the security levels prevent execution of the X'd functions:

Table 9. Security Levels

FUNCTION	LOW	MEDIUM	HIGH
[RANGE] key			X
[UNIT] key			X
[CONTROL] key			X
[UPPER LIMIT] key			X
[SEQ] key, Run current quick sequence, <2No>			X
[CUSTOM CONTROL] key		X	X
[HEAD] key			X
[SETUP] menu, <1ControlRef>			X
[SETUP] menu, <1ControlRef>, change status		X	X
[SETUP] menu, <2Resltn>		X	X
[SETUP] menu, <3Sequence>, <2Edit>			X
[SETUP] menu, <4Drivers>			X
[SPECIAL] menu		X	X
[SPECIAL] menu, <1AutoZ>		X	X
[SPECIAL] menu, <1AutoZ>, edit	X	X	X
[SPECIAL] menu, <2Head>		X	X
[SPECIAL] menu, <3PresU>		X	X
[SPECIAL] menu, <4Internal>		X	X
[SPECIAL] menu, <1Config>	X	X	X
[SPECIAL] menu, <4Internal>, <2Cal>	X	X	X
[SPECIAL] menu, <4Internal>, <4Time>, edit	X	X	X
[SPECIAL] menu, <4 Internal>, <5Reset>, <4cal>	X	X	X
[SPECIAL] menu, <4Internal>, <5Reset>, <5all>	X	X	X

❍ OPERATION

PPC2+ is delivered with no active password and access to the User Level menu is open. The user level is set to 1Low. User levels can be changed freely until a password has been created.

To access the User Level function, press **[SPECIAL]** and select **<4Internal>**, **<6Level>**. If no password yet exists or if the correct password has been entered. The display is:

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

Selecting **<1change>** user level brings 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. Passwords can be up to six numbers in length and cannot start with a zero.

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

⚠ *Once a password has been entered, the user level cannot be changed without reentering the password.*

If **<0>** is entered, then the password is made inactive and the user will not be required to enter a password to access the user level menu. This is the factory default with a security level of **<2low>**.

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

```
PPC2+ SNnnnn-xx
Password:  pppppp
```

The first field ***<nnnn>*** is the serial number of the PPC2+, 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 or forgotten. It can be obtained by contacting DHI Customer Service. The factory secondary password is different for all PPC2+'s and changes each time it is used.*

3.4.4.7 ATM

- **PURPOSE**

To view the value of atmospheric pressure as measured by the on-board barometer.

In the PPC2+ BG0002 model, the on-board barometer measures the pressure on the TEST(-) port (see the PPC2+ BG0002 Operation and Maintenance Manual).

- **PRINCIPLE**

PPC2+ has an independent on-board barometer. The atmospheric pressure measurements made by the on-board barometer are used only for dynamic compensation of atmospheric pressure when using an absolute reference pressure transducer to make gauge pressure measurements (see Sections 3.4.1, PRINCIPLE and 1.2.6).

The on-board barometer is a low accuracy sensor used only for measuring changes in atmospheric pressure over short periods of time (see Section 3.4.1, PRINCIPLE). PPC2+ measurement accuracy does not depend on the absolute accuracy of the on-board barometer.

- **OPERATION**

To view the current reading of the on-board barometer press **[SPECIAL]** and select **<4Internal>**, **<7Atm>**. The display is in the pressure units of the current PPC2+ range.

3.4.4.8 PURGE

- **PURPOSE**

To enable and disable the purge function which makes automated use of the optional SPLT (see Section 3.2.8.3).

- **OPERATION**

To access the purge enable/disable function press **[SPECIAL]** and select **<4Internal>**, **<8Purge>**. Select **<1yes>** to enable purge or **<2no>** to disable purge.

When the purge function is enabled, PPC2+ will make background use of valve driver channel #8 independently of user actions (see Section 3.3.4).

3.4.4.9 SCRSAV

- **PURPOSE**

To adjust the PPC2+ screen saver function.

- **PRINCIPLE**

PPC2+ has a screen saver function which causes the display to dim after a front panel key is not pressed for a certain amount of time. This function is factory set to activate after 10 minutes of inactivity but can be adjusted by the user.

- **OPERATION**

To access the screen saver function press **[SPECIAL]** and select **<4Internal>**, **<9ScrSav>**. Edit the screen saver on time in minutes as desired.

Setting screen saver time to zero eliminates the screen saver function so that the display will permanently remain at full brightness.

NOTES

4. REMOTE OPERATION

4.1 OVERVIEW

Most of the PPC2+ front panel functions can also be executed by commands from a remote computer. The host computer can communicate to the PPC2+ using the PPC2+ COM1 RS-232 port or the IEEE-488 port.

Before writing test code which makes use of PPC2+ remote commands, familiarize yourself with its operating principles by reading Section 3 of this manual.

4.2 INTERFACING

Sending a program message to the PPC2+ will place it into **remote** mode. The remote indicator in the lower left hand corner of the PPC2+ front panel will light when the PPC2+ is in **remote** mode. It will also flicker when a program message is received. The menus usually accessed from the front panel are locked out while in remote. The **[ESCAPE]** key returns the PPC2+ to local operation unless the **<REMOTE>** program message was sent to the unit, which locks out all keypad operation.

4.2.1 RS-232 INTERFACE

4.2.1.1 COM1

The PPC2+ COM1 RS-232 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 RS-232 cable to be used to connect to a DTE host.

Handshaking is not required or supported. The COM1 receive buffer is 80 bytes deep. If you overflow the buffer by sending too much data, the data will be lost. Because of this, you **must** send a single program message at a time and you **must** wait for the PPC2+ to reply from the previous command before issuing another command.

Table 10. Pin Designations and Connections

PPC2+ COM1 DB-9F PIN DESIGNATIONS		
PIN #	**FUNCTION**	**DESCRIPTION**
2	TxD	This pin transmits serial data from the PPC2+ 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+ 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 IEEE-488

The PPC2+ IEEE-488 interface is located on the back of the unit. The physical and electrical interface conforms to IEEE Std 488.1-1987 Subset E2 and IEEE Std. 488.2-1992. You should not attempt to communicate with the IEEE-488 interface while using the COM1 interface. The IEEE-488 receive buffer is 250 bytes deep. If you attempt to overflow the buffer, the PPC2+ will hold off release of the NRFD handshake line until it can service and empty the receive buffer. This keeps the buffer from overflowing.

4.2.1.3 COM2

The PPC2+ COM2 RS-232 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+. This allows the user to use one Host COM port to communicate with the PPC2+ and an additional RS-232 device. Refer to the **<PASSTHRU>** remote program message for details.

COM2 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 RS-232 cable to be used to connect to a DCE device.

Handshaking is not required or supported.

Table 11. List of PPC2+ COM2 DB-9F Pin Designations

PIN #	FUNCTION	DESCRIPTION
2	TxD	This pin transmits serial data from the PPC2+ 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	DTR	This pin is Data Terminal Ready (DTR) (held at +5 V).

4.3 PROGRAMMING FORMATS

The PPC2+ program message set is downward compatible with the previous PPC2 program message set. PPC2+ also introduces a new enhanced program message format to support IEEE Std 488.2 syntax, format, and status reporting. The user must select whether to use either the original "classic" program message format, or the new "enhanced" program message format. The enhanced format is recommended when possible, as the classic format is obsolete. Selection can be accomplished from the front panel (see Section 3.4.4.3) or remotely by using the "MSGFMT" program message. The default is the classic program message format to allow downward compatibility with existing host software. The basic commands are similar for both the classic and enhanced formats, but the usage, syntax, format and status reporting are different.

The PPC2+ enhanced program message format also includes new additional common program messages that are required in every device that complies with the IEEE Std 488.2. These addition common program messages are covered separately in Section 4.6.1.

4.3.1 CLASSIC PROGRAM MESSAGE FORMAT

The classic program message format is downward compatible with the previous PPC2 program message set. However, several PPC2 functions are not supported by PPC2 and neither are their corresponding commands (see DEVICE, DPG, ISO, PPC, HOLD, TOUT, TS, CONFIG10). This format is recommended only if you need downward compatibility with older PPC2 controllers. Each program message sent is also a query. You can only send one program message to the PPC2+ at time. After sending any program message, you must wait for the PPC2+ to reply before sending another program message. This reply will contain data, or a numeric error message if the program message was invalid. You must wait for this reply before issuing another program message to the PPC2+. This insures that the PPC2+ has completed the program message. Most remote program messages will return a reply within 500 ms except:

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

The syntax and format used for each program message in the classic mode is listed next to the keyword 'Classic:' in each program message summary in Section 4.4.4.

4.3.2 ENHANCED PROGRAM MESSAGE FORMAT

This enhanced program message format uses the IEEE Std. 488.2 format, syntax and status reporting and is recommended for new applications. Errors are reported using the IEEE Std. 488.2 status reporting model. If an error is reported, the error is put into an Error Queue and the "ERR?" query program message can be used to get a text description of the most recent error. If you are using the IEEE-488 port, the service request line can be setup to be asserted if this occurs (see Section 4.5.2). There are two possible program message types for every program message. Each of these two types starts with the same basic text referred to as the program message header.

4.3.2.1 ENHANCED PROGRAM MESSAGE USING THE COMMAND TYPE

The COMMAND type of program message executes a process and can additionally send data to the PPC2+ in the form of comma delimited arguments. This data is usually a setting of some sort that is stored in the PPC2+. If data is specified, it must be preceded by at least one white space from the program message header and be within the range and format described in the program message description. The keyword "Command:" will appear to the left of the required syntax in each program message description.

If you are using the IEEE-488 port, the Command type does not generate a reply so you do not need to wait for a reply. You also may send multiple program messages at once by separating each program message with a semicolon. The commands will be queued and executed in as received order.

If you are using the RS-232 port COM1, the Command type will always generate a reply so you **must** wait for a reply before issuing another program message. Because of this, you can only send one Command program message at a time while using the COM1 port.

4.3.2.2 ENHANCED PROGRAM MESSAGE USING THE QUERY TYPE

The Query type of program message just requests data from the PPC2+. You **must** wait for a reply with a query. If you send any type of program message to the PPC2+ after a Query before receiving a reply, the program message will be discarded and an error will be generated. Errors are reporting using the IEEE Std. 488.2 status reporting model. A Query program message always ends with a question mark. Most queries will return a reply within 200 ms except:

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

The syntax for using a QUERY program message is listed next to the keyword "Query:" in each program message summary in Section 4.4.4.

4.4 COMMANDS

4.4.1 PROGRAM MESSAGES

Shown are the basic program messages for the classic and the enhanced formats. There are also additional IEEE Std. 488.2 common commands (they start with an '*') that are common in all IEEE-488.2 compatible devices These commands and the enhanced format status reporting model are covered in Sections 4.5 and 4.6.

Table 12. Program Message List

#	Send a command string out of the PPC2+ COM2 port.
ABORT	Stop pressure generation.
AINCAL	To set or retrieve the measurement modifiers for the current range.
AINR	To request the next available measurement of the analog inputs.
AINRNG	To set or retrieve the current analog input range.
ATM	Read the current atmospheric pressure (on-board barometer).
AUTOZERO	Read or set the status of the automatic zero function.
AUTOPURGE	Read or set the status of the automatic purge function.
AUTOVAC	Read or set the status of the control reference (EXHAUST port).
COM1	Read or set the configuration of the COM1 port.
COM2	Read or set the configuration of the COM2 port.
CONFIG	Obsolete PPC2 Command.
DATE	Read or set the current date.
DEVICE	Obsolete PPC2 Command.
DF	Decrease the pressure quickly.
DP	Decrease the pressure a given amount.
DPG	Obsolete PPC2 Command.
DRV	Read or set the status of an the external valve drivers.
DS	Decrease pressure slowly.
ERR	Read the last error message.
HEAD	Read or set the head settings.
HOLD	Obsolete PPC2 Command.
HS	Read or set the current control hold limit in pressure.
HS%	Read or set the current control hold limit in percent full scale.
IF	Increase the pressure quickly.
IP	Slowly increase the pressure a given amount.
IS	Increase the pressure slowly.
ISO	Obsolete PPC2 Command.
LL	Read or set the lower limit for the current range (PPC2+ BG0002 model only)
LOCAL	Returns control to the PPC2+ front panel.
MEM	Read the power-up memory test status.
MODE	Read or set the current pressure control mode.
MSGFMT	Read or set the type of program message format to use.
NVENT	Read or set the status of the lo vent valve (PPC2+ BG0002 model only)
PASSTHRU	Send a command string out of the PPC2+ COM2 port.
PCAL*d*,LO	Read or set the user LO RPT calibration information.
PCAL*d*,HI	Read or set the user HI RPT calibration information.
PPC	Obsolete PPC2 Command.
PR	Read the next PPC2+ pressure.
PRR	Read the next PPC2+ PRT pressure, rate, and ATM.
PS	Set a new target pressure and start automated pressure control.
PSF	Set a new target pressure and use only the fast speed to reach the target.
PSH	Obsolete PPC2 Command.

Table 12. Program Message List (Continued)

PSS	Set a new target pressure and use only the slow speed to reach the target.
QPRR	Read the last PPC2+ RPT pressure, rate and ATM.
RANGE	Read or set the active range of the PPC2+.
RATE	Read the next available rate of change of pressure.
READY	Obsolete PPC2 Command.
READYCK	Read or set a flag that is cleared by a Not Ready (**<↑>** or **<↓>**) 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+ to the default user parameters.
RETURN	Start a new automated pressure control set using the current target value.
SCRSAV	Read or set the front panel screen saver period.
SN	Read the serial number of the PPC2+.
SR	Read the next available pressure status.
SS	Read or set the stability required for a Ready (**<*>**) condition.
SS%	Read or set the stability required for a Ready (**<*>**) condition (% FS/ s).
STAT	Read the pressure generation status.
TIME	Read or set the current time of day.
TOUT	Obsolete PPC2 Command.
TP	Read the current target pressure.
TS	Obsolete PPC2 Command.
UCOEF	Convert a pressure in Pascal to pressure in the current units.
UDU	Read or set the user defined pressure unit.
UL	Read or set the upper limit for the current range.
UNIT	Read or set the pressure unit for the current range.
VAC	Read or set the exhaust reference status flag.
VENT	Read, execute or abort a vent process.
VER	Read the PPC2+ software version.
ZNATERRd,HI	Read or set the autozero natural error for Hi RPT.
ZNATERRd,LO	Read or set the autozero natural error for Lo RPT.
ZOFFSETd,HI	Read or set the autozero offset for Hi RPT.
ZOFFSETd,LO	Read or set the autozero offset for Lo RPT.

4.4.2 ERROR MESSAGES

The PPC2+ will always reply to a program message while using the classic format. If the program message 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.

In the enhanced format, each error is placed into the Error Queue as it occurs. The **<ERR?>** query can then be used to remove from the queue and reply the text description of each error that has occurred. If you are using the COM1 port, the Error Queue is cleared each time a program message (except **<ERR>**) is received. Section 4.5 explains the details of the Error Queue. Table 13 is a list of the possible errors numbers and the error description for each.

Table 13. Error #'s and Descriptions

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 time-out error"
ERR #9	"Unknown command"
ERR #11	"Command missing argument"
ERR #12	"System overpressured" or "overpressure may result"
ERR #13	"Text detected in numeric field"
ERR #14	"User unit not defined"
ERR #16	"Not available with gauge units"
ERR #18	"Command not yet available"
ERR #19	"Not available with absolute units"
ERR #20	"Not available with gauge transducer"
ERR #21	"User device not defined"
ERR #22	"Pressure is not stable"
ERR #23	"Option not available or installed"
ERR #24	"Unit must be vented"
ERR #25	"Transducer out of calibration"
ERR #26	"COM port failed to initialize"
ERR #27	"Internal device#1 time-out error"
ERR #28	"Internal device#2 time-out error"
ERR #30	"Must be on range H3"
ERR #31	"Upper limit is too low"
ERR #32	"Not stable enough"
ERR #33	"Failed to generate pressure"

4.4.3 PROGRAM MESSAGE DESCRIPTION OVERVIEW

Each program message description is separated into the following sections:

Purpose	A brief description of the programs message's function.
Command	This is the Enhanced program message syntax to send data to the PPC2+ or to execute a PPC2+ function. The PPC2+ **must** be set to use the enhanced format (see Section 4.3). It may be sent alone, or followed by at least one white space and additional argument(s) to show that arguments can be passed. If there are multiple arguments, then commas must separate them. If you are using the IEEE-488 port, multiple Command type program messages can be sent in one message if you separate them with a semicolon. There will be no reply from the PPC2+ using the IEEE-488 port. If you are using the COM1 port, the PPC1 will reply and you **must** wait for this reply. If this field is not listed in the program message description, then the Command type is not supported when using the Enhanced format.
Query	This is the Enhanced program message syntax to request data from the PPC2+. The PPC2+ **must** be set to use the enhanced format (see Section 4.3.2). The PPC2+ will always reply to a query. You **must** wait for this reply before issuing another program message. If this field (Query) is not listed in the program message description, then the Query type for the program message is not supported when using the Enhanced format.
Classic	This is the Classic program message syntax to send data to the PPC2+, to execute a PPC2+ function, or to query for data. This type of command is not recommended for new applications. The PPC2+ **must** be set to use the classic format (see Section 4.3). It may be followed by a '(=)' and additional argument characters to show that argument(s) can be passed. If there are multiple arguments, then commas must separate them. The PPC2+ will always reply to a Classic program message. You **must** wait for this reply before issuing another program message. If this field is not listed in the program message description, then it is not supported when using the classic format.
Arguments	If the program message can be used to set data inside the PPC2+, then this section will describe the arguments and their limits.
Default	If the program message can be used to set data inside the PPC2+, then this line will show (using the enhanced format) the default setting from the factory.
Remarks	This field has the details and remarks about the command.
Example	Examples are given for the enhanced and classic methods. **Enhanced:** An example of the use of an enhanced method program message to be sent to the PPC2+ is shown. The message sent to the PPC2+ appears after the "Cmd sent:" label. If only a Query type exists, the "Query sent:" label is shown instead. Directly under this label, "Query reply" shows a typical reply to a query type. "Reply:" shows that a query format does not exist. It may have a short description next to it. **Classic:** An example of the use of a classic program message to be sent to the PPC2+ is shown. The command sent to the PPC2+ appears after the "Cmd sent:" label. The "Reply" label shows a typical reply to the "Sent" example. It may have a short description next to it.
Errors	If the program message can report an argument error, the types of errors are listed. If using the classic format or the COM1 port, the error message will be replied after receiving the program message. If using the enhanced format via the IEEE-488 port, the error condition will be handled by the status reporting model which will store the errors in an Error Queue and can be programmed to assert the IEEE-488 SRQ line to signal an error has occurred. In either case, the "ERR" or "ERR?" program message can be used to retrieve a text description of the error.
See Also	Indicates related program messages ("----") and refers to manual sections giving detail on PPC2+ operation corresponding to the program message.

4.4.4 PROGRAM MESSAGE DESCRIPTIONS

#	
Purpose	To allow the host PC to communicate with a device connected to the PPC2+ COM2 port. This program message is obsolete. You should instead use the "PASSTHRU" program message. This command is **not** available when using the enhanced command format. Instead, use the "PASSTHRU" command.
Classic	"#xx"
Arguments	xx: The string to send out of the COM2 port. It must be less than 40 characters long.
Remarks	The PPC2+ COM2 port can be used to communicate to another RS-232 device (such as another PPC2+). This allows the user to use one COM port or IEEE-488 port on the host computer to communicate with the PPC2+ and another device. A carriage return and a line feed (**<CR><LF>**) are added to the string. After this program message is issued, the PPC2+ will reply back the first string received by the PPC2+ COM2 port that is terminated with a carriage return. Line feeds are discarded. This will discontinue when the next program message is sent to the PPC2+. There is no other reply from this program message. Prior to using this program message, you must ensure that the PPC2+ COM2 port is correctly set up to communicate with the device on COM2. Refer to the "COM2=" program message.
Example (classic)	Sent: "#VER" Reply: "DH INSTRUMENTS, INC PPC2+ us A1000/A0015 Ver2.00 " This example assumes that a second PPC2+'s COM1 port is connected to the PPC2+ COM2 port. This example gets the version of the second PPC2+.
See Also	"PASSTHRU", "COM2"

abort	
Purpose	Stops an active pressure generation. All control valves are closed. The exhaust and transducer isolation valves are not affected.
Command Classic	"ABORT" "ABORT"
Remarks	This program message has no effect if the PPC2+ is not using automated pressure control. When using automated pressure control, it will abort the control.
Example (enhanced)	Cmd sent: "ABORT" Reply: "ABORT" (no reply if IEEE-488)
Example (classic)	Sent: "ABORT" Reply: "ABORT"
See Also	Sections 3.2.3, 3.1.2.3

aincal	
Purpose	To set or retrieve the measurement modifiers (adder multiplier) for the current analog input range.
Query	"AINCALn a,m" "AINCALn?"
Classic	"AINCALn=a,m" "AINRNG"
Default	"AINRNGn 0,1"
Arguments	n: The input channel to modify (1 through 4). a: The adder modifier in the current range units (V, mV or mA). m: The multiplier modifier.
Remarks	These modifiers allow the user to adjust the measurement displayed. The Adder value is normally set at 0, and the multiplier is set to 1 to display the actual measured value. The displayed measurement is calculated as: Disp = (Meas m) + a
Example (enhanced)	Cmd sent: "AINCAL1.012, 1.002" Query reply: "0.012, 1.002"
Example (classic)	Cmd Sent: "AINCAL=.012, 1.002" Reply: "0.012, 1.002"
Errors	ERR# 6: The argument(s) are invalid.
See Also	Sections 3.2.9, 5.4

ainR	
Purpose	To request the next available measurement of the analog inputs.
Query Classic	"AINR" "AINR?"
Remarks	The PPC2+ measures the analog inputs every 0.75 seconds. This command requests the next measurement cycle results from the PPC2+. The results are returned for all four analog inputs at once, Input #1 measurement is first, followed by the measurement unit. Then a comma is used to separate the first measurement from the next field. This is repeated for inputs #2, #3, and #4. If an auto-calibration cycle is occurring, "BUSY" will be returned instead.
Example (enhanced)	Cmd sent: "AINR?" Query reply: "0.797 mV, 0.934 mV, -0.027 mV, 1.234 mV"
Example (classic)	Sent: "AINR" Reply: "0.797 mV, 0.934 mV, -0.027 mV, 1.234mV"
See Also	Section 3.2.9

AINRNG	
Purpose	To set or retrieve the current analog input range.
Query Classic	"AINRNG n" "AINRNG?" "AINRNGn" "AINRNG?"
Default	"AINRNG 3"
Arguments	n: The input range index 1 for 100 mv range 2 for 5 Volt range 3 for 10 Volt range 4 for 4-20 ma range
Remarks	The analog input option has 4 ranges. The selected range affects all four of the inputs at once. When a range is changed, an auto-calibration cycle occurs, which takes about 10 seconds.
Example (enhanced)	Cmd sent: "AINRNG 2" Query reply: "2"
Example (classic)	Cmd Sent: "AINRNG=2" Reply: "2"
Errors	ERR# 6: The argument(s) are invalid.
See Also	Section 3.2.9

ATM	
Purpose	Reads the next measured internal ambient pressure.
Query Classic	"ATM?" "ATM"
Remarks	The atmospheric pressure as measured by the PPC2+ on-board barometer will be returned in the current pressure units (always absolute). This measurement is followed by the units text.
Example (enhanced)	Query sent: "ATM? Query reply: "97.123 kPaa"
Example (classic)	Sent: "ATM Reply: "97.123 kPaa"
See Also	Section 3.4.4.7

AUTOPURGE	
Purpose	Read or set the status of the automatic purge function.
Command Query	"AUTOPURGE *n*" "AUTOPURGE?"
Classic	"AUTOPURGE=*n*" "AUTOPURGE"
Default	"AUTOPURGE 0"
Arguments	*n:* '0' To disable AUTO mode. '1' To enable AUTO mode.
Remarks	The PPC2+ can automatically control the external SPLT functions if desired.
Example (enhanced)	Cmd sent: "AUTOPURGE 1" Query reply: "0" (if PURGE not enabled) "1" (if PURGE enabled)
Example (classic)	Sent: "AUTOPURGE=1" Query reply: "AUTOPURGE=0" (if PURGE not enabled) "AUTOPURGE=1" (if PURGE enabled)
Errors	ERR# 6: The argument was other than a '0' or a '1'.
See	Sections 3.4.4.8, 3.2.8

AUTOVAC	
Purpose	Read or set the status of the automated Control Ref determination mode.
Command Query	"AUTOVAC *n*" "AUTOVAC?"
Classic	"AUTOVAC=*n*" "AUTOVAC"
Default	"AUTOVAC 1"
Arguments	*n:* '0' To disable AUTO mode. '1' To enable AUTO mode. This will override the manual selection.
Remarks	The PPC2+ has an internal sensor that can be used to automatically determine if the EXHAUST port is open to atmosphere or to a vacuum. You can disable it to manually override it.
Example (enhanced)	Cmd sent: "AUTOVAC 1" Query reply: "0" (if not in AUTO mode) "1" (if in AUTO mode)
Example (classic)	Sent: "AUTOVAC=1" Query reply: "AUTOVAC=0" (if not in AUTO mode) "AUTOVAC=1" (if in AUTO mode)
Errors	ERR# 6: The argument was other than a '0' or a '1'.
See Also	Section 3.3.1, "VAC" program message

AUTOZERO	
Purpose	Read or set the status of the automatic zero function.
Command Query	"AUTOZERO *n*" "AUTOZERO?"
Classic	"AUTOZERO=*n*" "AUTOZERO"
Default	"AUTOZERO 1"
Arguments	*n:* '0' Autozero OFF '1' Autozero ON
Remarks	The PPC2+ autozero function can be turned ON and OFF.
Example (enhanced)	Cmd sent: "AUTOZERO 1" Query reply: "0" If autozero OFF "1" If autozero ON
Example (classic)	Sent: "AUTOZERO=1" Query reply: "AUTOZERO=0" If autozero OFF "AUTOZERO=1" If autozero ON
Errors	ERR# 6: The argument was other than a '0' or a '1'.
See Also	Section 3.4.1

COM1	
Purpose	Read or set the RS-232 settings for the COM1 port.
Command Query	"COM1 *baud, parity, data, stop*" "COM1?"
Classic	"COM1=*baud, parity, data, stop*" "COM1"
Arguments	*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. *data:* The number of data bits. This may be '7' or '8' *stop:* The number of stop bits. This may be '1' or '0'
Defaults	"COM1 2400,E,7,1"
Remarks	The COM1 port is used to communicate to the PPC2+. When the COM1 port configuration of the PPC2+ is changed, the program message reply (COM1 use only) will be sent at the old COM1 settings, but all subsequent communications will be accomplished at the new COM1 settings.
Example (enhanced)	Cmd sent: "COM1 9600,N,8,1" Query reply: "9600,N,8,1"
Example (classic))	Sent: "COM1=9600,N,8,1" Reply: "9600,N,8,1"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	Section 3.4.4.1, "PASSTHRU"

COM2	
Purpose	Read or set the RS-232 settings for the COM2 port.
Command Query	"COM2 *baud,parity,data,stop*" "COM2?"
Classic	"COM2= *baud,parity,data,stop*" "COM2"
Arguments	*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. *Data:* The number of data bits. This may be '7' or '8' *stop*: The number of stop bits. This may be '1' or '0'
Defaults	"COM2 2400,E,7,1"
Remarks	The COM2 port can be used to allow the host computer to communicate through the PPC2+ to an additional device connected to COM2. This can be useful if the Host computer does not have 2 serial ports available.
Example (enhanced)	Cmd sent: "COM2 9600,N,8,1" Query reply: "9600,N,8,1"
Example (classic)	Sent: "COM2=9600,N,8,1" Reply: "9600,N,8,1"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	Section 3.4.4.3, "PASSTHRU"

CONFIG	
	This is an obsolete PPC2 Command
Purpose	PPC2+ does not support a remotely activated configuration routine. The CONFIG command from PPC2 will reply as if CONFIG had occurred.
See	Section 3.4.4.1

DATE	
Purpose	Read or set the PPC2+ date.
Command Query	"DATE yymmdd" "DATE?"
Classic	"DATE=yymmdd" "DATE"
Arguments	yymmdd: The date in the numerical only format year-month-day with no spaces.
Remarks	The PPC2+ has an internal real time calendar clock. It is used for date stamping calibrations.
Example (enhanced)	Cmd sent: "DATE 961201" Query reply: "961201"
Example (classic)	Sent: "DATE=961201" Reply: "961201"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	Section 3.4.4.4

DEVICE	
	This is an obsolete PPC2 Command.
Purpose	PPC2+ does not support external devices so the "DEVICE" Command is not supported. Will respond ERR# 9.
See	None

DF		
Purpose	Decrease the pressure quickly.	
Command	"DF *n*"	
Classic	"DF=*n*"	
Arguments	'0'	Closes the fast down valve.
	'1'	Opens the fast down valve.
Remarks	Opening the fast down valve will cause the pressure to decrease quickly.	
Example (enhanced)	Cmd sent:	"DF 1"
	Reply:	"1" (no reply if IEEE-488)
Example (classic)	Sent:	"DF=1"
	Reply:	"DF=1"
Errors	ERR# 6:	The *n* argument is a '0' or a '1'.
See Also	Section 5.8.1.7	

DP		
Purpose	Decrease the pressure slowly a given amount using the slow speed.	
Command	"DP *n*"	
Classic	"DP=*n*"	
Arguments	*n*	The decrease in pressure desired (current pressure units). This can be from 0 to 2 % FS of the current RPT 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+ will not attempt to control the pressure to a target, so the change in pressure will be approximate.	
Example (enhanced)	Cmd sent:	"DP 2"
	Reply:	"2.000 kPa"(no reply if IEEE-488)
Example (classic)	Sent:	"DP=2"
	Reply:	"2.000 kPa"
Errors	ERR# 6:	The *n* argument is not within given limits.
See Also	None.	

DPG	
	This is an obsolete PPC2 Command.
Purpose	PPC2+ does not support external devices so the "DPG" command is not supported. Will respond ERR# 9.
See	None

DRVN	
Purpose	Read or set the status of the external electrical driver.
Command Query	"DRV*n* *x*" "DRV*n*?"
Classic	"DRV*n*=*x*" "DRV*n*"
Arguments	*n* The driver to operate. This can be from 1 to 8. *x* The state to change the driver to; '0' to de-activate it, '1' to activate it.
Remarks	The PPC2+ control has eight optional external drivers.
Example (enhanced)	Cmd sent: "DRV1 1" Query reply: "1"
Example (classic)	Sent: "DRV1=1" Reply: "DRV1=1"
Errors	ERR# 6: The *n* or *x* arguments are not within given limits.
See Also	Section 3.3.4

DS	
Purpose	Decrease the pressure slowly.
Command	"DS *n*"
Classic	"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 (Enhanced)	Cmd sent: "DS 1" Reply: "1" (no reply if IEEE-488)
Example (Classic)	Sent: "DS=1" Reply: "DS=1"
Errors	ERR# 6: The *n* argument is a '0' or a '1'.
See Also	Section 5.8.1.7

ERR	
Purpose	Read the new available error message from the Error Queue.
Query	"ERR?"
Classic	"ERR"
Remarks	This program message obtains additional details about an error that has occurred. If the user receives an "ERR# nn" reply, or the enhanced mode is enabled using the IEEE-488 interface and an error has been detected, the error is put into a FIFO Error Queue. The "ERR" program message pulls and replies the oldest error message available. "OK" will be replied if there are no error messages left.
Example (enhanced):	Query sent: "ERR?" Query reply: "Numeric argument missing or out of range"
Example (classic)	Sent: "ERR" Reply: "Numeric argument missing or out of range"
See Also	Section 4.4.2

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

HOLD	
	This is an obsolete PPC2 Command.
Purpose	Makes the current pressure the target pressure and controls to the target pressure in the current control mode.

HS		
Purpose	Read or set the hold limit for automated pressure control.	
Command Query	"HS *n*" "HS?"	
Classic	"HS=*n*" "HS"	
Arguments	*n:*	The hold limit in the current pressure units.
Remarks	The hold limit can be read and set as a pressure.	
Example (enhanced)	Cmd sent: Query reply:	"HS .1" "0.1 kPa"
Example (classic)	Sent: Reply:	"HS=0.1" "0.1 kPa"
Errors	ERR# 6	The *'n'* argument was invalid.
See Also	Sections 3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6	

HS%	
Purpose	Read or set the hold limit for automated pressure control in percent of range full scale.
Command Query	"HS% *n*" "HS%?"
Classic	"HS%=*n* "HS%"
Arguments	*n:* 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.
Example (enhanced)	Cmd sent: "HS .01" Query reply: "0.0100 %"
Example (classic)	Sent: "HS=.01" Reply: "0.0100 %"
Errors	ERR# 6 The *'n'* argument was invalid.
See Also	Sections 3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6, "HS"

IF	
Purpose	Increase the pressure quickly.
Command	"IF *n*"
Classic	"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 (enhanced)	Cmd sent: "IF 1" Reply: "1" (no reply if IEEE-488)
Example (classic)	Sent: "IF=1" Reply: "IF=1"
Errors	ERR# 6: The *n* argument is a '0' or a '1'.
See Also	Section 5.8.1.7, "UL"

IP	
Purpose	Increase the pressure a given amount using the slow speed.
Command	"IP *n*"
Classic	"IP=*n*"
Arguments	*n* The increase in pressure desired (current pressure units). This can be from 0 to 2 % FS of the current RPT 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+ will not attempt to control the pressure to a target, so the change in pressure will be approximate.
Example (enhanced)	Cmd sent: "IP 2" Reply: "2.000 kPa"(no reply if IEEE-488)
Example (classic)	Sent: "IP=2" Reply: "2.000 kPa"
Errors	ERR# 6: The *n* argument is not within given limits.
See Also	None.

IS	
Purpose	Increase the pressure slowly.
Command	"IS *n*"
Classic	"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 (enhanced)	Cmd sent: "IS 1" Reply: "1"(no reply if IEEE-488)
Example (classic)	Sent: "IS=1" Reply: "IS=1"
Errors	ERR# 6: The *n* argument is a '0' or a '1'.
See Also	Section 5.8.1.7, "UL"

ISO	
	This is an obsolete PPC2 Command.
Purpose	PPC2+ has a standard bypass isolation valve that automatically cuts off the PPC2+ internal bypass flow when PPC2+ is vented or setting zero absolute pressure.
See	Section 5.8.1.7

LL(=)	
Purpose	Read or set the lower pressure limit for the current range. PPC2+ BG0002 model only.
Command	"LL *n*"
Classic	"LL=*n*"
Arguments	*n* The lower pressure limit for the current pressure range in the current unit of measure. Value is always gauge pressure.
Remarks	The PPC2+ BG0002 has a lower limit for each of its ranges. New automated pressure control targets can not be less than this value. If the pressure does exceed the lower 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 below the lower limit. Increases in pressure will be allowed. This feature should always be used to prevent accidental over (under) pressure of a device under test.
Example (enhanced)	Cmd sent: "LL -4" Reply: "-4 kPa g"(no reply if IEEE-488)
Example (classic)	Sent: "LL=-4" Reply: "-4 kPa g"
See Also	Section 5.8.1.7, PPC2+ BG0002 Operation and Maintenance Manual Section 3.2.3, "UL"

LOCAL	
Purpose	Returns control to the PPC2+ front panel.
Command	"LOCAL"
Classic	"LOCAL"
Remark	The REMOTE program message can lock the front panel out completely. The user can return to local operation by sending the LOCAL program message, sending the IEEE-488 'GTL' command (if in enhanced format), or by cycling PPC2+ power.
Example (enhanced)	Cmd sent: "LOCAL" Reply: "LOCAL" (no reply if IEEE-488)
Example (classic)	Sent: "LOCAL" Reply: "LOCAL"
See Also	"REMOTE"

MEM	
Purpose	Read the status from the power-up memory test.
Query	"MEM?"
Classic	"MEM"
Remarks	The PPC2+ system memory stores the user settings (units, resolution, generation settings) and retains them when the unit is OFF. On power-up, this memory is checked. If this memory is corrupted, all user settings are reset to default (as if the "RESET" program message was executed), and the MEM status will be set to reflect this.
Example (enhanced)	Query sent: "MEM?" Reply "0" PPC2+ data corrupted and was set to factory defaults "1" The memory was found to be OK on power-up
Example (classic)	Sent: "MEM" Reply "MEM=0" PPC2+ data corrupted and was set to factory defaults "MEM=1" The memory was found to be OK on power-up
See Also	Section 3.4.4.5, "RESET" program message

MODE	
Purpose	Read or set the control mode.
Command Query	"MODE *n*" "MODE?"
Classic	"MODE=*n*" "MODE"
Arguments	*n:* '0' for static pressure control. '1' for dynamic pressure control.
Remarks	The method which the PPC2+ controls pressure is selected with the MODE program message. When the control mode is set, control parameters go to default parameters for that range. The mode setting is range dependent.
Example (enhanced)	Cmd sent: "MODE 1" Query reply: "1"
Example (classic)	Sent: "MODE=1" Reply: "MODE=1"
Errors	ERR# 6 The argument is invalid.
See Also	Sections 3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6

MSGFMT	
Purpose	Read or set the type of program message format to use.
Command Query	"MSGFMT *n* "MSGFMT?"
Classic	"MSGFMT=*n* "MSGFMT"
Arguments	*n:* '1' to use the enhanced command format. '0' to use the classic command format.
Defaults	"MSGFMT 0"
Remarks	The user can select the type of remote command format to use. This format must agree with the format sent to the PPC2+.
Example (enhanced)	Cmd sent: "MSGFMT 1" Query reply: "1"
Example (classic)	Sent: "MSGFMT=1" Reply: "MSGFMT=1"
Errors	ERR# 6: Missing or improper program message argument(s).
See Also	Section 4.3

NVENT	
Purpose	Read or set the status of lo vent valve (PPC2+ BG0002 model only)
Command Query	"NVENT *n*" "NVENT?"
Classic	"NVENT=*n*" "NVENT"
Default	"NVENT AUTO"
Arguments	*n:* '0' to close the lo vent valve '1' to open the lo vent valve 'AUTO' for the PPC2+ BG0002 to open and close the lo vent valve
Remarks	PPC2+ BG0002 has a second vent valve that is used to vent the TEST(-) port. This valve is normally controlled automatically depending on current PPC2+ BG0002 operation but it can be commanded to open or close using "NVENT".
Example (enhanced)	Cmd sent: "NVENT 0" Query reply: "0" If valve is closed "1" If valve is opened
Example (classic)	Sent: "NVENT=1" Query reply: "NVENT=0" If valve is closed "NVENT=1" If valve is open
See Also	Section 3.4.1, PPC2+ BG0002 Operation and Maintenance Manual Section 3.3.2, "VENT"

PASSTHRU	
Purpose	To allow the host PC to communicate with a device connected to the PPC2+ COM2 port.
Command Query	"PASSTHRU *n* "PASSTHRU?"
Classic	"PASSTHRU= *n*" "PASSTHRU"
Arguments	*n*: The string to send out of the COM2 port. It must be less than 40 characters long.
Remarks	This program message is a replacement for the '#' program message which is obsolete. The PPC2+ COM2 port can be used to communicate to another RS-232 device (such as another PPC2+). This allows the user to use one COM port or IEEE-488 port on the host computer to communicate with the PPC2+ and another device. The Command format specifies and sends the argument. A carriage return and a line feed (**<CR><LF>**) are added to the string that is sent. The Query format is used to check the PPC2 COM2 receive buffer to see if a message has been received on COM2 from the device. This message received by the COM2 port must be terminated with a carriage return or a carriage return and a line feed. Only one message will be retained by the COM2 port. The label "COM2:" will precede the message text. If the COM2 receive buffer is empty, then the reply will just be 'COM2:"
Example (enhanced)	Cmd sent: "PASSTHRU VER" Query reply: "COM2:DH INSTRUMENTS, INC PPC2+ VER1.01a" Query reply: "COM2:" (If the COM2 buffer is empty)
Example (classic)	Sent: "PASSTHRU=VER" Reply: "COM2:DH INSTRUMENTS, INC PPC2+ VER1.01a" Reply: "COM2:" (If the COM2 buffer is empty)
See Also	"COM2", "#"

PCALn:HI and PCALn:LO	
Purpose	Read or set the user RPT calibration information.
Command Query	"PCAL*n*:HI *adder, mult, CalDate*" "PCAL*n*:LO *adder, mult, CalDate*" "PCAL*n*:HI?" "PCAL*n*:LO?"
Classic	"PCAL*n*:HI =*adder, mult, CalDate*" "PCAL*n*:LO =*adder, mult, CalDate*" "PCAL*n*:HI" "PCAL*n*:LO"
Defaults	"PCAL*n*:HI = 0.0, 1.0, 800101" "PCAL*n*:LO = 0.0, 1.0, 800101"
Arguments	*N:* The RPT range. '1' for the low, '2' for the medium '3' for the high range of the selected RPT (Hi or Lo). *Adder:* The RPT calibration adder (PA) from –10 000 to 10 000 Pa. *Mult:* The RPT calibration multiplier (PM) from 0.9 to 1.1. *CalDate:* The date of the calibration in the format "YYMMDD".
Remarks	The user defined pressure calibration information for the specified RPT (HI or LO pressure) and RPT range (1, 2, or 3) can be accessed with this program message Using this program message will overwrite the current calibration coefficients, so caution must be used. Changes made using this program message will take affect immediately.
Example (enhanced)	Cmd sent: "PCAL1:LO 2.1, 1.000021, 961201" Query reply: " 2.10 Paa, 1.000021, 961201"
Example (classic)	Sent: "PCAL1:LO=2.1, 1.000021, 961201" Reply: " 2.10 Paa, 1.000021, 961201"
Errors	ERR# 6: One of the arguments is out of range.
See Also	Section 5.2

PPC	
	This is an obsolete PPC2 Command.
Purpose	PPC2+ does not support external devices so the "PPC" command is not supported. Will respond ERR# 9.
See	None

PR	
Purpose	Read the next available pressure.
Query	"PR?"
Classic	"PR"
Remarks	The next available pressure value for the active RPT 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" program message. The pressure measurement value and pressure units are right justified in this field. After receiving this program message, the PPC2+ will reply back with the data once a new pressure measurement cycle is complete. This can take up to 1.5 seconds.
Example (enhanced)	Query sent: "PR?" Query reply: "R 1936.72 kPaa"
Example (classic)	Query sent: "PR" Reply: "R 1936.72 kPaa"
See Also	"QPRR", "SR", Sections 3.1.2.3, 3.1.2.4

PRR	
Purpose	Read the next available pressure, rate and ATM pressure.
Query	"PRR?"
Classic	"PRR"
Remarks	The next available ready condition, RPT pressure, rate of pressure change, and ambient pressure is replied 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 Here are the field descriptions: ready: 'R' if the current pressure ready criteria has been met, 'NR' if the criteria has not been met (see the "SR" program message). pressure: The measured pressure for the selected RPT and range in the current pressure units. This is followed by the current pressure units. rate: The measured rate for the selected RPT 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+ on-board barometer in the current pressure units (but always absolute). This is followed by the current pressure units. After receiving this program message query, the PPC2+ will reply back with the data once a new pressure measurement cycle is complete. This can take up to 1.5 seconds.
Example (enhanced)	Query sent: "PRR?" Query reply: "R,2306.265 kPaa,0.011 kPa/s,97.000 kPaa"
Example (classic)	Query sent: "PRR" Reply: "R,2306.265 kPaa,0.011 kPa/s,97.000 kPaa"
See Also	Sections 3.1.2.3, 3.1.2.4, 3.4.4.7, "PR", "QPRR", "SR"

PS	
Purpose	Set a new target pressure and start a new pressure generation cycle. Allows the test volume to be specified which causes the pressure generation cycle to be executed omitting the automated control configuration routine.
Command	"PS *n (,v)*"
Classic	"PS=*n (,v)*"
Arguments	*n:* The target pressure in the current pressure units. *v:* The device under test volume in cc (optional, only available on PPC2+ Ver. 2.00e or higher).
Remarks	The PPC2+ will generate the given target pressure using the current generation settings and mode. Generation will continue until a new target pressure is set, the PPC2+ goes into LOCAL mode, or an "ABORT" program message is executed. If the given target is '0' and the pressure units are gauge, the PPC2+ will vent. The "PR?", "PRR?", "STAT?", or "SR?" program message queries can be used to monitor the progress of the generation. If the optional "*v*" argument is used, the PPC2+ will not attempt to self configure itself to the volume under test, but instead will use the given volume for the pressure generation. This can reduce pressure set times when operating into a consistent volume since the configuration routine takes 5 to 6 seconds to execute. The "v" argument should only be used in automated conditions, where the test volume is constant and the unit configuration does not change. This argument is only a coarse value, and it may be adjusted empirically for correct operation. A higher "v" setting will speed up the generation with a greater chance of control overshoot, and a lower "v" setting will slow down the generation. Note: with PPC2+ BG0002, the volume size specified is the difference in volume form the 840 cc accessory volume.
Example (enhanced)	Cmd sent: "PS 1000" Reply: "1000.000 kPa a (no reply if IEEE-488)
Example (classic)	Sent: "PS=1000" Reply: "1000.000 kPa a
Errors	ERR# 6 The target pressure is out of range.
See Also	Sections 3.1.2.3, 3.2.3, "PR?", "PRR?", "STAT?", and "SR?" program messages

PSF	
Purpose	Set a new target pressure and use just the fast speed to generate the pressure.
Command	"PSF *n*"
Classic	"PSF=*n*"
Arguments	*n:* The target pressure in the current pressure units.
Remarks	The PPC2+ 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?" program message queries can be used to monitor the progress of the generation.
Example (enhanced)	Cmd sent: "PSF 1000" Reply: "1000.000 kPaa (no reply if IEEE-488)
Example (classic)	Sent: "PSF=1000" Reply: "1000.000 kPaa
Errors	ERR# 6 The target pressure is out of range.
See Also	"PR", "PRR", "STAT", "SR", "PSS"

PSH	
	This is an obsolete PPC2 Command.
Purpose	Has the same effect as the PS Command.
See	"PS"

PSS	
Purpose	Set a new target pressure and use just the slow speed to generate the pressure.
Command	"PSS *n*"
Classic	"PSS=*n*"
Arguments	*n:* The target pressure in the current pressure units.
Remarks	The PPC2+ 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?" program message can be used to monitor the progress of the generation.
Example (enhanced)	Cmd sent: "PSS 1000" Reply: "1000.000 kPaa (no reply if IEEE-488)
Example (classic)	Sent: "PSS=1000" Reply: "1000.000 kPaa
Errors	ERR# 6 The target pressure is out of range.
See Also	"PR", "PRR", "STAT", "SR", "PSF"

QPRR	
Purpose	Read the last RPT pressure, rate. and ATM pressure.
Query	"QPRR?"
Classic	"QPRR"
Remarks	The last measured ready condition, pressure rate of pressure change, and ambient pressure for the active RPT (Lo or Hi) and range is returned in the current pressure units. This program message is useful when a rapid response of measured pressure is needed. Each data field is separated by a comma, and is returned in the following order: ready, pressure UNITS, rate UNITS/s, atm UNITS Here are the field descriptions: ready: 'R' if the current pressure ready criteria has been met, 'NR' if the criteria has not been met. (see the "SR" program message) pressure The measured pressure for the selected RPT and range in the current pressure units. This is followed by the current pressure units. rate The measured rate for the selected RPT 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+ internal barometer in the current pressure units (but always absolute). This is followed by the current pressure units.
Example (enhanced)	Query sent: "QPRR?" Query reply: "R,2306.265 kPaa,0.011 kPa/s,97.000 kPaa"
Example (classic)	Query sent: "QPRR" Reply: "R,2306.265 kPaa,0.011 kPa/s,97.000 kPaa"
See Also	"PR", "PRR", "SR"

RANGE	
Purpose	Read or change the active RPT range.
Command Query	"RANGE *n*:*XX*" "RANGE?"
Classic	"RANGE=*n*:*XX*" "RANGE "
Default	"RANGE 3,HI"
Arguments	*n:* '1' for the low range of the selected RPT. '2' for the mid range of the selected RPT. '3' for the high range of the selected RPT. *XX:* 'LO' for the low pressure RPT. 'HI' for the high pressure RPT or if PPC2+ has only one RPT.
Remarks	The range and active RPT must be selected before making changes to settings that are dependent on the range. Each RPTs has 3 separate ranges. You must specify both the range and the RPT. The system MUST BE VENTED to switch RPTs. The query reply is in the current units unless the current units are altitude units. If the units are meters, then the range will be specified in kPa. If the units are feet, then the range will be specified in psi.
Example (enhanced)	Cmd sent: "RANGE 1:LO" Query reply: "30 psia"
Example (classic)	Sent: "RANGE=1:LO" Reply: "30 psia"
Errors	ERR# 6: Invalid *n* or *XX* argument. ERR# 22: System must be vented for the requested operation. ERR# 38: The selected range is not available.
See Also	Sections 3.1.2.5, 3.2.1

RATE	
Purpose	Read the next available pressure rate of change.
Query	"RATE?"
Classic	"RATE"
Remarks	The next available pressure rate of change in the current pressure units per second is returned. After receiving this program message, the PPC2+ will reply back with the data once a new pressure measurement cycle is complete. This can take up to 1.5 seconds.
Example (enhanced)	Query sent: "RATE?" Query reply: "0.01 kPa/s"
Example (classic)	Sent: "RATE" Reply: "0.01 kPa/s"
See Also	"PRR", "QPRR"

READY	
	This is an obsolete PPC2 Command.
Purpose	Has the same effect as "MODE".
See	"MODE"

READYCK	
Purpose	Read or set the ready check flag.
Command Query	"READYCK 1" "READYCK?"
Classic	"READYCK=1" "READYCK"
Remarks	The internal ready check flag is cleared whenever the PPC2+ reaches a Not Ready (NR) condition. The "READYCK" query will return the status of this flag. This flag is set by sending the "READYCK 1" program message while the PPC2+ is in a Ready (**<*>**) condition. You can then use "READYCK" program message query at a later time to determine if a Not Ready (NR) condition has occurred since.
Example (enhanced)	Cmd sent: "READYCK 1" Query reply: "1" (if PPC2+ condition has stayed ready) "0" (if PPC2+ condition has NOT stayed ready)
Example (classic v2.01 & up)	Sent: "READYCK=1" Query reply: "READYCK=1" (if PPC2+ condition has stayed ready) "READYCK=0" (if PPC2+ condition has NOT stayed ready)
Example (classic v2.00)	Sent: "READYCK=1" Query reply: "1" (if PPC2+ condition has stayed ready) "0" (if PPC2+ condition has NOT stayed ready)
Errors	ERR# 6: Argument is not a '0' or a '1'.
See Also	Section 3.1.2.4, "SR?" program message

REMOTE	
Purpose	Lock out the front panel controls.
Command	"REMOTE"
Classic	"REMOTE"
Remarks	The PPC2+ goes into remote mode whenever communications take place. The user can return to local operation by pressing the **[ESC]** key. The REMOTE program message locks out the front panel completely. The only way to unlock the front panel is by using the LOCAL program message, the IEEE-488 'GTL' command, or by cycling the PPC2+ power.
Example (enhanced)	Cmd sent: "REMOTE" Reply: "REMOTE" (no reply if IEEE-488)
Example (classic)	Sent: "REMOTE" Reply: "REMOTE"
See Also	"LOCAL"

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

RESET	
Purpose	Reset the user's settings to factory defaults.
Command	"RESET"
Classic	"RESET"
Remarks	The PPC2+ has user settings (units, resolution, control modes, etc.) that can be reset to factory defaults. Calibration sequences and communications settings will not be affected. The remote "RESET" program message corresponds to the local "Reset-sets." function (See 3.4.4.5, Reset-sets.) The reset cycle takes up to 10 seconds to complete. Remote communications should not take place during this period.
Example (enhanced)	Cmd sent: "RESET" Reply: "RESET" (no reply if IEEE-488)
Example (classic)	Sent: "RESET" Reply: "RESET"
See Also	Section 3.4.4.5, Reset-sets

RETURN	
Purpose	Start a new generation using the current target pressure.
Command	"RETURN"
Classic	"RETURN"
Remarks	The "RETURN" program message 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+ goes into LOCAL mode, or an "ABORT" program message is executed.
Example (enhanced)	Cmd sent: "RETURN" Reply: "1000.000 kPaa" (no reply if IEEE-488)
Example (classic)	Sent: "RETURN" Reply: "1000.000 kPaa"
Errors	ERR# 6 The current target pressure is invalid.
See Also	Section 3.2.3, "PS", "TP"

SCRSAV	
Purpose	Read or set the front panel screen saver period.
Command Query	"SCRSAV *n*" "SCRSAV?"
Classic	"SCRSAV=*n*" "SCRSAV"
Arguments	*n:* The inactivity period. (minutes)
Default	"SCRSAV 10"
Remarks	The PPC2+ front panel will dim after a period of keyboard and remote inactivity. Setting this value to '0' will disable this feature.
Example (enhanced)	Cmd sent: "SCRSAV 30" Query reply: "300"
Example (classic)	Sent: "SCRSAV=30" Reply: "300"
Errors	ERR# 6 The argument was invalid.
See Also	Section 3.4.4.9

SN	
Purpose	To read the serial number of the PPC2+.
Query	"SN?"
Classic	"SN"
Remarks	The PPC2+ is serialized. The serial number can be read using this program message.
Example (enhanced)	Query sent: "SN?" Query reply: "321"
Example (classic)	Sent: "SN" Reply: "321"
See Also	None.

SR	
Purpose	Read the next available ready/not ready status.
Query	"SR?"
Classic	"SR"
Remarks	The current ready status can be read using this program message. If the reply is "NR", then the pressure is Not Ready within the limits defined by the control mode and current control parameters. If the reply is "R" then the pressure meets the ready criteria. The status is replied when the next pressure measurement is finished.
Example (enhanced)	Query sent: "SR?" Query reply: "NR"
Example (classic)	Sent: "SR" Reply: "NR"
See Also	Sections 3.1.2.4, 3.2.3, "PR", "PRR", "HS", "SS" Commands

SS%	
Purpose	Read or set the current stability limit.
Command Query	"SS% *n*" "SS%?"
Classic	"SS%=*n*" "SS%"
Arguments	*n:* The stability limit in %FS of the current active range.
Remarks	The stability limit can be read and set as a percent of the full scale range of the RPT. If this program message is used to set the stability limit, the PPC2+ will then use CUSTOM control settings.
Example (enhanced)	Cmd sent: "SS% .1" Query reply: "0.10 %"
Example (classic)	Sent: "SS%=.1" Reply: "0.10 %"
Errors	ERR# 6 The argument was invalid.
See Also	Sections 3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6, "SS"

SS	
Purpose	Read or set the current stability limit.
Command Query	"SS *n*" "SS?"
Classic	"SS=*n*" "SS"
Arguments	*n:* The stability limit in the current pressure units.
Remarks	The stability limit can be read and set as a pressure. If this program message is used to set the stability limit, the PPC2+ will then use CUSTOM control settings.
Example (enhanced)	Cmd sent: "SS .1" Query reply: "0.10 kPa/s"
Example (classic)	Sent: "SS=.1" Reply: "0.10 kPa/s"
Errors	ERR# 6 The argument was invalid.
See Also	"Sections 3.1.2.3, 3.1.2.4, 3.2.3, 3.2.6, SS%"

STAT	
Purpose	Read the pressure generation status.
Query	"STAT?"
Classic	"STAT"
Remarks	The generation cycle status can be checked using this program message. The reply is a numeric code which references a specific generation action: Multiple codes are returned by logically ORing them together. 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. 1024 A new target has been requested but generation has not started. 4096 Dynamic pulsing is being used to control a pressure. 8192 Static pulsing is being used to control a pressure. 16394 Low pressure control is active. 32768. Very low pressure control is active.
Example (enhanced)	Query sent: "STAT?" Query reply: "32"
Example (classic)	Sent: "STAT" Reply: "32"
See Also	"PS" program message

TIME	
Purpose	Read or set the PPC2+ time.
Command Query	"TIME *hh:mmXX*" "TIME?"
Classic	"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+ has an internal real time clock. It is used for date stamping calibrations and log data.
Example (enhanced)	Cmd sent: "TIME 12:52PM" Query reply: "12:52pm"
Example (classic)	Sent: "TIME=12:52PM" Reply: "12:52pm"
Errors	ERR# 7: Missing or improper program message argument(s).
See Also	Section 3.4.4.4

TOUT	
	This is an obsolete PPC2 Command.
Purpose	PPC2+ does not support external devices so the “TOUT” command is not supported. Will respond ERR# 9.
See	None

TP	
Purpose	To read the current target pressure.
Query	“TP?”
Classic	“TP”
Remarks	The current target pressure is replied in the current pressure units.
Example (enhanced)	Query sent: “TP?” Query reply: “1000.00 kPaa”
Example (classic)	Sent: “TP” Reply: “1000.00 kPaa”
See Also	Section 3.1.2.3, “PS“

TS	
	This is an obsolete PPC2 Command.
Purpose	The PPC2+ target limit cannot be set independently so the “TS” command has no effect. Will always respond with ½ of current hold limit.
See	“HOLD”

∗TST	
Purpose	Read the power on self test status.
Query	“∗TST?””
Remarks	The PPC2+ 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 “∗RST” program message was executed), and the ∗TST query will return a non zero value. If the PPC2+ passed the test on power-up OR if the ∗TST query was used at least once since the PPC2+ was powered up the reply will be a ‘0’.
Example (enhanced)	Sent: “∗RST?” Reply: “1”

UCOEF	
Purpose	To convert 1 Pascal to the current pressure units.
Query	"UCOEF?"
Classic	"UCOEF"
Remarks	The PPC2+ handles all pressure values internally in Pascal. The coef replied is equivalent of 1 Pa. This program message allows the user to convert pressures
Example (enhanced)	Query sent: "UCOEF?" Query reply: "0.0010000000 kPa"
Example (classic)	Sent: "UCOEF" Reply: "0.0010000000 kPa"
See Also	Section 3.2.2

UDU	
Purpose	Read or set the user defined pressure units.
Command Query	"UDU *label, ucoef*" "UDU?"
Classic	"UDU=*label, ucoef*" "UDU" *label:* User unit Device label (4 alphanumeric char maximum). It cannot be an already supported unit. *ucoef*: "User conversion coefficient (units/Pa).
Default	"UDU USER,1.0"
Remarks	The user defined unit must be set up with the program message prior to remote or local selection.
Example (enhanced)	Cmd Sent: "UDU MYUN, .001" Query reply: "MYUN, 0.0010"
Example (enhanced)	Sent: "UDU=MYUN, .001" Reply: "MYUN, 0.0010"
See Also	Section 3.2.2

UL	
Purpose	Read or set an upper limit for the current RPT and range.
Command Query	"UL *n*" "UL"
Classic	"UL=*n*" "UL"
Arguments	*n:* The upper limit pressure in the current pressure units. This value is always in absolute units if the RPT is absolute, or gauge units if the RPT is gauge.
Remarks	The PPC2+ has an upper limit for each range of each RPT and for each measurement mode (gauge and absolute). New automated pressure control 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 (enhanced)	Cmd sent: "UL 1000" Query reply: "1000.00 kPaa"
Example (classic)	Sent: "UL=1000" Reply: "1000.00 kPaa"
Errors	ERR# 6: The argument is out of range.
See Also	Section 3.2.4

UNIT	
Purpose	Read or set the pressure display unit and measurement mode.
Command	"UNIT *unit (, ref*)" "UNIT *unit*g *(, ref*)" "UNIT *unit*a *(, ref*)"
Query	"UNIT?"
Classic	"UNIT=*unit (, ref*)" "UNIT=*unit*g *(, ref*)" "UNIT=*unit*a *(, 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 program message determines what unit and what measurement mode 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 'a' if an absolute measurement mode is desired, or else a gauge unit will be assumed. The unit text can optionally be followed by a 'g' to specify a gauge measurement mode 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 (enhanced)	Cmd sent: "UNIT kPaa" Query reply: "kPaa" Sent: "UNIT InWag, 4" Query reply: "inWag, 4dC"
Example (classic)	Sent: "UNIT=kPaa" Reply: "kPaa" Sent: "UNIT=InWag, 4" Reply: "inWag, 4dC"
Errors	ERR# 7: The *unit* is invalid. ERR# 6: The *ref* is invalid. ERR# 20: Absolute measurement mode and altitude units are not allowed with a gauge RPT.
See Also	Sections 3.2.2, 7.3, 3.4.1

VAC	
Purpose	Read or set the control ref status.
Command Query	"VAC *n*" "VAC?"
Classic	"VAC=*n*" "VAC"
Default	"VAC 0"
Arguments	*n:* '0' To disable auto mode and specify that the PPC2+ EXHAUST port is open to atmosphere. '1' To disable auto mode and specify that the PPC2+ EXHAUST port is connected to a vacuum source.
Remarks	The PPC2+ has an internal sensor that determines if the exhaust port is open to atmosphere or to a vacuum. You can manually override it if desired. The query can also be used to see the sensor status (if auto is enabled). If the auto function is disabled, then the query returns the last VAC setting.
Example (enhanced)	Cmd sent: "VAC 1" Query reply: "0" "1"
Example (classic)	Sent: "VAC=1" Query reply: "VAC=0" "VAC=1"
Errors	ERR# 6: The argument is not a '0' or a '1'.
See Also	Section 3.3.1, "AUTOVAC"

VENT	
Purpose	Read, execute or abort a vent process.
Command Query	"VENT *n*" "VENT?"
Classic	"VENT=*n*" "VENT"
Arguments	*n:* '1' to start a vent process. '0' to abort a vent process and close the exhaust valve.
Remarks	The PPC2+ vents by generating close to atmosphere, and then opening the exhaust valve. This program message query will return a '0' if the exhaust valve is closed, or a '1' if the exhaust valve is open.
Example (enhanced)	Cmd sent: "VENT 1" Query reply: "0" (if not vented) "1" (if vented)
Example (classic)	Sent: "VENT=1" Reply: "VENT=0" (if not vented) "VENT=1" (if vented)
Errors	ERR# 6: The argument is not a '0' or a '1'.
See Also	Section 3.1.2.2

VER	
Purpose	Read the PPC2+ version.
Query	"VER?"
Classic	"VER"
Remarks	The software version of the PPC2+ can be read. This is useful for checking presence of the PPC2+ and for reference purposes.
Example (enhanced)	Query sent: "VER?" Query reply: "DH INSTRUMENTS, INC PPC2+ Ver2.00 "
Example (classic)	Query sent: "VER?" Query reply: "DH INSTRUMENTS, INC PPC2+ Ver2.00 "
See Also	None

ZOFFSETn:HI and ZOFFSETn:LO	
Purpose	Read or set the autozero pressure offset (ZOFFSET) for the current RPT range and measurement mode.
Command	"ZOFFSET*n*:HI *offset, Date*" "ZOFFSET*n*:LO *offset, Date*"
Query	"ZOFFSET*n*:HI?" "ZOFFSET*n*:LO?"
Classic	"ZOFFSET*n*:HI =*offset, Date"* "ZOFFSET*n*:LO =*offset, Date"* "ZOFFSET*n*:HI" "ZOFFSET*n*:LO"
Defaults	"ZOFFSET*n*:HI = 0.0, 800101" "ZOFFSET*n*:LO = 0.0, 800101"
Arguments	*n:* The RPT range. '1' for the low, '2' for the medium '3' for the high range of the selected RPT (Hi or Lo). *offset:* The RPT pressure offset (ZOFFSET) for the current measurement mode (gauge or absolute) in Pa. *Date:* The date when the last edit to the *offset* was made.".
Remarks	The pressure offset (ZOFFSET) for the specified RPT (HI or LO pressure) and RPT range (low, medium, or high) in the current measurement mode can be accessed with this program message There is a separate offset for gauge and absolute measurement modes. Using this program message will overwrite the current offset, so caution must be used. Changes made using this program message will take effect immediately.
Example (enhanced)	Cmd sent: "ZOFFSET1:LO 2.1, 961201" Query reply: " 2.10 Paa, 961201"
Example (classic)	Sent: "ZOFFSET1:LO=2.1, 961201" Reply: " 2.10 Paa, 961201"
Errors	ERR# 6: One of the arguments are out of range.
See Also	Section 3.4.1

ZNATERRn:HI and ZNATERRn:LO		
Purpose	Read or set the autozero natural error (ZNATERR) for the selected RPT range and measurement mode.	
Command	"ZNATERR*n*:HI *NatErr, Date*"	
	"ZNATERR*n*:LO *NatErr, Date*"	
Query	"ZNATERR*n*:HI?"	
	"ZNATERR*n*:LO?"	
Classic	"ZNATERR*n*:HI =*NatErr, Date"*	
	"ZNATERR*n*:LO =*NatErr, Date"*	
	"ZNATERR*n*:HI"	
	"ZNATERR*n*:LO"	
Defaults	"ZNATERR*n*:HI = 0.0, 800101"	
	"ZNATERR*n*:LO = 0.0, 800101"	
Arguments	*n:*	The RPT range. '1' for the low, '2' for the medium '3' for the high range of the selected RPT.
	NatErr:	The RPT natural error for the RPT range.
	Date:	The date when the last edit to the *NatErr* was made.".
Remarks	The natural error (ZNATERR) for the specified RPT (HI or LO pressure) and RPT range (1, 2, or 3) can be accessed with this program message. Using this program message will overwrite the current natural error, so caution must be used. Changes made using this program message will take effect immediately.	
Example (enhanced)	Cmd sent:	"ZNATERR1:LO 10, 961201"
	Query reply:	" 10.00 Paa, 961201"
Example (classic)	Sent:	"ZNATERR1:LO=10, 961201"
	Reply:	" 10.00 Paa, 961201"
Errors	ERR# 6:	One of the arguments are out of range.
See Also	Sections 3.4.1, 5.2.6	

4.5 STATUS REPORTING SYSTEM

The PPC2+ status reporting system is used to track and report system status and errors. It follows the model of the IEEE Std 488.2 and works for the COM1 and the IEEE-488 port with slight differences. The PPC2+ can be programmed to respond to various status conditions by asserting the SRQ of the IEEE-488 interface. The COM1 port cannot be supported in such a way, so polling must be used.

4.5.1 ERROR QUEUE

The PPC2+ keeps track of remote errors by using an error queue. If an error occurs, it is pushed onto the Error Queue. If you are using the COM1 port, the error number is immediately replied in the form "ERR#*nn* where *nn* is the error code from 0 to 99. The "ERR?" (or "ERR") query can then be used to pull the error from the Error Queue in it's descriptive text format. If you are using the enhanced program message format, the Error Queue will accumulate errors until full unless they are pulled from the queue. If you are using the classic program format, the Error Queue is cleared every time a new program message is received.

4.5.2 STATUS BYTE REGISTER

The PPC2+ contains an 8 bit Status Byte Register that reflects the general status of the PPC2+:

Table 14. 8 Bit Status Byte Register

OPER (128)	RQS/MSS (64)	ESB (32)	MAV (16)	N/A (8)	ERROR (4)	N/A (2)	RSR (1)

This register is affected by the PPC2+ reply output queue, the Error Queue, the Standard Event Status register and the Ready Event Status register:

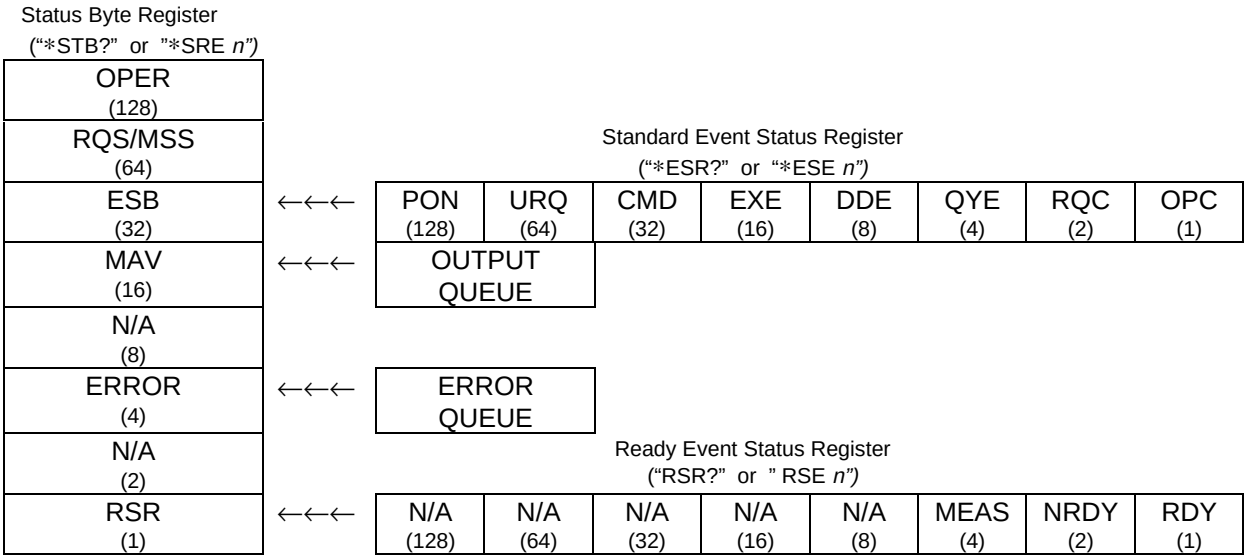


Figure 11. Status Register Schematic

The Status Byte Register can be read using the "*STB?" query, or by performing a serial poll on the IEEE-488 bus. If you read this using a serial poll then Bit 6 is the RQS. If the "∗STB?" query is used, then bit 6 is the MSS bit. All of the other bits are common to both types of query.

Each of these status bits can cause a SRQ to occur. The Service Request Enable Register ("∗SRE" program message) determines which of these flags are able to assert the SRQ line. This enable register has a matching set of bits that each will enable the designated bit to cause a SRQ, except for the RQS/MSS bit(s) which cannot cause a SRQ. If you set this register to 20 ($14 hex), an SRQ will occur if the MAV or the ERROR bit are set. The description of these bits are given as:

- OPER: N/A (Bit 7)
- RQS: Requested Service (Bit 6)

  Indicates that the SRQ line of the IEEE-488 interface has been asserted by the PPC2+. This bit is cleared when a serial poll is performed on the PPC2+, and is a part of the Status Byte Register when read using a serial poll. This bit does not apply if the COM1 port is being used.
- MSS: Master Summary Status (Bit 6)

  Indicates that an event or events occurred that caused the PPC2+ to request service from the Host, much like the RQS bit. Unlike the RQS bit, it is READ ONLY and can be only cleared when the event(s) that caused the service request are cleared.
- ESB: Event Summary Bit (Bit 5)

  Indicates if an enabled bit in the Standard Event Status Register became set (see Section 4.5.3).
- MAV: Message Available Bit (Bit 4)

  Indicates that at least one reply message is waiting in the PPC2+ IEEE-488 output queue.
- ERROR: Error Queue not empty (Bit 2)

  Indicates that at least one command error message is waiting in the PPC2+ IEEE-488 error message queue. Use the "ERR?" query to get this message.
- RSB: Ready Summary Bit (Bit 0)

  Indicates that an enabled bit in the Ready Status Register became set.

4.5.3 STANDARD EVENT REGISTER

The PPC2+ contains an 8 bit Standard event register that reflects specific PPC2+ events. Enabled events in this register will set or clear the ESB bit of the Status Byte Register.

Table 15. 8 Bit Standard Event Register

PON (128)	URQ (64)	CMD (32)	EXE (16)	DDE (8)	QYE (4)	RQC (2)	OPC (1)

This register can be read using the "*ESR?" query, Each of these status bits can set the ESB bit of the Status Byte Register, causing a SRQ to occur IF the ESB bit is enabled to do so. The Standard Event Status Enable Register ("∗ESE" program message) determines which of these flags are able to assert the ESB bit. The description of these bits are given as:

- PON: Power On (Bit 7)

  Indicates that the PPC2+ power has been cycled since the last time this bit was read or cleared.

- URQ: User Request (Bit 6)

  Indicates that the PPC2+ was set to local operation manually from the front panel by the user (pressing the **[ESC]** key).

- Command Error (Bit 5)

  Indicates that a remote command error has occurred. A command error is typically a syntax error in the use of a correct program message.

- EXE: Execution Error (Bit 4)

  Indicates if a remote program message cannot be processed due to device related condition.

- DDE: Device Dependent Error (Bit 3)

  Indicates that an internal error has occurred in the PPC2+ such as a transducer time-out.

- QYE: Query Error (Bit 2)

  Indicates that an error has occurred in the protocol for program message communications. This is typically caused by a program message being sent to the PPC2+ without reading a waiting reply.

- RQC: Request Control (Bit 1)

  This bit is not supported as the PPC2+ cannot become the active controller in charge.

- OPC: Operation Complete (Bit 0)

  Indicates that the PPC2+ has completed all requested functions.

4.5.4 READY STATUS REGISTER

The PPC2+ contains an 8 bit Ready Status Register that reflects specific PPC2+ measurement and generation ready events. Enabled events in this register will set or clear the RSB bit of the Status Byte Register.

Table 16. 8 Bit Ready Status Register

N/A (128)	N/A (64)	N/A (32)	N/A (16)	N/A (8)	MEAS (4)	NRDY (2)	RDY (1)

This register can be read using the "*RSR?" query, Each of these status bits can set the RSB bit of the Status Byte Register, causing a SRQ to occur IF the RSB bit is enabled to do so. The Standard Event Status Enable Register ("∗RSE" program message) determines which of these flags are able to assert the RSB bit. The description of these bits are given as:

- MEAS: Measurement ready (Bit 2)

  Indicates that the PPC2+ has completed an RPT measurement.

- NRDY: Generation Not Ready (Bit 1)

  Indicates that the PPC2+ made a transition from Ready (**<*>**) to Not Ready (**<↑>** or **<↓>**) as defined by the control settings (see Section 3.1.2.4).

- RDY: Generation Ready (Bit 0)

  Indicates that the PPC2+ has reached a target pressure and is Ready (**<*>**) as defined by the control settings (see Sections 3.1.2.4 and 3.1.2.3).

4.6 IEEE STD. 488.2 COMMON AND STATUS PROGRAM MESSAGES

The PPC2+ supports a set of commands that are common to all instruments conforming to IEEE Std. 488.2. These command make it easy to perform basic function for any device that supports these commands. These command also cover the status reporting commands. See Section 4.5 for details on the status registers mentioned in these commands.

Table 17. Program Message List

∗**CLS**	Clear all of the status & event structures.
∗**ESE**	Read or set the Standard Event Status Enable Register.
∗**ESR**	Read the Standard Event Status Register.
∗**IDN**	Identify the PPC2+ version, range, and serial number.
∗**OPC**	Sets the operation complete bit when all operations have completed.
∗**OPT**	Reads the list of installed PPC2+ options.
∗**RST**	Resets the PPC2+ control settings to factory settings.
∗**TST**	Read the power on self test status.
∗**SRE**	Read or set the Service Request Enable Register.
∗**STB**	Read the Status Byte Register.
RSE	Read or set the Ready Status Enable Register.
RSR	Reads the Ready Status Register.

4.6.1 PROGRAM MESSAGE DESCRIPTIONS

∗CLS	
Purpose	Clear all of the status & event structures.
Command	"∗CLS"
Remarks	This program message clears the following events and status registers: Standard Byte Register (STB) Standard Event Status Register (ESR) Error Queue Pending OPC operations
Example (classic)	Sent: "∗CLS" Reply: none

∗ESE	
Purpose	Read or set the Standard Event Status Enable Register.
Command Query	"∗ESE *n*" "∗ESE?"
Default	"∗ESE 0"
Arguments	*n:* '0 to 255' This is the decimal representation of the bit(s) to enable. To enable the PON and QYE bits, the argument would be 128 + 4 = 132.
Remarks	The Standard Event Status Enable register determines which bits in the standard Event Status Register are enabled and included in the Status Byte Register (ESB bit), and can assert the SRQ line. The reply is in decimal numeric form.
Example (enhanced)	Sent: "∗ESE=128"(enables the PON bit) Query reply: "128" (no reply if IEEE-488)
Errors	ERR# 6: *n* is not valid.

∗ESR	
Purpose	Read the Standard Event Register.
Command	"∗ESR?"
Remarks	The Standard Event Register contents are cleared after reading. The reply is in decimal numeric form.
Example (enhanced)	Sent: "∗ESR?" Reply: "20" (the QYE and EXE bits are set)

∗IDN	
Purpose	Identify the PPC2+ version, range, and serial number.
Query	"∗IDN?"
Remarks	The identification reply is made up of the manufacture, the model, the serial number and the software version. Each is separated by a comma.
Example (enhanced)	Sent:"∗IDN?" Reply:"DH INSTRUMENTS INC, PPC2+ A0100/A0015, 1234, Ver2.00 -dhf"

∗**OPC**	
Purpose	Sets the operation complete bit when all operations have completed.
Command Query	"∗OPC" "∗OPC?"
Remarks	This Command enables the PPC2+ to set the OPC bit in the Standard Event Status Register when it has completed all pending functions. The Query replies with a "1" when all functions are complete.
Example (enhanced)	Sent: "∗OPC" Query reply: "1"

∗**OPT**	
Purpose	Reads the list of installed PPC2+ options.
Query	"∗OPT?"
Remarks	This Query returns any registered option(s) installed in the PPC2+. Each option is separated by a comma. Possible options: "IEEE-488:0" The IEEE-488 option is installed. "ANALOG:n" The analog option is installed. 'n' is the revision on the analog option hardware from 'A' to 'Z' or '-' if original revision.
Example (enhanced)	Sent: "∗OPT?" Reply: "IEEE-488:0, ANALOG:-"

∗**RST**	
Purpose	Resets the PPC2+ control settings to factory settings.
Command	"∗RST""
Remarks	This Command sets the PPC2+ settings to factory settings. This equivalent to a front panel executed RESET/SET. This does not affect the communications settings.
Example (enhanced)	Sent: "∗RST" Reply: "∗RST" (no reply if IEEE-488)
See Also	Section 3.4.4.5, Reset - Sets

∗SRE		
Purpose	Read or set the Service Request Enable Register.	
Command Query	"∗SRE *n*" "∗SRE?"	
Default	"∗SRE 0"	
Arguments	*n:*	'0 to 255' This is the decimal representation of the bit(s) to enable. To allow the MAV and ESB bits to assert the SRQ line, the argument would be 32 + 16 = 48. Bit 6 (64) is reserved and cannot be set.
Remarks	The Service Request Enable Register determines which bits of the Status Byte can set the MSS bit of the Status Byte and request service by asserting the SRQ line of the IEEE-488 interface.	
Example (enhanced)	Sent: Query reply:	"∗SRE=48" (enables the MAV and ESB bits) "48" (no reply if IEEE-488)
Errors	ERR# 6:	*n* is not valid.

∗STB		
Purpose	Read the Status Byte Register.	
Command	"∗STB?"	
Remarks	The Status Byte Register reflects the general status of the PPC2+. The 'MSS' bit state is represented by bit 6.	
Example (enhanced)	Sent: Reply:	"∗STB?" "80" (The MSS and MAV bits are set)

RSE		
Purpose	Read or set the Ready Status Enable Register.	
Command Query	"RSE *n*" "RSE?"	
Default	"RSE 0"	
Arguments	*n:*	'0 to 255' This is the decimal representation of the bit(s) to enable. To enable the RDY bit, the argument would be 1.
Remarks	The Ready Status Enable Register determines which bits in the Ready Status Register are enabled and included in the Status Byte Register (RSR bit), and can assert the SRQ line. The reply is in decimal numeric form.	
Example (enhanced)	Sent: Query reply:	"∗RSE=1" (enables the RDY bit) "1" (no reply if IEEE-488)
Errors	ERR# 6:	*n* is not valid.

RSR		
Purpose	Read the Ready Status Register.	
Command	"RSR?"	
Remarks	The Ready Status Register contents are cleared after reading. The reply is in decimal numeric form.	
Example (enhanced)	Sent: Reply:	"RSR?" "6" (The MEAS and NRDY)

NOTES

5. MAINTENANCE, ADJUSTMENTS AND CALIBRATION

5.1 OVERVIEW

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

- Rezeroing of reference transducers (RPT) as needed (see Section 3.4.1).
- Regular reference transducer calibration (see Section 5.2).
- Adjustment of the on-board barometer as needed (see Section 5.3).
- Automated adjustment of pressure controlling parameters as needed (see Section 5.5).

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

PPC2+ 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, use this manual and other training facilities to become thoroughly familiar with PPC2+ operation. For rapid assistance in specific situations (see Chapter 6).

PPC2+ is covered by a limited one (1) 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.

5.2 CALIBRATION OF REFERENCE PRESSURE TRANSDUCERS

5.2.1 PRINCIPLE

PPC2+ has one or two reference pressure transducers (RPT) that are the source of accurate pressure measurement for the system. Each transducer has three independent ranges.

To calibrate a range, pressures from a standard are applied to the RPT at ascending and descending points over the range. The pressure defined by the standard and the corresponding RPT readings are recorded at each point. After all of the pressures have been applied and recorded, adjustments are made to fit the RPT 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 by user settable coefficients: PA (an adder or offset) and PM (a multiplier or span set) (see Section 5.2.1.1).

The calibration process is performed independently on each range of each RPT to arrive at the optimal fit for each range. This technique allows improved accuracy for individual ranges lower than the RPT's maximum range by taking into account specific transducer performance characteristics, in particular localized non-linearity and excursion dependent hysteresis. Independent range calibration also makes it possible to calibrate only certain ranges if ranges are on different calibration intervals or not all ranges are needed.

The normal calibration process for absolute RPTs has a second step which is the determination of the value of ZNATERR (see Section 5.2.1.2). This added step is necessary to get the full benefit of the autozero function between calibrations (see Section 3.4.1). It is only needed if the RPT will be operated in absolute measure mode.

CalTool for RPTs software provided with the PPC2+ supports the calibration process of PPC2+ RPTs. CalTool and it's documentation are provided on a General Accessories Disk with the new PPC2+. Most users should use CalTool software to assist in the calibration of PPC2+.

PPC2+ is delivered with an interactive RPT calibration utility that steps the operator through the complete reference transducer calibration procedure including applying the necessary pressures to each range, collecting data automatically, calculating new PA/PM values, previewing the results of the new calibration, determining ZNATERR and activating the results of the new calibration (see the CalTool for RPTs manual on the General Accessories Disk). PPC2+ also provides complete front panel and remote access to RPT calibration parameters so that RPT calibrations can be performed without using CalTool software (see Section 5.2.7).

See the PPC2+ BG0002 Operation and Maintenance Manual for information specific to calibration of the BG0002 RPT.

5.2.1.1 PA/PM COEFFICIENTS

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

Corrected reading = (uncorrected reading o PM) + PA

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

PM is dimensionless.

There are individual PA/PM values for each of PPC2+'s six ranges. The current PA/PM values in use can be viewed in the calibration function (see Section 5.2.5). PA/PM values are automatically edited when CalTool software is used and the results are activated. PA/PM values can also be edited manually under the calibration function (see Section 5.2.5).

As editing PA/PM values will change RPT calibration, they should only be edited by qualified personnel as part of the calibration process. Caution should be taken to avoid accidental editing (see Section 3.4.4.6).

A new PPC2+ is delivered with PA/PM values set to zero and 1 for all ranges. This does not mean that the PPC2+ has not been calibrated. For the original factory calibration, PA/PM are set to zero and 1 and privileged factory coefficients are used for calibration adjustment.

5.2.1.2 SETTING ZNATERR

Setting ZNATERR is necessary on absolute RPTs that will be used in the **absolute measure** mode if the AutoZ function that *rezeros* the reference transducers between calibrations is to function properly (see Section 3.4.1).

Setting ZNATERR is procedurally identical to running the AutoZ function but the result is changes to the ZNATERR value rather than the ZOFFSET value. The ZNATERR setting procedure is prompted automatically by CalTool software. It can also be run separately by pressing **[SPECIAL]** and selecting **<4Internal>**, **<2Cal>**.

As ZNATERR must reflect the "natural" error between the RPT and ZSTD at the time the reference transducer is calibrated, the run ZNATERR function should not be executed between calibrations. Only the AutoZ function should be used to "rezero" the reference transducer between calibrations (see Section 3.4.1).

5.2.1.3 ORDER OF OPERATIONS

If the PPC2+ has an absolute Lo RPT (AXXXX) and an absolute Hi RPT (AXXXX), and the Hi RPT will be autozeroed by the Lo RPT (see Section 3.4.1), calibrate and determine the ZNATERR of the Lo RPT Range3 prior to calibrating the Hi RPT. This is necessary since the ZNATERR determinations for the Hi RPT ranges will be made relative to the Lo RPT Range 3 (L3).

5.2.1.4 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+ RPTs can be obtained in several ways.

When the PPC2+ CalTool calibration assistance software is used, as received data is displayed while running the calibration and is automatically recorded and provided if desired. As left data is also calculated and presented.

At any time, with knowledge of pressures applied, associated transducer readings, PA/PM and ZOFFSET values can be used to calculate as received/as left values. For example, backing out PA/PM on the as left data yields the transducer readings with PA = 0 and PM = 1. Then applying the as received PA/PM and ZOFFSET values to the readings calculates *as received* readings (the readings that the transducer would have made with the old PA/PM and ZOFFSET).

⚠ It is recommended that "as received" values of PA/PM and ZOFFSET (for absolute RPTs if autozero is used in normal operation) be recorded for each range prior to running the calibration. The current PA/PM can be viewed by pressing [SPECIAL] and selecting <4Internal>, <2Cal>, <1View>. ZOFFSET's current value can be viewed by pressing [SPECIAL] and selecting <1AutoZ>, <2view>.

5.2.2 EQUIPMENT REQUIRED

1. **Gas operated piston gauge (deadweight tester)**, with the following characteristics:

   - **Accuracy of ± 0.0035 % of reading or better**, if best PPC2+ accuracy is to be obtained. A lower accuracy standard may be used but PPC2+ accuracy will be degraded proportionally from published specifications.

   - **Able to apply absolute pressures if the RPT is absolute (AXXXX) and will be used in the absolute measure mode:** Absolute pressures may be arrived at either by operation relative to an evacuated bell jar or, for higher pressures, by addition of atmospheric pressure measured by a high accuracy barometer. Absolute RPTs that will **not** be used in **absolute measure** mode (as is often the case for higher pressure RPTs) do not require the application of absolute pressure for calibration and may be calibrated using a gauge pressure standard.

⚠ Absolute RPTs calibrated in gauge measurement mode by applying gauge reference pressure values will no longer be accurate when used in absolute mode.

- **Able to apply 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 FS of the range being calibrated from the nominal increment. For the zero point on absolute ranges, use the lowest point the piston gauge can define accurately.

The recommended calibration standards for supporting PPC2+ are either the DHI PG7102 or PG7601 gas operated piston gauges. Contact DHI for additional information.

2. **High accuracy barometer:** Needed only if an absolute RPT (AXXXX) is being calibrated and ZNATERR will be set to allow the use of the autozero function between calibrations (see Section 3.4.1). Barometer accuracy should be ± 0.01 % or better but its most important feature is stability over time. Ideally, the same barometer should be used to set ZNATERR and for subsequent running of the autozero function to update ZOFFSET.

The recommended source for measuring atmospheric pressure to set ZNATERR and for subsequent autozeroing is a DHI RPM1, RPM2 or RPM3 reference pressure monitor. Contact DHI for additional information.

5.2.3 SET-UP AND PREPARATION

To set-up and prepare the PPC2+ for calibration of an RPT:

1. Set the PPC2+ on a stable surface near the calibration standard at an altitude 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+ rear panel SUPPLY port (1/8 in. NPT F). (See Section 2.3.4.)

3. If the calibration will include pressures under atmospheric pressure, connect a vacuum pump to the PPC2+ 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 (see Section 2.3.5).

4. Connect the calibration standard output to the PPC2+ rear panel TEST port (1/4 in. NPT F).

⚠ 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. Damage to internal PPC2+ components could result. It is highly recommended when using a piston gauge to calibrate PPC2+, that the PPC2+ direct pressure control keys (see Section 3.1.2.2) be used to change the pressure rather than the piston gauge control system valves. The piston gauge vernier can then be used for fine pressure adjustment to float the piston if necessary.

5.2.4 RPT CALIBRATION USING CALTOOL FOR RPTS SOFTWARE

To calibrate PPC2+ using CalTool software (supplied on the General Accessories Disk), refer to Sections 5.2.1, PRINCIPLE, 5.2.2, and 5.2.3 in this manual and then refer to the CalTool for RPTs Software Manual (supplied on the General Accessories Disk).

5.2.5 EDITING AND VIEWING RPT CALIBRATION INFORMATION

❍ **PURPOSE**

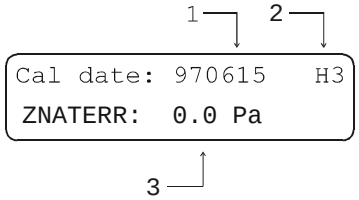
RPT calibration information fields include:

- The calibration date.
- The value of ZNATERR.
- The value of PA.
- The value of PM.

These fields can be viewed and/or edited. Viewing and editing calibration information is range specific.

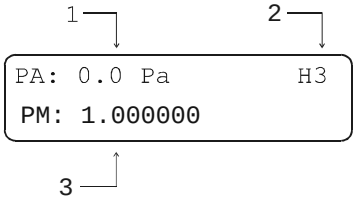
❍ **OPERATION**

Select the desired range from the main run screen using the RANGE function. Then, to view or edit calibration information, press **[SPECIAL]** and select **<4Internal>**, **<2Cal>**, **<1RPT>**. Select **<1view>** or **<2edit>**. The **<1view>** selection displays the calibration information fields. The **<2edit>** function displays the fields and allows them to be edited. The display is:



1. Edit field for calibration date if in edit mode.
2. Current RPT measurement range.
3. Edit field for value of ZNATERR if in edit mode.

If in **edit** mode, the calibration information fields can be edited. Pressing **[ENTER]** from the ZNATERR field goes to the next view/edit screen:



1. Edit field for value of PA if in edit mode.
2. Current RPT measurement range.
3. Edit field for value of PM if in edit mode.

If in **edit** mode, the calibration fields can be edited. Pressing **[ENTER]** from the PM field returns to the view/edit screen. If editing and changes have been made, confirmation of change activation is requested. Pressing **[ESCAPE]** in any edit screen will exit the edit screen without activating any changes.

⚠ As editing PA/PM values will change the calibration of the RPTs, the edit function should only be used by qualified personnel as part of the calibration process. Caution should be taken to avoid accidental editing (see Section 3.4.4.6).

The value of PA is always in Pascal (Pa). The value of PM is dimensionless.

5.2.6 SETTING ZNATERR

❍ PURPOSE

Setting ZNATERR is required as part of the calibration process for absolute RPTs that will be used in the **absolute measurement** mode if the autozeroing feature will be used between calibrations (see Sections 5.2.1, PRINCIPLE and 3.4.1).

ZNATERR is range specific and operating mode specific. There is no ZNATERR for gauge RPTs (GXXXX).

Running ZNATERR and activating the new ZNATERR value automatically sets ZOFFSET to zero.

❍ OPERATION

See Section 3.4.1.

To set ZNATERR, press **[SPECIAL]** and select **<4Internal>**, **<2Cal>**, **<1RPT>**, **<3run ZNATERR>**. Procedurally, running ZNATERR is identical to running AutoZ (see Section 3.4.1.3).

⚠ Changing the value of ZNATERR between RPT calibrations may invalidate the autozero function for that range. Run ZNATERR should not be used between calibrations.

5.2.7 RPT CALIBRATION/ADJUSTMENT WITHOUT CALTOOL FOR RPTS SOFTWARE

❍ PRINCIPLE

The reference pressure transducers can be calibrated and adjustments made without using CalTool for RPTs software. This requires:

- Applying pressures with a calibration standard and recording the pressures measured by PPC2+.
- Calculating new PA/PM values and entering them.
- Setting ZNATERR for the calibrated range (if the RPT is absolute, will be operated in **absolute measurement** mode and the autozero function will be used between calibrations).

⚠ *Before proceeding to calibrate a reference pressure transducer without using CalTool for RPTs software, Sections 5.2, Calibration of Reference Pressure Transducers, 5.2.1 PRINCIPLE, 5.2.2 Equipment Required, 5.2.3 Setup and Preparation should be reviewed thoroughly.*

❍ OPERATION

A typical procedure for calibrating an RPT range is:

❶ Set-up and prepare the PPC2+ for calibration (see Sections 5.2.2., 5.2.3).

❷ From the main run screen, using the **[RANGE]** function key, select the reference transducer and range to be calibrated (see Section 3.2.1). Set the HEAD to zero using the HEAD function (see Section 3.2.7). Turn AutoZ ON if it is left ON in normal PPC2+ operation (see Section 3.4.1).

❸ Pressing **[SPECIAL]**, **<4Internal>**, **<2Cal>**, **<1RPT>**, **<1view>**, read and record the current values of PA/PM.

❹ Pressing **[SPECIAL]**, **[1Autoz]**, **[2View]**, read and record the current value of ZOFFSET (for absolute RPT in **absolute** mode only).

❺ Run the calibration pressures for the range recording the pressure applied by the standard and the PPC2+ reading at each calibration point. Dwell at least two minutes after setting the reference pressure at each point to allow full stabilization The data recorded is the “as received” data for this calibration.

❻ Enter the calibration pressure and PPC2+ readings into a spreadsheet. Calculate the "non-corrected" PPC2+ readings by backing out the PA, PM and ZOFFSET (absolute RPTs only) recorded in Steps ❸ and ❹ above, following:

non-corrected reading = (corrected reading - PA + ZOFFSET)/PM

❼ Perform a linear regression to find the offset and slope that best fit the non-corrected PPC2+ readings to the calibration standard pressures. The offset is the new value of PA, the slope is the new value of PM.

❽ Press **[SPECIAL]** and select **<4Internal>**, **<2Cal>**, **<1RPT>**, **<2edit>** and write the new calibration date and the new values of PA/PM for the RPT and range calibrated.

❾ Press **[SPECIAL]** and select **<4Internal>**, **<2Cal>**, **<1RPT>**, **<3run ZNATERR>**, run the ZNATERR routine (absolute RPTs only) (see Section 5.2.6).

❿ Calculate as **left data** for the calibration if desired following:

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

5.3 ADJUSTMENT OF ON-BOARD BAROMETER

❍ **PURPOSE**

To adjust the output of the on-board barometer (see Section 1.2.2.2).

❍ **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 5.2.1).

The on-board barometer is a low accuracy sensor used only for measuring changes in atmospheric pressure over short periods of time (see Section 3.4.1). PPC2+ measurement accuracy does not depend on the absolute accuracy of the on-board barometer.

❍ **OPERATION**

To edit the values of PA and PM for the barometer, press **[SPECIAL]** and select **<4Internal>**, **<2cal>**, **<2barometer>**. Pressing **[ENTER]** steps through displays of the calibration date [YYMMDD] and PA/PM. In **edit** mode, the values can be edited. Pressing **[ENTER]** after the last screen activates the edited values.

To view the current atmospheric pressure measurement made by the barometer board, press [SPECIAL] and select <4Internal>, <7Atm>.

5.4 CALIBRATION OF ANALOG INPUT

❍ **PURPOSE**

To adjust the measurements made by the analog input option to compensate for external line conditions or to agree with an external voltage or current reference.

5.4.1 CALIBRATION PRINCIPLE

The PPC2+ analog input option measures on four channels. The measurement ranges for all four channels simultaneously can be selected between:

- to 100 mV.
- to 5 V.
- to 10 V.
- to 20 mA.

5.4.1.1 AUTOMATED INTERNAL CALIBRATION

The four channels are automatically calibrated relative to ground and a voltage reference whenever the PPC2+ is first turned ON or the analog input option range is changed and/or every 30 minutes of operation.

The automated calibration uses an internal Adder and Multiplier to best fit the measurement range to the two points defined by the internal references.

The automated internal calibration function assures the stability over time of the analog measurement ranges relative to the highly stable internal references. The original accuracy of the analog input option is obtained by individual five point calibration of each channel in each range relative to an external reference. The user may adjust the ranges independently with user defined Adders and Multipliers to compensate for specific external line conditions and/or to cause the analog measurements to agree with their own external voltage or current reference (see Section 5.4.1.2).

5.4.1.2 USER ADJUSTMENT OF ANALOG MEASUREMENT RANGES AND CHANNELS

For each channel in at each range, user definable measuring modifiers are available. The measured signal is modified using an Adder and a Multiplier. The initial measurement is multiplied by the Multiplier and then the Adder is added following:

Displayed value = (Meas X Multiplier) + Adder;

The analog input option automated internal calibration function described in Section 5.4.1.1, Automated Internal Calibration, always operates and the results are applied the measurement values before the Adders and Multipliers are applied. This allows the internal calibration cycle to continue to assure the stability over time of the analog measurements relative to the internal references even when Adders and Multipliers have been used to cause the analog measurements to agree with an external standard.

The Adder and Multiplier values can be changed through the front panel (see Section 5.4.2) or by a remote command (see Section 4.4).

A new PPC2+ with the analog input option is delivered with Adder and Multiplier values set to <0> and <1> for all ranges (i.e., they have no effect). This does not mean that the analog input option has not been factory calibrated. For the original calibration, the user Adder and Multipliers are set to <0> and <1>1 and privileged factory commands are used for calibration adjustment.

5.4.2 ADJUSTING ANALOG MEASUREMENT CHANNELS

- **OPERATION**

To view or edit the analog measurement channel modifiers, first select the range you wish to modify using the ANALOG function (see Section 3.2.9).

Then, from the main run screen press **[SPECIAL]** and select **<4Internal>**, **<2Cal>**, **<3analog>**. Specify the desired analog channel. The values of the adder and multiplier can then be edited.

As editing adder and multiplier values will change the calibration of the analog input measurements, they should only be edited by qualified personnel as part of the calibration process. Caution should be taken to avoid accidental editing (see Section 3.4.4.6).

5.5 PNEUMATIC CONTROL MODULE CONFIGURATION

❍ PURPOSE

To run an automated routine that allows PPC2+ to readjust automated pressure control coefficients to take into account changes in the characteristics of its pressure control hardware over time or to return automated pressure control coefficients to factory default values.

❍ PRINCIPLE

PPC2+ uses default 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 change 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 configuration function should be considered a maintenance function used only when PPC2+ pressure control has deteriorated noticeably as evidenced by significant *changes* in the time required to set a pressure, excessive overshoot when setting a pressure and/or hunting around the target value in **dynamic control** mode.

The configuration 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 factory recharacterization of the pneumatic module.

The configurations function also allows pressure control parameters to be returned to factory default values.

❍ OPERATION

⚠ Poor control is usually caused by invalid control parameters excessive leaks and restrictions in the test line or other set up problems. These problems should be identified and eliminated before resorting to use of the configuration function (see Chapter 6).

See the PPC2+ BG0002 Operation and Maintenance Manual for information specific to using the configuration function with the BG0002 model.

To access the Config function press **[SPECIAL]** and select **<4Internal>**, **<1Config>**.

The display is:

```
1Run 2Defaults
```

Selecting **<2Defaults>** will cause PPC2+ to reload the factory default control coefficients. This feature can be useful to return to a normal condition if a faulty Config routine has been activated.

Selecting **<1Run>** will cause the pneumatic module configuration routine to execute. Before running a user Config, remove any external volume, plug the TEST port, and connect the normal supply pressure to the rear panel SUPPLY port.

If the Hi RPT is less than or equal to A0050 (e.g., A0050, A0030, A0023, A0015, G0030, G0015), the configuration routine will need to be run twice, once with a vacuum source attached to the EXHAUST port and once without. If the Hi RPT is greater than A0050, the configuration routine can be run with or without a vacuum pump (use your most common configuration).

If the Hi RPT is greater than A0050, you go directly to the CAUTION… screen below. If the Hi RPT is less than or equal to A0050 the display is:

```
Config type:
1vac 2atm
```

Select **<1vac>** or **<2atm>** depending on whether the EXHAUST port is at vacuum or atmosphere. If the ControlRef setting (see Section 3.3.1) does not correspond to your choice, you will receive an error. To complete the Config function, the routine will have to be run twice, once in each condition.

The next display is:

```
CAUTION:  About to
set  25 psi a
```

This display warns the user that pressure will increase to roughly 50 % of range H3. Press **[ENTER]** to continue.

PPC2+ will then pulse and set pressures around mid scale pressure, and “CFG” will flash in the lower right 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 coefficients.

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

If the PPC2+ being configured has a Hi RPT less than or equal to A0050, repeat the configuration routine in the other **operating** mode (**<1vac>** or **<2atm>**). If you never use the PPC2+ in one of the two conditions, it is not necessary to configure it in that condition.

The configuration routine must be run with NO external volume connected to the PPC2+ (TEST port plugged). Running the configuration routine with a volume connected to the TEST port will result in poor pressure control.

The effect of the Cfg function can be eliminated and control coefficients returned to factory defaults by pressing [SPECIAL] and selecting <4Internal>, <1Config>,<1Defaults>.

5.6 OVERHAUL

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

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

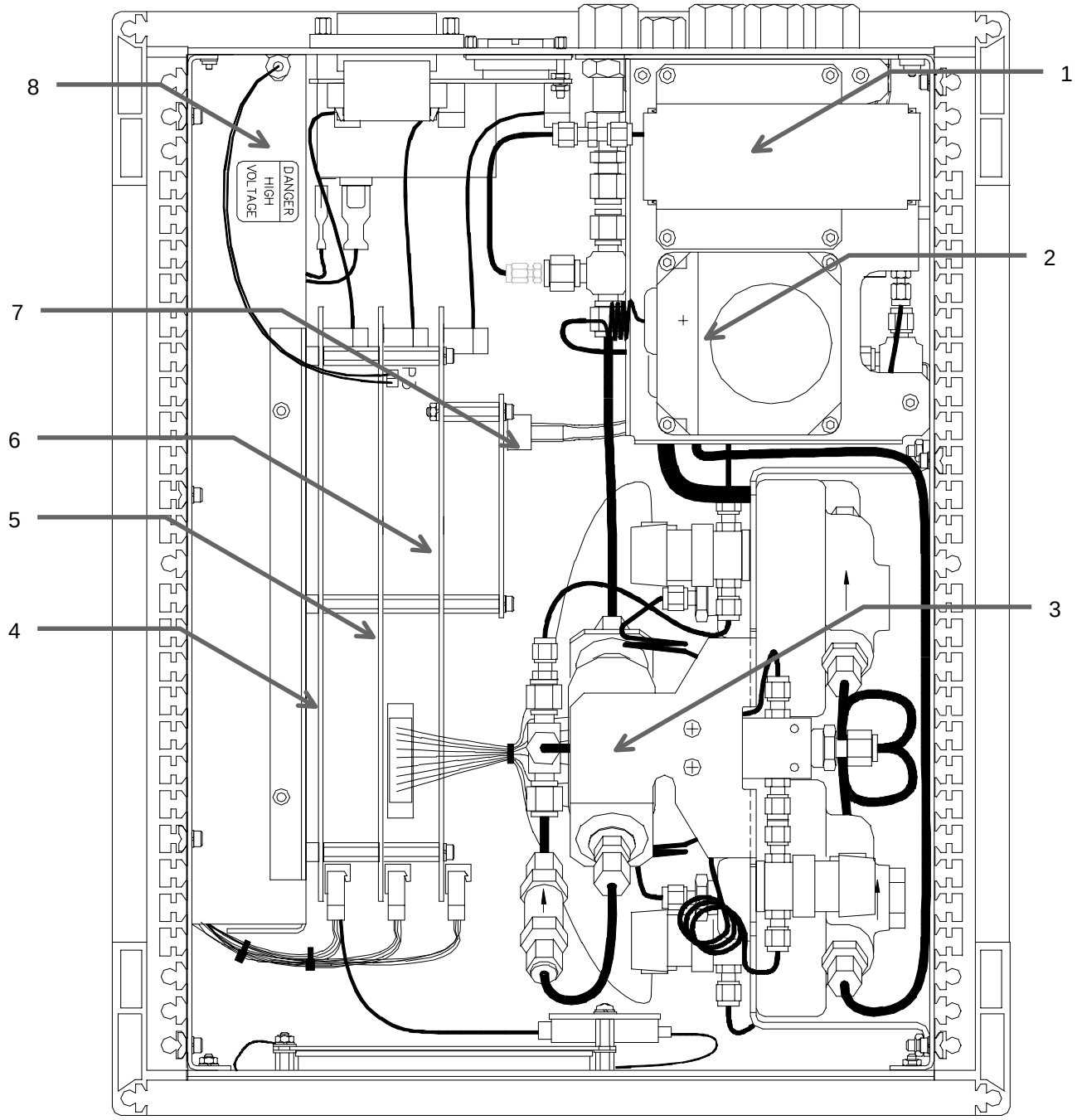
- Disassemble pneumatic module filters and clean filter elements. Replace, if necessary.
- Clean front panel.
- Clean threads of rear panel fittings. Check for damage and replace, if necessary.
- Check that rear panel cooling fan operates when PPC2+ is ON.
- Check that internal screws, bolts and nuts are tight.
- Check that the gas flow through exhaust port when VENT is closed and test port at atmosphere is between 500 sccm and 1.5 slm.
- Verify that internal barometer reads atmospheric pressure within ± 0.15 psi (1 kPa).
- Perform system leak and operational check.
- Perform calibration of reference pressure transducers if necessary.

5.7 RELOADING EMBEDDED SOFTWARE INTO FLASH MEMORY

- The PPC2+ uses FLASH memory. This allows the embedded software that controls PPC2+ operations and functions to be loaded into PPC2+ over its COM1 port from a personal computer with a simple FLASH loading utility.
- To replace corrupted software or upgrade your software, your authorized service provider will provide you with a FLASH memory loading utility along with a file containing the PPC2+ embedded software.
- If the your embedded software is suspected of a problem, record all symptoms and contact your Authorized Service Provider.

5.8 SUBASSEMBLY DESCRIPTION AND LOCATION

5.8.1 INTERNAL VIEW



1. Hi Reference Transducer
2. Lo Reference Pressure Transducer
3. Pneumatic Module
4. Micro Card
5. Driver Board
6. Analog Board (Optional)
7. On-Board Barometer
8. Power Supplies: +5V DC, +12V DC

Figure 12. Internal View

5.8.1.1 ON-BOARD BAROMETER

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 (see Section 3.4.1). The temperature sensor is used for temperature compensation of the barometric sensor.

5.8.1.2 POWER SUPPLY

- + 12 V DC (± 2 %) @ 3.3 Amps: For internal and external valve actuation.
- + 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.

5.8.1.3 TRANSDUCER SELECTION MODULE

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

5.8.1.4 DRIVER BOARD

The driver board is controlled by the micro card (see Section 5.8.1.5). It supports the 12 V drivers for the internal and external solenoid valve actuation and the barometer board (see Section 5.8.1.1). It also supplies power to the cooling fan.

5.8.1.5 MICRO CARD

The micro card supports a Motorola 68302 microcontroller; EPROM, EEPROM, NVRAM and flash memories; RS-232 communications; IEEE-488 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+.

5.8.1.6 REFERENCE PRESSURE TRANSDUCERS

A PPC2+ has one or two reference pressure transducers (RPT). Their basic sensing principle is the measurement of the change in the natural oscillating frequency of a quartz tuning fork. Changes in temperature and mechanical stress results from the change in pressure applied to a connecting bellows or bourdon tube. Two independent quartz elements are used. One quartz element is subjected to pressure related stress. The other quartz element is used only to monitor temperature. Every RPT has three ranges that fall between 0 to 5 psi (33 kPa) and 0 to 1 500 psi (10 000 kPa).

Hi Reference Pressure Transducer (Hi Rpt)

In single RPT PPC2+s, the RPT is designated the Hi RPT. In dual RPT models, the Hi RPT is the RPT with the highest pressure range.

Lo Pressure Reference Transducer (Lo Rpt)

In dual RPT PPC2+s, the RPT with the lower range is designated the Lo RPT. The Lo RPT is protected by an isolation valve and vented to atmosphere when not in use.

5.8.1.7 PNEUMATIC MODULE

The pneumatic module is an integrated assembly that includes two inlet (fast and slow); two exhaust (fast and slow) control valves; vent valve 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.

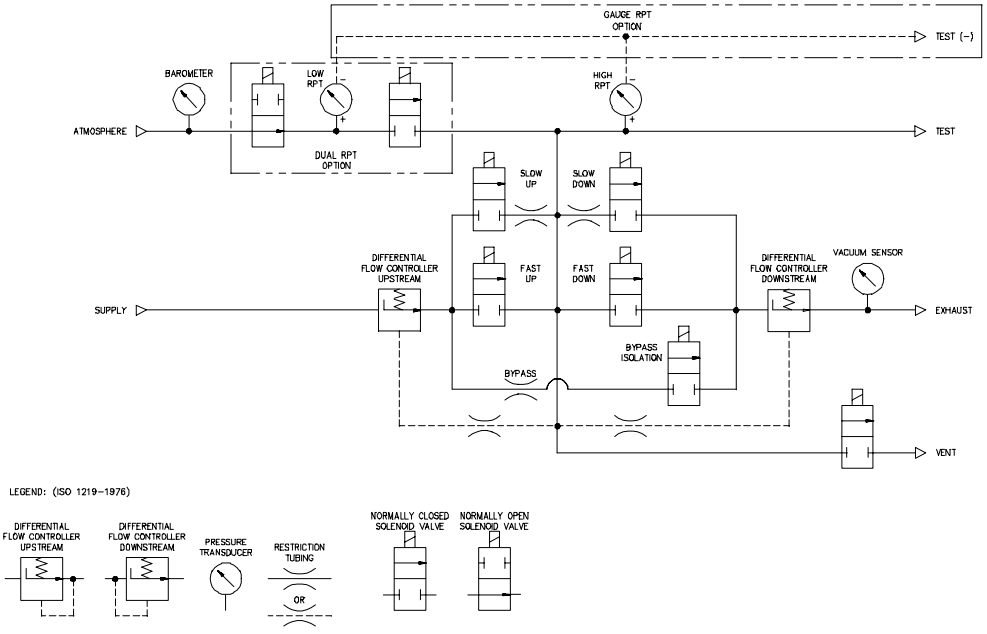


Figure 13. Pneumatic Module (Schematic)

NOTES

6. TROUBLESHOOTING

6.1 OVERVIEW

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

Table 18. Troubleshooting Guide

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Will not power up.	Blown fuse.	Replace fuse.
There is a leak through the EXHAUST port.	Normal flow through bypass of internal pressure controllers when pressure supply is connected and system is not vented or OFF.	None necessary if flow rate is normal. If system is vented or OFF, contact **DHI** Authorized Service Representative.
Measured pressure display has too much/not enough resolution.	Resolution setting needs to be changed.	Use Res function to change resolution setting (Section 3.3.2).
The pressure units available under the **[PRESSURE]** function key are not the ones you want.	UNIT function needs to be customized.	Use PresU function to customize the UNIT function (Section 3.4.3) or reset units to default (Section 3.4.4.5.2).
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+ power.
Valve driver #8 seems to be operating erratically.	Driver #8 is used by the automated purge function when purge is activated.	Deactivate purge function or don't use driver #8 other than to support an SPLT (Section 3.4.4.8).

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Front panel display is dim.	Screen saver option has activated.	Press any key to resume full screen power. Adjust, if desired (Section 3.4.4.9).
Cannot access certain functions. **>ACCESS RESTRICTED<**	User levels have been set that restrict access to certain functions.	Change user level or consult system manager (Section 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 your **DHI** Authorized Service Representative.
There is a C to the right of 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 (Section 3.2.3).
Pressure display is flashing and buzzer is sounding.	Current upper limit of active range has been exceeded.	Correct overpressure condition. Change UL and/or active range if needed (Sections 3.2.4, 3.2.1).
Pressure display is flashing, no buzzer is sounding and direct pressure control keys are inactive.	PPC2+ has been overpressured (pressure higher than UL).	Correct the overpressure condition and cycle power ON and OFF (Section 3.2.4).
A Ready (**<*>**) indication is never achieved.	Control parameter settings are too tight and/or existing conditions will not allow Ready (**<*>**) to be achieved.	Adjust control parameters or correct other conditions (Sections 3.1.2.4, 3.2.6).
Will not set pressure.	Pressure and/or vacuum supply incorrectly connected or not adequate.	Correct pressure and/or vacuum supply (Sections 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 (Section 1.3.2, 3.2.6).

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
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 due to ZNATERR.	Check that ZOFFSET value is in tolerance and verify value of ZNATERR. (Sections 3.4.1, 1.2.2.1, 5.2.5).
Will not accept pressure command.	Target exceeds UL and/or current range.	Check UL (Section 3.2.4) and range (Section 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 gauge pressure.	Vacuum source on exhaust is needed.	Connect vacuum source to exhaust (Sections 2.3.5, 3.3.1).
Poor pressure control at low pressures.	ControlRef not properly set to reflect pressure conditions at EXHAUST port.	Set ControlRef properly (Section 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 (Sections 2.3.5, 3.3.1).
Poor pressure control characterized by “hunting” around target.	Pneumatic control module needs to be reconfigured after checking all other possibilities.	Reconfigure control module (Section 5.5).
Poor pressure control characterized by control interrupting near the target pressure.	Control mode is set to static rather than dynamic.	Set control mode to dynamic (Sections 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+ and the test.	Remove the restriction to allow free flow between the PPC2+ and the test .
Poor pressure control characterized by excessive overshooting and/or undershooting, inability to **lock on** target.	A filter in the PPC2+, the SPLT or an accessory is dirty and causing a restriction.	Clean and dry or replace the filter element.

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
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 or increase hold limit (Sections 3.2.8, 3.2.6).
Poor pressure control characterized by minor overshooting.	Some overshooting is part of normal operation to speed up pressure stabilization..	Check whether overshooting is within normal limits. Increase test volume.
Poor pressure control characterized by very slow slew rate.	Test volume is too large.	Reduce test volume if slew rate is unacceptable.
Poor pressure control characterized by excessively fast slew rate and overshooting.	Test volume too small.	Increase test volume.
Poor pressure control.	Unstable or incorrect pressure supply.	Connect regulated pressure supply set to correct supply pressure (Section 2.3.4).
Poor pressure control and measurement.	The PPC2+ and/or the connection to the test system is contaminated with liquids.	Purge and clean affected systems (Section 3.2.8).
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 (Section 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 (Section 3.2.2).
Apparent inaccurate pressure measurement/control.	Reference sensor transducer calibration coefficients have been altered.	Check and correct calibration coefficients if needed (Section 5.2).

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Apparent inaccurate pressure measurement control.	AutoZ has been run and turned ON with an incorrect standard for zero.	Check value of ZOFFSET. Rerun autoZ with a valid ZSTD reference (Section 3.4.1).
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 (Section 3.2.2)
Will not vent.	VENT port is plugged.	Open VENT port to atmosphere.
Will not vent.	Vent valve not operating.	Have unit serviced.
Will not vent.	Purge function is activated but no SPLT is connected or SPLT valve is not operating.	Deactivate SPLT; correct SPLT connection or repair SPLT exhaust valve.

NOTES

7. APPENDIX

7.1 DRIVERS

The PPC2+ 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 and released.

Each output can sink 500 mA at 12 V. 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.

Table 19. Driver Output

# 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+ accessories if the driver option was ordered.

Table 20 and Figure 14 should be used as reference when building a cable to utilize the drivers port.

Table 20. External Drivers

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)

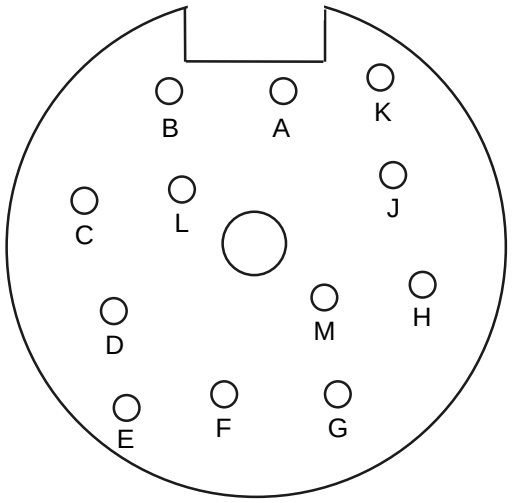


Figure 14. Cable Schematic

7.2 ANALOG

Table 21 should be used to correctly build the interfacing cable required to connect analog signals to the PPC2+ analog input option.

Table 21. Analog Port/Signal Descriptions

PPC2+ ANALOG PORT (15 PIN DSUB) PIN NO.	SIGNAL DESCRIPTION
1	Power Common
2	Power Common
3	Power Common
4	Analog input + for channel 4
5	Analog input + for channel 3
6	Analog input + for channel 2
7	Analog input + for channel 1
8	Analog input - for channel 4
9	Analog input- for channel 3
10	Analog input - for channel 2
11	Analog input - for channel 1
12	+24 V power source
13	+24 V power source
14	+24 V power source
15	+24 V power source

7.2.1 DETAILED SIGNAL DESCRIPTIONS

- V power source: These four pins provide common access to a +24 Volt power supply. This power source can be used to power the analog equipment that is providing an analog signal to the PPC2+. These pins can source up to 250 mA at 24 Volts. Any combination of devices on the four channels can be powered by this source as long as their total draw is less than 250 mA at 24 Volts.

- Power common: These three pins are common and provide the ground path for the +24 Volt line.

- Analog input + for channels 1 - 4: These pins are used to input analog signals from external devices into the PPC2+.

- Analog input - for channels 1 - 4: These pins are the analog ground to which each analog input channel is referenced. They should be connected to the - signal of your device under test and not to the power common.

⚠ All analog inputs (+ and -) must be within 12 V of the power common. The analog input could be damaged if any input is more than 12 V from the power common.

7.3 UNIT CONVERSION

7.3.1 PRESSURE

PPC2+ 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.

Table 22 provides the conversion coefficients used by PPC2+ to convert numerical values expressed in SI units to corresponding values expressed in other units.

Table 22. Conversion Coefficients

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
user	*user*	User defined coefficient
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+ 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 Table 22 above. For altitude expressed in meters, meters are converted to feet using 1 m = 3.28084 ft.*

8. WARRANTY STATEMENT

8.1 OVERVIEW

Except to the extent limited or otherwise provided herein, **DH Instruments, Inc.** warrants for one year from purchase, each new product sold by it or one of its authorized distributors, only against defects in workmanship and/or materials under normal service and use. Products which have been changed or altered in any manner from their original design, or which are improperly or defectively installed, serviced or used are not covered by this warranty.

DH Instruments, Inc. and any of its authorized service providers' obligations with respect to this warranty are limited to the repair or replacement of defective products after their inspection and verification of such defects. All products to be considered for repair or replacement are to be returned to **DH Instruments** or its authorized service provider after receiving authorization from **DH Instruments** or its authorized service provider. The buyer assumes all liability vis a vis third parties in respect of its acts or omissions involving use of the products. In no event shall **DH Instruments** be liable to purchaser for any unforeseeable or indirect damage, it being expressly stated that, for the purpose of this warranty, such indirect damage includes, but is not limited to, loss of production, profits, revenue, or goodwill, even if **DH Instruments** has been advised of the possibility thereof, and regardless of whether such products are used individually or as components in other products.

The provisions of this warranty and limitation may not be modified in any respect except in writing signed by a duly authorized officer of **DH Instruments, Inc.**

The above warranty and the obligations and liability **of DH Instruments, Inc.** and its authorized service providers exclude any other warranties or liabilities of any kind.

Table 23. Warranty Service Centers

DH INSTRUMENTS, INC. AUTHORIZED SERVICE PROVIDERS 2000 JAN			
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 jbaines@dhinstruments.com	Worldwide
Minerva I.P.&M. B.V.	Handelsweg 13 Postbus 76-1270 AB Huizen NETHERLANDS	Tel 31/35.52.54.887 Fax 31/35.52.64.560 minervaipm@compuserve.com	European Union
Nippon CalService, Inc.	2-9-1 Sengen, Tsukuba-Shi Ibaraki Prefecture 305 JAPAN	Tel 0298-55-8778 Fax 0298-55-8700 aohte@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.go.cn	Peoples Republic of China

9. GLOSSARY

Absolute Mode	Measurement mode in which the RPT indicates absolute pressure (difference from vacuum).
Atm Ref	The on-board barometer reading.
ATMOFFSET	The difference between the reading of the on-board barometer at the last tare and the current reading of the on-board barometer. Used to dynamically compensate the atmospheric offset (ZOFFSET) when operating in gauge measurement and mode with an absolute RPT and AutoZ ON.
Autozero	A process by which an RPT range and measurement mode is rezeroed (offset) relative to a standard.
Barometer	PPC2+'s on-board atmospheric pressure measuring sensor. Also referred to as on-board barometer.
Control Mode	The type of pressure control that is active (static or dynamic pressure control).
Control Parameter	Parameters affecting pressure control and the Ready (**<*>**)/Not Ready (**<↑>** or **<↓>**) determination (target, hold limit, stability limit).
Custom Control	Automated pressure control in which the control parameters are not the default control parameters.
Deviation	The deviation of the current pressure from the target pressure control value. Indicated in main run screen when in dynamic control mode.
DUT	Device Under Test. The device or devices pneumatically connected to the PPC2+ TEST port that the PPC2+ is being used to test or calibrate.
Dynamic Control	Control mode in which the pressure is constantly adjusted to remain as close as possible to the target value.
FS	Abbreviation of "full scale". The full scale value is the maximum pressure or the span of a measurement range. Limits and specifications are often expressed as % FS.
Gauge Mode	Measurement mode in which the RPT indicates gauge pressure (difference from atmospheric pressure).

Head	A difference in height between the PPC2+ reference level and the DUT.
Hold Limit	An automated pressure control parameter. Maximum acceptable difference between the current pressure and the target pressure value.
Measurement Mode	Whether pressure is being measured relative to absolute zero or vacuum (absolute mode) or relative to atmospheric pressure (gauge mode).
PA	Pressure adder, used to offset an RPT range or barometer in calibration.
PM	Pressure multiplier, used to adjust span of an RPT range or barometer in calibration.
Rate	The rate of change of the current pressure. Indicated in the main run screen when control is suspended.
Ready (<*>)/Not Ready (<↑> or <↓>)	Indication used in automated control to indicate when control is complete and data may be taken within control parameters.
RPM	Reference pressure monitor manufactured by **DHI**. Models are RPM1, RPM2, RPM3.
RPT (Reference Pressure Transducer)	**1.** The transducer used by PPC2+ for high accuracy pressure measurement. The RPT in a single RPT PPC2+ or the higher pressure range RPT in a dual RPT PPC2+ is referred to as the Hi or primary RPT. **2.** The lower pressure range RPT in a dual RPT PPC2+ is referred to as the Lo RPT. RPTs are designated by a leading A or G (absolute or gauge) followed by four numbers indicating the maximum range of the RPT in psi (e.g., A0100).
SPLT	Self Purging Liquid Trap. An optional device to protect PPC2+ from liquid and particulate contamination returned from a DUT.
Stability Limit	A limit expressed in units of pressure per second (e.g., psi/second). The stability limit is used as the Ready (**<*>**)/Not Ready (**<↑>** or **<↓>**) criterion. **Ready (<*>)** if inside stability limit. **Not Ready (<↑> or <↓>)** if stability limit is exceeded.
Static Control	Control mode in which the pressure is set near the target value and then shut OFF and allowed to evolve freely.
Target	The value to which automated pressure control attempts to set and maintain the pressure.
UL	Same as Upper Limit.
Upper Limit	A range specific maximum value of pressure not be exceeded and at which PPC2+ will abort pressure setting and buzz.
User Level	Levels of security that can be set to protect certain PPC2+ functions from being accessed.

ZNATERR	The disagreement between the RPT indication and ZSTD at the autozero pressure just after the RPT has been calibrated.
ZCURERR	The disagreement between the RPT indication and ZTSD at some time after the RPT has been calibrated.
ZOFFSET	ZCURERR corrected for ZNATERR (the value used to autozero the RPT range).
ZSTD	The value indicated by the device used as the reference in determining ZNATERR and ZCURERR.

NOTES