PPCK+™
High Pressure Controller/Calibrator
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 PPCK+ 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 PPCK+ 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 PPCK+ 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 PPCK+ 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 PPCK+ and then 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 PPCK+. THEN... when you have questions or start to wonder about all the great features you might be missing, get into the manual!

Certain words and expressions have specific meaning as they pertain to PPCK+. The Glossary Section (Section 7.3) 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 PPCK+ screen displays (e.g., **<1yes>**).

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

PPCK+ is a stand-alone, microprocessor driven, pressure controller/calibrator intended to precisely measure and control precise gas pressure as needed for the calibration and testing of pressure measuring instruments. PPCK+ offers very high performance combined with maximum versatility and ease of use. PPCK+ is designed to cover very high gas pressures, especially ranges above 7 MPa (1 000 psi). PPCK+ measures and controls pressure in ranges from 0 to 1 000 psi (7 MPa) up to
0 to 10 000 psi (70 MPa), in both gauge and absolute measurement modes. For pressure ranges of 7 MPa (1 000 psi) and below, see **DHI**'s PPCK+ pressure controller/calibrator.

PPCK+ measures pressure using a high precision reference pressure transducer (RPT) and an on-board barometer. Pressure control is achieved by pneumatically actuated high pressure valves and a patented thermal pressure control (TPC) system for very fine adjustment.

PPCK+ can be controlled locally by the operator through the front panel display, keypad and special function keys or remotely over an RS232 or IEEE-488 interface using ASCII character command strings.

1.2 SPECIFICATIONS

1.2.1 GENERAL SPECIFICATIONS

Power Requirements:	85 to 264 VAC, 47 to 440 Hz, 60 VA max. consumption
Operating Temperature Range:	15 to 35 °C
Storage Temperature Range:	-20 to 70 °C
Vibration:	Meets MIL-T-28800D
Weight:	15.4 kg (34 lb)
Dimensions:	18 cm H x 32 cm W x 40 cm D (7.1 in. H x 12.6 in. W x 15.8 in. D)
Microprocessor:	Motorola 68302, 16 MHz
Communication Ports:	RS232 (COM1), RS232 (COM2), IEEE-488.2
Pressure Ranges:	Each PPCK+ has three ranges (H1, H2, H3). Ranges are from 0 to 1 000 psi (7 MPa) to 0 to 10 000 psi (70 MPa). (See Table 1.)
Operating Medium:	Any clean, dry, non-corrosive gas
Pressure Supplies:	SUPPLY port: Range H3 + 5 %, supply pressure must remain constant ± 1 % to meet control specifications DRIVE IN port: 700 - 850 kPa (100 - 120 psi), supply must remain constant ± 5 % to meet control specifications
Pressure Connections:	High Pressure Supply: DH200 F Test and Drain: DH200 F Vent: 1/8 in. NPT F Drive In: 1/8 in. NPT F Drive Out: 1/8 in. NPT F ATM (on-board barometer): 10-32 UNF Note: DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc.
Pressure Limits:	Maximum Working Pressure: Range H3 +10 % Maximum Pressure without Damage: Range H3 +20 % Maximum Working Supply Pressure: Range H3 + 10 % Maximum Supply Pressure without Damage: Range H3 + 20 %

1.2.2 PRESSURE MEASUREMENT SPECIFICATIONS

Each PPCK+ has three ranges using one Reference Pressure Transducers (RPT) and a barometer. All three ranges operate in both **gauge** and **absolute** mode.

All RPTs are of the absolute pressure type using an evacuated, permanently sealed reference. Gauge pressures are defined by offsetting atmospheric pressure with dynamic compensation for atmospheric changes using the on-board barometer (see Section 3.4.1, **Gauge Mode, Dynamic Compensation for Atmospheric Pressure**).

Table 1. Model Designations and Ranges

RPT DESIGNATION	US UNITS VERSION (psi)			SI UNITS VERSION (MPa)		
	RANGE1 (LO)	RANGE2 (MID)	RANGE3 (HI)	RANGE1 (LO)	RANGE2 (MID)	RANGE3 (HI)
A10000	3 000	6 000	10 000	20	40	70
A6000	2 000	4 000	6 000	13	25	40
A3000	1 000	2 000	3 000	6	12	20

Note: All ranges are both absolute and gauge and support all measurement units available. The "US" or "SI" distinction only affects the nominal range values and settings.

1.2.2.1 REFERENCE PRESSURE TRANSDUCER (RPT) SPECIFICATIONS

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

Warm Up Time: 30 minutes for best performance

Resolution: To 1 ppm, user settable by individual range

Temperature Effect: Fully compensated from 0 to 50 °C with active independent temperature measurement
0.005 % maximum temperature effect in normal ambient 15 to 35° C operating range

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

Measurement Precision[1]*:* ± 0.01 %

Predicted Stability[2]*:*

	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 Uncertainty[3]*:*

	90 day	1 year
Gauge Mode (w/Autozero):	0.012 %	0.015 %
Absolute Mode (w/Autozero):	0.012 %	0.015 %
Absolute Mode (w/out Autozero):	0.015 %	0.020 %

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

2 Predicted Stability: Maximum change in zero and span over specified time period for typical RPT used under typical conditions. As stability can only be predicted and varies from RPT to RPT, stability for a specific RPT should be established from experience.

3 Measurement Uncertainty: Maximum deviation of the reference pressure transducer indication from the true value of measured pressure including precision, stability, temperature effect and calibration standard uncertainty of ± 0.005 % of reading.

The influence of the dynamic compensation for atmospheric pressure in gauge mode measurement is less than ± 2.5 Pa (0.00035 psi).

1.2.2.2 ON-BOARD BAROMETER

The on-board barometer is NOT used as a source of absolute accuracy. It is ONLY used to measure changes in atmospheric pressure between zeroing opportunities to provide dynamic compensation of the RPTs atmospheric pressure offset when making 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 maintains rate of change lower than stability limit
		Pressure is ***Ready*** when within hold limit and rate of change is less than stability limit
	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)	
Control Precision[1]*:*	± 0.003 %, ± 0.01 % default dynamic control hold limit	
Normal Test Volume:	PPCK+ A3000:	0 to 500 cc (100 cc optimal)
	PPCK+ A6000:	0 to 200 cc (50 cc optimal)
	PPCK+ A10000:	0 to 200 cc (50 cc optimal)
	Note: Pressure control system will operate in larger volumes but pressure setting times are increased.	

Gas is a compressible fluid. The larger the pressurized the volume, the larger the stored energy. The size of high pressure volumes should be minimized for safety

Control Speed:	Slew Rate (0 to Controller FS)	
	in Optimal Volume with No Control:	60 to 120 seconds
	Pressure Setting (Typical Time To ***Ready*** Indication for a 10 % Increment in Dynamic Mode):	90 seconds (reduced by increasing hold limit)
Minimum Pressure:	Gauge Mode:	0 (vented)
	Absolute Mode:	Atmospheric pressure (vented)
Minimum Controlled Pressure:	No limit (greater than atmosphere)	

Delivered *Pressure Uncertainty*[2]*:*	*90 day*	*1 year*
Gauge Mode:	0.016 %	0.018 %
Absolute Mode (w/Autozero):	0.016 %	0.018 %
Absolute Mode (w/out Autozero):	0.018 %	0.022 %

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

2 Delivered Pressure Uncertainty: 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 uncertainty as in Section 1.2.2.1. In static control mode, the control error can be eliminated making delivered pressure uncertainty equal to measurement uncertainty.

Table 2. Default Pressure Control Parameters

DYNAMIC CONTROL MODE		STATIC CONTROL MODE	
HOLD LIMIT	**STABILITY LIMIT**	**HOLD LIMIT**	**STABILITY LIMIT**
± 0.01 % FS of active pressure range	± 0.005 % FS/sec of active pressure range (used only when control is not active)	± 1% FS of active pressure range	± 0.005 % FS/sec of active pressure range

NOTES

2. INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 REMOVING FROM PACKAGING

PPCK+ is delivered in a 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.

Remove the PPCK+ 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 PPCK+ includes all items indicated in Table 3.

Table 3. PPCK+ Packing List

DESCRIPTION	PART NO.
PPCK+ Pressure Controller/Calibrator PPCK+ A3000 PPCK+ A6000 PPCK+ A10000	FAM0006-01
Calibration Certificate	550100
Test Report	550120
Accessories:	401655 or 401655-CE
User's Manual	550118
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
Nip, SS, DH200, 2.75 in.	100204
Gland, SS, DH200, 7/16-20	100272
Plug, SS, DH200, 4T	100279
Adpt, SS, DH200F x 2NPTF	100299
(2) Clr, SS, DH200	101200

2.2 SITE REQUIREMENTS

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

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

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

Support facilities required include:

- **An electrical power source** of 85 to 264 VAC, 47 to 440 Hz.

- **A continuous regulated high pressure supply** of clean, dry, non-corrosive gas at maximum PPCK+ range (H3) + 5 % to be connected to the SUPPLY port. Supply pressures of less than range H3 + 5 % may cause out of tolerance pressure control. The SUPPLY source must remain stable ± 1 % while PPCK+ is controlling. If a gas booster is used to supply high pressure, an accumulator is required to dampen the pressure changes caused by the booster cycling. Consider using the **DHI** GB-K gas booster package.

- **A continuous regulated drive air pressure supply** of clean, dry non-corrosive gas at 700 to 850 kPa (100 to 120 psig). The drive air supply must remain stable ± 5 % during PPCK+ operation. This DRIVE pressure supplies the precision low pressure control system that actuates PPCK+'s high pressure valves. The flow and consumption requirements are extremely low. Use of instrument grade nitrogen or air from a compressed air bottle is recommended. If shop or factory air is used, a filter/dryer must be installed. The **DHI** GB-K gas booster package includes a DRIVE air regulator and connection.

2.3 INITIAL SETUP

2.3.1 PREPARING FOR OPERATION

To prepare PPCK+ for check out and operation:

❶ Remove the plastic caps from the PPCK+ rear panel pressure connections.

❷ Remove the protective plastic sheet from the front panel display.

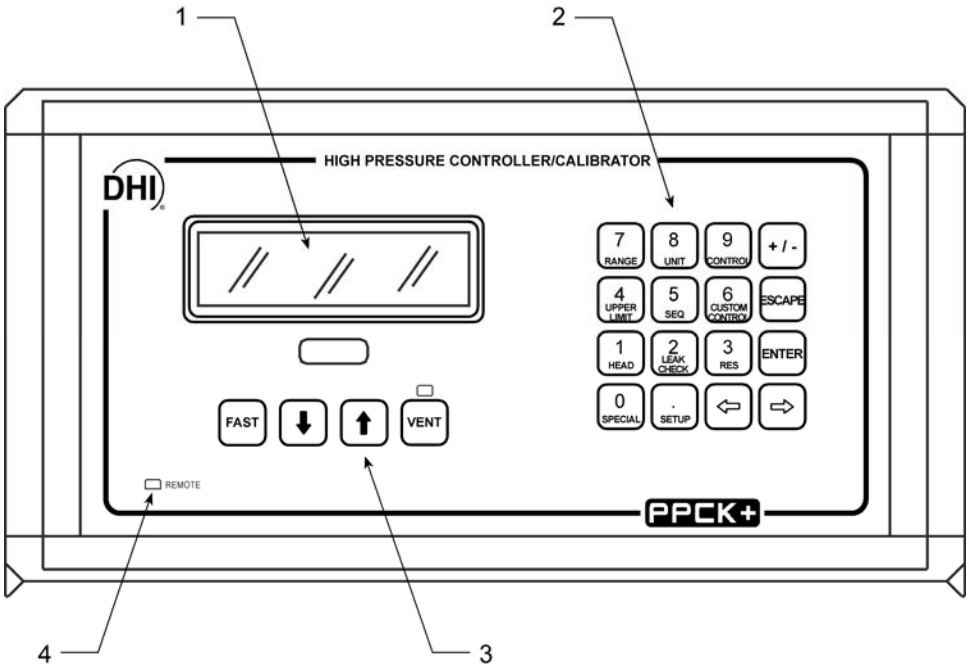
❸ Install the rubber feet caps onto the bottom case feet, if desired.

❹ 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 PPCK+ operating status and a membrane keypad for local user control.

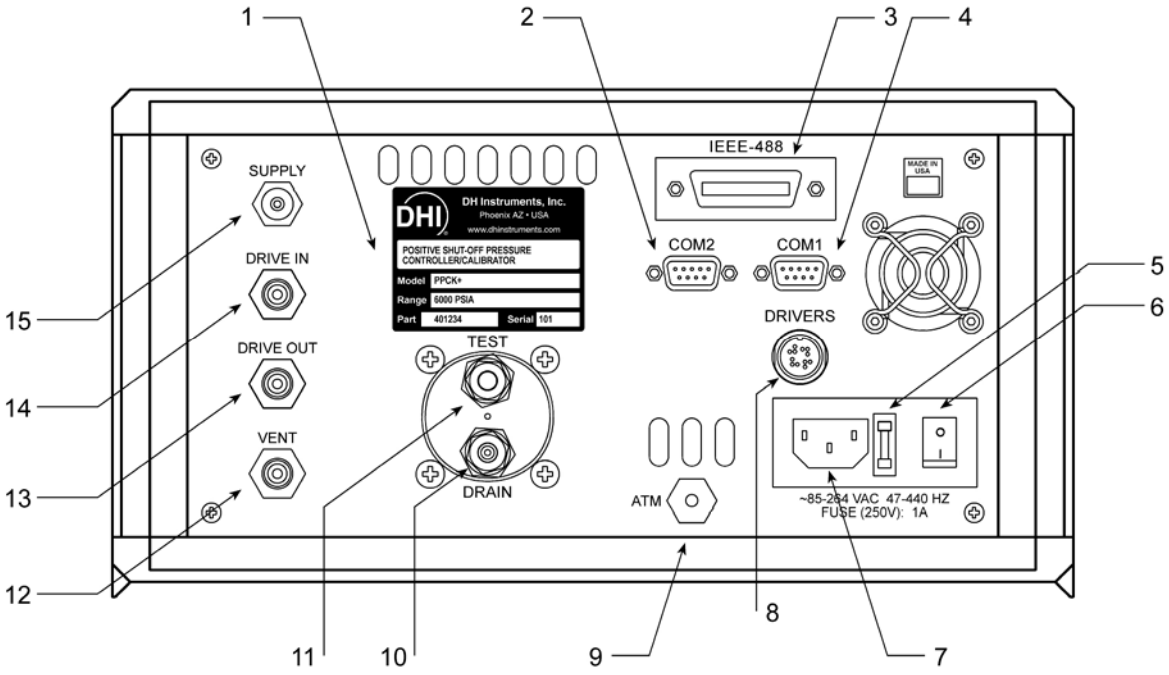


1. Display
2. Multi-Function Keypad
3. Manual Pressure Control Keys
4. Remote Indicator

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. COM2 Connector
3. IEEE-488 Connector
4 COM1 Connector
5. Fuse
6. Power Switch
7. Power Plug (IEC320-C13)
8. Drivers Option Connector
9. Pass Through, ATM REF (10-32 UNF)
10. DRAIN Port (DH200 F)
11. TEST Port (DH200 F)
12. VENT Port (1/8 in. NPT F)
13. DRIVE OUT Port (1/8 in. NPT F)
14. DRIVE IN Port (1/8 in. NPT F)
15. SUPPLY Port (DH200 F)

Figure 2. Rear Panel Assembly

2.3.3 POWER CONNECTION

❶ Check that the PPCK+ power switch is OFF.

❷ Connect the supplied power cable to the rear panel power module.

❸ 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 THE HIGH PRESSURE SUPPLY (SUPPLY PORT)

The SUPPLY port is for connection of the high pressure gas that PPCK+ controls.

Using a pressure connecting hose or rigid tube of appropriate pressure rating, connect the pressure supply to the SUPPLY port on the rear panel of PPCK+. The SUPPLY connection is **DH200 F**.

DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc. DO NOT USE INCORRECT FITTINGS; DAMAGE TO THE FITTING AND DANGER TO THE OPERATOR COULD RESULT.

The supply pressure should be **equal to the maximum PPCK+ range + 5 %**. The supply pressure must be **stable ± 1 %** for PPCK+ pressure control to operate within specifications (see Section 1.2.3).

Never connect a pressure supply greater than 20 % over the maximum range (H3) of the PPCK+ model you are using. Always use the correct fittings.

Take care NOT to connect the high pressure supply to a port other than the SUPPLY port. CONNECTING THE HIGH PRESSURE SUPPLY TO ANY PORT OTHER THAN THE SUPPLY PORT MAY DAMAGE THE PPCK+ AND MAY CAUSE OPERATOR INJURY.

2.3.5 CONNECTING TO THE DEVICE UNDER TEST (TEST PORT)

The TEST port is for connection of the PPCK+ to the system into which it will measure and control high gas pressures.

Using a pressure connecting hose or hard tube of appropriate pressure rating, connect the device or system to be tested to the TEST port. The PPCK+ TEST connection is **DH200 F.**

DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc. DO NOT USE INCORRECT FITTINGS; DAMAGE TO THE FITTING AND DANGER TO THE OPERATOR COULD RESULT.

Gas is a compressible fluid. The larger the pressurized volume, the larger the stored energy. The size of high pressure volumes should be minimized for safety.

NEVER apply pressure to the TEST port greater than the PPCK+ maximum range (H3) working pressure. Internal damage to the PPCK+ may result.

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

Minimizing the length and complexity of the test connection tubing enhances control performance and reduces pressure setting time. For optimum operation, the total volume of the device or system under test including connecting tubing should be less than 500 cc (30 in^3) up to 200 MPa (3 000 psi) and less than 200 cc (12 in^3) over 200 MPa (3 000 psi).

PPCK+ pressure control will not operate properly if there are excessive leaks in the test system. As a general rule, the maximum acceptable leak rate for optimal PPCK+ automated pressure control operation and to assure in tolerance measurements with default pressure control parameters is ± 0.01 % of active range FS/second. If working with larger leaks is unavoidable, consider using STATIC CONTROL mode (see Section 3.1.2.4).

2.3.6 CONNECTING THE DRIVE PRESSURE SUPPLY (DRIVE IN PORT)

PPCK+'s high pressure valves are actuated by a drive pressure. This drive pressure must be connected and properly set for PPCK+ to operate properly.

Using a pressure connecting hose of appropriate pressure rating, connect the drive pressure supply to the DRIVE IN connection on the rear panel of PPCK+. The DRIVE IN connection is **1/8 in. NPT F**.

The drive pressure must be **between 700 - 850 kPa (100 - 120 psi)**. The supply pressure must be stable ± 5 % for PPCK+ pressure control to operate within specifications (see Section 1.2.3).

Never connect a pressure supply to the DRIVE IN port that is greater than 1 MPa (150 psi). Damage to PPCK+ could result.

2.3.7 DRIVE OUT PORT

The DRIVE OUT port is the exhaust point for drive air used by PPCK+'s high pressure valve drive system (see Figure 5). The DRIVE OUT port should be open to atmosphere and unobstructed to allow drive air to escape. The drive air consumption is very low so there is no significant flow through the DRIVE OUT port.

Though a pressure hose can be connected to the DRIVE OUT port to direct the exhausted gas flow, the flow is very low and a completely unobstructed connection to atmosphere must be maintained.

The PPCK+ DRIVE OUT port is **1/8 in. NPT female**.

NEVER plug, obstruct or connect a supply pressure to the DRIVE OUT port.

2.3.8 VENT PORT

The PPCK+ VENT port is the test exhaust port as well as the vent to atmosphere point used to set zero gauge pressure. Though a pressure hose can be connected to the VENT port to direct the vented gas flow, a completely unobstructed connection to atmosphere must be maintained for PPCK+ reference pressure measurements to operate normally.

The PPCK+ VENT port is **1/8 in. NPT female**.

NEVER plug, obstruct or connect a supply pressure to the PPCK+ VENT port.

2.3.9 THE DRAIN PORT

The DRAIN port connects to the low point in the PPCK+ thermal pressure control volume (see Figures 2, 12). The volume serves as a sump to trap small quantities of liquids that may return to PPCK+ from the system connected to the TEST port.

The PPCK+ is delivered with a plug installed in the DRAIN port and the port is left plugged during normal operation. The DRAIN port should occasionally be purged by slowly opening the fitting with approximately 700 kPa (100 psi) trapped in the PPCK+ (see Section 5.4).

The PPCK+ DRAIN connection is **DH200 F**.

DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc. DO NOT USE INCORRECT FITTINGS; DAMAGE TO THE FITTING AND DANGER TO THE OPERATOR COULD RESULT.

2.3.10 THE ATM PORT (BAROMETER)

The ATM pass through is connected to the on-board barometer. The ATM pass through assures that the on-board barometer is exposed to atmospheric pressure rather than to the pressure inside the PPCK+ case which may be slightly different from atmospheric pressure.

For calibration or verification of the on-board barometer through the ATM port, a pressure reference may be connected. The ATM REF port connection is 10-32 UNF F.

Do not plug or obstruct the ATM REF pass through as this may adversely affect GAUGE mode operation.

NEVER connect a pressure greater than 110 kPa ABSOLUTE (16.5 psia) to the ATM REF port or damage to the on-board barometer may result.

2.4 POWER-UP AND VERIFICATION

2.4.1 SWITCH POWER ON

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

PPCK+ operating condition at power-up is all valves closed. Powering down PPCK+ also causes all valves to close.

If the PPCK+ fails to reach the main run screen, service is required. Record the sequence of operation and displays observed and contact a **DHI** Authorized Service Provider (see Table 22).

The pressure range that was active on power down is active on power up.

2.4.2 CHECK PROPER PRESSURE MEASUREMENT OPERATION

2.4.2.1 CHECKING ABSOLUTE MODE PRESSURE MEASUREMENT

Check that the PPCK+ operates properly in **absolute** mode.

If the PPCK+ is not vented, press the **[VENT]** manual pressure control key to vent the PPCK+ (VENT LED ON) (see Section 3.1.2.2). Open the TEST port as well to be sure the RPT is exposed to atmospheric pressure.

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

Observe the current value of atmospheric pressure displayed on the PPCK+ main run screen (see Section 3.1.1). Check that the value agrees with the local value of atmospheric pressure within measurement tolerances. Repeat this process for all three PPCK+ ranges. Check that the values of atmospheric pressure measured by the different ranges agree with each other within PPCK+ measurement tolerances (see Section 1.2.2). If the values do not agree within tolerances, PPCK+ may need calibration or repair.

2.4.2.2 CHECKING GAUGE MODE PRESSURE MEASUREMENT

If the PPCK+ is not vented, press the **[VENT]** manual pressure control key to vent the PPCK+ (VENT LED ON) (see Section 3.1.2.2). Open the TEST port as well to be sure the RPT is exposed to atmospheric pressure.

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

Observe that, within 60 seconds, the [VENT] LED flashes and zero is indicated. It is normal for PPCK+ to indicate a value other than zero for up to 60 seconds when first entering **gauge** mode.

Using the **[RANGE]** function key to change ranges, observe that zero is indicated for each range within 60 seconds. When **gauge** mode is first entered or ranges are changed, it is normal for PPCK+ to indicate a value other than zero when vented. After up to 60 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) and that the TEST port is truly exposed to atmospheric pressure. If the display will not zero, PPCK+ 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 CHECK PROPER PRESSURE CONTROL OPERATION

Select a pressure range using the [RANGE] key (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).

PPCK+ should set the target pressure and indicate Ready (see Section 3.1.2.5) continuously within 45 to 150 seconds. If it does not, see Section 6 to troubleshoot pressure control. Remember that the correct pressure supplies must be connected to the SUPPLY pressure DRIVE IN pressure ports for pressure control to operate properly (see Sections 2.3.6, 3.1.2.3).

Before setting a pressure with PPCK+, assure that the test system connected to the PPCK+ TEST port is rated for the pressure that will be generated.

2.5 SHORT TERM STORAGE

The following is recommended for short term storage of PPCK+:

❶ Vent the PPCK+.

❷ Turn power OFF using the rear panel power switch.

❸ Shut OFF or disconnect the pressure supply.

❹ Shut OFF or disconnect the drive air supply.

NOTES

3. OPERATION

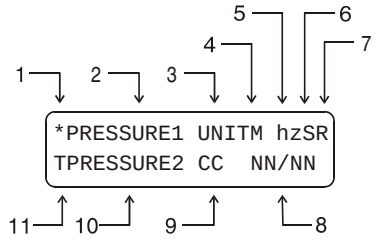
3.1 GENERAL/MANUAL OPERATION

PPCK+ is designed to balance simple, intuitive operation and the availability of a wide variety of functions with a high level of operator discretion. The local operator interface is through a 2 x 20 display, 4 x 4 keypad and four manual pressure control keys on the front panel.

3.1.1 MAIN RUN SCREEN

The PPCK+ 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 PPCK+ 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 3.1.2.5): **<*>** 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 pressure unit of measure (see Section 3.2.2).
4. **Pressure measurement mode:** **<g>** gauge, **<a>** absolute (see Section 3.2.2).
5. **Head correction indication:** Indicates whether a head correction is applied. **<h>** if applied, **< >** (blank) if not (see Section 3.2.7).
6. **Autozero indication:** Indicates whether the autozero function is ON or OFF. **<z>** if ON; **< >** (blank) if OFF (see Section 3.4.1).
7. **Range indicator:** Indicates **<H>** for high RPT and **<1>** for low range, **<2>** for mid range, **<3>** for high range (see Section 3.2.1).
8. **Sequence counter:** Not used in PPCK+.
9. **Control mode indicator:** Pressure control mode (**<S>** for static, **<D>** for dynamic, **<M>** for manual) with a **<C>** appended if custom control settings are in use. Shows **<VLV>** when the inlet or exhaust valve is in its opening routine (see Sections 3.1.2.3, 3.1.2.4). The control mode indicator characters flash when the system is controlling pressure (see Sections 3.2.3, 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 current pressure unit of measure. 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***.
    - Static control is active and pressure is outside of the hold limit.

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

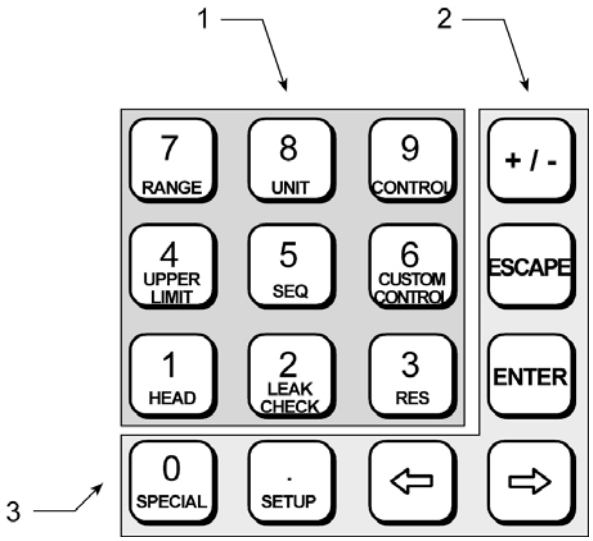
    Rate of change **<R>** is indicated when:
    - No control is active (e.g., control is suspended or system is vented).
    - Static control is active, and pressure is inside the hold limit.

PPCK+ 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 3.4.4.8).

3.1.2 GENERAL OPERATING PRINCIPLES

3.1.2.1 KEYPAD LAYOUT AND PROTOCOL

The PPCK+ 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 Sections 3.1.2.7, 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 **[ENTER]** within a menu or function 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 **[ESCAPE]** moves back in the menu tree and/or causes execution to cease or suspend. Pressing **[ESCAPE]** repeatedly eventually brings you back to the main run screen and from there will allow a momentary viewing of the PPCK+ introduction screen.

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

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

The manual pressure control keys provide direct operator 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 manual pressure control keys interrupt and override automated pressure control.

Pressing the **[VENT]** key causes PPCK+ to execute its vent routine in which pressure is controlled to near atmospheric pressure and then the exhaust valve is fully opened. A RED LED just above the **[VENT]** key indicates the PPCK+ is in vent mode. The vent valve will remain open until the **[VENT]** key is pressed again, another manual pressure control key is pressed, or an automated pressure control command is given.

Pressing **[↑]** or **[↓]** causes pressure to increase or decrease at the slow slew rate. These are momentary keys that are active only as long as they are pressed. Releasing the key stops the pressure increase or decrease.

Pressing and holding the **[FAST]** key while pressing the **[↑]** or **[↓]** causes the pressure increase or decrease speed to change from slow to fast.

Figure 4. Manual Pressure Control Keys

3.1.2.3 PRESSURE CONTROL OPERATING PRINCIPLES

Numerical references in this section refer to Figure 5.

PPCK+ is designed to precisely measures and control gas pressures into a volume connected to its TEST port (14). Pressure is measured by a Reference Pressure Transducer (RPT)(17).

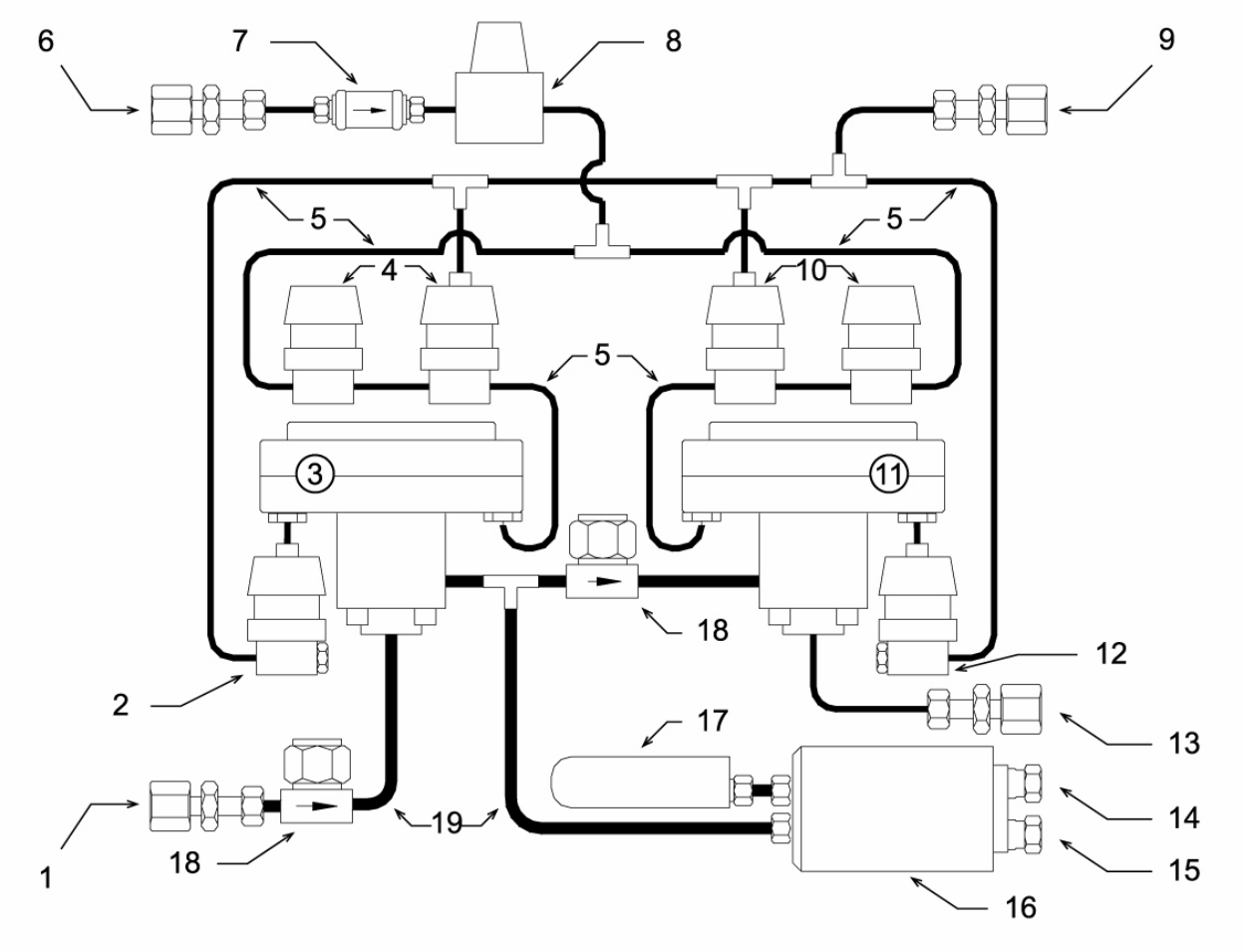
Pressure is controlled in two stages.

The first stage of pressure control is valve control. Valve control is used for all aspects of pressure control except the final stage of dynamic pressure control in which pressure is maintained at the target value (see Section 3.1.2.4). Valve control is accomplished by high pressure inlet and exhaust valves (3, 11). The HP inlet valve (3) controls the admission of pressure from the SUPPLY port (1). The HP exhaust valve (11) controls the exhaust of pressure out of the VENT port (13). The HP inlet and HP exhaust valves are dome-loaded needle valves. The valve is normally closed by a Belleville spring. The valve is opened and its needle position is controlled by the application of drive pressure onto the dome in opposing force to the Belleville spring. The drive pressure is supplied from the DRIVE IN port (6) and controlled by the drive air solenoid valves (2, 4, 10, 12).

When a command is given to set a pressure, the high pressure inlet (3) or exhaust (11) valve must be opened to admit or exhaust pressure. The opening procedure takes 5 to 10 seconds during which PPCK+ may appear to be idle. To notify the operator that the valve opening procedure is in process, the main run screen pressure control characters FLASH **<VLV>** during the valve opening routine (see Section 3.1.1).

The second stage of pressure control is thermal pressure control (TPC). TPC is used in the final stage of dynamic pressure control when very fine control is needed to maintain pressure at the target value (see Section 3.1.2.4). TPC, uses a pressurized volume in which there is a heating element and around which there is a forced air cooling system (16). Heating and cooling the gas in the volume causes it to expand or contract, increasing or decreasing pressure. This patented, pressure control system allows extremely fine pressure control without hysteresis or wear of mechanical parts.

The TPC system response is dependent on the volume connected to the TEST port. Whenever TPC response indicates that the test volume has changed, PPCK+ runs an automated routine to determine the new test volume. This routine is initiated automatically when needed. The execution of the volume determination routine may occur occasionally while TPC is active in dynamic control mode. This normal behavior appears as a delay in pressure control during which the pressure may vary by up to 700 kPa (100 psi). The volume determination configuration can also be launched by the user (see Section 3.4.4.1).



1. SUPPLY Port (DH200 F)
2. HP Inlet Valve Dome Exhaust Valve
3. High Pressure Inlet Valve
4 HP Inlet Valve Dome Supply Valves
5. Drive Air Lines
6. DRIVE IN Port (1/8 in. NPT F)
7. Drive Air Filter
8. Drive Air Regulator (factory adj.)
9. DRIVE OUT Port (1/8 in. NPT F)
10. HP Exhaust Valve Dome Exhaust Valves
11. High Pressure Exhaust Valve
12. HP Exhaust Valve Dome Exhaust Valve
13. VENT Port (1/8 in. NPT F)
14. TEST Port (DH200 F)
15. DRAIN Port (DH200 F)
16. Thermal Pressure Control Unit (TPCU)
17. Reference Pressure Transducer (RPT)
18. High Pressure Filter(s)
19. High Pressure Lines

Figure 5. Pneumatic Schematic

3.1.2.4 AUTOMATED PRESSURE CONTROL MODES

PPCK+ automated pressure control provides automated adjustment and control of pressure to a user designated target value. This feature allows pressure values to be set precisely by simple numerical entry. Pressing **[SET P]** from the main run screen allows a pressure control target value to be entered and executed. Pressing **[ESCAPE]** or a manual pressure control key causes active pressure control to be interrupted (see Section 3.1.2.2).

PPCK+ supports two pressure control modes to meet different pressure setting and controlling requirements. The two control modes are designated **static** and **dynamic**. Pressure control parameters for each **control** mode are automatically set to optimal default values for each PPCK+ range when the **control** mode is selected in the active range (see Sections 3.2.1, 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*** condition in static control or when automated control is not active.

See **STATIC CONTROL** and **DYNAMIC CONTROL** in this section for a detailed explanation of each **control** mode and its advantages, the default control parameters and the Custom Control options. See Table 4 for a summary of the two control modes.

Table 4. Static and Dynamic Pressure Control Modes Summary

CONTROL MODE	ADVANTAGES	DISADVANTAGES	BEST USED
Static	• Control error can be completely eliminated. • Minimizes pressure setting time (*Ready* to *Ready*). • Provides maximum tolerance for leaks in test volume.	• May require averaging of DUT readings for best results. • When testing multiple DUTs, final pressure is not exactly the same for each DUT at a set point. • Set pressure is not equal to target pressure.	• When data acquisition from the DUT is automated allowing averaging of the DUT readings. • When minimizing uncertainty is a priority. • When reducing pressure setting time is a priority.
Dynamic	• Set pressure is equal to target pressure. • When testing multiple DUTs, final pressure is the same for all DUTs at each set point.	• Control error is added to measurement uncertainty. • Increases pressure setting time (*Ready* to *Ready*). • Limited tolerance of leaks in test volume.	• When DUT readings must be recorded manually. • When it is imperative that the final pressure be equal to the set pressure requested.

Static Control

Static control mode is designed to bring the pressure near the target value and then set a very slow pressure ramp during which valid comparative measurements between the PPCK+ and the DUT can be made. Static control is not intended to set and maintain pressure at a specific value, but rather to establish a very low rate of change of pressure near a nominal target value. The advantage of **static control** mode is that pressure can be set and/or measured without the random interference that is typical of a dynamic pressure control system. This can allow pressure control errors to be completely eliminated from the measurements. In addition, **static control** mode is almost always faster than dynamic control mode because the "hunt" time required to zero in on a specific set value is eliminated.

In **static control** mode, test measurements are made when a ***Ready*** condition occurs. *Ready* occurs when the current pressure value is within the hold limit and the rate of change of pressure is less than the stability limit (see Sections 3.1.2.5, 3.2.6). When *Ready* occurs, the reference pressures applied to the test system is not the set pressure requested, it is the momentary pressure value read back from the PPCK+. Since the pressure is evolving very slowly (in a fixed ramp at less than the stability test rate), measurements between the PPCK+ and the DUT can be compared very precisely by averaging the two over short periods.

During static pressure control, the hold limit is active. If the current pressure goes outside of the hold limit, a *Not Ready* condition occurs (see Section 3.1.2.5) and pressure is readjusted to be inside the hold limit. The hold limit is used to establish the maximum distance from the nominal set point at which data can be taken. The wider the hold limit, the lower the likelihood of an interruption of the *Ready* condition to readjust pressure. (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).

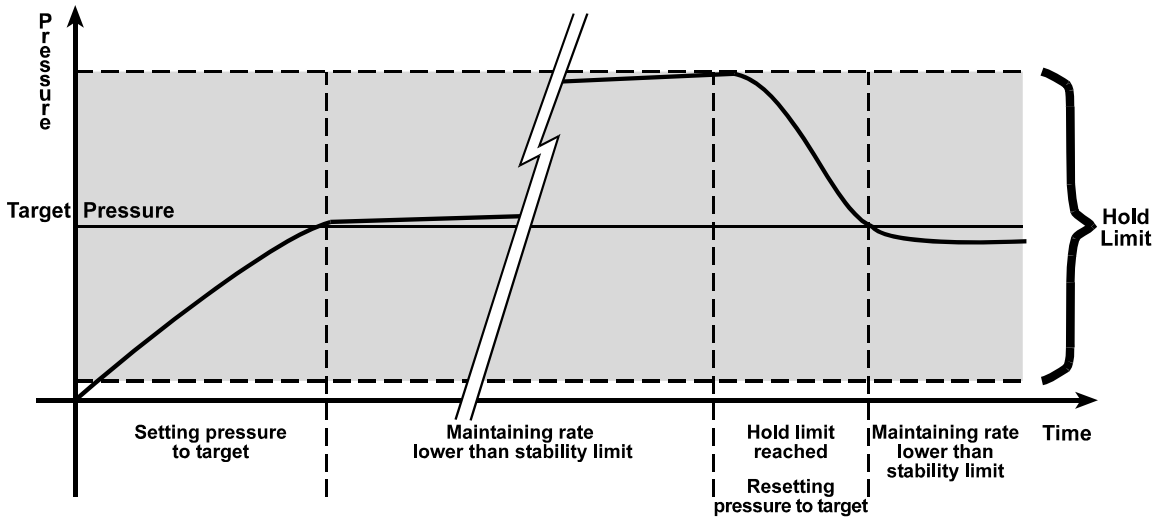


Figure 6. Static Pressure Control Operation

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, as close to the target value as possible. The advantage of this **dynamic control** mode is that the final pressure achieved is the same as the target value. However, unlike static control, in dynamic control a control error must be included in the uncertainty on the final pressure applied. The maximum value of the control error is equal to the current hold limit. The typical value of the control error is generally well inside the hold limit.

In **dynamic control** mode, test measurements are made when a *Ready* condition occurs. *Ready* occurs when the set pressure is within the hold limit. The reference pressure value applied to the test system is assumed to be equal to the nominal pressure set value when *Ready* occurs.

During dynamic pressure control, the hold limit is active. If the pressure goes outside of the hold limit, a *Not Ready* condition will occur (see Section 3.1.2.5). 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 to a user defined value. During active dynamic pressure control, the stability limit is not used. The stability limit is used as the *Ready*/*Not Ready* criterion when control is suspended.

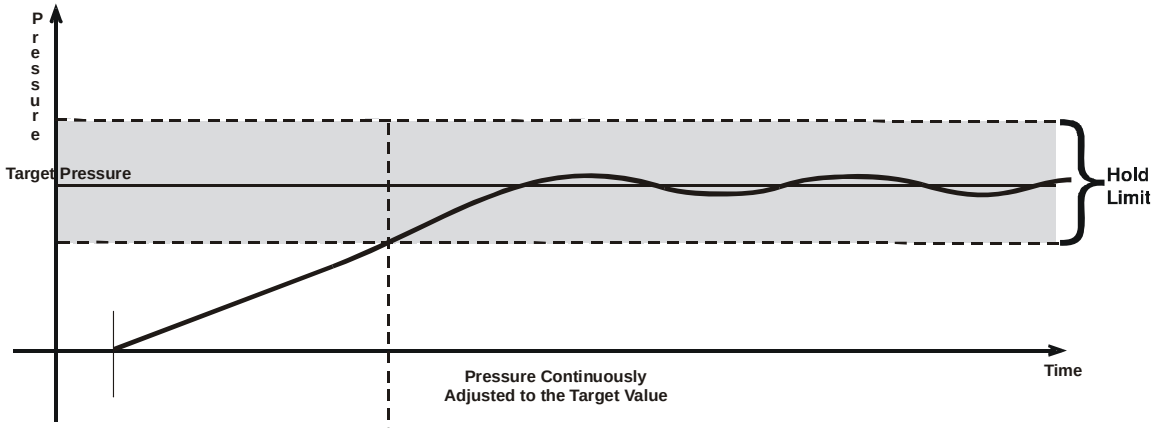


Figure 7. Dynamic Pressure Control Operation

3.1.2.5 PRESSURE *READY /NOT READY*

PPCK+ provides a *Ready/Not Ready* indication. This indication is intended to provide the user with a clear and objective criterion for determining when a valid pressure measurement can be made. On the main run screen, the far left character of the top display lines indicates *Ready*/*Not Ready*. In remote command responses, *Ready*/*Not Ready* is indicated by "R" or "NR" in the response string.

Ready/*Not Ready* front panel display indications are:

- **<*>:** Pressure ***Ready***.
- **<↓>:** Pressure ***Not Ready*** and decreasing.
- **<↑>:** Pressure ***Not Ready*** and increasing.

When pressure control is NOT active: A *Ready* condition occurs any time 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 (see Section 3.2.6).

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

The Ready condition is handled specially when responding to an automated pressure command of zero (see Section 3.2.10.1).

***Ready*/*Not Ready* In Static Control Mode**

When static pressure control mode is active a *Ready* condition occurs whenever:

- The current measured pressure is inside the hold limit.
- The rate of change of pressure is less than the current stability limit.

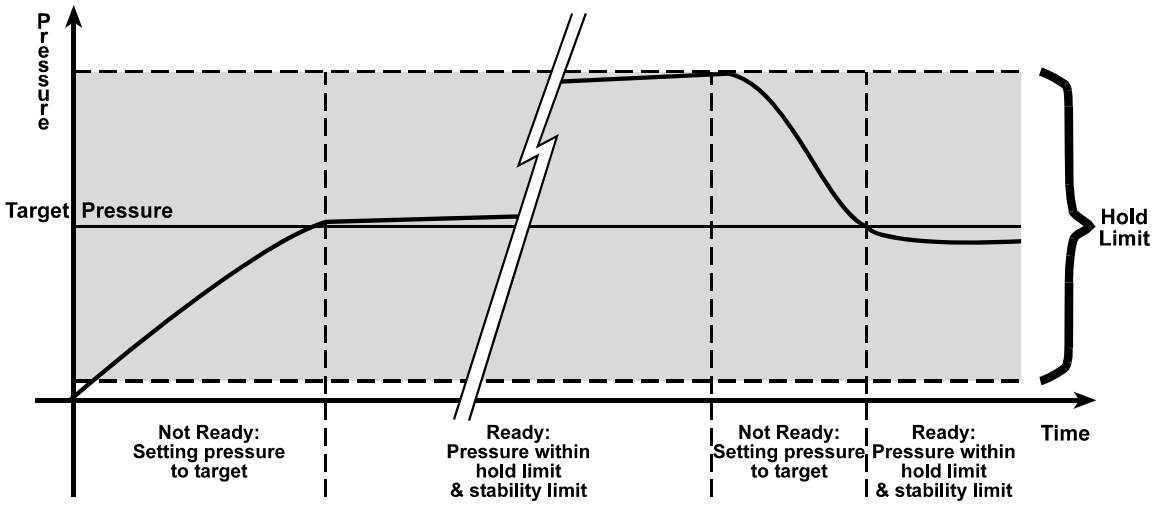


Figure 8. *Ready*/*Not Ready* in Static Control Mode

***Ready*/*Not Ready* In Dynamic Control Mode**

When **dynamic pressure control** mode is active, a ***Ready*** condition occurs whenever:

- The current measured pressure is inside the hold limit.

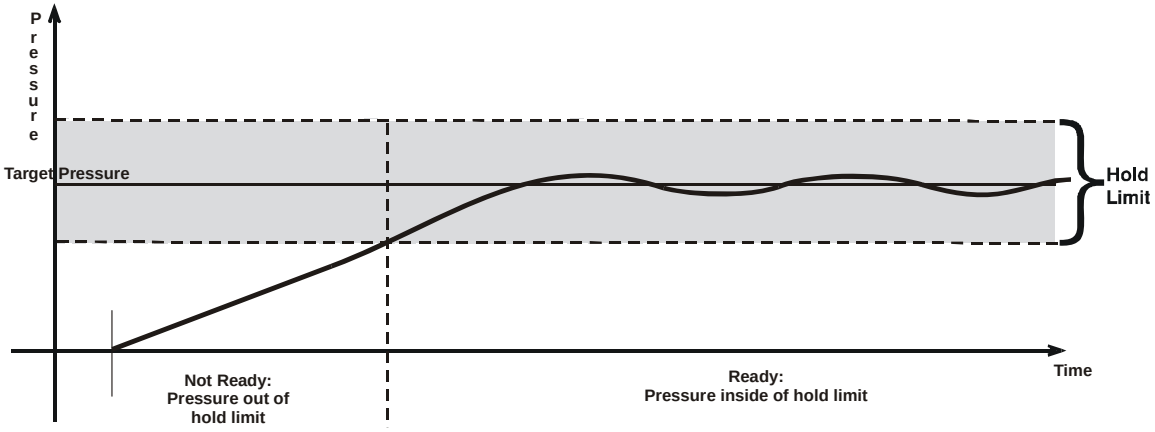


Figure 9. *Ready*/*Not Ready* in Dynamic Control Mode

***Ready/Not Ready* When Pressure Control Is Not Active**

When automated pressure control is NOT active, *Ready* is indicated whenever the rate of change of pressure is less than the current stability limit.

3.1.2.6 MULTIPLE PRESSURE RANGES

PPCK+ has one reference pressure transducer (RPT) which has three ranges. The multi-ranging feature allows measurement uncertainty 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.

Ranges available can be viewed at any time, but a range change can only be executed when PPCK+ is vented (see Section 3.1.2.2).

When a range is changed, the upper limit (UL) 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 3.2.1.1).

Each PPCK+ has three ranges. In general, user settings and operational adjustments are specific to the range currently in use, as if you had three instruments rather than one.

Ranges And Identification

The 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 PPCK+ is referred to as the Hi RPT.

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

Table 5. PPCK+ Range Identification Summary

REFERENCE PRESSURE TRANSDUCER AND RANGE	DESIGNATION	DISPLAY SYMBOL *
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 PPCK+ menu displays as a convenient indicator of active range.

3.1.2.7 DIRECT FUNCTION KEYS SUMMARY

Local operation of PPCK+ is through the 4 x 4 pressure sensitive keypad. To minimize the use of multi-layered menu structure, the 4 x 4 keypad numerical keys also provide direct access to the most commonly used functions. The function accessed is labeled on the bottom half of the key. Direct function keys are active whenever PPCK+ is in its main run screen. Table 6 summarizes the operation of the direct function keys.

Table 6 provides a brief summary of direct function key operation. It may be useful to keep a copy of this summary near the PPCK+, especially when first becoming acquainted with its operation.

3.2 DIRECT FUNCTION KEYS

3.2.1 [RANGE]

- **PURPOSE**

  To view and/or change the pressure measurement range.

- **PRINCIPLE**

  Each PPCK+ has three ranges (see Section 3.1.2.6).

  Pressing the **[RANGE]** function key allows the ranges to be viewed and selected.

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

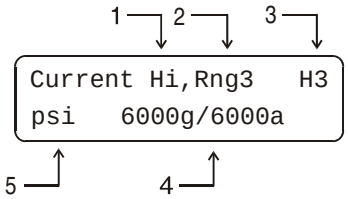
- **OPERATION**

  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 viewing function, if the PPCK+ is vented, causes 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.

Table 6. Summary of PPCK+ Direct Function Key Operation

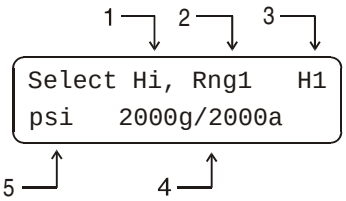
Direct Function Keys are active from the MAIN run screen See corresponding manual sections for full detail	
	MENU OF COMMONLY USED SETUP FEATURES INCLUDING
0 SPECIAL	Menu of less frequently used internal functions and settings.
1 HEAD	Adjust height of fluid head correction. Set to zero to defeat head correction.
2 LEAK CHECK	Runs an automated leak check at the current pressure.
3 RES	Adjust display resolution of measured pressure and other indications and settings.
4 UPPER LIMIT	Set the upper limit pressure alarm for the active range.
5 SEQ	Not used in PPCK+.
6 CUSTOM CONTROL	Set custom pressure control parameters (hold limit, stability limit) for the current control mode.
7 RANGE	Shows active range and then toggles through available ranges. [ENTER] on a range activates it.
8 UNIT	Change pressure measurement unit and/or measurement mode (gauge/absolute). Choice of units can be customized.
9 CONTROL	Change pressure control mode (static/dynamic). Set control parameters to default by selecting the control mode.
ENTER SET P	Give a pressure control set point command from run screen. ENTER values when editing.
⇦ ⇨	Jog the pressure control set point by the amount of the hold limit while controlling or when entering a set point.

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 (**<Hi>**).
2. Identifies current range (**<1>**, **<2>** or **<3>**) of the RPT.
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.
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 and back to Lo. For example:



1. Identifies RPT (**<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.
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. Use [UNIT] to change pressure units if desired (see Section 3.2.1).

The active range can only be changed when the system is vented. If [ENTER] is pressed while in the RANGE function when PPCK+ is NOT vented, the display indicates <Vent system fully to change range>. Pressing the [VENT] key causes PPCK+ to vent and return to the RANGE function when the VENT is complete.

3.2.1.1 RANGE SPECIFIC FUNCTIONS AND SETTINGS

PPCK+ 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
- **Setup Menu: <2Drivers>**

3.2.2 [UNIT]

PURPOSE

To specify the pressure unit of measure and measurement mode in which PPCK+ displays pressure values.

See also Section 3.4.3.

PRINCIPLE

PPCK+ allows the pressure measurement unit and mode to be changed. Internally, PPCK+ 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 7.2.1).

PPCK+ RPTs intrinsically measure **absolute** pressure relative to an evacuated and sealed reference. They are also used to measure in **gauge** mode by the subtraction of atmospheric pressure. PPCK+ supports extensive on-board logic and measurements to assure the precise atmospheric compensation of absolute RPTs to deliver achieve gauge pressure (see Section 3.4.1, **Gauge Mode, Dynamic Compensation For Atmospheric Pressure**). This allows simple, one step switching between gauge and absolute measurement modes by the operator without special procedures or hardware.

OPERATION

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

```
Measurement:      H1
1unit    2mode
```

Select **<1unit>** to change pressure units or **<2mode>** to change measurement mode.

If **<2mode>** is 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>** is selected from the measurement screen, the units screen is presented.

The cursor is 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.

```
1psi  2MPa  3kPa
4bar  5kcm2
```

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

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

Select the desired reference temperature for water density using the **[←]** or **[→]** key to move the cursor. 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 PPCK+ has been factory set as US or SI. Whether the PPCK+ is set up as US or SI is indicated by the right two characters on the top line of the PPCK+ introduction screen which can be viewed by pressing [ESCAPE] from the main run screen or when powering up PPCK+. For a US PPCK+ the default units are <1psi>, <2MPa>, <3kPa>, <4bar>, <5kcm2>. For an SI PPCK+, the default units are: <1MPa>, <2kPa>, <3bar>, <4psi>, <5kcm2>.

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 setting values are 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.

See Section 7.2.1 for tables of the conversion factors used by PPCK+.

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 active range and activate default control parameters.

PRINCIPLE

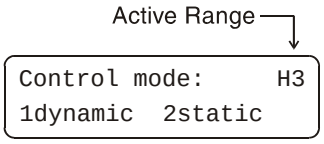
The CONTROL function allows the active control mode for the current range to be set to either **static control** or **dynamic control** (see Section 3.1.2.4). The control mode is specific to the active range and is maintained with the range when ranges are changed.

When the control mode is selected 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 PPCK+ 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 3.1.2.4.

OPERATION

To select the control mode for the 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.

The control mode setting is range specific. A change in control mode made while in one PPCK+ range does NOT affect the control mode setting in other ranges (see Section 3.2.1.1).

The current control mode is indicated by two characters in the middle of the bottom line of the main run screen (<S> for static, <D> for dynamic, <M> for manual, 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 3.2.10.1).

3.2.3.1 SYSTEM DEFAULT CONTROL PARAMETERS

Default control parameters for the control mode are automatically set whenever the control mode is selected.

Table 7. Default Pressure Control Parameters

DYNAMIC CONTROL MODE		STATIC CONTROL MODE	
HOLD LIMIT	**STABILITY LIMIT**	**HOLD LIMIT**	**STABILITY LIMIT**
± 0.01 % FS of active pressure range	± 0.005 % FS/sec of active pressure range	± 1 % FS of active pressure range	± 0.005 % FS/sec of active pressure range

3.2.3.2 EXECUTING AUTOMATED PRESSURE CONTROL COMMANDS

- **PURPOSE**

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

- **OPERATION**

  See Section 3.2.10.

3.2.4 [UL] (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 manual pressure control keys will abort off when the upper limit is reached.

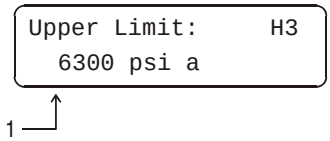
Upper limit settings are specific to each range (H1, H2, H3) and measurement mode *(*gauge *or* absolute*).*

The UPPER LIMIT function is most often used to protect the device or system connected to the PPCK+ 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 H3 and to 115 % of each range for all other ranges.

❍ **OPERATION**

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



1. Entry field to enter desired upper limit value.

Enter the desired upper limit value and PPCK+ 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 an intermittent beep sounds. To return to normal operation, reduce pressure using manual pressure control keys or an automated pressure command.

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 4 000 psi as the upper limit in absolute mode, the upper limit will not be (4 000 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.

3.2.4.1 OVERPRESSURE FUNCTION

In addition to the UL function, PPCK+ 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 PPCK+ power.

3.2.5 [SEQ] SEQUENCE

❍ **PURPOSE**

Not supported in PPCK+.

3.2.6 [CUSTOM CONTROL]

PURPOSE

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

See Sections 3.1.2.4, 3.2.3 for information on setting pressures automatically.

PRINCIPLE

Automated pressure control and the associated pressure *Ready*/*Not Ready* condition are characterized by hold limit and stability limit parameters which determine how PPCK+ controls and under what conditions a *Ready* indication will occur (see Sections 3.1.2.4 and 3.1.2.5).

PPCK+ provides system default values for the hold limit and stability limit parameters for each range. The default values are those most suitable for the typical user to operate within PPCK+ specifications. The default parameters are automatically set each time the control mode is selected using the **[CONTROL]** function key (see Table 6).

PRINCIPLE

The CUSTOM CONTROL function allows the hold and stability limit parameters to be customized 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 3.1.2.5). For example, changing the dynamic pressure control hold limit from its default value of ± 0.01 % FS of the current range to ± 0.02 % 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.

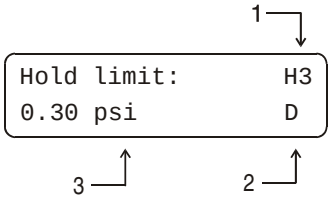
Adjusting default control parameters using the CUSTOM CONTROL function may result in control parameters that the PPCK+ is unable to meet so that a Ready condition never occurs. This does not indicate a PPCK+ malfunction, just that the control parameters need to be relaxed or set back to default parameters.

Default Pressure Control Parameters

DYNAMIC CONTROL MODE		STATIC CONTROL MODE	
HOLD LIMIT	**STABILITY LIMIT**	**HOLD LIMIT**	**STABILITY LIMIT**
± 0.01 % FS of active pressure range	± 0.005 % FS/sec of active pressure range	± 1 % FS of active pressure range	± 0.005 % FS/sec of active pressure range

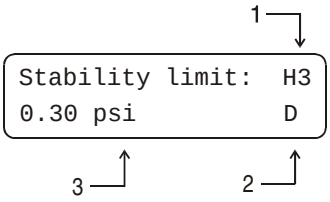
OPERATION

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) and range (**<1>**, **<2>** or **<3>**).
2. Current control mode setting for this range (**<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 control mode setting.

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 (see Section 3.1.1).

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). Making a control mode selection automatically sets the control parameters to default values.

3.2.7 [HEAD]

PURPOSE

To cause a pressure value representing a difference in height to be added to the pressure measured by the PPCK+ reference pressure transducer.

PRINCIPLE

PPCK+'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 PPCK+'s TEST port. This difference in height, frequently called **head**, can cause a significant difference between the pressure measured by the PPCK+ 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 PPCK+ RPT at its test port in order to accurately predict the pressure actually applied at a different height.

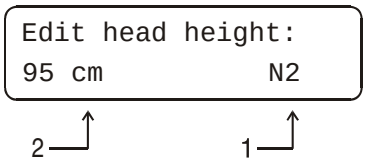
PPCK+ can accurately calculate **head** pressures for nitrogen, helium and air as the test gas over its working pressure range. The HEAD function allows the height difference to be specified and causes the resulting head pressure to be added to the pressure measured at the TEST port.

The **[HEAD]** function key is used to turn the head correction function ON and OFF and to specify the height difference between the PPCK+ TEST port and another height. The height unit of measure and the test gas are specified by pressing **[SPECIAL]** and selecting **<2Head>** (see Section 3.4.2).

In PPCK+'s measurement ranges with gas as the test medium, specifying the head height within ±30 cm (12 in.) 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.

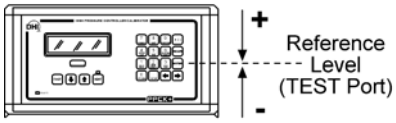
Entering a value of zero turns the HEAD function OFF. Entering a value other than zero turns the HEAD function ON using the height entered. Pressing **[ESCAPE]** returns to the main run screen with no change to the current head setting.

The HEAD function is *NOT* range specific. The HEAD setting remains the same as ranges are changed. Edits made to the head specifications are independent of range.

When the HEAD function is ON (head height not 0), the ON condition is indicated by an <h> in the top line, right side of the main run screen (see Section 3.1.1). When the HEAD function is OFF (head height 0), 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 3.4.2).

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



3.2.8 [LEAK CHECK]

- **PURPOSE**

To run an automated leak check routine using PPCK+'s measurement capability to measure the total pressure change and average rate of change over a period of time; to edit the leak check time.

- **PRINCIPLE**

The Leak Check function is provided to assist in using PPCK+ to measure leaks by measuring pressure changes.

The principle of the Leak Check function is the measurement of pressure increase or decrease. The Leak Check function allows a leak check time to be set. The total pressure change and the average rate of change over the leak check time are calculated and displayed.

Changing the pressure in a 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 2 to 5 minute wait before running a leak check is adequate to allow the adiabatic temperature change to dissipate sufficiently for valid leak measurements to be made. However, stabilization time may be much longer as volumes and pressures increase.

OPERATION

Use automated (see Section 3.2.10) or manual (see Section 3.1.2.2) pressure control to set the pressure at which the leak check is to be conducted. Once the pressure has been set, abort pressure control and wait three minutes for pressure stabilization.

To access the LEAK function press **[SETUP]**, **<5Leak>**.

The display is:

```
Leak Check          H3
1run  2view
```

Press **<2view>** to view the results of the last leak check executed. The results screen displays **<Data NOT available>** briefly and returns to main run screen if NO leak check data is stored (i.e., if the PPCK+ has never run a leak test or a reset has cleared previous leak test results). Pressing **[ENTER]** or **[ESCAPE]** returns to the main run screen.

In both dynamic and static pressure control mode, abort control and wait at least three minutes before conducting a leak check.

Leak check is range specific in the sense that leak check is run using the active range. However, only one set of leak check results is maintained in memory and each leak test completed overwrites the memory. View leak check always shows the results of the last leak check run regardless of the range that is now active. The results screen includes the range indicator to indicate the range in which the leak check was run.

Press **<1run>** to run a leak check and/or to edit the leak check time. The display is:

```
Set leak check time:
```

1

1. Edit field for leak check time in seconds (1 min, 999 max).

Edit the leak check time if desired. Press **[ENTER]** to run leak test. The display is:

1

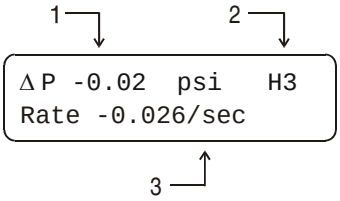
```
5458.55 psi a     zH3
Leak testing     13 s
```

2

1. Standard main run screen first line.
2. Indication that leak test is running and countdown of time[s] remaining.

Pressing [**ESCAPE]** during the countdown offers a leak check abort option to return to the main run screen or continue leak test. Pressing **[ENTER]** during the leak check countdown causes the countdown to restart.

Once the leak check countdown has completed, the results screen is displayed:



1. Net change in pressure over the leak check time period.
2. Indicator of range in which leak check was run.
3. Average rate of change of pressure over the leak check time period.

Pressing **[ENTER]** from the leak check results screen following execution of a leak check starts a new leak check routine directly without having to go through the leak check menu. Pressing **[ESCAPE]** returns to the main run screen.

Pressing [ENTER] while counting down a leak check or when in leak check results screen starts a new leak check sequence.

3.2.9 [RES] (RESOLUTION)

❍ PURPOSE

To set the resolution with which measured pressures and other indications and settings are displayed.

❍ PRINCIPLE

The resolution with which the pressure measured by PPCK+ is displayed can be adjusted. This feature can be used to reduce the resolution when lower precision measurements are being made and additional digits might confuse or distract the operator.

The resolution setting determines the number of digits with which pressure is displayed. The desired resolution is calculated based on the full scale of the range and then rounded to the furthest digit to the right.

The default resolution setting is 0.001 %. The maximum resolution setting is 0.0001 %.

❍ OPERATION

To access the resolution function, press **[RES].** The display is:

```
Measure resltn:  H3
0.0010% FS  < and >
```

Use the **[←]** and **[→]** keys to select the desired level of resolution. Press **[ENTER]** to set the resolution and return to the main run screen.

The resolution setting affects the display of the measured pressure as well as other indications and settings.

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

3.2.10 [SET P] (SETTING PRESSURE AUTOMATICALLY)

PURPOSE

To set a pressure automatically.

See Sections 3.2.3, 3.1.2.4 for information on setting the control mode (Static or Dynamic).

PRINCIPLE

PPCK+ automatically sets and holds pressure to a user designated target value. This feature allows pressure values to be set easily and precisely by simple numerical entry from the front panel or by remote command (see Sections 3.1.2.3, 3.1.2.4).

Automatic pressure setting is controlled from the main run screen using **[ENTER]** and **[SET P]** from the main run screen. **[SET P]** causes the pressure target entry screen to be displayed and then launches automated pressure control. **[ESCAPE]** aborts automated pressure control.

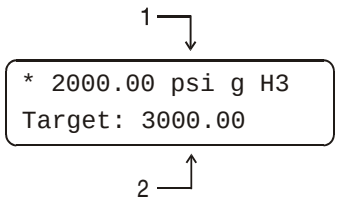
PPCK+ supports two pressure control modes to meet different pressure setting and controlling requirements: **static** and **dynamic** (see Section 3.1.2.4). Control initiated using **[SET P]** executes in the current control mode. Use **[CONTROL]** to change control modes (see Section 3.2.3).

Manual pressure control keys are also available to adjust pressure directly without a target value (see Section 3.1.2.2). Pressures set manually are not controlled after the setting process.

For information on PPCK+'s pressure control technology see Section 3.1.2.3.

OPERATION

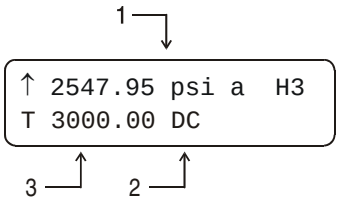
To set a pressure, press **[SET P]** from the main run screen. The display is:



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

Use the numerical keys and editing keys to enter the target pressure value desired (see Section 3.2.10.1 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, **in the current control mode** (see Section 3.2.3) and return to the main run screen. The main run screen is:



1. *Ready*/*Not Ready* indication, current pressure, units, measurement mode, range (regular first line of main run screen).
2. 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. **<VLV>** when opening a control valve (see Sections 3.2.3, 3.1.2.3).
3. **<T>**, target pressure value when controlling and in *Not Ready* condition. **<R>**, pressure rate of change when in static control inside the hold limit. **<D>**, deviation from the target value when in dynamic control mode and in *Ready* condition.

Observe the *Ready*/*Not Ready* indication to determine when *Ready* conditions have been satisfied (see Section 3.1.2.5). PPCK+ will continue controlling following static or dynamic control operation protocol (see Section 3.1.2.4) until automated pressure control is interrupted.

Automated pressure control is interrupted by:

- Pressing **[ESCAPE]**: Suspends control and remains in main run screen.
- Pressing any manual 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/SET P]**: Suspends control and goes to ENTER target pressure value screen.

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

Pressure control status is indicated by the pressure control characters of the main run screen. These are located in the middle of the bottom line of the display. The control character indications are as follows:

- <D> dynamic control mode with default control parameters
- <S> static control mode with default control parameters
- <DC> dynamic control mode with custom control parameters
- <SC> static control mode with custom control parameters
- <VLV> static or dynamic control mode and a control valve is in the opening process
- <M> manual control mode
- FLASHING character: System is actively controlling pressure
- NON FLASHING character: Control is idle

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 3.2.10.1).

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 PPCK+ is unable to control pressure or appears to control pressure poorly.

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 [SET P] screen (see Section 3.2.11).

3.2.10.1 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]** manual pressure control key had been pressed (see Section 3.1.2.2). A *Ready* condition occurs when the vent valve has been opened and the pressure meets the current stability test.

Zero in absolute mode: Since PPCK+ has no provision for setting pressure lower than atmosphere, a command for automated pressure control to a target value of zero when **absolute pressure measurement mode** is interpreted in the same way as a command for zero in **gauge measurement mode**. PPCK+ executes the **[VENT]** function (see Section 3.1.2.2) and a *Ready* condition occurs when the vent valve has been opened and the pressure meets the current stability test. The vented condition (atmospheric pressure) is the lowest pressure that PPCK+ can set.

Due to the manner in which PPCK+ handles an automated pressure command for zero in absolute pressure measurement mode, a *Ready* condition will occur at an atmospheric pressure, not zero. 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 PPCK+ TEST port is open to atmospheric pressure and the rate of change of pressure has reached the current stability limit. The current displayed pressure should be used as the measured value of pressure applied to the device or system under test.

3.2.11 [←] AND [→] (JOG PRESSURE SET POINT)

PURPOSE

To jog the pressure target value in small increments around the set point.

See Section 3.2.10 for information on setting pressure automatically.

PRINCIPLE

PPCK+ sets and adjusts pressure automatically to a user designated target value. In some cases, it can be useful to slightly adjust the target value, for example to set the DUT to read a specific value as commonly done when verifying or calibrating an analog gauge.

The PPCK+ jog function makes it easy to adjust the target pressure slightly. Pressing the **[←]** and **[→]** keys of the 4 x 4 keypad while controlling pressure in the main run screen or when displaying the target pressure in the set pressure screen, causes the target value to increase or decrease by the amount of the current hold limit (see Section 3.2.3).

For information on setting pressure automatically with PPCK+ see Sections 3.2.10, 3.1.2.3, 3.1.2.4).

OPERATION

The target pressure value can be jogged:

- In dynamic control mode while controlling pressure in the main run screen.
- In dynamic control mode in the set target screen.

To jog the target pressure value, press **[←]** to increase the target value or **[→]** to decrease the target value.

Each time **[←]** or **[→]** is pressed, the target value is adjusted up or down by the current value of the hold limit each time the key is pressed. Use **[CUSTOM CONTROL]** to adjust the hold limit (see Section 3.2.6).

It will take several seconds after the pressure control target value has been adjusted for PPCK+ to respond.

3.3 SETUP MENU KEY

- **PURPOSE**

The **[SETUP]** menu key accesses a menu of functions and features commonly used in setting up PPCK+ for use.

- **OPERATION**

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

```
1Sequence  2Drivers
```

3.3.1 SEQUENCE

- **PURPOSE**

Not supported in PPCK+.

3.3.2 DRIVERS

- **PURPOSE**

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

- **PRINCIPLE**

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


See Section 7.1 for driver specifications and pin-outs.

- **OPERATION**

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

The display is:

```
External drivers:  1
2  3  4  5  6  7  8
```

Pressing the keypad numerical key driver number turns that driver ON and OFF with either a momentary or a toggled response (see 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 will be **<1momentary>** or **<2toggle>**.

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 2Head 3PresU
4Internal
```

Press **<1AutoZ>** to turn AutoZ ON/OFF and view AutoZ values (see Section 3.4.1).

Press **<2Head>** to set head height units and change the head fluid (see Section 3.4.2).

Press **<3PresU>** to customize the choice of pressure units of measure under **[UNIT]** (see Section 3.4.3).

Press **<4Internal>** to access internal settings and functions RPT calibration, remote interface settings, time and date, resets, user levels and screen saver (see Sections 3.4.4.1 to 3.4.4.8).

3.4.1 AUTOZ

- **PURPOSE**

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

To assure operation within "with autozero" measurement uncertainty specifications (see Section 1.2.2.1), it is recommended that AutoZ be run (the value of ZOFFSET updated) at least every 30 days or when PPCK+ 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 PPCK+ RPTs is zero drift or offset, independent of span. Rezeroing PPCK+ RPTs relative to a more stable reference between recalibrations allows lower measurement uncertainty specifications to be maintained with less frequent full calibrations. The PPCK+ 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 reference pressure as indicated by the reference autozero device.

   In ***absolute measurement*** *mode*, the autozero pressure is usually a pressure value near atmospheric pressure and the ZSTD value can be supplied either: a) by manual entry; b) automatically from a **DHI** RPM connected to the PPCK+ COM2 port.

   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 ZOFFSET - 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.

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). 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 PPCK+ 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 PPCK+. 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, Dynamic Compensation For Atmospheric Pressure

PPCK+ 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 PPCK+ 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, PPCK+ dynamically compensates the atmospheric tare value. PPCK+'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 measurement uncertainty, allows gauge measurements with an absolute RPT with an additional uncertainty due to possible changes in atmospheric pressure limited to ± 2.5 Pa (0.00035 psi).

Recommendations For The Use Of The AutoZ Function

The AutoZ function provides a powerful and easy to use tool for improving the measurement uncertainty specifications of a PPCK+ 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 unless the on-board barometer has malfunctioned (see Section 3.4.4.7).
- 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 measurement uncertainty is known to be significantly lower than that of the PPCK+ RPT is available. Keep range ratios in mind when comparing uncertainties. A ± 0.01 % FS barometer has roughly 200 times lower measurement uncertainty than a ± 0.02 % FS 2 000 psi (14 MPa) PPCK+ range because the RPT/barometer range ratio is 10:1.
- The best day to day reference for running AutoZ in absolute mode is a properly calibrated, barometric range, **DHI** PPCK+ interfaced directly to the PPCK+ COM2 port. The on-board barometer can also be used as a stable atmospheric pressure reference.
- Allow the PPCK+ to stabilize at atmospheric pressure and ambient temperature for 5 to 10 minutes before running AutoZ in gauge measurement mode.

OPERATION

The AutoZ function and values are range AND mode (gauge or absolute) specific.

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

```
1off  2view        H3
3edit  4run
```

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.

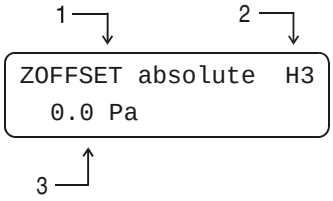
Selecting **<2view>** allows the current value of ZOFFSET for the current range and mode to be viewed.

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.

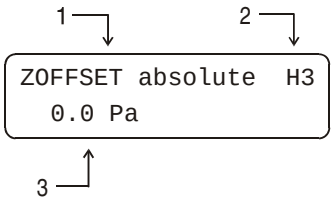
ZOFFSET should be zero when the PPCK+ is new or has just been calibrated. ZOFFSET in absolute mode should be roughly equal to atmospheric pressure for an absolute RPT operating in gauge mode.

The value of ZOFFSET is always displayed and entered in Pascal (Pa) as PPCK+'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 PPCK+ 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.

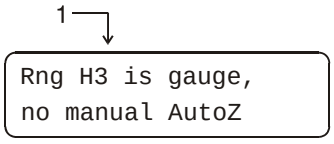
The value of ZOFFSET is always displayed and entered in Pascal (Pa).

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).

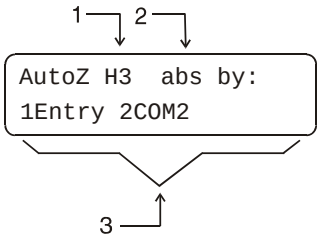
To access run AutoZ, press **[SPECIAL]** and select **<1AutoZ>**, **<4run>**.

If the measurement mode of the current range is gauge, run AutoZ occurs transparently to the user whenever AutoZ is ON and the PPCK+ 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 PPCK+'s COM2 communications port.

Allow the PPCK+ 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 ± 0.015 % FS of the current PPCK+ measurement range, the PPCK+ 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 ± 0.015 % FS of the current PPCK+ range, check to be sure that both the PPCK+ 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.

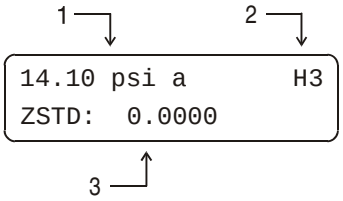
The value of ZOFFSET in absolute mode will not be exactly equal to the difference between the current reading and ZSTD if ZNATERR is not zero (see Section 3.4.1, PRINCIPLE, How AutoZ Works).

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

Run Autoz By Entry (Absolute Mode Only)

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 PPCK+.

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:

```
Old ZOFFSET:    0.0 Pa
New ZOFFSET:  978.5 Pa
```

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

Press **[ENTER]** to activate the new ZOFFSET for the current range absolute measurement mode and return to the main run screen.

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

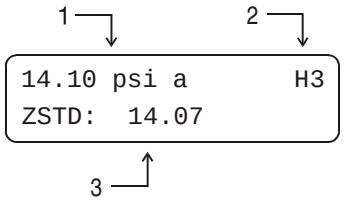
The value of ZOFFSET is always displayed and entered in Pascal (Pa).

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

Run Autoz By Com2 (Absolute Mode Only)

AutoZ by COM2 allows the value of ZSTD (see Section 3.4.1, PRINCIPLE, How AutoZ Works) to be read automatically from a **DHI** RPM3 connected by RS232 interface to the PPCK+ 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 PPCK+'s COM2 port.

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

```
Old ZOFFSET:     0.0 Pa
New ZOFFSET:   756.8 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 PPCK+ to communicate with an RPM connected to it's COM2 port, the PPCK+ and the RPM RS232 interfaces must be set up properly (see Section 3.4.4.3). If the PPCK+ 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).

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.

- **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 PPCK+. The characteristics of the gas selected will be used by PPCK+ in calculating head pressures.

3.4.3 PresU

- **PURPOSE**

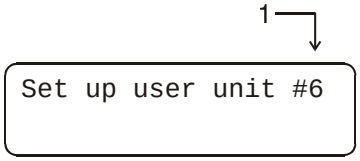
To customize the selection of pressure units that are available for selection from the **[UNIT]** function key.

- **PRINCIPLE**

The **[UNIT]** function key makes available a choice of six default pressure units (US or SI units depending on whether the PPCK+ has been factory set as US or SI) (see Section 3.2.2). PPCK+ 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 **[SPECIAL]**, **<3PresU>**. This allows PPCK+ 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.

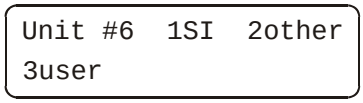
- **OPERATION**

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.

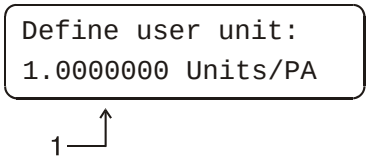
The units available are listed in Table 8.

Table 8. UNIT Function - Available Units

<1SI>	<2other>	<3user>
<1Pa>	<1psi>	
<2kPa>	<2psf>	
<3MPa>	<3inHg>	
<4mbar>	<4inWa>	
<5bar>	<5kcm2>	
<6mmHg>	*<6none>	
<7mmWa>		

The UNIT function display may include less than six units. To delete the current unit from the UNIT screen and show no unit, select **<2other>**, **<6none>** for that unit number.

If **<3user>** is 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 7.2 for the pressure unit conversion factors used by PPCK+.

3.4.4 INTERNAL

- **PURPOSE**

To view, set, adjust, and maintain various aspects of PPCK+'s internal operation including:

<1Config> to run the thermal pressure control volume determination routine (see Section 3.4.4.1).

<2Cal> to view and edit calibration coefficients for the PPCK+ RPT ranges and on-board barometer (see Section 3.4.4.2).

<3Remote> to view and edit RS232 (COM) port and IEEE-488 interface settings (see Section 3.4.4.3).

<4Time> to adjust the date and time (see Section 3.4.4.4).

<5Reset> to access various system reset functions (see Section 3.4.4.5).

<6Level> to set the user protection level and password (see Section 3.4.4.6).

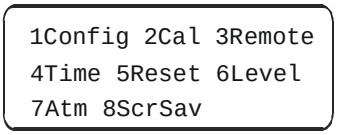
<7Atm> to view the on-board barometer reading (see Section 3.4.4.7).

<8ScrSav> to adjust the activation time of the front panel display saver (see Section 3.4.4.8).

<9Log> to view and/or clear the PPCK+ event log.

- **OPERATION**

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



Select the desired internal function.

Select **<2Cal>** to view and edit calibration coefficients for the PPCK+ RPT ranges and on-board barometer (see Section 3.4.4.2).

Select **<3Remote>** to view and edit RS232 (COM) port and IEEE-488 interface settings (see Section 3.4.4.3).

Select **<4Time>** to adjust the date and time (see Section 3.4.4.4).

Select **<5Reset>** to access various system reset functions (see Section 3.4.4.5).

Select **<6Level>** to set the user protection level and password (see Section 3.4.4.6).

Select **<7Atm>** to view the on-board barometer reading (see Section 3.4.4.7).

Select **<9ScrSav>** to adjust the activation time of the front panel display saver (see Section 3.4.4.8).

3.4.4.1 CONFIG

- **PURPOSE**

  To run an automated routine that determines the volume of the system into which PPCK+ is controlling pressure to optimize the performance of thermal pressure control (TPC) used in dynamic control mode.

- **PRINCIPLE**

  PPCK+ uses thermal pressure control (TPC) for very fine pressure control around the target value in dynamic control mode (see Section 3.1.2.3). For optimal TPC operation, PPCK+ must have a good estimation of the size of the volume connected to the PPCK+ TEST port. In normal dynamic control mode operation, if PPCK+'s estimation of the volume seems incorrect as evidenced by unexpected control response, PPCK+ runs a 0.5 to 2.5 minute routine to determine the test volume. The volume determination routine can also be initiated by the operator using **[SPECIAL], 4Internal, 1Config**.

  The operator initiated volume determination routine can be useful after a test volume change to avoid the increased control time and reduced control precision that may exist until PPCK+ automatically determines the volume.

Thermal pressure control (TPC) is only used in dynamic control mode. Therefore, the volume configuration routine only executes when dynamic control mode is active.

Due to the high compressibility of low pressure gas, the configuration routine does not produce reliable results at when run at a starting pressure under 1 MPa (150 psi). Therefore, the volume configuration routine cannot be run under 1 MPa (150 psi).

- **OPERATION**

PPCK+ uses self diagnostics to determine when to run the TPC configuration routine in dynamic control mode. Therefore, it is not normally necessary to run the configuration routine separately.

Running the Config routine may cause the set pressure to increase or decrease by up to 1.4 MPa (200 psi).

The dynamic control mode volume determination routine may be run at any pressure greater than 1 MPa (150 psi). Dynamic pressure control mode must be active.

To run the volume determination routine, first set a pressure above 1 MPa (150 psi). Then press **[SPECIAL]** and select **<4Internal>**, **<1Config>**. The display is:

```
Run config?
1Yes 2No
```

Selecting **<1Yes>** causes the volume determination routine to run. While the routine is running, **<Running config…>** flashes on the bottom line of the PPCK+ display. Completing the routine may take up to 2.5 minutes and cause the pressure to change by 0.7 to 1.4 kPa (100 to 200 psi).

When the volume determination is complete the display is:

```
Activate new config?
1Yes 2No
```

Select **<1Yes>** to activate the new volume determination. Select **<2No>** to retain the old volume determination and return to the main run screen.

The volume configuration routine cannot be run under 1 MPa (1 000 psi). An error message is displayed if the volume configuration routine is initialized at a pressure under 1 MPa (150 psi).

3.4.4.2 CAL

- **PURPOSE**

To calibrate the PPCK+ reference pressure transducer (RPT) and adjust the on-board barometer. This function is considered part of PPCK+ 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 PPCK+ communication ports including COM1, COM2 and the IEEE-488 interface.

- **PRINCIPLE**

  The PPCK+ has two RS232 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 PPCK+ front panel.

- **OPERATION**

  To access the port configurations and **remote program command** mode, select **[SPECIAL]**, **<4Internal>**, **<3Remote>**. 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 PPCK+. The PPCK+ looks for an ASCII(13) (carriage return) to terminate a received command but responds with both and ASCII(13) (carriage return) and an ASCII(10) (line feed). There are no other options.

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 PPCK+ 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 PPCK+ 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 PPCK+ 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 20000115
  ```

  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 YYYYMMDD format.

  The PPCK+ 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 PPCK+ settings to default or factory values.

PPCK+ 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 PPCK+ to a known state. PPCK+ will go through its reboot sequence after any type of reset is executed.

PPCK+ reset functions change current settings to factory defaults. These may include settings vital to PPCK+ operation and affecting the calibration of the reference pressure transducer. 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 under **[UNIT]** (see Section 3.2.2).
- Returns measurement mode to the absolute (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 3.2.3.1).
- All upper limit values to defaults (see Section 3.2.4).
- Pressure display resolution to 0.001 % FS (see Section 3.2.9).
- Control mode to dynamic (see Section 3.2.3).

- COM ports and IEEE-488 settings to default (see Section 3.4.4.3).
- Autozero enabled (see Section 3.4.1).
- Screen saver to 10 minutes (see Section 3.4.4.8).

Reset - Units

❍ **PURPOSE**

Sets the six pressure units available under the UNIT function to the SI or US default selections depending on whether the PPCK+ has been factory set for SI or US. See Sections 3.2.2 and 3.4.3.

Reset - Seq

❍ **PURPOSE**

- The SEQUENCE function is not supported in PPCK+.

Reset - Cal

❍ **PURPOSE**

The reset - cal function will delete RPT calibration coefficients changing the PPCK+ 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 5.2.1.1).
- 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
- Reset - units
- Reset - seq
- Reset - cal
- Reset - Com1, Com2 and IEEE-488 interface to defaults (see Section 3.4.4.3)

None of the reset options 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**

PPCK+'s front panel user interface provides the means to access all PPCK+ 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 PPCK+ 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 PPCK+ 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.

PPCK+ 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			•
[UNIT] key			•
[CONTROL] key			•
[UPPER LIMIT] key			•
[CUSTOM CONTROL] key		•	•
[HEAD] key			•
[LEAK CHECK] key		•	•
[RES] key		•	•
[SETUP] menu, <2Drivers>			•
[SPECIAL] menu		•	•
[SPECIAL] menu, <1AutoZ>		•	•
[SPECIAL] menu, <1AutoZ>, edit	•	•	•
[SPECIAL] menu, <2Head>		•	•
[SPECIAL] menu, <3PresU>		•	•
[SPECIAL] menu, <4Internal>		•	•
[SPECIAL] menu, <1Config>	•	•	•
[SPECIAL] menu, <4Internal>, <2Cal>	•	•	•
[SPECIAL] menu, <4Internal>, <4Time>, edit	•	•	•
[SPECIAL] menu, <4 Internal>, <5Reset>, <4cal>	•	•	•
[SPECIAL] menu, <4Internal>, <5Reset>, <5all>	•	•	•

OPERATION

PPCK+ is delivered with no active password and open access to the User Level menu. 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 PPCK+ password entry screen will appear. The user must enter the user defined password or the factory **secondary** password to proceed any further:

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

The first field **<*nnnn*>** is the serial number of the PPCK+, 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 PPCK+'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.

- **PRINCIPLE**

PPCK+ 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 Section 3.4.1, PRINCIPLE).

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). PPCK+ measurement uncertainty does not depend on the absolute uncertainty 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 PPCK+ range.

3.4.4.8 SCRSAV

- **PURPOSE**

  To adjust the PPCK+ screen saver function.

- **PRINCIPLE**

  PPCK+ 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>**, **<8ScrSav>**. 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.

3.4.4.9 LOG

- **PURPOSE**

  To view and/or clear the PPCK+ event log.

- **PRINCIPLE**

  PPCK+ records to a log each time one of the following events occurs:

  - The RPT is overpressure.
  - A memory fault occurs.

- **OPERATION**

  To view the event log press **[SPECIAL]** and select **<4Internal>**, **<9Log>**. The oldest logged event appears. Pressing **[ENTER]** steps through the logged events from the oldest to the most recent and ending with the option to clear the log, YES or NO.

  If NO events have been logged, **<End of log>** displays.

NOTES

4. REMOTE OPERATION

4.1 OVERVIEW

Most of the PPCK+ front panel functions can also be executed by commands from a remote computer. The host computer can communicate to the PPCK+ using the PPCK+ COM1 RS232 port or the IEEE-488 port.

Before writing code which makes use of PPCK+ remote commands, familiarize yourself with its operating principles by reading Sections 2 and 3 of this manual.

4.2 INTERFACING

Sending a program message to the PPCK+ will place it into remote mode. The remote indicator in the lower left hand corner of the PPCK+ front panel lights when the PPCK+ is in remote mode. It also flickers 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 PPCK+ to local operation unless the "REMOTE" program message was sent to the unit, which locks out all keypad operation.

4.2.1 RS232 INTERFACE

4.2.1.1 COM1

The PPCK+ COM1 RS232 interface is located on the back of the unit. It is a 9-pin female DB-9F connector configured as a DCE device. Data is transmitted out of the unit using pin 2, and is received on pin 3. This allows a normal pin-to-pin DB-9M to DB-9F RS232 cable to be used to connect to a DTE host.

Handshaking is not required or supported. 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 PPCK+ to reply from the previous command before issuing another command.

Table 10. Pin Designations and Connections

PPCK+ COM1 DB-9F PIN DESIGNATIONS		
PIN #	**FUNCTION**	**DESCRIPTION**
2	TxD	This pin transmits serial data from the PPCK+ 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 PPCK+ 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 PPCK+ 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 PPCK+ 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 PPCK+ COM2 RS232 interface is located on the back of the unit. It can be used to allow the Host computer to communicate with another device through the PPCK+. This allows the user to use one Host COM port to communicate with the PPCK+ and an additional RS232 device. Refer to the ”PASSTHRU” remote program message for details.

COM2 is a 9-pin male DB-9M connector configured as a DTE device. Data is transmitted out of the unit using pin 3, and is received on pin 2. This allows a normal pin-to-pin DB-9M to DB-9F RS232 cable to be used to connect to a DCE device.

Handshaking is not required or supported.

Table 11. List of PPCK+ COM2 DB-9M Pin Designations

PIN #	FUNCTION	DESCRIPTION
3	TxD	This pin transmits serial data from the PPCK+ to a device.
2	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 PPCK+ program message set is downward compatible with the previous PPCK program message set. It is identical to the PPC2+ program message set with the exception of a few commands that are not included for PPCK+ because they support PPC2+ functions that PPCK+ does not include. This message set includes an 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 PPCK+ enhanced program message format also includes 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 PPCK program message set. However, several PPCK functions are not supported by PPCK+ and neither are their corresponding commands (see CFG, DEVICE, DPG, ISO, PPC, HOLD, TOUT, TS, CONFIG). This format is recommended only if you need downward compatibility with older PPCK controllers. Each program message sent is also a query. You can only send one program message to the PPCK+ at time. After sending any program message, you must wait for the PPCK+ 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 PPCK+. This ensures that the PPCK+ 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 PPCK+ in the form of comma delimited arguments. This data is usually a setting of some sort that is stored in the PPCK+. 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 RS232 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 PPCK+. You **must** wait for a reply with a query. If you send any type of program message to the PPCK+ 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 PPCK+ COM2 port.
ABORT	Stop pressure generation.
AINCAL	Obsolete PPC2+ command not supported by PPCK+.
AINR	Obsolete PPC2+ command not supported by PPCK+.
AINRNG	Obsolete PPC2+ command not supported by PPCK+.
ATM	Read the current atmospheric pressure (on-board barometer).
AUTOPURGE	Command for PPC2+ feature not supported by PPCK+.
AUTOVAC	Command for PPC2+ feature not supported by PPCK+.
AUTOZERO	Read or set the status of the automatic zero function.
CALAMB	Read or set the PPCK+ ambient sensor user calibration
COM1	Read or set the configuration of the COM1 port.
COM2	Read or set the configuration of the COM2 port.
CONFIG	Run a TPC configuration routine.
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.
GPIB	Read or set the GPIB interface address.
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.
LOCAL	Returns control to the PPCK+ 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.
PASSTHRU	Send a command string out of the PPCK+ COM2 port.
PCAL*d*,LO	Read or set the user Lo RPT calibration information. PPCK+ has no Lo RPT.
PCAL*d*,HI	Read or set the user Hi RPT calibration information for the specific range.
PPC	Obsolete PPC2 Command.
PR	Read the next PPCK+ RPT pressure.

Table 12. Program Message List (Continued)

PRR	Read the next PPCK+ RPT 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.
PSS	Set a new target pressure and use only the slow speed to reach the target.
QPRR	Read the last PPCK+ RPT pressure, rate and ATM.
RANGE	Read or set the active range of the PPCK+.
RANGEHI	Read values of all three PPCK+ ranges.
RATES	Read or set the rates that define the manual or remote fast and slow rates.
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* condition.
REMOTE	Enable remote local lockout operation.
RES	Read or set the pressure display resolution for the current RPT and range.
RESET	Reset the PPCK+ to the default user parameters.
RETURN	Start a new automated pressure control set using the current target value.
RPMS	Obsolete PPC2 command.
RS	Start a fixed rate generation at the rate specified.
SCRSAV	Read or set the front panel screen saver period.
SETS	Specify default or custom generation settings.
SN	Read the serial number of the PPCK+.
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 in % 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.
UDD	Obsolete PPC command.
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 of measure for the current range.
VAC	Command for PPC2+ feature not supported by PPCK+.
VENT	Read, execute or abort a vent process.
VER	Read the PPCK+ 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. PPCK+ has no Lo RPT.
ZOFFSETd,HI	Read or set the autozero offset for Hi RPT.
ZOFFSETd,LO	Read or set the autozero offset for Lo RPT. PPCK+ has no Lo RPT.

4.4.2 ERROR MESSAGES

The PPCK+ always replies 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 4.5.1 explains the details of the Error Queue. Here 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# 10	"Missing or invalid command suffix" or "the pressure is not greater than 1 MPa or PPCK+ is busy"
ERR# 11	"Command missing argument"
ERR# 12	"System overpressured"
ERR# 13	"Text queue overflow"
ERR# 14	"User unit not defined"
ERR# 16	"Generation failure"
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" or "Must be vented"
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	"Device failure"
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"
ERR# 44	"Entry already exists"
ERR# 45	"Argument not allowed"

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 PPCK+ or to execute a PPCK+ function. The PPCK+ **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 PPCK+ using the IEEE-488 port. If you are using the COM1 port, the PPCK+ 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 PPCK+. The PPCK+ **must** be set to use the enhanced format (see Section 4.3.2). The PPCK+ 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 PPCK+, to execute a PPCK+ function, or to query for data. This type of command is not recommended for new applications. The PPCK+ **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 PPCK+ 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 PPCK+, then this section describes the arguments and their limits.
Default	If the program message can be used to set data inside the PPCK+, then this line shows (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 PPCK+ is shown. The message sent to the PPCK+ 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 PPCK+ is shown. The command sent to the PPCK+ 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 PPCK+ 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 PPCK+ 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 PPCK+ COM2 port can be used to communicate to another RS232 device (such as another PPCK+). This allows the user to use one COM port or IEEE-488 port on the host computer to communicate with the PPCK+ and another device. A carriage return and a line feed (**<CR><LF>**) are added to the string. After this program message is issued, the PPCK+ will reply back the first string received by the PPCK+ 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 PPCK+. There is no other reply from this program message. Prior to using this program message, you must ensure that the PPCK+ 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 PPCK+ us A1000/A0015 Ver1.00 " This example assumes that a second PPCK+'s COM1 port is connected to the PPCK+ COM2 port. This example gets the version of the second PPCK+.
See Also	"PASSTHRU", "COM2"

ABORT	
Purpose	Stops an active pressure generation. All control valves are closed.
Command Classic	"ABORT" "ABORT"
Remarks	This program message has no effect if the PPCK+ 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	3.2.3, 3.1.2.3, 3.1.2.4

ATM	
Purpose	Reads the next measured internal ambient pressure.
Query Classic	"ATM?" "ATM"
Remarks	The atmospheric pressure as measured by the PPCK+ 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	3.4.4.7

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 PPCK+ autozero function can be turned ON and OFF.
Example (enhanced)	Cmd sent: "AUTOZERO 1" Query reply: "0" If autozero OFF "1" autozero ON
Example (classic)	Sent: "AUTOZERO=1" Query reply: "AUTOZERO=1"If autozero ON
Errors	ERR# 6: The argument was other than a '0' or a '1'.
See Also	3.4.1

CALAMB	
Purpose	Read or set the user ambient pressure RPT calibration.
Command Query	"CALAMB *adder, mult*" "CALAMB?"
Classic	"CALAMB= *adder, mult*" "CALAMB"
Arguments	*Adder:* The pressure adder. Always in Pa' *mult:* The pressure multiplier.
Defaults	"CALAMB=0.00, 1.0000000"
Remarks	The user ambient calibration can be used to allow the user to calibrate the PPCK+'s internal ambient pressure calibration.
Example (enhanced)	Cmd sent: "CALAMB .45,1.00021" Query reply: " 0.45 Pa, 1.000210"
Example (classic)	Sent: "CALAMB= .45,1.00021" Reply: " 0.45 Pa, 1.000210"
Errors	ERR# 7: Missing or improper program message argument(s)
See Also	3.4.4.2, 5.3, "CAL"

CAL	
Purpose	Read or set the user RPT pressure RPT calibration.
Command Query	"CAL *adder, mult*" "CAL?"
Classic	"CAL= *adder, mult*" "CAL"
Arguments	*Adder:* The pressure adder. Always in the current units *mult:* The pressure multiplier.
Defaults	"CAL=0.000 psi, 1.0000000"
Remarks	The user RPT calibration can be used to allow the user to calibrate the PPCK+'s internal RPT pressure calibration for the currently active range. This command has been superceded by the "PCAL" command, and should not be used for new applications.
Example (enhanced)	Cmd sent: "CAL 2.1,1.00012" Query reply: " 2.11 psi, 1.000120"
Example (classic)	Sent: "CAL 2.1,1.00012" Reply: " 2.11 psi, 1.000120"
Errors	ERR# 7: Missing or improper program message argument(s)
See Also	3.4.4.2, "PCAL"

COM1	
Purpose	Read or set the RS232 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 PPCK+. When the COM1 port configuration of the PPCK+ 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	3.4.4.3, "PASSTHRU"

COM2	
Purpose	Read or set the RS232 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 PPCK+ 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	3.4.4.3, "PASSTHRU"

CONFIG	
Purpose	Run the configuration routine to optimize the PPCK+ TPC system for changes in the test volume.
Command	“CONFIG”
Classic	“CONFIG”
Remarks	Thee PPCK+ TPC configuration typically takes from 30 to 150 seconds. During this period, no other PPCK+ operations or remote commands should take place. All commands will result in a “BUSY” reply until the configuration is complete. Only the “ABORT” command will function during this period and will abort the config function. The PPCK+ pressure must be greater than 1 MPa, stable and leak free to execute this configuration.
Example (enhanced)	Cmd sent: “CONFIG” Query reply: “CONFIG”
Example (classic)	Sent: “CONFIG” Reply: “CONFIG”
Errors	ERR# 10: The pressure is not less than 1 MPa or the PPCK+ is not idle.
See Also	3.4.4.1

DATE	
Purpose	Read or set the PPCK+ 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 PPCK+ 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	3.4.4.4

DF	
Purpose	Decrease the pressure at the fast rate.
Command	"DF *n*"
Classic	"DF=*n*"
Arguments	'0' Stops the pressure decrease. '1' Starts the pressure decrease.
Remarks	The PPCK+ will set and maintain the fast decrease rate until "DF=0" or "ABORT" is sent.
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	3.1.2.2, "DS", "RATES", "ABORT", "RS"

DP	
Purpose	Decrease the pressure a given amount.
Command	"DP *n*"
Classic	"DP=*n*"
Arguments	*n* The decrease in pressure desired (current pressure units).
Remarks	The PPCK+ will set a pressure that is lower than the current pressure by the specified amount.
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	3.1.2.2, "IP", "RATES", "RS"

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 PPCK+ 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# 7: The *n* or *x* arguments are not within given limits.
See Also	3.3.2

DS	
Purpose	Decrease the pressure at the slow rate.
Command	"DS *n*"
Classic	"DS=*n*"
Arguments	*n* *'0'* Stops the decrease. *'1'* Starts the decrease.
Remarks	PPCK+ sets and maintains the slow rate of pressure decrease until "DS=0" or "ABORT' is sent.
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	3.1.2.2, "ABORT", "IS", "IF", "DF", "RATES", "RS"

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	4.4.2

GPIB	
Purpose	Read or set the GPIB interface address.
Command Query	"GPIB *addr*" "GPIB?"
Classic	"GPIB=*addr*" "GPIB"
Defaults	"GPIB 10"
Arguments	*addr:* The address of the GPIB488 interface (1 to 31)
Remarks	The GPIB address will be changed following the reply of this command
Example (enhanced)	Cmd sent: "GPIB 21" Query reply: "21"
Example (classic)	Sent: "GPIB=21" Reply: "21"
Errors	ERR# 6: The argument is not within given limits.
See Also	3.4.4.3

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 PPCK+. This will be positive if the test is above the PPCK+, or negative if below the PPCK+. 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 PPCK+ can make a head correction to allow it to display the pressure at the test instead of the pressure at the PPCK+.	
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	3.2.7, 3.4.2	

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	3.1.2.3, 3.1.2.4, 3.1.2.5, 3.2.3, 3.2.6, "HS%"	

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	3.1.2.3, 3.1.2.4, 3.1.2.5, 3.2.3, 3.2.6, "HS"

IF	
Purpose	Increase the pressure at the fast rate.
Command	"IF *n*"
Classic	"IF=*n*"
Arguments	*N* *'0'* Stops the pressure increase. *'1'* Starts the pressure increase.
Remarks	PPCK+ will set and maintain the fast increase pressure rate. Care must be used, as the pressure will not stop increasing until "IF=0" or "ABORT" is sent, 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	3.1.2.2, "ABORT", "DF", "DS", "DF", "UL", "RATES", "RS"

IP	
Purpose	Increase the pressure a given amount.
Command	"IP *n*"
Classic	"IP=*n*"
Arguments	*N* The increase in pressure desired (current pressure units).
Remarks	PPCK+ will increase the pressure by the specified amount and stop.
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	"DP"

IS	
Purpose	Increase the pressure at the slow increase rate.
Command	"IS *n*"
Classic	"IS=*n*"
Arguments	*N* *'0'* Stops the pressure increase. *'1'* Starts the pressure increase.
Remarks	PPCK+ will increase pressure at the slow increase rate until "IS=0" or "ABORT" is sent or the upper limit is reached.
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	3.1.2.2, "ABORT", "DF", "DS", "IF", "UL", "RATES", "RS"

LOCAL	
Purpose	Returns control to the PPCK+ 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 PPCK+ 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 PPCK+ 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" PPCK+ 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"PPCK+ data corrupted and was set to factory defaults "MEM=1"The memory was found to be OK on power-up
See Also	3.4.4.5, "RESET"

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 PPCK+ 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	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 PPCK+.
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	4.3

PASSTHRU	
Purpose	To allow the host PC to communicate with a device connected to the PPCK+ 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 PPCK+ COM2 port can be used to communicate to another RS232 device (such as another PPCK+). This allows the user to use one COM port or IEEE-488 port on the host computer to communicate with the PPCK+ 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 PPCK+ VER1.01a" Query reply: "COM2:" If the COM2 buffer is empty
Example (classic)	Sent: "PASSTHRU=VER" Reply: "COM2:DH INSTRUMENTS, INC PPCK+ VER1.01a" Reply: "COM2:" If the COM2 buffer is empty
See Also	"COM2", "#"

PCALN:HI	
Purpose	Read or set the user RPT calibration information. The PPCK+ RPT is always the Hi RPT.
Command Query	"PCAL*n*:HI *adder, mult, CalDate*" "PCAL*n*:HI?"
Classic	"PCAL*n*:HI =*adder, mult, CalDate*" "PCAL*n*:HI"
Defaults	"PCAL*n*:HI = 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 (always HI in PPCK+) 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:HI 2.1, 1.000021, 961201" Query reply: " 2.10 Paa, 1.000021, 961201"
Example (classic)	Sent: "PCAL1:HI=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	5.2, "CAL"

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, NR, ER, OL or OP). The *Ready* status is detailed in the "SR" program message. The pressure measurement value and pressure units are right justified in this field. After receiving this program message, the PPCK+ 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	3.1.2.5, "QPRR", "SR", "PRR"

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/Not Ready*, pressure UNITS, rate UNITS/s, atm UNITS. Here are the field descriptions: *Ready/Not 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 PPCK+ 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 PPCK+ 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	3.1.2.4, 3.1.2.5, 3.4.4.7, "ATM", "PR", "QPRR", "SR"

PS	
Purpose	Set a new target pressure and start a new pressure generation cycle. Allows the test volume to be specified.
Command	"PS *n (,v)*"
Classic	"PS=*n (,v)*"
Arguments	*n:* The target pressure in the current pressure units. *v:* The device system under test volume in cc (optional).
Remarks	The PPCK+ will generate the given target pressure using the current generation settings and mode. Generation will continue until a new target pressure is set, the PPCK+ goes into LOCAL mode, or an "ABORT" program message is executed. If the given target is '0' and the pressure units are gauge, the PPCK+ 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 PPCK+ will not attempt to self configure itself to the volume under test, but instead will use the given volume for the pressure generation. 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 may initially need to 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.
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	3.1.2.4, 3.1.2.5, 3.2.3, 3.4.4.1, "CONFIG", "MODE", "PR?", "PRR?", "STAT?", "SR?"

PSF	
Purpose	Set a new target pressure and use just the fast speed to set the pressure.
Command	"PSF *n*"
Classic	"PSF=*n*"
Arguments	*n:* The target pressure in the current pressure units.
Remarks	The PPCK+ will set 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. Control stops after the pressure is set. 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	3.1.2.2, "PR", "PRR", "STAT", "SR", "PSS", "RATES"

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 PPCK+ will set 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. Control stops after the pressure is set. 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	3.1.2.2, "PR", "PRR", "STAT", "SR", "PSF", "RATES"

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 (always Hi RPT in PPCK+) 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/Not Ready*, pressure UNITS, rate UNITS/s, atm UNITS. Here are the field descriptions: *Ready/Not* 'R' if the current pressure *Ready* criteria has been met, *Ready*: '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 PPCK+ 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", "ATM", "RATE"

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. PPCK+ has only a high pressure 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.
Example (enhanced)	Cmd sent: "RANGE 1:HI" Query reply: "30000 psia"
Example (classic)	Sent: "RANGE=1:HI" Reply: "3000 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	3.1.2.6, 3.2.1

RANGEHI	
Purpose	Read the three RPT ranges available.
Query	"RANGEHI?"
Classic	"RANGE"
Remarks	The PPCK+ supports three ranges. The "RANGEHI" command fetches the PPCK+ model, the range units and the ranges available for the PPCK+ in gauge and absolute mode. These values are returned in the following order: *RptType, model, unit, AbsRng1, AbsRng2, AbsRng3, GaRng1, GaRng2, GaRng3* Field Descriptions: *RptType:* Always '0' *Model:* "A3000", "A6000" or "A10000" *unit:* The range units "psi", "kPa" or "MPa" *AbsRng* Range #1..3 in absolute mode in the replied *unit* *GaRng* Range #1..3 in gauge mode in the replied *unit*
Example (enhanced)	Cmd sent: "RANGEHI?" Query reply: "0,A3000,psi, 1000, 2000, 3000, 1000, 2000, 3000"
Example (classic)	Sent: "RANGEHI" Reply: "0,A3000,psi, 1000, 2000, 3000, 1000, 2000, 3000"
See Also	3.1.2.6, "RANGE"

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 PPCK+ 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	3.1.2.5, "PRR", "QPRR"

RATES	
Purpose	Read or change the fixed rate generation slow and fast rates.
Command Query	"RATES *FastRate, SlowRate*" "RATES?"
Classic	"RANGE=*FastRate, SlowRate*" "RANGE"
Default	Range dependent
Arguments	*FastRate* The rate set (units/s) when the manual up or down and fast keys are pressed, or when a "PSF", "IF=1" or "DF=1" command is executed. *SlowRate:* The rate set (units/s) when the manual up or down key is pressed, or when a "PSS", "IS=1" or "DS=1" command is executed.
Remarks	The PPCK+ executes fixed rate generations using one of these two target rates. It will maintain the rate until the user aborts the generation. The fast rate default is the PPCK+ full scale in 60 seconds, and the slow speed is 10% of the fast.
Example (enhanced)	Cmd sent: "RATES?" Query reply: "50.000 psi/s, 5.000 psi/s"
Example (classic)	Sent: "RATES" Reply: "50.000 psi/s, 5.000 psi/s"
Errors	ERR# 6: Invalid argument.
See Also	3.1.2.2, "DF", "DS", "IF", "IS", "RS"

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 PPCK+ 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 PPCK+ 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 PPCK+ condition has stayed *Ready*) "0" (if PPCK+ condition has NOT stayed *Ready*)
Example (classic v2.01 & up)	Sent: "READYCK=1" Query reply: "READYCK=1" (if PPCK+ condition has stayed *Ready*) "READYCK=0" (if PPCK+ condition has NOT stayed *Ready*)
Example (classic v2.00)	Sent: "READYCK=1" Query reply: "1" (if PPCK+ condition has stayed *Ready*) "0" (if PPCK+ condition has NOT stayed *Ready*)
Errors	ERR# 6: Argument is not a '0' or a '1'.
See Also	3.1.2.5, "SR?"

REMOTE	
Purpose	Lock out the front panel controls.
Command	"REMOTE"
Classic	"REMOTE"
Remarks	The PPCK+ 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 PPCK+ 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	3.2.9

RESET	
Purpose	Reset the user's settings to factory defaults.
Command	"RESET"
Classic	"RESET"
Remarks	The PPCK+ has user settings (units, resolution, control modes, etc.) that can be reset to factory defaults. Communications settings will not be affected. The remote "RESET" program message corresponds to the local "Reset-sets." function (see Section 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	3.4.4.5

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 PPCK+ 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	3.2.3, 3.2.10, “PS“, “TP”

RS	
Purpose	Adjust pressure at a fixed rate.
Command	“RS *RateReq*”
Classic	“RS=*RateReq*”
Arguments	*RateReq:* The rate for the PPCK to generate to. Negative rates cause the pressure to decrease and positive rate cause the pressure to increase.
Remarks	The requested rate is an approximation, and the PPCK will set and maintain a rate near to the requested rate to be the best of its ability. Actual rates that can be set depend on the volume of the device under test. The PPCK+ will continue to maintain the rate given until the “ABORT” command or [ESCAPE] key is used to cancel the operation, or the UL pressure is reached.
Example (enhanced)	Cmd sent: “RS 10” Query reply: “10 kPa/s”
Example (classic)	Sent: “RS=10” Reply: “10.00 kPa/s”
See Also	“ABORT”, “RATES’, “IF”, “DF”, “IS”, “DS”, “UL”

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 PPCK+ 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	3.4.4.8

SETS	
Purpose	Set or read the control settings to use.
Command Query	"SETS *type*" "SETS?"
Classic	"SETS=*type*" "SETS"
Arguments	*Type:* "SYS" Set the generation settings to the factory defaults "USER" Allows user specified custom generation settings
Remarks	This command allows the user to set the generation hold and stability settings to factory defaults, or to use user specified hold and stability settings.
Example (enhanced)	Cmd sent: "SETS SYS" Query reply: "SYS"
Example (classic)	Sent: "SETS=USER" Reply: "USER"
Errors	ERR# 6: Incorrect argument
See	3.1.2.4, 3.2.6, "HL"; "HL%"; "SS"; "SS%"

SN	
Purpose	To read the serial number of the PPCK+.
Query	"SN?"
Classic	"SN"
Remarks	The PPCK+ 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. "NR " The pressure is *Not Ready* within the limits defined by the control mode and current control parameters. "R " The pressure meets the *Ready* criteria. The status is replied when the next pressure measurement is finished. "ER " The previous request pressure generation failed to complete due to failure of the hardware (leaks, gas supply or valve failures). "OL " The pressure has exceeded the user specified upper limit. Only decreasing pressure excursions will be allowed. "OP " The pressure has exceeded the factory maximum pressure limit. Normal operation cannot continue.
Example (enhanced)	Query sent: "SR?" Query reply: "NR"
Example (classic)	Sent: "SR" Reply: "NR"
See Also	3.1.2.5, 3.2.3, 3.1.2.4, "PR", "PRR","HS", "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 % 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 PPCK+ 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	3.1.2.5, 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 PPCK+ 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	3.1.2.5, 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 ORinging them together. 0 The system is not generating or holding a pressure. 2 A new generation has been requested. 4 The generation is preparing to begin. 8 Valve is adjusting close to it's opening position. 16 Valve is seeking it's exact opening position. 256 Valve is being used to reach the target. 512 Volume determination routine is running 1024 Valve is being used for a fixed rate generation. 2048 Thermal reset is running. 4096 Thermal control is active. 64536 Generation abort has been requested.
Example (enhanced)	Query sent: "STAT?" Query reply: "32"
Example (classic)	Sent: "STAT" Reply: "32"
See Also	3.1.2.3, "PS"

TIME	
Purpose	Read or set the PPCK+ 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 PPCK+ 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	3.4.4.4

TOUT	
	This is an obsolete PPC2 Command.
Purpose	PPCK+ 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	3.2.3, 3.2.10, "PS"

UCOEF	
Purpose	To convert 1 Pascal to the current pressure units.
Query	"UCOEF?"
Classic	"UCOEF"
Remarks	The PPCK+ 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	7.2.1, 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	3.2.2, 3.4.3

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 PPCK+ 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	3.2.4

UNIT	
Purpose	Read or set the pressure display unit and measurement mode.
Command Query	"UNIT *unit (, ref*")" "UNIT *unit*g *(, ref*")" "UNIT *unit*a *(, ref*")" "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	3.2.2, 7.2, 3.4.3

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 PPCK+ 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	3.1.2.2

VER	
Purpose	Read the PPCK+ version.
Query	"VER?"
Classic	"VER"
Remarks	The software version of the PPCK+ can be read. This is useful for checking presence of the PPCK+ and for reference purposes.
Example (enhanced)	Query sent: "VER?" Query reply: "DH INSTRUMENTS, INC PPCK+ Ver1.00 "
Example (classic)	Query sent: "VER?" Query reply: "DH INSTRUMENTS, INC PPCK+ Ver1.00 "
See Also	None

ZOFFSETn:HI		
Purpose	Read or set the autozero pressure offset (ZOFFSET) for the current RPT range and measurement mode. PPCK+ has only a Hi RPT.	
Command Query	"ZOFFSET*n*:HI *offset, Date*" "ZOFFSET*n*:HI?"	
Classic	"ZOFFSET*n*:HI =*offset, Date"* "ZOFFSET*n*:HI"	
Defaults	"ZOFFSET*n*:HI = 0.0, 800101"	
Arguments	*n:* *offset:* *Date:*	The RPT range: '1' for the low, '2' for the medium '3' for the high range of the selected RPT (always Hi RPT in PPCK+). The RPT pressure offset (ZOFFSET) for the current measurement mode (gauge or absolute) in Pa. The date when the last edit to the *offset* was made.
Remarks	The pressure offset (ZOFFSET) for the specified RPT (always Hi RPT in PPCK+) 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: Query reply:	"ZOFFSET1:HI 2.1, 961201" " 2.10 Paa, 961201"
Example (classic)	Sent: Reply:	"ZOFFSET1:HI=2.1, 961201" " 2.10 Paa, 961201"
Errors	ERR# 6:	One of the arguments are out of range.
See Also	3.4.1	

ZNATERRn:HI		
Purpose	Read or set the autozero natural error (ZNATERR) for the selected RPT range and measurement mode. PPCK+ has only a Hi RPT.	
Command Query	"ZNATERR*n*:HI *NatErr, Date*" "ZNATERR*n*:HI?"	
Classic	"ZNATERR*n*:HI =*NatErr, Date"* "ZNATERR*n*:HI"	
Defaults	"ZNATERR*n*:HI = 0.0, 800101"	
Arguments	*n:* *NatErr:* *Date:*	The RPT range: '1' for the low, '2' for the medium '3' for the high range of the selected RPT. The RPT natural error for the RPT range. The date when the last edit to the *NatErr* was made.".
Remarks	The natural error (ZNATERR) for the specified RPT (always Hi RPT in PPCK+) 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: Query reply:	"ZNATERR1:HI 10, 961201" " 10.00 Paa, 961201"
Example (classic)	Sent: Reply:	"ZNATERR1:HI =10, 961201" " 10.00 Paa, 961201"
Errors	ERR# 6:	One of the arguments are out of range.
See Also	3.4.1, 5.2.6	

4.5 STATUS REPORTING SYSTEM

The PPCK+ 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 PPCK+ 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 PPC 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 PPCK+ contains an 8 bit Status Byte Register that reflects the general status of the PPCK+.

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 PPCK+ reply output queue, the Error Queue, the Standard Event Status register and the Ready Event Status register.

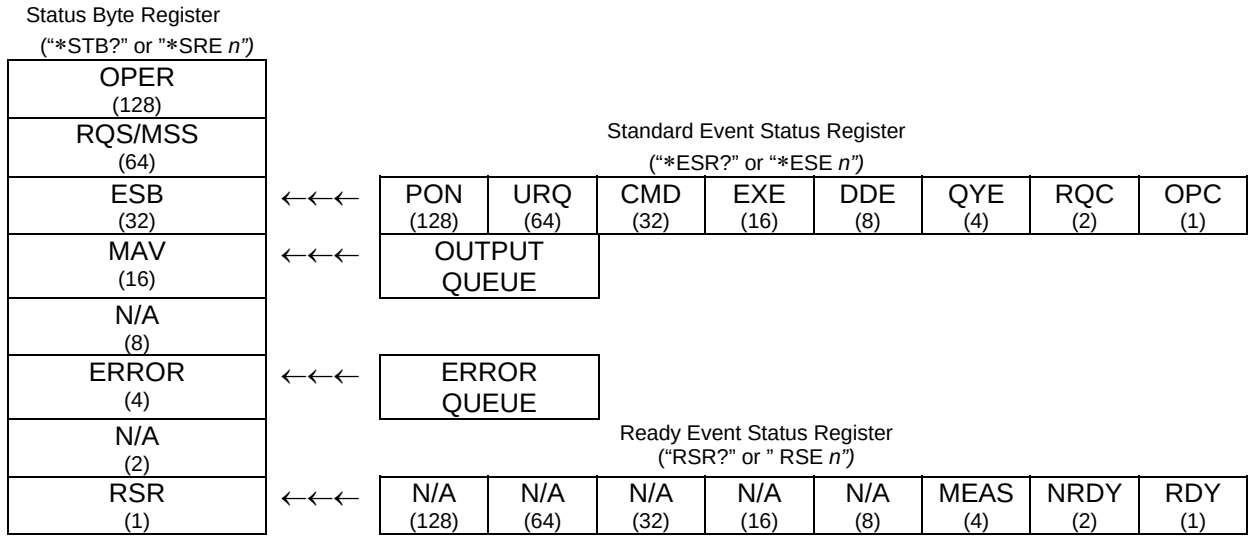


Figure 10. Status Register Schematic

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 PPCK+. This bit is cleared when a serial poll is performed on the PPCK+, 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 PPCK+ 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 PPCK+ IEEE-488 output queue.

- ERROR: Error Queue not empty (Bit 2)

  Indicates that at least one command error message is waiting in the PPCK+ 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 PPCK+ contains an 8 bit Standard event register that reflects specific PPCK+ 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 PPCK+ power has been cycled since the last time this bit was read or cleared.

- URQ: User Request (Bit 6)

  Indicates that the PPCK+ 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 PPCK+ 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 PPCK+ without reading a waiting reply.

- RQC: Request Control (Bit 1)

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

- OPC: Operation Complete (Bit 0)

  Indicates that the PPCK+ has completed all requested functions.

4.5.4 READY STATUS REGISTER

The PPCK+ contains an 8 bit Ready Status Register that reflects specific PPCK+ 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 PPCK+ has completed an RPT measurement.

- NRDY: Generation *Not Ready* (Bit 1)

  Indicates that the PPCK+ made a transition from *Ready* to *Not Ready* as defined by the control settings (see Section 3.1.2.5).

- RDY: Generation *Ready* (Bit 0)

  Indicates that the PPCK+ has reached a target pressure and is *Ready* as defined by the control settings (see Sections 3.1.2.4, 3.1.2.5 and 3.2.3).

4.6 IEEE STD. 488.2 COMMON AND STATUS PROGRAM MESSAGES

The PPCK+ 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 PPCK+ version, range, and serial number
∗OPC	Sets the operation complete bit when all operations have completed
∗OPT	Reads the list of installed PPCK+ options
∗RST	Resets the PPCK+ 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 PPCK+ 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, PPCK+ A0100/A0015, 1234, Ver1.00 -dhf"

∗OPC	
Purpose	Sets the operation complete bit when all operations have completed.
Command Query	"∗OPC" "∗OPC?"
Remarks	This Command enables the PPCK+ 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 PPCK+ options.
Query	"∗OPT?"
Remarks	This Query returns any registered option(s) installed in the PPCK+. 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 PPCK+ control settings to factory settings.
Command	"∗RST""
Remarks	This Command sets the PPCK+ 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	3.4.4.5, "RESET"

∗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: "∗SRE=48" (enables the MAV and ESB bits) Query reply: "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 PPCK+. The 'MSS' bit state is represented by bit 6.
Example (enhanced)	Sent: "∗STB?" Reply: "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: "∗RSE=1" (enables the RDY bit) Query reply: "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: "RSR?" Reply: "6" (The MEAS and NRDY)

5. MAINTENANCE, ADJUSTMENTS AND CALIBRATION

5.1 OVERVIEW

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

- Rezeroing of reference transducer (RPT) as needed (see Section 3.4.1).
- Regular RPT recalibration (see Section 5.2).
- Adjustment of the on-board barometer as needed (see Section 5.3).
- Purging of the DRAIN port (see Section 5.4).

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

PPCK+ 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 PPCK+ operation. For rapid assistance in specific situations (see Section 6).

PPCK+ is covered by a limited one 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

PPCK+ has reference pressure transducers (RPT) that is the source of precise pressure measurement for the system. The RPT 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 RPT range to arrive at the optimal fit for each range. This technique allows reduced measurement uncertainty 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 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) if the RPT will be operated in absolute measure mode.

CalTool for RPTs software provided with the PPCK+ supports the calibration process of PPCK+ RPTs. CalTool and its documentation is provided on a General Accessories Disk with the new PPCK+ accessories. Most users should use CalTool software to assist in the calibration of PPCK+.

PPCK+ is delivered with an interactive reference pressure transducer calibration utility that steps the operator through the complete RPT calibration procedure including applying the necessary pressures to each range, collecting data automatically, calculating new PA and 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). PPCK+ also provides complete front panel and remote access to RPT calibration parameters so that RPT calibrations can be performed without using CalTool software if desired (see Section 5.2.7).

5.2.1.1 PA AND 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 • PM) + PA

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

PM is dimensionless.

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

As editing PA and PM values will change RPT calibration, these 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 PPCK+ is delivered with PA and PM values set to 0 and 1 for all ranges. This does not mean that the PPCK+ has not been calibrated. For the original factory calibration, PA and PM are set to 0 and 1 and privileged factory coefficients are used for calibration adjustment.

5.2.1.2 SETTING ZNATERR

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

Setting ZNATERR is procedurally identical to running the AutoZ function (see Section 5.2.1.2), 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>**.

Since ZNATERR is a measurement of the “natural” disagreement between the PPCK+ range in absolute measurement mode and a barometric reference, the PPCK+ range must be calibrated and new PA and PM applied BEFORE ZNATERR is determined.

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 PPCK+ on-board barometer is to be used as the source of ZSTD for autozeroing in absolute mode, the on-board barometer should be adjusted prior to calibrating the PPCK+'s RPT.

The ZNATERR determination should be performed AFTER the RPT ranges have been calibrated and new PA and PM values activated.

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 PPCK+ RPTs can be obtained in several ways.

When the PPCK+ 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 and PM and ZOFFSET values can be used to calculate as received/as left values. For example, backing out PA and PM on the as left data yields the transducer readings with PA = 0 and PM = 1. Then applying the as received PA and PM and ZOFFSET values to the readings calculates *as received* readings (the readings that the transducer would have made with the old PA and PM and ZOFFSET).

It is recommended that "as received" values of PA and 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 and 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

The following specific items, in addition to a normally equipped pressure calibration laboratory, are required to calibrate a PPCK+:

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

   - **Measurement uncertainty of ± 0.005 % of reading or better**, if best PPCK+ measurement uncertainty is to be obtained. A standard with higher measurement uncertainty may be used but PPCK+ measurement uncertainty will be degraded proportionally from published specifications.

   - **Able to apply absolute pressures if the RPT will be used in the absolute measure mode:** Absolute pressures in the range of PPCK+ are usually defined by applying gauge (relative) pressures with a piston gauge and adding atmospheric pressure measured by a precision barometer. If the PPCK+ RPT will **not** be used in **absolute measure** mode (as is often the case for high pressure RPTs), absolute pressures are not required for calibration and the calibration may be performed by applying gauge pressures only.

     
     The measurement uncertainty in absolute measurement mode is unknown when a PPCK+ RPT is calibrated in gauge mode. A PPCK+ calibrated in gauge mode should not be used to make accurate measurement 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 or atmospheric pressure if a barometer with appropriate measurement uncertainty is available.

     
     Contact DHI for additional information on calibration standards available to calibrate PPCK+.

2. **Precision barometer:** Needed only if the PPCK+ RPT is to be calibrated in absolute mode for absolute operation. The barometer is used to obtain absolute pressure by adding atmospheric pressure to gauge pressure defined by a piston gauge. It is also used to set ZNATERR to allow the use of the autozero function between calibrations (see Section 3.4.1). Barometer measurement uncertainty should be ± 350 Pa (0.05 psi) or better.

   
   A recommended source for measuring atmospheric pressure to set ZNATERR and for subsequent autozeroing is a DHI RPM3 reference pressure monitor. Contact DHI for additional information.

5.2.3 SET-UP AND PREPARATION

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

❶ Set the PPCK+ on a stable surface near the calibration standard at a height 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.

❷ Connect the output of the calibration standard to the PPCK+ TEST1 port (DH200 F). (See Section 2.3.4.)

DH200 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6 mm) OD tube, equivalent to AE SF250C, HIP LF4, etc. IT MAY DAMAGE THE FITTING AND MAY BE DANGEROUS TO THE OPERATOR TO USE INCORRECT FITTINGS.

❸ Shut the PPCK+ VENT if it is open (see Section 3.1.2.2). Abort pressure control. The PPCK+ is calibrated with pressure control idle. This allows its RPT to be calibrated as a measuring device. Pressures are normally generated and adjusted by the pressure standard, not by the PPCK+.

❹ Allow PPCK+ to warm up with power on for at least 30 minutes before running the calibration.

NEVER apply pressure to the PPCK+ TEST port that is greater than 105 % of PPCK+ range 3. Damage to internal PPCK+ RPT could result.

5.2.4 RPT CALIBRATION USING CALTOOL FOR RPTs SOFTWARE

To calibrate PPCK+ using CalTool software (supplied on the General Accessories Disk), refer to Sections 5.2.1, 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**

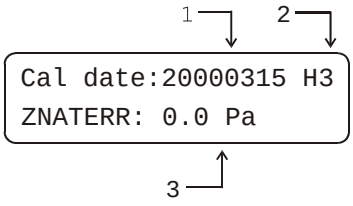
RPT calibration information is available for each RPT range. Fields include:

- The calibration date
- The value of ZNATERR (see Section 5.2.6)
- The value of PA (see Section 5.2.1.1)
- The value of PM (see Section 5.2.1.1)

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

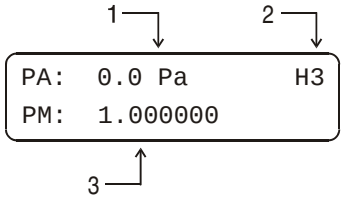
OPERATION

Select the desired range from the main run screen using the RANGE function. To view or edit calibration information for the active range, 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 exits the edit screen without activating any changes.

As editing PA and 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, 3.4.1).

ZNATERR is range specific and absolute measurement mode specific. There is no ZNATERR for gauge mode.

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 PPCK+ reference pressure transducer 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 PPCK+.
- Calculating new PA and PM values and entering them.
- Setting ZNATERR for the calibrated range (if the RPT 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 5.2.1, 5.2.2, 5.2.3 should be reviewed thoroughly.

OPERATION

The typical procedure for calibrating an RPT range is:

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

❷ From the main run screen, using the **[RANGE]** function key, select the 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 PPCK+ operation (see Section 3.4.1).

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

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

❺ Allow the PPCK+ to warm-up with power on for at least 30 minutes before running the calibration.

❻ Apply the calibration pressure for each point (normally atmosphere – FS – zero in 20 % increments. Dwell at least two minutes after setting the reference pressure at each point to allow full stabilization. Record the pressure the value of the pressure applied by the reference and the value indicated by the PPCK+ at each point. The data recorded is the "as received" data for this calibration.

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

$$\text{non-corrected reading} = (\text{corrected reading} - PA + ZOFFSET)/PM$$

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

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

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

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

$$\text{as left reading} = (\text{non-corrected reading} \bullet \text{new } PM) + \text{new } PA$$

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 the reference pressure transducer (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). It needs a traceable calibration only if it is to be used as the source of ZSTD for autozeroing the PPCK+ RPT in absolute measurement mode (see Section 3.4.1).

- **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 [YYYYMMDD] and PA and 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 DRAIN PURGE

- **PURPOSE**

  To purge any liquids that may have collected in the PPCK+ thermal pressure control unit (TPCU) volume.

- **PRINCIPLE**

  PPCK+ is designed to precisely measure, set and control gas pressures. Liquid contamination of the PPCK+ internal pneumatic control module and/or reference pressure transducer can cause poor pressure control and interfere with pressure measurement. Liquid contaminants that may be present in test devices or systems that are connected to the PPK+ TEST port are likely to make their way back to PPCK+'s internal pneumatic system as the test device or system is pressurized and depressurized by PPCK+. To every extent possible, only clean hoses and connections should be used in connecting PPCK+ to test devices or systems and those devices and systems should be free of contaminants.

In the event that PPCK+ is used to test some devices or systems that contain small amounts of liquid contaminant, PPCK+ has been designed to protect itself from contamination. PPCK's thermal pressure control unit (TPCU) is designed as a trap for liquids that may make their way into PPCK+. The bottom of the volume is the low point (see Figure 5) of the system and a DRAIN port is provided on the rear panel to exhaust collected contaminant.

The procedure described under OPERATION below should be conducted regularly whenever PPCK+ may have been connected to a source of contamination.

- **OPERATION**

Poor pressure control is usually caused by invalid control parameters excessive leaks and restrictions in the test line or other set up problems. Along with purging the PPCK+ drain, these potential problems should be identified and eliminated when troubleshooting poor pressure control (see Section 3.1.2.3).

To purge the PPCK+ DRAIN port proceed as follows:

❶ Plug the TEST port or connect it to a leak free system.

❷ Use the PPCK+ increase pressure direct pressure control key (see Section 3.1.2.2) to set a pressure of approximately 700 kPa (100 psi).

❸ Using a 1/2 in. wrench, slowly loosen the DH200 gland nut on the DRAIN port on the rear panel of PPCK+. Gas will escape from the port.

❹ Observe the exhaust from the DRAIN port. If liquids and/or bubbles can be seen or heard, there is liquid in the drain port. Tighten the DH200 gland nut to shut the DRAIN and repeat Steps ❷ through ❹ until dry gas blows out of the DRAIN port.

5.5 RELOADING EMBEDDED SOFTWARE INTO FLASH MEMORY

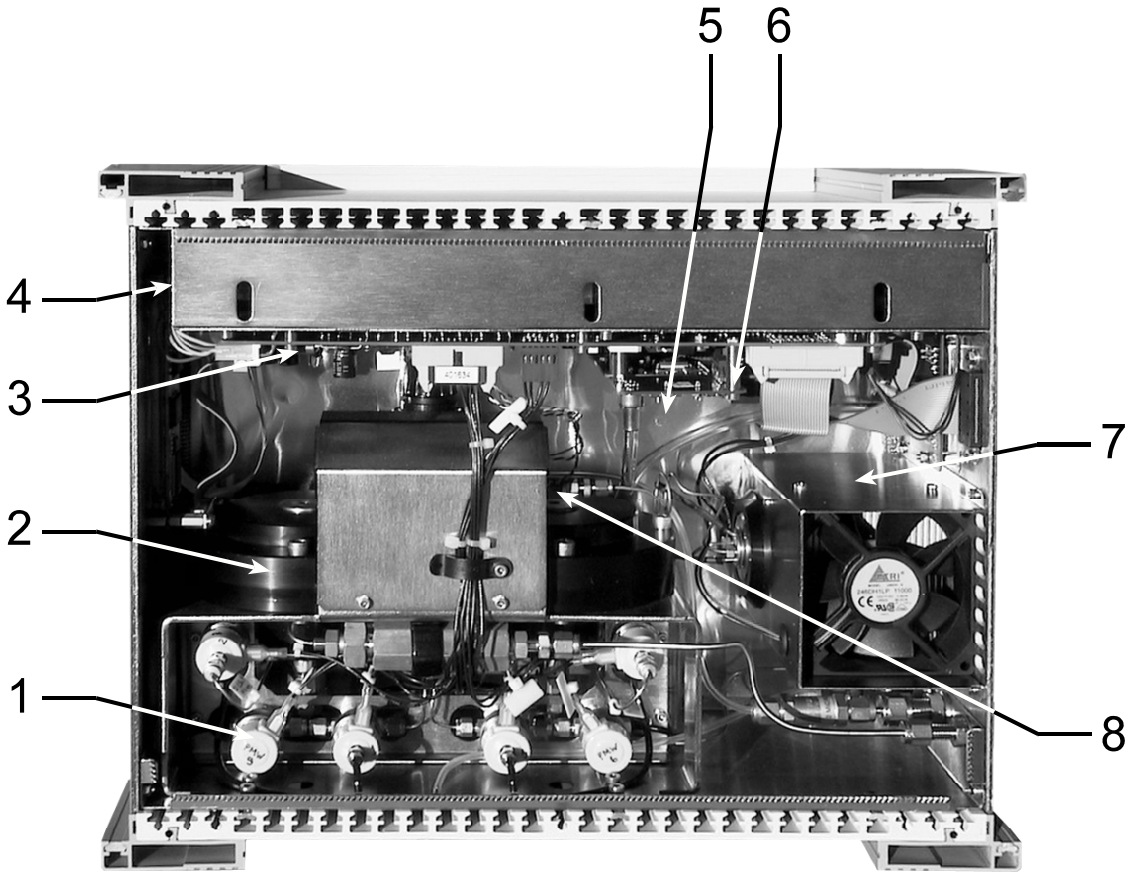
- PPCK+ uses FLASH memory. This allows the embedded software that controls PPCK+ operations and functions to be loaded into PPCK+ over its COM1 port from a personal computer with a simple FLASH loading utility.

- To replace corrupted software or upgrade your software, access the **DHI** worldwide web site at www.dhinstruments.com and go to the "SOFTWARE" section. A FLASH loading utility and the latest PPCK+ software are available for download at no charge. If you do not have access to the web or have difficulty downloading or loading software, contact your normal **DHI** representative or a **DHI** Authorized Service Provider for assistance.

- If the you believe you have discovered an error of "bug" in PPCK+ software, please report it with complete details by email to dhi@dhinstruments.com.

The DHI flash software loading utility and PPCK+ embedded software are available for download from the "SOFTWARE" section of the DHI's world wide web site at www.dhinstruments.com.

5.6 SUBASSEMBLY DESCRIPTION AND LOCATION



1. Low Pressure Pneumatic Module
2. High Pressure Pneumatic Module
3. Driver Board
4. Power Supplies: +5V DC, +12V DC
5. On-Board Barometer
6. Micro Card (behind Barometer)
7. Thermal Pressure Control Unit
8. Reference Pressure Transducer

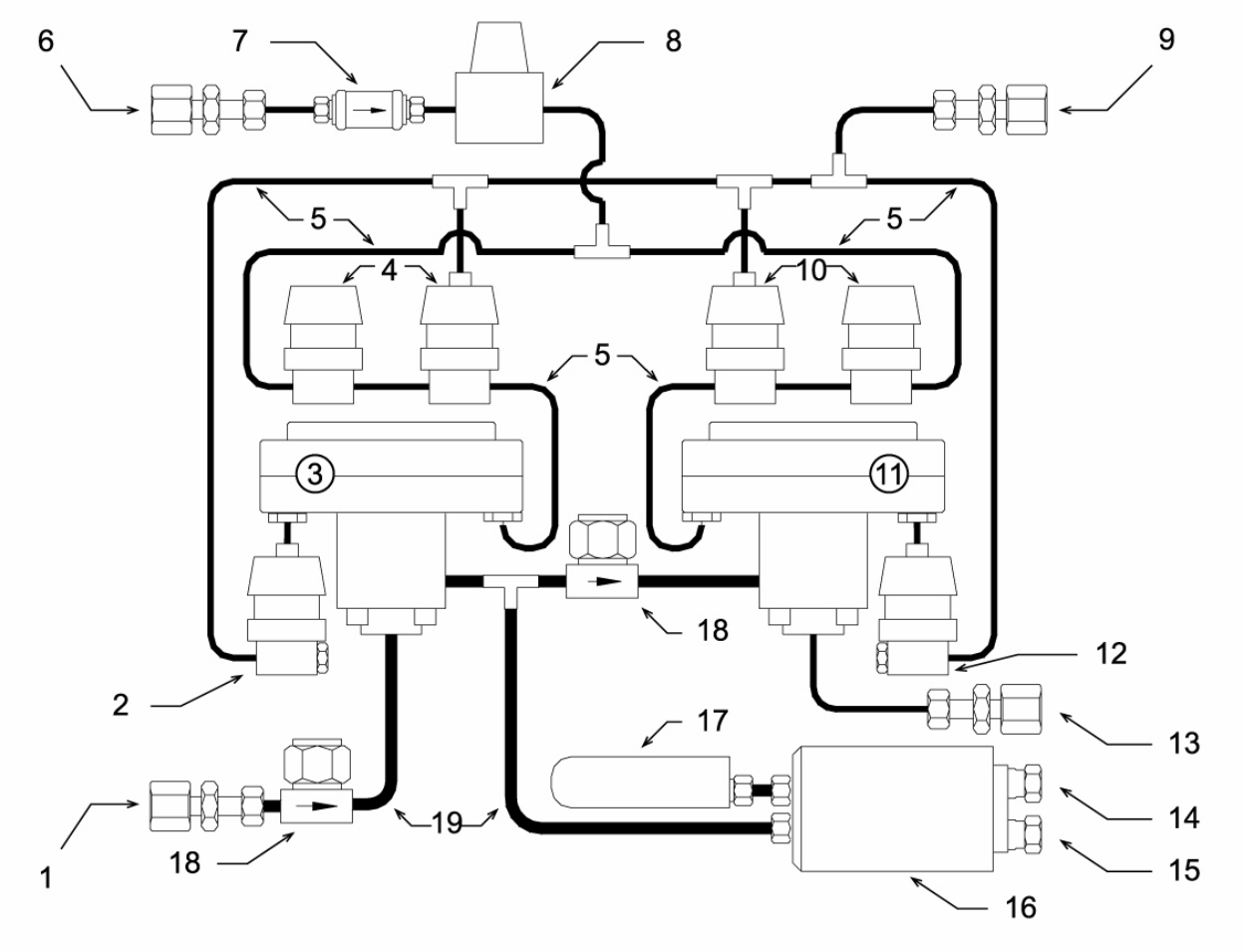
Figure 11. Internal View

5.6.1 LOW PRESSURE PNEUMATIC MODULE

The low pressure pneumatic module is an integrated assembly that includes six solenoid valves and interconnecting tubing (see Figures 11, 12). The function of the low pressure pneumatic module is to precisely control the drive air that actuates the high pressure control valves of the high pressure pneumatic module (see Section 5.6.2).

5.6.2 HIGH PRESSURE PNEUMATIC MODULE

The high pressure pneumatic module is an integrated assembly that includes the high pressure inlet and exhaust valves (see Figures 11, 12). These valves are used for precise high pressure control. They are dome loaded needed valves. The actuating pressure on the dome is controlled by the low pressure pneumatic module (see Section 5.6.1).



1. SUPPLY Port (DH200 F)
2. HP Inlet Valve Dome Exhaust Valve
3. High Pressure Inlet Valve
4 HP Inlet Valve Dome Supply Valves
5. Drive Air Lines
6. DRIVE IN Port (1/8 in. NPT F)
7. Drive Air Filter
8. Drive Air Regulator (factory adj.)
9. DRIVE OUT Port (1/8 in. NPT F)
10. HP Exhaust Valve Dome Exhaust Valves
11. High Pressure Exhaust Valve
12. HP Exhaust Valve Dome Exhaust Valve
13. VENT Port (1/8 in. NPT F)
14. TEST Port (DH200 F)
15. DRAIN Port (DH200 F)
16. Thermal Pressure Control Unit (TPCU)
17. Reference Pressure Transducer (RPT)
18. High Pressure Filter(s)
19. High Pressure Lines

Note: The low pressure pneumatic module is made up of references 2, 4, 5, 6, 7, 8, 9, 10, 12.

Figure 12. Pneumatic Module, High and Low

5.6.3 DRIVER BOARD

The driver board is controlled by the micro card (see Section 5.6.6). It supports the 12 V drivers for the internal and external solenoid valve actuation and the barometer board (see Section 5.6.5). It also supplies power to the cooling fan.

5.6.4 POWER SUPPLIES

- +12 V DC (± 2 %) @ 3.3 Amps: For internal and external valve actuation, thermal pressure control unit (TPCU).
- +5 V DC (± 1 %) @ 3.0 Amps; + 15 V DC (± 3 %) @ 2.0 Amps; -15 V DC (± 3 %) @ 0.35 Amps: For the supply of the micro board and driver board electronics.

5.6.5 ON-BOARD BAROMETER

The barometer board supports a barometric range, micromachined silicon sensor, an ambient temperature sensor and associated electronics. 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. The barometer board includes a memory in which its specific calibration coefficients are stored.

5.6.6 MICRO CARD

The micro card supports a Motorola 68302 microcontroller; EPROM, EEPROM, NVRAM and flash memories; RS232 communications; IEEE-488 communications; the front panel keypad and display control; and a two channel frequency counter for reading the reference pressure transducers. An I/O port controls other boards and devices in PPCK+.

5.6.7 THERMAL PRESSURE CONTROL UNIT (TPCU)

The PPCK+ thermal pressure control unit is used for fine pressure control in dynamic control mode (see Section 3.1.2.3). It is a high pressure volume containing a helicoidal heating element. The TEST and DRAIN ports are machined in to the volume.

5.6.8 REFERENCE PRESSURE TRANSDUCER (RPT)

A PPCK+ has a single reference pressure transducer (RPT) used to measure the high pressure gas the PPCK+ controls. The RPT's basic sensing principle is the measurement of the change in the natural oscillating frequency of a quartz tuning for with temperature and mechanical stress resulting from the change in pressure applied to a connecting bourdon tube. Two independent quartz elements are used: one is subjected to pressure related stress; the other is used only to monitor temperature. Every RPT has three ranges.

6. TROUBLESHOOTING

PPCK+ 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 PPCK+ operation. This troubleshooting guide is intended as an aid in identifying the reason for PPCK+ 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.
Measured pressure display has too much/not enough resolution.	Resolution setting needs to be changed.	Use **[RES]** to change resolution setting (3.2.9).
The pressure units available under the **[UNIT]** function key are not the ones you want.	UNIT function needs to be customized.	Use **[SPECIAL]**, **<3PresU>** to customize the UNIT function (3.2.2) or reset units to default (3.4.4.5, Reset – Units).
Front panel keys seem to be disabled.	**<Remote>** command has been sent from a host computer.	Send **<local>** command from host computer or cycle PPCK+ power (4.4).
Front panel display is dim.	Screen saver option has activated.	Press any key to resume full screen power. Adjust screen saver delay time, if desired (2.4.4.8).
Cannot access certain functions. **>ACCESS RESTRICTED<**	User levels have been set that restrict access to certain functions.	Change user level or consult system manager (3.4.4.6).

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
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 Provider (Table 22).
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 **[CONTROL]** function (3.2.3).
Pressure display is flashing and beeper is sounding.	Current upper limit of active range has been exceeded.	Correct overpressure condition. Change **[UL]** and/or active range if needed (3.2.4, 3.2.1).
Pressure display is flashing, no buzzer is sounding and manual pressure control keys are inactive.	PPCK+ has been overpressured (pressure higher than UL).	Correct the overpressure condition and cycle power ON and OFF (3.2.4, 3.2.4.1).
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 (3.1.2.5, 3.2.6).
Will not set pressure.	Pressure supply(ies) incorrectly connected or not adequate.	Correct pressure supply(ies) (2.3.4).
Will not set pressure.	Valve drive air supply is not connected or too low so high pressure valves are not opening.	Connect valve drive air correctly and/or increase drive air pressure to 700 kPa (100 psi) (2.3.6).
Will not set pressure.	There is a very large leak in the test system or TEST port is not connected.	Correct leak.
Disagreement between transducer ranges appears excessive.	Difference is actually in tolerance and represents *natural* disagreement.	Compare differences observed to tolerances on reference pressure transducer measurements (1.2.2.1).

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 in absolute measurement mode can disagree even after a valid autozero due to ZNATERR.	Check that ZOFFSET value is in tolerance and verify value of ZNATERR (3.4.1, 1.2.2.1, 5.2.6).
Will not accept command to set pressure.	Target exceeds UL and/or current range.	Check UL (3.2.4) and range (3.2.1).
Poor pressure control.	High pressure supply is not of the correct value or excessively unstable.	Connect correct pressure supply, regulate pressure supply, install a pressure accumulator if the action of a booster is causing the pressure supply to fluctuate excessively (2.3.4).
Poor pressure control in dynamic control mode characterized by "hunting" around target.	Thermal Pressure Control (TPC) has incorrectly calculated test volume.	Run Config routine (5.5, 3.1.2.3).
Poor pressure control characterized by control not “locking on” target pressure.	Control mode is set to static rather than dynamic. Behavior is normal.	Use **[CONTROL]** to set control mode to dynamic (3.1.2.3, 3.2.3).
Poor pressure control characterized by *Ready* condition occurring when the pressure is not at the target value.	Control mode is set to static rather than dynamic or control is not active. Behavior is normal.	Use **[CONTROL]** to set control mode to dynamic; use **[ENTER/SET P]** to active pressure control (3.1.2.3, 3.2.3, 3.2.10).
Poor pressure control when setting zero absolute pressure characterized by *Ready* condition occurring when vented at atmospheric pressure.	Pressure setting commands for zero absolute are interpreted as a VENT command because PPCK+ cannot set pressures under atmosphere.	Operation is normal (3.2.10.1).
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 PPCK+ and the test.	Remove the restriction to allow free flow between the PPCK+ and the test.

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Poor pressure control characterized by excessive overshooting and/or undershooting, inability to lock-on target, unstable readings.	PPCK+ is contaminated with liquids.	Purge PPCK+ from the drain. Avoid sources of liquids in the future. Contact Authorized Service Center if purging does not eliminate liquid (5.4, Table 22).
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. Consider using static pressure control if you must work with large leaks present (3.2.8, 3.2.6, 3.1.2.3).
Poor pressure control characterized by very slow slew rate and/or time to *Ready* condition when setting a pressure.	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 characterized by pauses at the start of a pressure setting sequence.	Ten to fifteen seconds are required for the high pressure valve opening routine to execute. During this time, pressure does not change. The control status characters display **<VLV>** flashing.	Operation is normal. Watch the pressure control characters on the main run screen. They indicate **<VLV>** during the valve opening routine (3.1.1, 3.1.2.3).
Poor pressure control characterized a pause of up to 45 seconds while controlling in dynamic control mode while **<CFG>** is flashing a the valve control characters.	PPCK+ has determined that the test volume has changed and is running a new volume determination routine. The routine takes 30 to 45 seconds to execute and should repeat only if the test volume is changed.	Operation is normal.
Apparent inaccurate pressure control/measure and little or no response or nonsensical indication from reference pressure transducer.	Reference transducer destroyed by overpressure.	Contact **DHI** Authorized Service Provider (Table 22).

Table 18. Troubleshooting Guide (Continued)

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Apparently inaccurate pressure measurement/control and **<h>** is displayed on top line of screen.	An unplanned "head" correction is active or head height or gas is incorrect.	Remove or change "head" correction (3.2.7).
Apparently inaccurate pressure measurement/control.	Incorrect pressure units and/or measurement mode (gauge or absolute).	Set desired pressure units and/or measurement mode. Consider reference temperature if unit is inWa (3.2.2).
Apparently inaccurate pressure measurement/control.	Reference pressure transducer calibration coefficients have been altered.	Check and correct calibration coefficients if needed (5.2).
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 (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 (3.2.2).
Will not vent.	VENT port is plugged.	Open VENT port to atmosphere.
Will not vent.	Exhaust valve not operating.	Check that high pressure valve drive air supply is connected and of correct pressure (2.3.6).

NOTES

7. APPENDIX

7.1 DRIVERS

The PPCK+ 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 1 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 401382) for the DRIVERS port is an optional PPCK+ accessory.

Table 20 and Figure 13 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 (+12V)
D		Drivers (+12V)
F		Drivers (+12V)
H		Drivers (+12V)

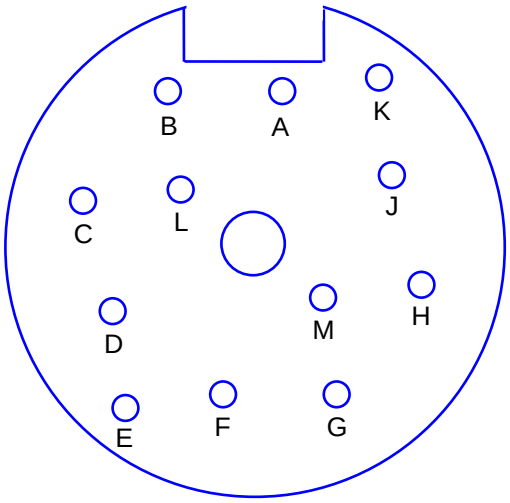


Figure 13. Driver Cable Schematic

7.2 UNIT CONVERSION

7.2.1 PRESSURE

PPCK+ 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 21 provides the conversion coefficients used by PPCK+ to convert numerical values expressed in SI units to corresponding values expressed in other units.

Table 21. 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

7.3 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	PPCK+'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*** 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.
Drive Air	Pneumatic power used to actuate PPCK+'s high pressure valves.
DUT	Device Under Test. The device or devices pneumatically connected to the PPCK+ TEST port that the PPCK+ 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 PPCK+ 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	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 PPCK+ for high accuracy pressure measurement. The RPT in a single RPT PPCK+ or the higher pressure range RPT in a dual RPT PPCK+ is referred to as the Hi or primary RPT. 2. The lower pressure range RPT in a dual RPT PPCK+ 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 PPCK+ 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*** criterion. ***Ready*** if inside stability limit. ***Not Ready*** 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.
Thermal Pressure Control (TPC)	Fine pressure adjustment by heating and cooling the pressurized gas using a thermal pressure control unit (TPCU).
TPCU	Thermal pressure control unit, the assembly used for thermal pressure control.
UL	Same as Upper Limit.
Upper Limit	A range specific maximum value of pressure not be exceeded and at which PPCK+ will abort pressure setting and buzz.

User Level	Levels of security that can be set to protect certain PPCK+ 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.

7.4 WARRANTY STATEMENT

Except to the extent limited or otherwise provided herein, **DH Instruments, Inc.** (**DHI)** 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.

DHI 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 **DHI**, or its Authorized Service Provider, freight prepaid, after receiving authorization from **DHI** or its Authorized Service Provider. The buyer assumes all liability vis-à-vis third parties in respect of its acts or omissions involving use of the products. In no event shall **DHI** 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 **DHI** has been advised of the possibility thereof, and regardless of whether such products are used individually or as components in other products.

Items returned to **DHI** under warranty claim but determined to not have a defect covered under warranty or to not have a defect at all are subject to an evaluation and shipping charge as well as applicable repair and/or calibration costs.

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

The above warranty and the obligations and liability of **DHI** and its Authorized Service Providers exclude any other warranties or liabilities of any kind.

Table 22. DHI Authorized Service Providers

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

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