

HANDHELD PRESSURE CALIBRATOR

OPERATING MANUAL

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Please Note

This manual is intended to support your new multifunction, interchangeable-module, pressure and temperature calibrator. In this manual, for simplicity, the base unit will be referred to as the HHC-1 and the modules will be referred to DLP for dual port low pressure and SPP for single port pressure measurement modules. The RTD temperature interface module is referred to as the RTD-IM module.

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Section 1.0 Introduction

Congratulations! Your purchase of the HHC-1 calibration system equips you to perform a wide variety of pressure and temperature measurement applications. The general pressure and temperature measurement capabilities of the HHC-1 are supplemented by application specific firmware as well as the availability of optional data logging capability.

The HHC-1 is a complete pressure calibration system providing: interchangeable pressure ranges, simultaneous measurement and display of two pressure ranges, measurement and display of current and voltage. The HHC-1 also provides the ability to perform high accuracy temperature measurement. Conversion between temperature and pressure measurement can be done in a matter of seconds and requires no tools.

A standard HHC-1 system consists of a base unit that acts as a host for one or two Quick Select modules. The Quick Select pressure modules are interchangeable and are available in a wide variety of ranges from 0.25 inches of water to 7500 psi. A brief description of the main components of an HHC-1 system follows. In addition, a Quick Select module is available that allows the base unit to work in conjunction with most any standard RTD temperature probe.

Section 3 and its various subsections include all the information needed to begin using the HHC-1 system for basic pressure and temperature measurement. Higher level functions are detailed in later sections of this manual. It is strongly recommended that the pertinent sections of this manual be reviewed prior to using the HHC-1 system for higher level and application specific measurement and test activities.

General Instructions

Important: Failure to follow the instructions provided in this manual may result in personal injury and/or damage to the instrument, accessories, products under test or other equipment

Section 1.1 Base Unit Overview HHC-1

The base unit functions as the host for the Quick Select pressure and temperature module(s). Each base unit includes a keypad, microprocessor based electronics and a two line LCD display. The base unit displays the measurement data transmitted from the

Quick Select module(s). Measurement outputs from two installed Quick Select modules can be simultaneously displayed. Quick Select modules for the measurement of either pressure or temperature can be plugged into either of the 2 module "bays" in the base unit. Pressure engineering units can be independently selected from the library of twelve factory programmed or one operator designated engineering unit. Temperature measurement data can be displayed in degrees Celsius, Fahrenheit, Kelvin or Rankine. In addition, when used with the RTD-IM1 Quick Select module for temperature measurement with an RTD temperature probe, the calibrator system can display the RTD measurement in terms of ohms.

In addition to displaying two pressure measurements simultaneously the operator can elect to display pressure and temperature or the measured value from either of the two installed Quick Select modules as well as either a voltage or mA measurement. This allows for the easy calibration and test of pressure and temperature transducers, transmitters and switches.

The base unit includes a wide variety of general and application specific measurement capabilities. These capabilities allow the HHC-1 measurement and calibration system to be used for basic pressure and temperature measurement as well as application specific pressure measurement activities. Basic pressure and temperature measurement capabilities include; max/min recall, operator programmable tare values, display hold, operator programmable damping and user selected engineering units. Application specific capabilities include; flow velocity measurement, flow volume measurement, leak detection, leak rate quantification and switch testing. Optional data logging, time delayed data logging and programmable alarms are also available.

Section 1.2 Quick Select Modules Overview

The Quick Select pressure module is a calibrated pressure measurement device. Quick Select pressure module units are available in a wide variety of pressure measurement ranges. The Quick Select RTD interface module allows the HHC-1 base unit to provide precision temperature measurement data using standard RTD (Resistance Temperature Detector). The RTD-1IM module allows the HHC-1 to function with most common platinum, nickel and copper RTDs.

The Quick Select module communicates with the base unit via a 10 pin connector. Quick Select pressure modules slide into the base unit automatically aligning the female 10 pin connector on the Quick Select pressure module with the male 10 pin connector in the base unit.

All calibration data is stored in Electrically Erasable Programmable Read Only Memory (EEPROM) resident in the Quick Select module. As such, any Quick Select module can be used in any base unit and the measurement system will provide measurement accuracy in conformance with the published specification.

Section 1.2.1 The DLP-1 Quick Select Pressure Module

DLP-1 Quick Select pressure modules provide specialized low pressure measurement capabilities. DLP-1 Quick Select pressure modules incorporate a micro-machined silicon variable capacitance sensor.

Inside the sensor there is a micro-machined silicon diaphragm. This diaphragm is between two non-moving plates on which metal has been sputtered. The air between the diaphragm and the non-moving plates acts as an insulator.

As pressure or vacuum is applied to the sensor, the diaphragm moves changing the distance between the diaphragm and the fixed plates. This change in distance changes the capacitance of the sensor. It is this variable capacitance that is measured and correlated to pressure or vacuum during the calibration process.

The sensor is connected to an Application Specific Integrated Circuit (ASIC). This ASIC generates a linear signal ramp and applies this signal to the top plate of the sensor while an equal and opposite signal is applied to the bottom plate.

When the measured pressure is balanced, for example, when both ports are opened to atmosphere, the distance between the diaphragm and both of the fixed plates is the same. When this is the case, the signal to the top plate is capacitively coupled to the equal and opposite signal applied to the bottom plate. As a result, no signal current will flow through the center plate (diaphragm). When the diaphragm is moved off center by the application of pressure or vacuum, the excess current flows through the center plate to an input differentiator in the ASIC. The differentiator translates the frequency of the sensor output into a

voltage which is scaled over the full scale range of the instrument. DLP-1 modules are available in ranges from 0.25 inches of water through 200 inches of water. These modules can be configured to provide differential/gauge or compound pressure measurement capabilities. They are designed for use on clean, dry, noncorrosive and nonconductive gases. Contact your supplier for a complete list of available ranges.

Section 1.2.2 The SPP-1 Quick Select Pressure Module

The SPP-1 Quick Select pressure module incorporates a micro-machined piezoresistive strain gauge sensor. This technology takes advantage of the fact that, when put under stress, (as with the flexing of a diaphragm under pressure or vacuum) the resistive properties of a piece of silicon will change. In the manufacturing process resistors are deposited in a silicon substrate. The resistors are typically configured in a wheatstone bridge orientation. When positioned in this fashion, the output will be near zero when no pressure (stress) is applied and will increase in a near linear fashion with the application of pressure or vacuum. The reverse side of the substrate is etched to provide the required diaphragm thickness for the given pressure range.

When power is applied to the sensor the level of resistance across the wheatstone bridge will change in proportion to the level of pressure applied. The output from the sensor is extremely repeatable and has minimal hysteresis due to the fact that the sensor substrate is silicon. The sensor output is then amplified by circuitry within the Quick Select pressure module. The amplified output is then calibrated over the operating range of the module. Calibration coefficients for the module are stored in Electrically Erasable Programmable Read Only Memory (EEPROM) within the Quick Select pressure module.

SPP-1 modules are available in ranges from 5 through 7500 psi. These modules can be configured to provide gauge, compound or absolute pressure measurement, as well as vacuum measurement capabilities. SPP-1 modules in ranges up to 300 psi are designed for use on clean, dry, noncorrosive and nonconductive gases. Optional 316 stainless steel sensor isolation is available for ranges from 0/10 through 0/300 psi. Ranges from 500 psi through 7500 psi are provided with 316 stainless steel isolation as standard. A complete listing of the available SPP-1 modules is available from your supplier.

Section 1.2.3 The RTD-IM Quick Select RTD Interface Module

The RTD-IM1 allows the HHC-1 base unit, when used with RTD temperature probes, to provide precision temperature measurement data. The RTD-IM plugs directly into the Quick Select module bay in the base unit. Any standard RTD probe with a Switchcraft TA4M can be plugged into the Switchcraft TA4F connector on the module. The RTD-IM module comes factory programmed with the curves for Pt 100 (385 & 392), Cu 10 and Ni 120 RTD probes. It supports RTDs with outputs in the range of 0/400 ohms. The RTD-IM2 is supplied factory programmed to support the Pt1000 (385 & 392) RTD. This module will support RTDs through an output up to 4000 ohms. The RTD-IM module can be programmed with coefficients for other RTD probes of interest and specific characteristics of a probe already included in the on-board library can be programmed into the RTD-IM unit to provide enhanced accuracy. Each RTD-IM module can accommodate up to 8 different programmed RTD calibration curves. Programming of the RT module is accomplished via an optional software package and any PC compatible computer with an available standard serial communication port. Contact your calibrator supplier for information on this software package.

Section 2.0 Unpacking & General Care

General instructions for unpacking and calibrator care follow.

Section 2.1 Unpacking Product Upon Receipt

Prior to removing the HHC-1 from the packaging material inspect all cartons for shipping damage. Document any damage evident in the event that a damage claim must be made against the shipper. After inspection, remove the base unit, module(s), manual and any accessories purchased from the packaging material. Retain the packaging for use in returning the HHC-1 to the factory for future recertification or repair.

Section 2.2 Product Storage

The product should be stored in an area that is maintained in the temperature range indicated in the

storage temperature in the product specification. The storage temperature limits are -4 to + 158 degrees Fahrenheit. Storage of product in environments that will exceed these temperature limits results in significant risk of product damage. It is recommended that the product not be left in closed cars or truck cabs as temperature damage can easily occur due to the "greenhouse effect" of closed vehicles or extreme cold temperatures that can result from winter conditions.

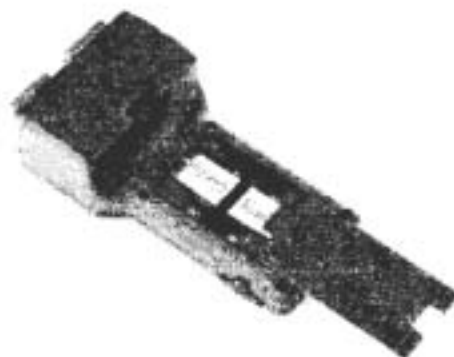
Section 2.3 Product Cleaning

The enclosure of the calibrator is not watertight. As such, care should be taken during cleaning to assure liquid does not penetrate the enclosure for the base unit or Quick Select modules. Cleaning of the product should be done with a cloth moistened with a warm, mild detergent mixture.

Section 3.0 System Start-Up General Instructions

The HHC-1 can perform a wide variety of simple and complex temperature and pressure based measurement, test and calibration operations. Due to the menu driven set up procedures the system can be quickly and easily configured for most any of its measurement functions. By following the steps in this section you can be ready to use your HHC-1 to perform basic pressure and temperature measurement functions in a matter of minutes.

Section 3.1 Battery Installation



Step 1 To gain access to the battery compartment, remove the bottom end of the strap assembly by detaching the Velcro connection and pulling the bottom end of the strap from the retaining pin in the bottom of the case of the base unit.

Step 2 Open the battery compartment by sliding the battery enclosure cover out of the compartment opening. To do this press down on the circular, ribbed indentation on the battery cover while pushing the enclosure cover outward with pressure on the two standoffs located near the pin used to retain the strap on the base unit.

Step 3 Note the polarity information for installation of the two 9 volt alkaline batteries as outlined on the inside of the battery enclosure.

Step 4 Locate the two 9 volt batteries and the foam retaining spacer provided in a small plastic bag. Install these batteries as shown on the diagram in the battery enclosure. The HHC-1 will operate for approximately 30 hours on the two 9 Vdc batteries. Alkaline batteries are recommended for use in the HHC-1 system.

Step 5 Insert the retaining spacer between the two 9 volt batteries. This will insure that the batteries will not disconnect or be shaken loose during normal operation.

Step 6 Replace battery compartment cover by sliding cover back into position until it locks in place.

Step 7 Replace strap by threading strap through the opening, starting closest to the battery compartment and reattaching Velcro. The strap may be adjusted in this fashion to provide for proper strap length to accommodate any hand size.

An optional AC adapter is available for line powered operation of the HHC-1 system.

Section 3.2 Installation of Quick Select Module in a Vacant Sensor Bay

Caution: Quick Select modules should be installed with the power off on the base unit. Failure to turn the base unit off prior to changing pressure measurement modules could damage the instrument or sensor electronics or "lock up" microprocessor operation. If power is inadvertently left on and the base unit locks up (loses communication) after changing Quick Select modules, simply power down the unit and restart.



Refer to Section 3.5 for the procedure to remove a Quick Select module.

To insert a Quick Select module follow the process below.

Step 1 Make certain the power is off on the base unit.

Step 2 Hold the base unit, in one hand, with the keypad side down.

Step 3 Holding the Quick Select module to be installed in the other hand, align the module with the locking tab up, with the sensor bay on the base unit.

Step 4 Slide the Quick Select module into the sensor base until the retaining/release tab pops into the square cutout in the sensor bay of the base unit. This will lock the Quick Select module into the base unit.

Step 5 Installation of the Quick Select module is now complete. If an RTD-IM RTD interface module is to be used plug the desired RTD probe into the connector on the Quick Select Module. To set up the HHC-1 and RTD-IM combination to the desired temperature measurement parameters proceed to Section 16.

Important Note:

If only one module is to be used, install the Quick Select System Protection module provided. Follow the same procedure to install the system protection module as that used for a standard pressure measurement module. Both sensor bays of the base unit should contain a Quick Select module to protect from dirt or other debris getting into the base unit assembly. If only one Quick Select pressure module is needed install the System Protection Module supplied with your unit at the time of shipment when using the HHC-1 system.

Section 3.3 Starting-Up the HHC-1 System

After the desired Quick Select pressure module(s) or Quick Select temperature measurement interface module and probe has been installed the HHC-1 can be started up as follows:

Turn the system power on by pressing the on/off key on the instrument's key pad.

ON
OFF

During the start up process the HHC-1 will display the following information:

First Screen

MFG Datexx/x/xx

Second Screen

Property of "—"

(You can enter your name for display during start-up by selecting "owner" from the setup menu. Details on entering owner information are included in Section 3.4.5.)

Third Screen

Range Range
xx EngUnit xx EngUnit

The range indication is provided in the primary engineering unit for each installed Quick Select module. Upon initial power up an HHC-1 used with an RTD-IM1 temperature module and probe will default to displaying the ohms (resistance value) for the probe. Once set up this combination will default to the previously used temperature measurement unit, such as Celsius, Fahrenheit, Kelvin or Rankine. The primary engineering unit for a given Quick Select pressure module, along with the measurement range, is included on the module label. The information on the left side of the display corresponds with the Quick Select module installed in the left sensor bay and information on right side of the display corresponds with the Quick Select module installed in the right sensor bay. If only one sensor is installed the corresponding side of the display will indicate "no module" on power up.

After the third screen the HHC-1 will commence providing pressure measurement data. The format for display of the measurement data is as follows:

Eng Unit Eng Unit (primary engineering unit)
+ XX.XXX + XX.XXX (measured value with sign)

When only one module is installed, the side of the display corresponding to the side of the base unit that does not have a module will display "-----"

If necessary, the HHC-1, used with a Quick Select pressure module, may be zeroed by pressing the Zero key prior to beginning measurement activities. Additional details on zeroing the HHC-1 system are provided in Section 6.0 of this manual.

The HHC-1 is now ready for basic pressure or temperature measurement. Simply connect the pressure port(s) of the Quick Select pressure module(s) to be used to the pressure source to be measured. If a gauge pressure measurement is to be made using a differential Quick Select pressure module be sure to connect the pressure to be measured to the high pressure port on the Quick Select pressure module. For temperature measurement, connect the RTD probe to be used to the Switchcraft connector on the interface module and proceed to Section 16.1 for instructions on setting up the calibrator for temperature measurement.

Section 3.4 Optional System Start Up Procedures

There are additional set up operations that can be performed to increase the overall capabilities of the HHC-1 system; these include:

- 1- Auto off function to protect from inadvertently leaving the HHC-1 system on.
- 2- Setting up battery level indication so that an estimate of the remaining battery life can be viewed at the push of a button.
- 3- Programming the current date and time for use in date stamping data logged pressure values and starting delayed data logging activities on HHC-1 systems with the optional data logging capability. **Current date and time information is only maintained in units with the data logging option.**

- 4- Programming owner/operator information for display on the HHC-1 to facilitate tracking of in-house instrumentation.

The following subsections provide information on the above listed start up procedures.

Section 3.4.1 Auto Off- Battery Save Function (BatSave)

The HHC-1 can be set up to automatically turn itself off if no keypad activity is detected for a 10 minute time period. This capability will protect the two 9 volt batteries from being depleted if the HHC-1 is left on inadvertently.

The following procedure is used to activate or disable the battery save function.

Step 1 With the HHC-1 on and reading pressure press the SET UP key.

**SET
UP**

Step 2 Using the arrow keys select the battery save function (designated BatSave in the set up menu). When selected, the text "BatSave" will flash on the display.

**BatSave PerCent
UserEng H2Oref**

Step 3 With the "BatSave" text flashing press the enter key.

ENT

Step 4 Using the left or right pointer select Disable or Enable, as desired. When selected the text will flash.

**Auto shut off
Disable Enable**

Step 5 With the word "Enable" flashing press enter to activate the battery save function.

ENT

If Enable is selected the HHC-1 will automatically turn off if there is no keypad activity detected for a period of 10 minutes. If Disable is selected the HHC-1 will remain on continuously until the battery voltage is no longer sufficient to power the system. The battery save mode selected is stored in Electrically Erasable Programmable Read Only Memory

(EEPROM). As such it does not require reprogramming on power up.

Note: An optional AC adapter is available for long term continuous measurement activities.

Section 3.4.2 Set Up for Battery Charge Level Indication

If the battery check function is set up the HHC-1 can provide an estimate of the remaining battery life. This estimate is expressed as a percentage of the expected 30 hour life of newly installed alkaline batteries. Use of non-alkaline, lithium or rechargeable batteries will render the life expectancy estimate inaccurate.

To have the capability to check the estimated remaining battery life follow the steps below.

Step 1 Press the ON/OFF key on the keypad to turn the power on to the base unit.

**ON
OFF**

Step 2 With the HHC-1 on and reading pressure press the battery check key, designated BAT CK.

**BAT
CK**

In response the HHC-1 will display:

**+X.XXV +90%
XXXXXXXXXXXXXX**

where:

XXXXXXXXXXXXXXXXXX is a bar graph representation of the remaining battery life and +X.XXV represents the voltage level of the installed batteries.

Step 3 After installation of new batteries use the right pointing arrow key to index the bar graph to 100%.

>

Step 4 After the bar graph has been refreshed press the enter key.

ENT

Note: An optional AC adapter is available for long term continuous measurement activities.

Section 3.4.3 Low Battery Icon

The HHC-1 provides advanced warning of a low battery condition. The icon, which looks like a miniature battery will appear and flash in the center of the top line of the display when the measured battery voltage drops to 5.7 Vdc. The calibrator will continue to function properly with the low battery icon flashing. To ensure uninterrupted measurement capability it is recommended that the batteries be replaced as soon as possible after the low battery icon appears. When the measured voltage drops to 5.5 Vdc, the low battery icon will flash on the display and the calibrator will turn itself off after 15 seconds. If the measured voltage drops to 5.4 Vdc the calibrator will not allow power up.

Summary of low battery warnings:

- 5.7 Vdc: Low battery icon appears
- 5.5 Vdc: Low battery icon remains on display, unit powers down after 15 seconds.
- 5.4 Vdc: Power up not allowed

It is estimated that the user will have between 45 and 60 minutes of battery life remaining when the low battery icon initially appears. Actual battery life remaining will vary based on tasks being performed and ambient operating temperature.

Section 3.4.4 Programming Date & Time Information

If the unit does not have the Data Logging option skip this section. The date/time function supports date/time recording capability that can be used in association with the Data Log option.

Note: HHC-1 units without the Data Logging option have no requirement for the date time tracking and will not keep track of the date and time when powered down.

For various application oriented functions the use of a real time clock will be required. Setting the real time clock is a simple process and should be done when the HHC-1 is received.

The real time clock may be set by following these steps:

Step 1 With the HHC-1 on and reading pressure press the SET UP key.

**SET
UP**

Step 2 Using arrow keys move through the menu selections and select "Date/Time" on the LCD display. Date/Time will flash on the display when selected.

Owner Alarm
Date/Time RS232

Step 3 With the words "Date/Time" flashing press the enter key.

ENT

This will activate the date time setup screen that looks as follows:

YYMMDDHHMMSS
XXXXXXXXXXXX

where:

YY = the last 2 digits of the current year
MM = the month (01 for Jan. through 12 for Dec.)
DD = the day of the month

(01-31 depending on day and month)

HH = the current hour using military time where:

0800 = 8:00 AM
1200 = noon
1500 = 3 PM
2000 = 8 PM

MM = minutes (from 0 to 60)

SS = seconds (from 0 to 60)

Setting the current date and time is accomplished by using the keys with the corresponding numerical values.

From left to right enter the appropriate number in each of the field positions using the numeral keys. Once a given field has the appropriate number centered the HHC-1 will automatically index to the next position for entry.

When completed the date/time information should look as follows:

YYMMDDHHMMSS
961003111500

For a date/time of October(10), 3rd day (03), 1996 (96) at a time of 11:15 AM (1115), and 0 seconds (00).

When the correct time/date information has been entered and appears on the display press the enter key to store the time/date information in memory.

ENT

Section 3.4.5 Input of Owner/Operator Information

Time/date information is stored in battery backed up Random Access Memory (RAM). This information should only need to be changed or reentered when a time change has occurred, the HHC-1 is to be used in a different time zone than the one in which it was in during initial setup or when the lithium battery used to back up the RAM needs replacement (every 1-2 years depending on the environmental conditions under which the HHC-1 is used). RAM memory is only supplied if unit is purchased with data logging option. Time/date information is not maintained in HHC-1 units without data log option.

The HHC-1 has the ability to display, on power up, the name of the individual, department or company responsible for its use or maintenance.

The following steps are to be followed to input user (owner) data.

Step 1 With the HHC-1 on and reading pressure press the Set Up key, designated SET UP.

**SET
UP**

Step 2 Using the arrow keys, select the Owner function from the setup menu. When selected the word "Owner" will flash on the display.

**Owner Alarm
DateTime RS232**

Step 3 With the word "Owner" flashing press the enter key.

ENT

Step 4 After pressing ENT the display will read:

**Access code?
.00000**

Step 5 A five digit owner access code was provided with your instrument at the time of shipment. Use the number keys on the HHC-1 to enter the Owner

Access Code from left to right.

**Access code?
12345**

Note: Two passwords were provided with your HHC-1. One password provides access to the owner programming field and the other provides access to the calibration data and recertification programming. Please be certain to select the correct password. These passwords are not interchangeable.

If, at any time during the entry process you enter a number in error, press the CE key to clear the entry and restart the access code entry process.

If the password codes have been lost, contact your calibrator supplier. The serial number of the base unit is required for the factory to provide product password information.

Step 6 With the proper access code displayed press the enter key.

ENT

If an incorrect access code is entered the HHC-1 will respond:

Access denied

To restart the entry process after the "access denied" response reenter the owner set up function through the setup menu.

Step 7 After entry of the proper access code the display will read:

**Enter owner name
xxxxxxxxxxxxxxxx**

To enter a new owner name use the up and down arrows to scroll through the alphanumeric entries and the left and right arrows to move the active entry field (cursor) to the next location.

A blank can be inserted by using the down arrow with the letter "A" flashing on the display. Continuing to press the down arrow after the blank appears will provide access to numerical values starting at 9 and decreasing to zero. The label may contain alphabetical, numerical or a combination of both types of entries.

To review:

Up/down arrows provide access as follows:

0, 1, 2, 3, 4, 5,

6, 7, 8, 9, —, A,

B, C, D, E, F, G,

H, I, J, K, L, M,

N, O, P, Q, R, S,

T, U, V, W, X, Y, Z

By maintaining pressure on the up/down arrow the displayed number or letter will continue to change until the last character has been reached.

By pressing and releasing the up/down arrow a single step from letter or number can be accomplished.

The left/right arrow keys allow for entry of alpha numeric data in any of the available positions.

Step 8 After the desired operator information has been keyed the display will look as follows:

Enter owner name

JOHN Q OPERATOR

Step 9 After the desired owner/user information has been entered and is displayed press the enter key.

ENT

The HHC-1 will respond:

JOHN Q OPERATOR

Ent – OK CE – Cancel

Step 10 To store the owner/user information displayed press the enter key. Pressing the CE key will return the HHC-1 to the pressure measurement mode. If entry of new owner information is still required restart the process as outlined in steps 1-9 above.

Owner information is stored in Electrically Erasable Programmable Read Only Memory (EEPROM). This information should only need to be changed or reentered when the owner/user changes.

Section 3.5 Removing Quick Select Pressure or Temperature Modules

Changing Quick Select pressure modules, therefore changing the measurement ranges in use, is quick and easy. Simply follow the steps below to change Quick Select pressure modules.

Step 1 Using the on/off key on the keypad of the base unit turn the power to the base unit off.

ON
OFF

Step 2 With one hand, hold base unit keypad side down and press down on the square retaining tab located near the upper strap pin on the bottom of the base unit.

Step 3 Maintain pressure on the retaining tab and with your other hand firmly grasp the pressure manifold that extends from the end of the Quick Select pressure module and slide the module out of the sensor bay.

Important Note: Both sensor bays of the base unit should contain a pressure module to protect from dirt or other debris getting into the base unit assembly. If only one Quick Select pressure module is needed install the System Protection Module supplied with your unit at the time of shipment.

Section 4.0 Key Function Overview

The HHC-1 has a great deal of functionality. Many of the product capabilities are activated by dedicated keys on the keypad. Other functions are either activated or set up through a set up menu activated by pressing the set up key. A brief overview of the function of each key follows.

Key Designation	Function
ON/OFF	Turn unit on and off.
SET UP	Provides access to set up functions for various on-board firmware functions/capabilities.
PORT SEL	Used to select displayed measurement data. Selection includes: reading pressure from either one or both installed sensors as well as selection of reading pressure and electrical measurements simultaneously. (See Section 5.0 for details.)
ZERO	Provides ability to zero, either one or both, Quick Select Modules. (See Section 6.0 for details.)

Key Designation	Function
BAT CK	Provides graphical representation of remaining battery power levels. (See Section 3.4.2 for details.)
*ENG UNIT	Used to select desired engineering unit from the following: psi, inHg, inWC, ftSW, Bar, mBar, kPa, Mpa, mmHg, cmWC, mmWC, kgcm, user. Where "user" is an operator programmable engineering unit, allowing the display of any single engineering unit not included in the above list. (See Section 8.0 for details.)
MIN/MAX	Displays the minimum and maximum pressure values measured. (See Section 11.0 for details.)
TARE	Allows for subtraction of an operator selected value from the displayed pressure measurement value for one or two Quick Select pressure modules. (See Section 9.0 for details.)
FLOW	Provides ability to measure the flow of a gas in terms of velocity or volume. (See Section 14.0 for details.)
*LEAK	Allows testing for leaks in terms of pressure decay over time or in terms of leak rate. (See Section 15.0 for details.)
DATA LOG	Provides set up capability for manual or (OPTIONAL) automated data logging. (See Section 21.0 for details.)
DATA STORE	Provides ability to store measured (OPTIONAL) pressure at the push of a key when HHC-1 is used in manual data logging mode. (See Section 21.3 for details.)
HOLD	Freezes the displayed pressure and electrical measurements. (See Section 10.0 for details.)

Key Designation	Function
^	Moves cursor up.
*TRIP DETECT	Provides access to pressure switch testing firmware. (See Section 17.0 for details.)
<	Moves cursor to the left.
*DAMP	Activates or disables damping used to smooth displayed pressure measurement data from the effects of low level pressure transients. (See Section 12.0 for details.)
>	Moves cursor to the right.
CE	Clears previous entry.
mA/V	Changes electronic measurement display from mA to V or V to mA and can also be used to deactivate either side of the display. (See Section 7.0 for details.)
v	Moves cursor down.
*%	Converts display from pressure units to % of f.s. (See Section 13.0 for details.)
ENT	Enters input data.

Notes on key functions:

* These functions require data input through activation of appropriate input fields in the setup menu. Examples of required input data include:

For Damping: Level of damping desired.

For Engineering Unit Selection: Water reference temperature or user (non library) engineering unit entry can be selected.

For Leak: Type of measurement (leak rate vs pressure decay), time to monitor and for leak rate applications the volume of the vessel to be monitored.

For % Readout: Input zero and span, output zero and span and device type (I/P, P/I, P/P, P/E).

The required data is input through the set up functions provided by the corresponding menu options accessed and available by pressing the setup key.

Complete details of each of the above outlined capabilities is included in the section referenced after the function summary provided above.

Section 5.0 Port Select Function

The Port Select Key, designated PORT SEL, provides the ability to select either of the two installed Quick Select modules for display, both modules for display or either a pressure/temperature module on one side and a current or voltage measurement on the other side of the display. For example, if the HHC-1 has two pressure modules installed and is reading in psi the standard display for dual pressure readout would be:

psi psi
+ 123456 + 123456

Pressing the Port Select key once will result in the following display change:

psi mA
+ 123456 + 1.234

Pressing the Port Select key a second time will result in the following display change:

mA psi
+ 1.234 + 123456

Pressing the Port Select key a third time will result in the display returning to a dual pressure readout mode. As seen below:

psi psi
+ 123456 + 123456

If the HHC-1 has a temperature measurement interface module installed the same type of sequence would be followed. For example, if the HHC-1 had an RTD interface module installed in the left sensor bay the following sequence would be observed as a result of pressing the PORT SEL key.

°F psi
+ 72.35 + 123456

Pressing the Port Select key once will result in the following display change:

°F mA
+ 72.35 + 1.234

Pressing the Port Select key a second time will result in the following display change:

mA psi
+ 1.234 + 123456

Pressing the Port Select key a third time will result in the display returning to a readout mode featuring the measurement data from both of the installed modules. As seen below:

°F psi
+ 72.35 + 123456

See 8.4 for display of pressure in two different engineering units.

See Section 7.0 for display of voltage measurement data.

Section 6.0 Zero Function

This section applies to pressure measurement only. The zero function does not apply to the function of temperature measurement. The tare capability will function in conjunction with temperature measurement modules. This allows for the subtracting of a displayed or operator entered temperature value from the displayed temperature measurement data. See Section 9.0 for information on the tare function.

Pressing the zero key when two Quick Select pressure modules are installed and displayed will simultaneously zero both pressure modules. In addition, each module can be zeroed independently, as outlined in the following section.

Section 6.1 Zeroing One of Two Installed Quick Select Pressure Modules

If zeroing one of two installed sensors is desired the following process should be followed:

In this example we will assume that the left pressure sensor is to be zeroed and the right sensor module is to be unchanged.

Step 1 Press the port select the number of times required (one or two) to deactivate the display of pressure on the side that you wish *not* to re-zero.

**PORT
SEL**

When set up in accordance with the requirements of this example the HHC-1 will have the following information on the display:

psi mA
+ 12345 + 1234

Step 2 With the pressure display deactivated for the side that is not to be zeroed press the zero key.

ZERO

The HHC-1 will respond by displaying:

psi mA
+ 00000 + 1234

Step 3 To resume the display of pressure measurement data, for the pressure sensor not zeroed, press the port select key the required number of times (one or two) to restore the dual pressure display.

When complete the HHC-1 will display:

psi psi
+ 00000 + 12345

Normal pressure measurement activity can now be resumed.

Section 7.0 Displaying Current and Voltage Measurements

As outlined in the previous section the port select (PORT SEL) key is used to select the information seen on the display.

The display configurations available are:

Left Side of Display	Right Side of Display
pres/temp	pres/temp
pres/temp	electrical measurement
electrical measurement	pres/temp

The pressure/temperature value on the display corresponds with the measured value of the Quick Select module installed in the sensor bay on the corresponding side of the calibrator.

To read a current or voltage follow the steps below.

Step 1 With the HHC-1 on and reading pressure/temperature set the display as outlined in Section 5.0 to display the pressure measurement of the desired sensor.

Step 2 With the pressure measurement, for the desired module, displayed on one side and the electronic measurement on the other press the mA/V key until the desired electrical measurement parameter appears. For example, with a pressure module installed in the left sensor bay, pressing the mA/V key will produce the following results:

First display when electronic measurement is initiated through the port select function:

psi mA
+ 123456 + 1.234

Result from pressing mA/V key first time:

psi ———
+ 123456

Result from pressing mA/V key a second time:

psi volts
+ 123456 + 1.234

Result from pressing mA/V key a third time:

psi mA
+ 123456 + 1.234

Using the combination of the port select function and the mA/V function any combination of electrical measurements and pressure measurements can be produced.

Section 8.0 Engineering Unit Selection-Pressure Measurement

The HHC-1 is factory programmed to provide pressure measurement in 12 engineering units. These include; psi, inches of mercury, inches of water, feet of sea water, bar, mbar, kilopascal, megapascal, millimeters of mercury, centimeters of water, millimeters of water and kilograms per square centimeter.

Pressure measurement data may also be displayed in a user programmable non-library engineering unit. Section 8.2 Programming a Custom (User) Defined Engineering Unit provides complete details on setting up an operator defined engineering unit.

Inch, centimeter and millimeter of water engineering units may be set up for conversion at temperatures of 4 degrees and 20 degrees C or 60 degrees F. Consult Section 8.5 H₂O Reference Temperature Selection to program the desired temperature for inches or centimeters of water conversions.

Section 8.1 Selecting a Factory Programmed Engineering Unit

To select an engineering unit from the on-board library follow the steps below:

Step 1 With the HHC-1 on and displaying pressure measurement data press the engineering unit key. This key is designated ENG UNIT.

**ENG
UNIT**

The HHC-1 will respond by displaying the engineering unit library as follows:

first screen:

psi inHg,inWCftSW
Bar mBar kPa mPa

second screen:

mmHgcmWCmmWCKgcm
user

The engineering unit abbreviations correspond to the following engineering units:

psi:	pounds per square inch
inHg:	inches of mercury
inH2O:	inches of water column*
ftSW:	feet of sea water
Bar:	bar
mBar:	millibar
kpa:	kiloPascals
mPa:	megaPascals
mmHg:	millimeters of mercury
cmWC:	centimeters of water column*
mmWC:	millimeters of water column*
kgcm:	kilograms per square centimeter
user:	user programmable engineering unit (see Section 8.2 for details)

*Conversion factor is programmable for temperature. Consult Section 8.5 for details.

Step 2 Using the left/right and up/down arrow keys select the desired engineering unit. When selected, the text for the desired engineering unit will flash.

psi inHg,inWCftSW
Bar mBar kPa mPa

In the above example mBar is the selected unit.

Step 3 With the desired engineering unit flashing press the enter key.

ENT

The calibrator will respond by displaying the pressure measurement(s) in the newly selected engineering unit. If two Quick Select pressure modules are installed the output of both will be displayed in the selected engineering unit. The HHC-1 can also display the measurement data of two installed Quick Select pressure modules in independent engineering units. Section 8.4 provides the set up procedures for dual sensor dual engineering unit operation.

Section 8.2 Setting up a Custom or User Defined Engineering Unit

The HHC-1 has a user programmable engineering unit available. This allows for the display of pressure measurement data in an engineering unit that is not in the library of the HHC-1. Any unit of pressure measurement that is linearly proportional to pressure change can be programmed for use in the user engineering unit field.

For this example, the pressure measurement unit of mSW (meters of sea water) will be used as the desired user engineering unit. To set the user engineering unit to provide pressure measurement data in mSW follow the steps below.

Step 1 With the HHC-1 on and reading pressure press the key designated SET UP.

**SET
UP**

Step 2 Using the arrow keys select the User engineering unit option displayed as "UserEng". The text "UserEng" will flash when selected.

BatSave PerCent
UserEng H2Oref

Step 3 With the text "User Eng" flashing press the enter key.

ENT

Step 4 After pressing the enter key the HHC-1 will respond by displaying:

Conv from psi
.000000

Step 5 Enter the conversion factor required to convert from psi to the engineering unit desired. For conversion from psi to mSW the conversion factor is 0.684482. Enter 6 digits to provide the required resolution to support the accuracy of the HHC-1. A complete list of conversion factors is provided in Appendix A.

Use the number keys to enter the desired conversion factor, entering the required factor from left to right. For our example of mSW the conversion factor is 0.684482 and the display should read:

Conv from psi
0.684482

If an incorrect conversion factor is entered press the clear entry key, designated CE, to re-initiate the entry process for the correct factor.

Step 6 When the correct numerical value appears on the display press the enter key.

ENT

After entering the conversion factor the HHC-1 will respond by displaying:

Enter unit's name

Step 7 Enter the name of the engineering unit selected, abbreviated to 6 characters or less. For our example mSW is a 4 character abbreviation for meters of sea water. This abbreviation will fit in the 6 digit field. To enter the mSW engineering unit label use the up and down arrow keys to increment or decrement through the alphabet/numerical values and the left and right arrows to move the active entry field (cursor) to the next location.

If needed for the desired engineering unit, a blank can be inserted by using the down arrow with the letter A flashing on the display. Continuing to press the down arrow after the blank appears will provide access to numerical values starting at 9 and decreasing to zero.

The label may contain alphabetical, numerical or both types of entries.

To review:

Up/down arrows provide access as follows:

0, 1, 2, 3, 4, 5,
6, 7, 8, 9, _, A,
B, C, D, E, F, G,
H, I, J, K, L, M,
N, O, P, Q, R, S,
T, U, V, W, X, Y, Z

By maintaining pressure on the up/down arrow the display number or letter will continue to change until the last character has been reached.

By pressing and releasing the up/down arrow a single increment or decrement between letters or numbers can be accomplished.

The left/right and up/down arrow keys allow for entry of letters or numbers in any of the available label positions.

Step 8 For this example, after the engineering unit label has been keyed the display will read:

Enter unit's name
mSW

Step 9 With the desired engineering unit label displayed press the enter key.

ENT

After the enter key has been pressed the HHC-1 will resume normal pressure measurement in the original engineering units. Instructions on how to use the custom engineering units are provided in the following section.

Section 8.3 Using A Custom Engineering Unit

After a custom engineering unit has been programmed it may be used by following the steps below. For information on programming a custom engineering unit refer to Section 8.2 Setting up a Custom or User Defined Engineering Unit.

To display pressure measurement data in the user engineering unit:

Step 1 With the HHC-1 on and measuring pressure press the engineering unit key, Designated ENG UNIT on the keypad.

**ENG
UNIT**

The HHC-1 will respond by displaying:
first screen:

psi inHg,inWCftSW
Bar mBar kPa mPa

second screen

mmHgcmWCmmWCkgcm
user

Step 2 Using the left/right and up/down arrow keys select the word "user". When selected the word "user" will flash.

mmHgcmWCmmWCkgcm
user

Step 3 With the word "user" flashing press the enter key.

ENT

The HHC-1 will respond by displaying pressure measurement data in the following display format:

u_mSW u_mSW
xxxxxx xxxxxx

where:

u_ indicates that the engineering unit in use is a user defined unit with a label of mSW

xxxxxx represents the current pressure measurement(s) in the user engineering unit.

See Section 8.4 Display of Two Engineering Units for information on how to simultaneously display the measured values from two Quick Select pressure modules in different engineering units.

Section 8.4 Display of Two Engineering Units

The HHC-1 can display pressure measurement data from two installed Quick Select pressure modules in independent engineering units. To display two different engineering units simultaneously the following procedure should be followed.

Step 1 With the HHC-1 on and displaying pressure measurement data from two Quick Select pressure modules press the engineering unit key, designated ENG UNIT on the keypad.

**ENG
UNIT**

Step 2 Using the arrow keys select either of the two desired engineering units. For this example we will select psi as one of the desired units.

With psi selected the text "psi" will flash on the display and the display will look as follows:

psi inHg,inWCftSW
Bar mBar kPa mPa

Step 3 Press the enter key to select psi.

ENT

The HHC-1 will respond by returning to the pressure measurement mode and will display the measurement data for both Quick Select pressure modules in psi, as follows:

psi psi
+ 12345 + 12345

Step 4 Next, press the port select to deactivate the display of pressure measurement data on the side that you wish to maintain pressure measurement in terms of psi. A pressure display is deactivated when the corresponding side of the display contains milliamp (mA) data, Voltage (V) data or is blank "-----".

See Section 5.0 for details on the port select function.

In this case we will assume that the right side will remain in psi and our goal is to present the measurement data from the left Quick Select pressure module in terms of mmHg.

Pressing the port select one time will deactivate the left pressure display converting it to a mA measurement field. Pressing the port select a second time will deactivate the right side, converting it to a mA measurement field and returning the left side of the display to the function of pressure measurement.

Since we want the right side to remain psi we will deactivate it in the psi mode by pressing the port select key once.

**PORT
SEL**

The HHC-1 will respond with the following display:

psi mA
+ 12345 + 1234

Step 5 With the right side deactivated from pressure measurement activities press the engineering unit key, designated ENG UNIT on the keypad.

ENG
UNIT

The HHC-1 will respond by displaying:

psi inHg,inWCftSW
Bar mBar kPa mPa

Using the arrow keys select the desired engineering unit for the left side. In this example we have opted for the engineering unit of Bar. With the Bar engineering unit selected the display will look as follows with the text "Bar" flashing:

psi inHg,inWCftSW
Bar mBar kPa mPa

Step 6 With the desired engineering unit selected (flashing) press the enter key.

ENT

The HHC-1 will respond by displaying the following:

Bar mA
+ 12345 + 1234

Step 7 Reactivate the right side of the display for pressure measurement by pressing the Port Select key, as required.

First press of the port select key.

PORT
SEL

HHC-1 will respond by displaying the following:

mA psi
+ 1234 + 123456

Second press of the

PORT
SEL

HHC-1 will respond by displaying the following:

Bar psi
+ 1234 + 123456

Using this process, any engineering unit may be selected for display of the right or left Quick Select pressure module measurement data.

Section 8.5 Temperature Selection for H₂O Conversion Factor

The HHC-1 includes a library of 12 factory programmed engineering units. This selection includes the engineering units inH₂O, mmH₂O and cmH₂O. The pressure generated by a column of water will vary with the temperature of the water.

Over the years, several temperatures have evolved into industry standards. These are the conversion factors most commonly used by manufacturers of pressure instruments when calibrating pressure measurement devices in terms of the height of a column of water. To facilitate your calibration and test of these instruments, the HHC-1 includes 3 conversion factors for each of the water column based pressure engineering units. The conversion factors are for the temperatures of 4 and 20 degrees Celsius and 60 degrees Fahrenheit.

The selection of the desired temperature for use in the conversion of water based pressure measurements can be accomplished by following these steps.

Step 1 With the HHC-1 on and reading pressure press the SET UP key.

SET
UP

Step 2 Using the up/down and left/right arrow keys select the H₂O reference option displayed as "H₂Oref" in the set up menu. When selected the text "H₂Oref" will flash on the display.

BatSave PerCent
UserEng H₂Oref

Step 3 With the text "H₂Oref" flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

H₂O ref temp
20C 60F 4C

Step 4 Using the left/right arrow keys select the desired temperature for the conversion factor. The

selected value will flash on the display.

H2O ref temp
20C 60F 4C

In the above example the conversion factor for water at 60 degrees Fahrenheit was selected.

Step 5 With the desired temperature for the conversion factor flashing press the enter key.

ENT

The selected conversion temperature will be activated and will be stored in Electrically Erasable Programmable Read Only Memory (EEPROM). It will not have to be reentered on power-up unless a change in the reference temperature is desired.

After pressing the enter key the HHC-1 will resume basic pressure measurement.

Section 9.0 Tare Function

The HHC-1 has the ability to tare (subtract an operator selected value) from the displayed pressure or temperature measurement value of either one or two installed Quick Select modules. This is most commonly required in applications where a pressure pre-load, as in a weighing application, must be subtracted from the displayed pressure measurement.

If the HHC-1 is in use with two Quick Select modules, independent tare values can be entered for each of the sensor modules. If one of two installed Quick Select modules has been deactivated, meaning the measured values are not shown on the display, the calibrator will request a tare value only for the active module. To input a tare value for one or two Quick Select pressure modules follow the steps below:

Step 1 With the HHC-1 on and displaying pressure measurement data press the tare key.

TARE

The HHC-1 will respond by displaying the following:

Left tare value
+ XXXXXX

If a tare value was previously programmed the HHC-1 will display that value. If the previous tare value was zero the HHC-1 will display the last pressure measurement value displayed prior to pressing the TARE key.

Step 2 Use the number keys to input a tare value other than the default value or to change the existing tare value. If no tare value is desired input zero (0).

Warning: Failure to enter the zero (0) will result in the HHC-1 automatically accepting the last displayed value as the desired tare value.

Left tare value
+ 12345

Step 3 With the desired value displayed press the enter key.

ENT

The HHC-1 will respond by displaying the following:

Right tare value
+ XXXXX

Step 4 Use the number keys to input a tare value other than the default value or to change the existing tare value. If no tare value is desired input zero (0).

Warning: Failure to enter the zero (0) will result in the HHC-1 automatically accepting the last displayed value as the desired tare value.

Right tare value
+ 12345

Step 5 With the desired value displayed press the enter key.

ENT

Note: The measurement data on the display will flash if the HHC-1 is operating in the tare mode.

After pressing the enter key the HHC-1 will resume normal pressure measurement activities. Tare values may be reviewed at any time by pressing the TARE key. If the HHC-1 is being used with two Quick Select modules and only one module has a nonzero tare value the display will only flash on the side that corresponds to the Quick Select module with the nonzero tare value.

Step 6 To exit the tare mode follow the procedures outlined in steps 1 through 5 and at the tare value prompt enter zero (0). When the tare values for both modules have been reset to zero tare mode operation will be discontinued and the display will stop flashing.

Section 10.0 Hold Function

The hold function provides the ability to freeze the displayed pressure, flow or electrical measurement values. In addition, pressing the hold key will result in an H appearing in the RS232 output data stream and will also result in a flashing H appearing on the left side of the top line of the instrument display.

The RS232 output will look as follows for a dual sensor measurement:

Normal Operation

+1.2345 inH2O +1.2345 inH2O
Left Min: +0.00000 Max: +1.2345
Right Min: +0.0000 Max: +1.2345
With Hold Function Invoked
+1.2345 H inH2O +1.2345 inH2O
Left Min: +xxxxx.x Max: +xxxxx.x
Right Min: +xxxxx.x Max: +xxxxx.x

Section 10.1 Using the Hold Function

Step 1 To invoke the hold function press the hold key.

HOLD

The HHC-1 will respond by freezing the displayed values and adding a flashing "H" that will appear in the left most position on the top line of the display.

Step 2 To exit the hold function press any key.

Note: While in the hold mode, if the RS232 interface is enabled, the HHC-1 will continue to transmit the displayed values.

Section 11.0 Minimum and Maximum Value Tracking

The HHC-1 monitors and stores in memory both the minimum and maximum pressure or temperature values measured. The following procedure will allow review of these values.

Step 1 To recall the minimum and maximum values simply press the key labeled:

MIN
MAX

The HHC-1 will respond by displaying:

+ 2345 + 12345
-12345 -12345

where:

maximum values are displayed on the top line and +12345 represents the maximum value(s) measured. Minimum values are displayed on the bottom line and 12345 represents the minimum value(s) measured. If two Quick Select modules are installed, the min/max function recalls and displays the minimum and maximum values for both modules simultaneously.

Step 2 To clear the stored minimum and maximum value press the clear entry key:

CE

Pressing any key other than the CE key will maintain the stored values in memory.

Pressing any key on the keypad will return the HHC-1 to normal pressure measurement activities.

Section 12.0 Damping

Damping provides the ability to stabilize the displayed or transmitted pressure value by minimizing the effects of low level transients and electronic instability. Damping is most commonly used with Quick Select pressure modules to overcome the effects of pressure pulsation and vibration transmitted through the measurement media. The level of damping is established in the set up menu. Activation of the damping process is accomplished through a dedicated key on the keypad.

Damping accomplishes the stabilization of the pressure measurement value by producing an averaged pressure value which is shown on the display and available for transmission over the RS232 interface. When damping is not activated the HHC-1 takes a new pressure value every 100 mS (10 times per second) and updates the display. If required, this same measurement data is also transmitted over the RS232 interface.

When damping is activated the value displayed and/or transmitted is an average value. The average consists of the average of from 1-16 consecutive readings. The higher the number of readings averaged the greater the stabilization effect of the damping. The number of consecutive readings averaged is programmable,

allowing the damping function to be tailored to the specific requirements of most any application.

Section 12.1 Set Up of the Damping Function

The following steps should be used to set up the level of damping desired.

Step 1 With the HHC-1 on and reading pressure press the SET UP key.

**SET
UP**

Step 2 Using the arrow keys move through the set up menu and select "Dampen" on the display of the HHC-1. The word "Dampen" will flash on the display when selected.

**EvntTimr Dampen
LeakRate Status**

Step 3 With the word Dampen flashing press the enter key.

ENT

Step 4 In response to the activation of the dampening set up menu the HHC-1 will respond by displaying the following:

**fast < ——— > slow
X**

Where the left most position represents zero damping (averaging of 1) and the right most position represents maximum damping (averaging of 16 readings). Starting from the left each movement of the highlighted box to the right increases the number of samples being averaged by one (1). By moving the highlighted field to the left the level of damping can be reduced.

The level of damping desired will likely vary from application to application and sensor range to sensor range. For best results, select the minimum amount of damping necessary to provide a stable display value. It is important to recognize that while damping will stabilize the displayed and/or transmitted value it will also slow down the response rate to a true pressure change. The slow down results from the fact that an averaged value will be displayed. If the damping level is set to 16 the displayed value will represent the average pressure measurement over the previous 1.6

seconds (16 readings times 100 mS/reading). Therefore, the greater the level of damping in use the greater the time lag will be between the displayed measurement and the true (not averaged) pressure measurement value.

Use the left/right arrow keys to set the desired damping level, for example, averaging 8 readings as shown here.

**fast < ————— > slow
X**

Step 5 With the desired level of damping shown press the enter key to store the damping level in EEPROM.

ENT

The level of damping has now been set. Proceed to Section 12.2 for instructions on how the damping process is activated.

Section 12.2 Activating or Discontinuing the Damping Function

The following process provides step by step instructions on how to activate or discontinue the damping function.

Step 1 Once established in the set up menu the damping process may be enabled or disabled through the use of the DAMP key on the keypad. To activate/deactivate the damping function press the DAMP key on the keyboard.

DAMP

In response to pressing the DAMP key the HHC-1 will respond by displaying:

**damping function
Disable Enable**

Step 2 Using the left or right arrow select "Disable" to turn damping off or "Enable" to initiate damping. When the desired option is selected (flashing) press the enter key.

ENT

On power up the HHC-1 will default to damping disabled. *Damping must be re-initiated via the keyboard after the instrument has been turned back on.* The level of damping, established in the set up menu is stored in EEPROM and, therefore, does not

need to be reprogrammed after power up unless the level of damping desired has changed.

Section 13.0 Percent Function

The percent function allows the calibrator to display the output from a device under test in terms of percent error at a given percentage of the total range. This function applies to the calibration of both temperature and pressure transmitters. For example, if the HHC-1 is being used to calibrate a 0-100 psi transmitter with a 4/20 mA output the HHC-1 can be programmed to display the following data:

Pressure Applied	Display Normal Mode
0 psi	4 mA
0 psi	5.6 mA
25 psi	8 mA
50 psi	12 mA
75 psi	16 mA
100 psi	20 mA

The percent mode of operation allows for quick and easy determination of the level of inaccuracy of the device under calibration. For example:

If 50 psi was applied to a 100 psi device with a 0-10 Vdc output but instead of 5 Vdc the transmitter being calibrated had an output of 4.995 Vdc the HHC-1, when used in the percent mode, would display the following:

% scale % error
+ 50 -0.05

Therefore, the percent mode of operation eliminates the need for operator calculations to determine the level of accuracy of the device under test.

If the HHC-1 is equipped with the data logging option the percent error and percent full scale information can be stored in the calibrator on-board memory. To do this follow the set up instruction provided in Section 21.3 Manual Data Logging.

Note: offers an accessory for use in calibrating transmitters and transducers designated the LPS-IIa loop power supply. The Model LPS-IIa is a portable 9 Vdc powered power supply that provides a 24 Vdc output. This device can be used to provide the necessary electrical supply to power transducers and transmitters for in-field calibration testing. For information request bulletin HACC-PS.

Section 13.1 Set Up of the Percent Function

The percent function is set up as follows:

Step 1 With the HHC-1 on and reading pressure press the SET UP key.

**SET
UP**

Step 2 Using the arrow keys select the text "PerCent" from the setup menu. When selected the text "PerCent" will flash on the display.

**BatSave PerCent
UserEng H2ORef**

Step 3 With the text "PerCent" flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Enter Input Zero
.000000**

Step 4 Using the number keys enter the lowest calibration point for the device to be tested.

For example:

For a 0-100 inH₂O range instrument enter zero.
For a 3-15 psi transmitter enter 3.
For a -5 to 0 to + 5 inH₂O transducer enter -5.
For a 0-200 degree RTD enter 0

When the desired "zero" value has been entered the display will look as follows for the testing of a 0-100 in H₂O transducer.

**Enter Input Zero
.000000**

If an incorrect value is entered use the CE key to clear the entry and re-key the zero value.

With the desired "zero" value displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

**Enter Input FS
.000000**

Step 5 Using the number keys enter the full scale range (F.S.) of the device to be calibrated. For our example of a 0-100 in H₂O range instrument the

display will look as follows:

Enter Input FS
100

Step 6 With the desired input full scale displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

Enter output Zero

As with input zero, the output zero is the lowest output the device being calibrated will produce.

For example:

For a 0-10 Vdc output device enter zero.

For a 4/20 mA output device enter 4.

For a 1-5 Vdc output device enter 1.

Step 7 With the desired output "zero" keyed in and displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

Enter output FS
0.0000

Step 8 Using the number keys enter the full scale output of the device being calibrated. For a 0-10 Vdc output device the display will look as follows:

Enter output FS
10

Step 9 With the desired full scale output displayed press the enter key.

ENT

The HHC-1 will respond by displaying the following:

Device type
I/P P/I P/P P/E

Using the left/right arrow keys select the appropriate device type where:

I/P is a current to pressure device

P/I is a pressure or temperature to current device

P/P is a pressure to pressure device

P/E is a pressure or temperature to voltage device

In this case we are testing a 0-100 inH₂O range transducer that produces a 0-10 Vdc output from zero to F.S. Therefore, the appropriate selection is P/I and

the display will look as follows:

Device type
I/P P/I P/P P/E

Step 10 With the desired device type flashing press the enter key.

ENT

At this time the HHC-1 will return to basic measurement activities.

Section 13.2 Use of the Percent Function

Note: The HHC-1 must be set up so that the desired Quick Select module is active and so that the desired electronic measurement is displayed prior to entering the % mode. Consult Sections 5.0 Port Select and 7.0 Current & Voltage Measurements for setup details.

Step 1 With the percent function set up, press the % key on the keypad of the HHC-1 to activate the percent mode of operation.

%

Step 2 Connect the output lines from the device under test to the miniature banana jack inputs on the front of the HHC-1. Use the mA and COM jacks for current devices and the V and COM jacks for voltage output devices.

Step 3 Make the necessary plumbing connections using a Tee fitting to allow input of applied pressure to both the HHC-1 and the device under test.

Step 4 Perform testing in accordance with the number of calibration points required for the device to be tested.

Step 5 To exit the percent mode press the percent key.

%

The HHC-1 will respond by returning to basic pressure or temperature measurement activities.

Section 14.0 Flow Velocity and Flow Volume Measurement Background

The HHC-1 used in conjunction with a pitot tube or an annubar has the ability of measuring the flow volume or flow velocity of a gas. The HHC-1 must be used in conjunction with an DLP-1 low differential pressure Quick Select module to perform the flow measurement function.

The accuracy of a flow measurement is a function of a number of contributing factors. These are; the basic accuracy of the differential pressure measurement, accuracy of the pitot tube or annubar in use as it relates to the K factor supplied by the manufacturer of the device and the accuracy of the correction being made for the air density. It is not possible to provide an all inclusive accuracy statement for flow measurement activities. Steps that can be taken to maximize system flow measurement accuracy include:

1- Calculation and input of the actual air density for the media to be measured. The air density is a function of temperature, humidity, barometric pressure.

The velocity equation (ft/min) is as follow:

$$V = 1097 \times K \times \sqrt{\frac{dpw}{Adw}}$$

where:

dpw= differential pressure in inches of water

Adw= the air density

The air density can further be calculated through employing the following equation:

$$A_d = 0.07649 \times (Pa/14.73) \times [520/(T+460)]$$

where:

Pa = the absolute pressure in duct in psia

T= air temperature in duct in degrees Fahrenheit

Flow Volume = (velocity x duct area)/144

2- Purchase of a characterized and certified pitot tube or annubar with a K factor determined for the specific probe to be used.

3- Purchase of the highest accuracy differential pressure Quick Select module available.

Section 14.1 Set Up for Flow Velocity and Flow Volume Measurement

In preparation to perform flow velocity and volume measurements the operator should have the following information available for entry during the set up of

the application on the HHC-1.

K factor	Provided by the manufacturer of the flow probe to be used.
Air density	A default value has been programmed into the HHC-1 in the event that a more accurate one cannot be calculated.
Duct area	For air volume measurement the area of the duct in which measurements are to be taken must be calculated.

A differential type (dual process connection) Quick Select pressure module must be used for flow measurement activities.

Basic keypad functions such as damping, tare, min/max recall, mA/V measurement display, battery check, display hold, data logging, zero and port select are available for use during flow measurement activities. Consult the appropriate sections of this manual for information on the set up and use of these product functions.

For flow measurement follow the steps outlined in the sections corresponding to the type of flow measurement (velocity or volume) to be performed.

Section 14.2 Flow Velocity Measurement

Step 1 With the HHC-1 on and displaying pressure measurement values press the flow key.

FLOW

The HHC-1 will respond by displaying:

Flow

Velocity Volume

Step 2 To perform flow velocity measurements select the word velocity using the left/right arrow keys. When selected the word velocity will flash.

Flow

Velocity Volume

Step 3 With the word Velocity flashing press the enter key:

ENT

The HHC-1 will respond by displaying:

Enter Air Density

lbs/ft3 .07480

Step 4 Using the number keys input the required air density value or press enter to use the 0.07480 default value.

Step 5 With the required air density value displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

EnterFlowCoef(K)

X.XXX

The flow coefficient or K factor is a value specific to the pitot tube or annubar to be used. Consult the manufacturer of the annubar or pitot tube for the K factor for your flow probe. A default value of 0.6 is factory programmed into the HHC-1 firmware. This value can be overwritten, with a K factor for the specific flow measurement probe, to optimize flow measurement accuracy.

Step 6 Connect the pitot tube or annubar to the Quick Select pressure module, as indicated in the manufacturers manual for the flow probe, high side to the high pressure port on the Quick Select pressure module and low side to the low pressure port on the Quick Select module.

Place the probe in the duct as instructed in the probe manual. The HHC-1 will now display the measured differential pressure in terms of flow velocity (ft/min).

To Exit Flow Velocity Measurement and Return to Basic Pressure Measurement Press the Clear Entry Key (CE).

Section 14.3 Engineering Units for Flow Velocity

As with standard pressure measurement the HHC-1 can provide flow velocity in a variety of units of measure. To select a unit of measure for flow velocity follow the steps below.

Step 1 With the HHC-1 operating in the flow velocity mode (refer to Section 14.1 for instructions on entering the flow velocity mode) press the engineering unit key.

**ENG
UNIT**

The HHC-1 will respond by displaying the following:

ft/min ft/sec

MPH MeterSec

These are the 4 units of measure available for display of flow velocity.

Step 2 Using the left/right and up/down arrow keys select the desired unit of measure. When selected the unit of measure will flash. In this example the engineering unit of ft/sec has been selected.

ft/min ft/sec

MPH MeterSec

Step 3 With the desired unit of measure flashing, press the enter key.

ENT

After pressing the enter key the HHC-1 will resume measuring flow velocity in the selected unit of measure.

Section 14.4 Flow Volume Measurement

Note: In order to do flow volume measurement you must first set up the measurement parameters required for flow velocity. Failure to do this will result in the calibrator accessing the previously stored input data on air density and K factor in the generation of the flow volume measurement.

Step 1 With the HHC-1 on and displaying pressure measurement data press the flow key.

FLOW

The HHC-1 will respond by displaying:

Flow

Velocity Volume

Step 2 Using the left/right arrow keys select the word volume. When selected the word volume will flash.

Flow

Velocity Volume

Step 3 With the word Volume flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Enter Duct Area
sq.in. xxxxxx

Step 4 Calculate the area of the duct for which flow volume is to be determined. The equations for area calculations are as follows:

For rectangular or square ducts:

$$\text{area (square inches)} = W \times H$$

where:

W = width of the duct in inches
H = height of the duct in inches

For round ducts:

$$\text{area (square inches)} = (\pi/4) D^2$$

where:

$\pi = 3.141592$
D = diameter of the duct in inches

Step 5 Using the number keys input the area value calculated in step 4.

Enter Duct Area
sq.in. 123456

Step 6 With the appropriate area value displayed press the enter key.

ENT

If an incorrect area value is keyed press the clear entry (CE) key to reenter the required data.

The HHC-1 will now be set up to provide flow volume measurement data for the desired duct.

To Exit Flow Volume Measurement and Return to Basic Pressure Measurement Press the Clear Entry Key (CE).

Section 14.5 Engineering Units for Flow Volume

As with standard pressure measurement the HHC-1 can provide flow volume measurements in a variety of units of measure. To select a unit of measure for flow velocity follow the steps below.

Step 1 With the HHC-1 operating in the flow volume mode (refer to Section 14.4 for instructions on entering the flow volume mode) press the engineering unit key, designated ENG UNIT on the keypad.

ENG
UNIT

The HHC-1 will respond by displaying the following:

ft3/min ft3/sec
m3/min m3/Sec

These are the 4 units of measure available for display of flow volume.

Step 2 Using the arrow keys select the desired unit of measure. When selected the unit of measure will flash. In this example the engineering unit of ft3/sec unit has been selected.

ft3/min ft3/sec
m3/min m3/sec

Step 3 With the desired unit of measure flashing, press the enter key.

ENT

After pressing the enter key the HHC-1 will resume measuring flow volume in the selected unit of measure.

Section 14.6 Simultaneous Display of Two Flow Measurements in Independent Engineering Units

The HHC-1 can display flow measurement data from two installed Quick Select pressure modules in independent engineering units. In order to display two different engineering units simultaneously the following procedure should be followed. In this example we will assume the operator is in the flow velocity mode and would like to present the measured values in ft/min on the right side of the display and meters/second on the left side of the display.

Step 1 With the HHC-1 on and displaying flow (velocity or volume) measurement data from two Quick Select pressure modules press the engineering unit key, designated ENG UNIT.

ENG
UNIT

When in the flow velocity mode the engineering unit selection is:

ft/min ft/sec
MPH MeterSec

When in the flow volume mode the engineering unit selection is:

ft3/min ft3/sec
m3/min m3/Sec

Step 2 Using the arrow keys select either of the two desired engineering units. For this example we will select ft/min first.

ft/min ft/sec
MPH MeterSec

Step 3 With one of the two engineering units to be used selected and flashing, in this example ft/min, press the enter key.

ENT

The HHC-1 will respond by returning to the flow measurement mode and will display the measurement data as follows:

ft/min ft/min
+ 12345 + 12345

Step 4 Next, press the port select to deactivate the display of flow measurement data on the side that you wish to maintain displayed measurement data in terms of ft/min. A pressure display is deactivated when it is replaced by a milliamp (mA), Voltage (V) or a blank (-----).

See Section 5.0 for details on the port select function.

In this case we have decided that the left side of the display will be in meters/second and the right side will remain in ft/min.

Pressing the port select one time will deactivate the left pressure display converting it to an mA measurement field. Pressing the port select a second time will deactivate the right side, converting it to an mA measurement field and returning the left side of the display to the function of flow measurement.

Since we want the right side to remain ft/min we will deactivate it in the ft/min mode by pressing the port select key once.

PORT
SEL

The HHC-1 will respond with the following display:

ft/min mA
+ 12345 + 1234

Step 5 With the right side deactivated from flow measurement activities press the engineering unit key.

ENG
UNIT

The HHC-1 will respond by displaying:

ft/min ft/sec
MPH MeterSec

Step 6 Using the arrow keys select the desired engineering unit for the data on the left side of the display. In this example we have opted to display the flow measurement data on the left side in terms of meters/second represented by MeterSec on the display. With the MeterSec engineering unit selected the display will look as follows with the text "MeterSec" flashing:

ft/min ft/sec
MPH MeterSec

Step 7 With the text "MeterSec" selected and flashing press the enter key.

ENT

The HHC-1 will respond by displaying the following:

MeterSec mA
+ 12345 + 1234

Step 8 Reactivate the right side of the display for flow measurement by pressing the Port Select key, as required.

First press of the

PORT
SEL

HHC-1 will respond by displaying the following:

mA ft/min
+ 1234 + 123456

Second press of the

PORT
SEL

HHC-1 will respond by displaying the following:

MeterSec ft/min
+ 1234 + 123456

To Exit Flow Measurement and Return to Basic Pressure Measurement Press the Clear Entry Key (CE).

Using this process, any engineering unit may be selected for display of the right or left Quick Select module measurement data.

Section 14.7 Simultaneous Display of Measurement Data for Flow (Volume or Velocity) and Pressure

The HHC-1 can simultaneously display a flow measurement from one installed Quick Select pressure module and a pressure measurement from a second installed Quick Select Pressure module. For example, the measurement of flow can be displayed in ft/min for one installed Quick Select pressure module and the second installed pressure module can be used to simultaneously display the measured value in terms of inches of water. This ability eliminates the need for “on-the-fly” change between flow and pressure measurement functions when doing airflow testing.

To set the HHC-1 up to present simultaneous display of pressure and flow (velocity or volume) data follow the steps below.

Step 1 With the HHC-1 on and displaying pressure measurement data from both modules, if necessary, select the desired engineering unit to be displayed for the pressure measurement. This is done by activating the Engineering Unit library accessed by pressing the ENG UNIT key. Details on engineering unit selection are provided in Section 8.0 of this manual.

Important Note: The HHC-1 must be set up for pressure measurement first. With pressure measurement set up, deactivate the side of the display to remain in pressure mode prior to setting up the desired flow measurement parameters. If flow measurement is set up before pressure measurement access to pressure engineering units will be lost. When set up to measure both pressure and flow engineering units for both measurements can be accessed as outlined in Section 8.4.

Step 2 Use the port select key to deselect the displayed output of pressure from the module which is to be left in the pressure readout mode of operation.

When a module is deselected the corresponding side of the display on the HHC-1 will read milliamp (mA), blank “ ” or Volts(V).

Press the port select key one time to deselect the right module. Press the port select two times to deselect the left module.

PORT SEL

Step 3 With the desired pressure module deselected follow the procedure outlined in Section 14.2 if the flow measurement is to be flow velocity or Section 14.4 if the flow measurement is to be a flow volume measurement.

Step 4 As outlined in Section 14.2 for flow velocity or Section 14.4 for flow volume select the desired engineering unit.

Step 5 With the display for the active flow measurement correct, reactivate the deactivated port using the port select function.

PORT SEL

Note: The units used to express flow measurement may be changed at any time while the HHC-1 is displaying any flow measurement data. Simply use the engineering unit select function as described in Section 14.2 for flow velocity and Section 14.4 for flow volume.

To Exit Flow Measurement and Return to Basic Pressure Measurement Press the Clear Entry Key (CE).

Section 14.8 Simultaneous Display of Measurement Data for Flow (Volume or Velocity) and Temperature

The HHC-1 can simultaneously display a flow measurement from one installed Quick Select pressure module and a temperature measurement from a second installed Quick Select module. For example, the measurement of flow can be displayed in ft/min for one installed Quick Select pressure module and the second installed pressure module can be used to simultaneously display the temperature measurement value in degrees Celsius or Fahrenheit. This ability eliminates the need for “on-the-fly” change between

flow and temperature measurement functions when doing airflow testing.

To set the HHC-1 up to present simultaneous display of temperature and flow (velocity or volume) data follow the steps below.

Step 1 With the HHC-1 turned off install the required differential pressure module and RTD probe interface module.

Step 2 Turn HHC-1 on.

Step 3 As outlined in Section 16.1 set up the temperature measurement function via the RTmodule submenu accessed via the main Set Up menu. See Section 16 for complete instructions on setting up the HHC-1 for temperature measurement using an RTD temperature probe.

Step 4 With the side of the display to be used for flow measurement active and reading the measured pressure from a dual process connection type Quick Select pressure module press the FLOW key.

FLOW

Proceed as directed in Section 14.2 for flow velocity and 14.4 for flow volume measurement.

Note 1: The units used to express flow measurement may be changed at any time while the HHC-1 is displaying any combination of flow and temperature measurement data. Simply use the engineering unit select function as described in Section 14.2 for flow velocity and Section 14.4 for flow volume.

Note 2: Units for display of temperature measurement data can be changed at any time via the "RTmodule" menu in the setup menu of the calibrator.

To Exit Flow Measurement and Return to Basic Pressure Measurement Press the Clear Entry Key (CE).

Section 14.9 Simultaneous Display of Flow Volume and Flow Velocity

The HHC-1 can simultaneously display flow measurement data from two installed differential low pressure Quick Select modules with one output displayed in terms of flow volume and the other pressure measurement displayed in terms of flow velocity. For example, the measurement of flow can be displayed in ft³/min for one installed Quick Select module and ft/min for the second installed module.

This ability eliminates the need for "on-the-fly" change between flow volume and flow velocity measurement functions when doing airflow testing.

To set the HHC-1 up to present simultaneous display of flow velocity and flow volume follow the steps below.

Step 1 Set the HHC-1 up to display flow velocity or volume (refer to Sections 14.2 and 14.4 for information on setting up the HHC-1 to perform flow velocity or flow volume testing) In this example, we will assume the HHC-1 is starting from the simultaneous display of two flow velocity measurements. In this mode the HHC-1 display will look as follows:

ft/min ft/min
+ 12345 + 12345

Step 2 Using the port select key, deactivate the side of the display that you wish to maintain in the current flow measurement mode. In this case we will display flow in terms of ft/min on the left side and ft³/min on the right side of the display.

PORT SEL

Pressing port select once will deactivate the right side of the display from flow or pressure measurement and convert it to an mA measurement function.

ft/min mA
+ 12345 + 1234

Pressing port select a second time will deactivate the left side of the display from flow or pressure measurement, converting it to an mA measurement function. The right side of the display will resume flow/pressure measurement activities. The second press of the port select key will result in the following data display.

m/A ft/min
+ 12345 + 12345

In this example, since we will be leaving the left side of the display in terms of ft/min the port select key should be pressed two times to produce the display:

m/A ft/min
+ 12345 + 12345

Step 3 With the desired side of the display deactivated press the flow key on the keypad of the HHC-1.

FLOW

The HHC-1 will respond by displaying:

Flow Velocity
Velocity Volume

Step 4 Using the left/right arrow keys select the desired measurement function.

In this case we have decided that the left side of the display will remain in the velocity mode and the right side will be changed to measure flow in terms of volume. Therefore, volume should be selected for this example.

Flow Velocity
Velocity Volume

Step 5 With the word volume flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

m/A ft3/min*
+ 12345 + 12345

*Refer to engineering unit selection, Section 14.5 if an alternate unit of expressing flow volume is desired.

Step 6 Press the port select key to reactivate the left side of the display for flow or pressure measurement.

PORT
SEL

The left side of the display will have remained in terms of ft/min. When reactivated the display will look as follows:

ft/min ft3/min
+ 12345 + 12345

The HHC-1 is now set up for simultaneous display of flow volume and flow velocity.

To Exit Flow Measurement and Return to Basic Pressure Measurement Press the Clear Entry Key (CE).

Section 14.10 Simultaneous Display of Flow and Electrical Output Measurements

As outlined previously, the HHC-1 can present pressure measurement data from one or two Quick Select pressure modules simultaneously. This ability also extends to the HHC-1's ability to display flow

measurement data. In addition, the HHC-1 can simultaneously display a flow measurement on one side of the display and a current or voltage measurement on the other side of the display. This capability can be useful in calibrating transducers and transmitters that are calibrated in terms of flow, such as 0-200 ft/minute.

To take a flow measurement and monitor the electrical output from the device under test follow the procedures below:

Step 1 Set the HHC-1 up to function in the desired flow measurement (velocity or volume) mode of operation. Refer to Section 14.2 for information on setting up the HHC-1 for velocity measurement or Section 14.4 for information on setting up the HHC-1 for volume measurement.

Step 2 Select the desired engineering units as outlined in Sections 14.3 for flow velocity and 14.5 for flow volume.

Step 3 Press the port select key.

PORT
SEL

The HHC-1 will respond by changing the right side of the display from pressure/flow measurement to the display of an mA measurement. The display will continue to display the output from the left Quick Select module in terms of flow.

To read the output of the right Quick Select module in terms of flow and the electrical measurement output from the device under test press the Port Select key a second time.

Step 4 With the flow and electrical measurements appearing in the desired locations on the display the current measurement can be changed to a voltage measurement by pressing the mA/V key.

mA
V

Pressing the mA/V key once will change the display to "-----".

Pressing the mA/V key a second time will change the display to "volts".

Step 5 Connect the Quick Select Sensor module to be used to the pressure source to be measured.

Step 6 Connect the output of the device to the miniature banana jacks on the keypad of the HHC-1 as follows:

For current output devices: use the mA and COM jacks.

For voltage output devices: use the V and COM jacks.

Percent mode operation is also available for flow test and calibration of measurement instruments. Refer to Section 13.0 for percent function set up and use information.

Section 15.0 Leak Detection Function

The HHC-1 provides the ability to detect and quantify leaks in terms of pressure decay over time (psi change per unit of time) or in terms of leak rate (cc/sec).

In the pressure decay over time mode the HHC-1 will monitor the desired pressure vessel for the programmed time interval and, at the end of the monitoring time period, display the measured change in pressure. In the leak rate mode the HHC-1 will monitor the pressure vessel over the programmed time interval and display the leak rate in terms of cc/seconds.

Use of the leak detection function requires the setup of the leak test parameters. The following procedures should be followed to set up and perform a leak test using the HHC-1.

Section 15.1 Leak Rate Function Setup

Step 1 With the HHC-1 on and displaying pressure press the set up key.

**SET
UP**

Step 2 Using the arrow keys, locate and select the words "LeakRate" in the set up menu. When selected the words "LeakRate" will flash.

**EvntTimr Dampen
LeakRate Status**

Step 3 With the words LeakRate flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Leak Mode
Rate Decay**

Step 4 Using the left/right arrow select the word Rate.

**Leak Mode
Rate Decay**

Step 5 With the word Rate flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Vessel Volume
cu.in. .000000**

Step 6 Using the number keys enter the volume of the vessel to be tested in cubic inches.

**Vessel Volume
cu.in. 12324**

Step 7 With the HHC-1 displaying the required vessel volume press the enter key.

ENT

Step 8 The HHC-1 will respond by displaying:

**Time to Monitor
sec. xxxxx**

Step 9 Using the number keys enter the time interval, in seconds, over which the leak rate test is to be performed. The time interval may be from 0.1 to 65,000 seconds.

**Time to Monitor
sec. 12345**

Step 10 With the desired test interval displayed press the enter key.

ENT

At this point the HHC-1 will return to basic pressure measurement.

See Sections 15.3 and 15.4 for information on performing leak rate testing.

Section 15.2 Pressure Decay Test Function Setup

Step 1 With the HHC-1 on and displaying pressure press the set up key.

**SET
UP**

Step 2 Using the arrow keys, locate and select the words "LeakRate" in the set up menu. When selected the words "LeakRate" will flash.

EvntTimr Dampen
LeakRate Status

Step 3 With the words LeakRate flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Leak Mode
Rate Decay

Step 4 Using the left/right arrow select the word Decay.

Leak Mode
Rate Decay

Step 5 With the word Decay flashing press the enter key.

ENT

Step 6 The HHC-1 will respond by displaying:

Time to Monitor
sec. xxxxx

Step 7 Using the number keys enter the time interval, in seconds, over which the pressure decay test is to be performed. The time interval may be from 0.1 to 65,000 seconds.

Time to Monitor
sec. 12345

Step 8 With the desired test interval displayed press the enter key.

ENT

At this point the HHC-1 will return to basic pressure measurement.

See Sections 15.3 and 15.4 for information on performing leak rate testing.

Section 15.3 Sensor Selection Rate or Pressure Decay Tests

In order to perform leak testing the desired Quick Select pressure module must be monitored by the HHC-1 system. The following provides information

on activating the desired pressure module for leak test applications:

With Two Quick Select Pressure Modules Installed

If two pressure modules are installed and the output of both are displayed, the HHC-1 will default to the left pressure module.

If two Quick Select pressure modules are installed and one of the two modules is deselected, meaning the measurement values of that module are not shown on the display, leak testing will use the active pressure module to perform the leak test measurements.

The port select key (PORT SEL) is used to select or deselect a module. When a pressure module is deselected the corresponding side of the display will indicate one of the following: mA, Volts or "-----".

If only one Quick Select pressure module is installed the HHC-1 will default to the installed pressure module for leak test measurements.

Section 15.4 Performing Leak Rate or Pressure Decay Tests

Leak rate and pressure decay tests can be performed as follows:

Step 1 With the HHC-1 on and reading pressure connect the pressure port of the selected pressure module to the vessel to be monitored. If the pressure module incorporates a differential pressure sensor use the High pressure port for the test procedure.

Step 2

For Pressure Decay Select the desired engineering unit to be used as described in Section 8.

For Leak Rate All leak rate measurements are made in cc/seconds and require no selection at this point.

Step 3 Pressurize the vessel to the required level for the test and allow vessel pressure to stabilize from the effects of sudden pressure increase or decrease.

Step 4 Press the key designated LEAK on the keypad of the HHC-1.

LEAK

The HHC-1 will display:

Timing eng unit
sec xxxxx

where:

Timing indicates that the HHC-1 is timing the desired monitoring interval.

sec = the remaining time left to be monitored.

eng unit = the engineering unit in use for the selected module.

xxxxx = the current pressure measured by the selected pressure module.

For Pressure Decay Testing at the end of the test the HHC-1 will display the following:

Eng Unit Decay

CCCC XXXX

where:

Eng Unit = the engineering unit of the measured value.

cccc = current pressure measurement for the selected pressure module.

xxxx = the measured pressure change during pressure decay test.

For Leak Rate Testing at the end of the test the HHC-1 will display the following:

Eng Unit cc/sec

CCCC XXXX

where:

Eng Unit = the engineering unit of the current pressure measurement value.

cccc = current pressure measurement for the selected pressure module.

xxxx = the measured leak rate over the test interval.

To resume basic pressure measurement press the clear entry (CE), enter (E) key or any of the four arrow keys. Pressing any function key will activate that selection. For example, pressing the engineering unit select key (ENG UNIT) will activate the engineering unit selection program.

Important Note: After completing leak testing the HHC-1 will display pressure measurement data for the module that was used in the testing process and will display " " on the other side of the display. If a second module is installed in the other sensor bay it can be re-selected using the port select function (PORT SEL) as detailed in Section 5.0.

Section 16.0 Temperature Measurement Using RTD probes

The HHC-1 can be used with most standard RTDs (Resistance Temperature Detectors) to provide precision temperature measurements. An RTD-IM type Quick Select module is needed in order for the HHC-1 to perform temperature measurement with an RTD. The RTD-IM provides the interface between the calibrator base unit and the RTD probe. There are two RTD-IM Quick Select modules available in order to provide support for the most common RTD resistance levels.

The capabilities of the modules are summarized below:

RTD-IM1 Quick Select Module

Pt 100 (385&392)

-200 to 550° C: $\pm 0.15^{\circ}$ C

550 to 850° C: $\pm 0.2^{\circ}$ C

Ni 120

80 to 260° C: $\pm 0.1^{\circ}$ C

Cu 10

70 to 150° C: $\pm 0.6^{\circ}$ C

Ohms

+0.01% reading +0.02 ohms

RTD-IM2 Quick Select Module

Pt 1000

184 to 275° C: $\pm 0.15^{\circ}$ C

Ohms

+0.01% reading +0.2 ohms

Engineering Units:

Fahrenheit, Celsius, Kelvin, Rankine or ohms

Ohms Measurement Range:

RTD-IM1 module: 0/400 ohms

RTD-IM2 module: 0/4000 ohms

The interface module incorporates a Switchcraft TA4B type connector and requires an RTD with the appropriate switchcraft TA4F meeting connector. The connector is available through your calibrator supplier.

Section 16.1 Setting Up the Calibrator for Temperature Measurement

Step 1 With the instrument off install the appropriate RTD-IM Quick Select RTD interface module. Instructions for installation of a Quick Select module can be found in Section 3.2 of this manual.

Step 2 Connect the desired RTD probe to the Switchcraft connector on the module

Step 3 Turn the calibrator on by pressing the On/Off key

ON
OFF

Step 4 To access the temperature setup menu press the Set up key.

SET
UP

Step 5 Use the downward pointing arrow to access the following selection screen.

Calib RTmodule
dp Meas*

* dp Meas is an optional feature that allows for the subtraction or addition of the measurement value of one sensor from the measurement value of the other sensor. If the calibrator was not ordered with this option it will NOT appear on the screen.

Step 6 As required, using the left/right and up/down arrows select the text "RTmodule". The text RTmodule will flash when selected.

Calib RTmodule
dp Meas

Step 7 With the text "RTmodule" flashing press the enter key.

ENT

The calibrator will respond by displaying:

Probe Connection
2W 3W 4W

This represents the configuration of the RTD to be used, where the number equals the number of wires the RTD uses. Note: The use of a 4 wire RTD is recommended for optimum accuracy.

Step 8 Using the left/right arrow keys select the appropriate configuration for the RTD probe to be used. In the example below the 4 wire configuration was selected.

Probe Connection

2W 3W 4W

Step 9 With the desired wiring configuration selected press the enter key.

ENT

The calibrator will respond by displaying the available units of measure as follows:

Engnring units:

°C °F K °R Ω

Step 10 Using the left/right arrow keys select the desired engineering unit for the measurements to be made. In the example here the measurements will be made in degrees Celsius

Engnring units:

°C °F K °R Ω

Step 11 With the desired engineering unit selected and flashing press the enter key.

ENT

The calibrator will respond by displaying the following:

Probe: 12345678

α385 -200/850

On initial use the first selection and the corresponding probe will appear selected. Use the arrow keys to select the desired coefficients from the available factory programmed curves. The RTD-11M is pre-programmed for the following RTDs

Position	Probe
1	α385 -200/850
2	α392 -200/850
3	Ni Minco
4	Cu 10 ohm
5-8	available for programming using the optional calibration and programming software for the RTD-IM module. Contact your calibrator supplier for this software.

Important Note: The RTD-IM1 is compatible with RTD probes with output resistance values of between

0 and 400 ohms. Use of the module with higher resistance RTD probes will result in diminished accuracy and possible damage to the module electronics.

The RTD-IM is pre-programmed for the following RTDs

Position	Probe
1	PT 1000
2-8	available for programming using the optional calibration and programming software for the RTD-IM module, contact your calibrator supplier for this software.

Important Note: The RTD-IM2 is compatible with RTD probes with output resistance values of between 1000 and 4000 ohms. Whereas this module will function with lower resistance RTDs accuracy will be greatly diminished. In addition, use of the module with higher resistance RTD probes will result in diminished accuracy and possible damage to the module electronics.

Step 12 Using the left/right arrow keys select the RTD probe type for the measurements to be made. In the example here the measurements will be made in using the PT 100 type 385

Probe: 12345678
α385 -200/850

Step 13 With the desired probe type selected and flashing press the enter key.

ENT

The calibrator will respond by displaying the following:

Resolution:
1 .1 .01 0.001

The maximum resolution that the combination of the Calibrator base unit, RTD interface module and probe can support can be determined as follows:
The resolution of the RTD module is 0.001% of the full scale resistance of the reference resistor used in the module. The RTD-IM incorporates a 400 ohm reference resistor and the RTD-IM2 incorporates a 4000 ohm reference resistor.

Using the RTD-IM1 as the example the maximum resolution is:

$$0.001\% \text{ of } 400 \text{ ohms} \\ = 0.00001 \times 400 = 0.004 \text{ ohms}$$

For a PT 100 the temperature resolution can be determined as follows:

$$0.004 \text{ ohms} / (100 \text{ ohms} \times 0.00385 \text{ ohms/degree C}) = 0.008 \text{ degrees C (approx } 0.005 \text{ degrees F)}$$

Therefore, rounding to the next highest digit results in a resolution of 0.01 degrees C.

The resolution supported for the factory programmed RTDs can be found below:

Using the RT-1

Probe type	Resolution
Pt 100 (385 & 392)	0.01 degrees C or F
Ni 120	0.1 degrees C or F
Cu 10	0.1 degrees C or F

Using the RT-2

Probe type	Resolution
Pt 1000	1.0 degrees C or F

Resolution must be selected in conjunction with the full scale ohms output for the RTD probe to be used.

Step 14 Select the desired resolution using the left/right arrow keys. In this case, since we are using the Pt100 RTD with a maximum resolution of 0.01 degrees C the 0.01 option has been selected

Resolution:
1 .1 .01 0.001

Step 15 With the desired resolution selected and flashing press the enter key.

ENT

The calibrator will briefly show internal limit settings and will then commence temperature measurement.

The measurement parameters can be changed at any time through the activation of the RTmodule set up menu.

Section 16.2 Calibrating/Programming the RTD-IM RTD Interface Module

The RTD-IM can be programmed in the field. Programming, calibration adjustment or recertification can be accomplished with the Calibration Programming Utility disk. Contact your calibrator supplier for information on this software. Please note, in order to improve the accuracy of the measurement system it will be necessary to generate a significant number of very accurate temperature calibration points using precision temperature baths. In general, the simplest way to enhance the accuracy of the temperature measurement is to simply re-zero the probe while immersed in an ice bath.

Section 17.0 Pressure and Temperature Switch Testing

The HHC-1 can be used to test pressure and temperature switches. On board firmware provides the ability to verify switch trip points, reset point and to test the deadband of a pressure switch. To perform these type of tests follow the procedures as outlined in the subsections of Section 17.

The switch testing process incorporated in the HHC-1 firmware looks for a change of state that produces a change of greater than either 2 volts or a 2 mA across the corresponding miniature banana jacks. The banana jacks are located on the bottom of the keypad on the HHC-1. Prior to initiating these test procedures the required electrical set up should be configured to provide the necessary signal levels.

Section 17.1 Setting Up the HHC-1 for Testing of Pressure and Temperature Switches

The following procedure outlines the set up requirements for the test of pressure and temperature switches.

Step 1 With the HHC-1 on and reading pressure or temperature, in accordance with the type of switch to be tested, press the Port Select key, designated PORT SEL, the required number of times to leave activated the Quick Select module being used for the test

function and deactivate (convert the display to mA, "-----" or Volts) the other side of the display.

PORT SEL

Step 2 Press the mA/V key as required to change the electrical measurement parameter to that to be used for the switch test. Switch to Volts if the change of state will be greater than 2 Volts; switch to mA if the change of state will be greater than 2 mA.

mA V

Step 3 Connect the switch electronics with a current or voltage source, as required, to provide the required greater than 2 Vdc or greater than 2 mA change in state. Be certain that the change in state to be generated corresponds to the electrical measurement (mA or V) set up on the display of the HHC-1.

Step 4 Connect the output signal of the switch to the miniature banana jacks on the front of the HHC-1 as outlined below.

For voltage: volts (V) jack and common (COM).

For current: milliamps (mA) jack and common.

Step 5 Connect the switch to a controlled pressure/vacuum source to generate the required level of pressure or vacuum to trip the switch.

Step 6 Proceed to Section 17.2 for trip detect testing or to Section 17.3 for deadband testing.

Section 17.2 Test of Switch Trip Point

Step 1 With the HHC-1 on and reading pressure or temperature press the trip detect key on the keypad.

TRIP DET

The HHC-1 will respond by displaying the following:

Disable Manual
Deadband

Step 2 Using the left/right and up/down arrow keys select the word manual in the menu selection. When selected the word manual will flash.

Disable Manual
Deadband

Step 3 With the word “manual” flashing press the enter key.

ENT

Step 4 Gradually increase the pressure, vacuum or temperature until the display of the HHC-1 indicates that a change of state has been detected. When the switch has tripped the HHC-1 will display:

Eng Unit Tripped
+12345 +vvvvv

where:

Eng Unit is the pressure or temperature engineering unit in use

Tripped indicates the pressure switch has tripped

+12345 represents the pressure or temperature at which the switch tripped

+vvvvv voltage value being measured

Step 5 To perform additional trip tests press any key and the trip detect system will be rearmed.

Step 6 To discontinue the switch testing process press the trip detect key.

TRIP
DET

The HHC-1 will respond by displaying:

Disable Manual
Deadband

Step 7 Using the left/right and up/down arrow keys select the word disable in the menu selection. When selected the word disable will flash.

Disable Manual
Deadband

Step 8 With the word “disable” flashing press the enter key.

ENT

The switch test operation has now been terminated.

Section 17.3 Switch Deadband Test Procedure

Step 1 With the HHC-1 on and reading pressure or temperature press the trip detect key on the keypad.

TRIP
DET

The HHC-1 will respond by displaying the following:

Disable Manual
Deadband

Step 2 Using the left/right and up/down arrow keys select the word deadband in the menu selection. When selected the word deadband will flash.

Disable Manual
Deadband

Step 3 With the word “Deadband” flashing press the enter key.

ENT

Step 4 Gradually increase or decrease, as required, pressure, vacuum or temperature until the display of the HHC-1 indicates that a change of state has been detected. When the switch has tripped the HHC-1 will display:

Eng Unit Tripped
+12345 +vvvvv

where:

Eng Unit is the pressure or temperature engineering unit in use

Tripped indicates the pressure or temperature switch has tripped

+12345 pressure at which the switch tripped

+vvvvv voltage value

Step 5 To perform a deadband test, maintain the pressure/vacuum or temperature and power applied to the switch and press any key to rearm the trip detection system.

TRIP
DET

Step 6 Gradually allow the pressure/vacuum or temperature level applied to the switch to return to the starting point.

Step 7 When the HHC-1 detects a reset of the switch the HHC-1 will respond by displaying:

**Deadband +xxxxxxx
+YYYYYYY +ZZZZZZ**

where:

xxxxxx is the measured trip point
zzzzzz is the measured reset point
yyyyyy is the measured deadband value

Step 8 To perform additional deadband tests press any key and the trip detect system will be rearmed.

Step 9 To discontinue switch testing press the trip detect key.

**TRIP
DET**

The HHC-1 will respond by displaying:

**Disable Manual
Deadband**

Step 10 Using the left/right and up/down arrow keys select the word disable in the menu selection. When selected the word disable will flash.

**Disable Manual
Deadband**

Step 11 With the word "Disable" flashing press the enter key.

ENT

The switch deadband test operation has now been terminated.

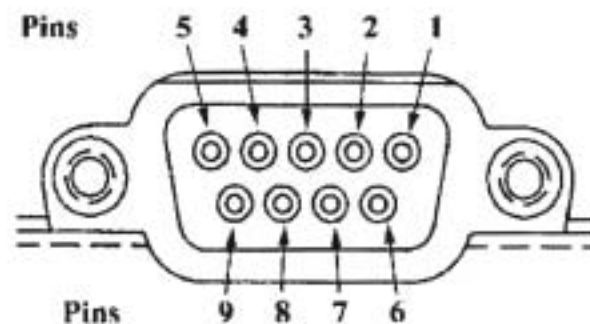
Section 18.0 RS232 Interface General Information

To simplify the interface of the HHC-1 with your computer, recorder, data acquisition hardware or dumb terminal two standard operating modes for the RS232 interface are available. A third RS232 operating mode, ISO1745, is included on the menu options. This mode is only used in uploading data from the optional data logging memory and in factory calibration, set up and repair activities.

To configure the RS232 interface on the HHC-1 for the requirements of your input device, first determine the interface requirements of the device. Then using the RS232 setup feature configure the RS232 interface on the HHC-1, following the steps below:

Pin out information follows. The RS232 connector is located above the AC adapter input on the right side of the calibrator when looking down at the calibrator with the keypad up in the normal operating orientation.

RS 232 Connector



Pin	Function
1	Relay 1 common (for alarm option)
2	Transmit data
3	Read data
4	Data set ready
5	Ground
6	Data transfer ready
7	Relay 1 normally open (for alarm option)
8	Relay 2 common (for alarm option)
9	Relay 2 normally open (for alarm option)

Section 18.1 Configuring RS232 Interface for Use with a Dumb Terminal

To communicate with the HHC-1 through the use of a dumb terminal set the terminal up as follows:

Select baud rate to be used: 300, 1200, 2400 or 9600

Select communications (com) port: 1 or 2

Set data bits to: 8

Set stop bits to: 2

Set parity to: None

Flow control: None

Section 18.2 RS232 Configuration Options

The HHC-1 has two communication formats for operator use. These communication formats will

appear as selection options during the set up of the RS232 interface. A third mode of RS232 communication, ISO1745, is listed in the menu selections and is only used for up loading data logged in the optional data logging memory to a computer and factory calibration, setup and repair activities. An overview of the features of these formats follows.

Section 18.2.1 RS232 Interface ISO1745 Operating Mode Overview

The ISO1745 mode of operation is used to interface the HHC-1 with the upload program provided to export data logged values into a P.C. compatible computer. If your calibrator is equipped with the *optional* data logging capability consult the data logging Addendum provided for directions on the use of the ISO1745 mode for data transfer to an IBM compatible personal computer. Units not equipped with the data logging option are not supplied with the upload program disk or manual addendum.

Section 18.2.2 RS232 Interface Journal Mode Overview

This mode allows the HHC-1 to be interfaced to an RS232 compatible printer or other device where a steady, timed data output is required. When the journal mode is selected the HHC-1 will transmit the current pressure measurement(s) as shown below:

```
+0.005 inH2O+0.0000 psi
Left Min: +0.0045 Max: +0.0053
Right Min: +0.0000 Max: +0.0000
+0.003 inH2O+0.0000 psi
Left Min: +0.0032 Max: +0.0049
Right Min: +0.0000 Max: +0.0000
+0.003 inH2O+0.0000 psi
Left Min: +0.0033 Max: +0.0035
Right Min: +0.0000 Max: +0.0000
```

Each data set consists of three (3) lines. The first line displays the current measurement data as seen on the instrument display. This line will display the pressure, flow, temperature or electrical measurement in the selected units of measure. Engineering units may be changed from the keypad as outlined in the engineering unit section of this manual, Section 8.0, while the

RS232 interface is in use. In addition, the HHC-1 can be changed from pressure to flow measurement while the RS232 interface is in use.

The second line displays the minimum and maximum values stored in memory for the left sensor module since the last time the memory locations were cleared.

The third line displays the minimum and maximum values measured by the right sensor since the last time the minimum and maximum pressure values were cleared from memory.

In the journal mode the RS232 interface will output the data as outlined above at a regular interval. The interval is selected in the RS232 setup procedure and may be from 1 second to 65,000 seconds.

Section 18.2.3 RS232 Interface Inquiry Mode Overview

When the RS232 interface of the HHC-1 is set up in the inquiry mode the HHC-1 transmits the data string shown below in response to an operator selected inquiry character.

+0.003 Eng Unit +0.0000 Eng Unit

The first value represents the measurement value displayed on the left side of the display and includes the selected unit of measure. The second value represents the measurement value displayed on the right side of the display, including the selected unit of measure.

Section 18.3 Setup of the RS232 Interface in the Journal Mode

To use the RS232 interface in the Journal Mode follow the steps below.

Step 1 With the HHC-1 on and reading pressure press the set up key.

**SET
UP**

Step 2 Using the arrow keys move through the menu selections and select "RS232" on the display of the HHC-1. The text "RS232" will flash on the display when selected.

**Owner Alarm
DateTime RS232**

Step 3 With the text RS232 flashing press the enter key.

ENT

This will activate the RS232 setup options sub menu.

The first screen that appears after selection of RS232 from the main setup menu is:

RS232 Interface

Disable Enable

The RS232 interface must be enabled (activated) for the HHC-1 to communicate with any RS232 device.

When the RS232 is not in use it is recommended that the RS232 interface be disabled to conserve on power use and maximize battery life.

Step 4 Use the arrow keys to select Enable (activate) and press the enter key.

RS232 Interface

Disable Enable

Step 5 With the word Enable flashing press the enter key.

ENT

Step 6 After selecting "Enable" the HHC-1 will respond with the following display.

Baud Rate

960024001200 300

The current baud rate selection will flash on the display.

Step 7 Using the left/right arrow keys select the desired baud rate. The selected baud rate will flash on the display.

Baud Rate

960024001200 300

In the above example the baud rate 9600 has been selected.

Step 8 With the desired baud rate flashing press the enter key.

ENT

After the desired baud rate has been entered the HHC-1 will display:

Disable ISO1745

Journal Inquiry

Step 9 Using the arrow keys select the word Journal. When selected the word Journal will flash.

Disable ISO1745

Journal Inquiry

Step 10 With the word Journal flashing press the enter key.

ENT

The HHC-1 will respond by displaying the following:

Report Interval

XXXXXXX

Step 11 Using the number keys enter the desired interval, in seconds, between data transmissions. The interval may be any value from 1 second to 65000 seconds. In the example below the HHC-1 is being instructed to transmit a set of readings every 600 seconds (10 minutes).

Report Interval

600

Step 12 With the desired time interval displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

End of message

CrLf Prog

Step 13 Select the desired end of message character. For data transmission to a screen on a dumb terminal the CrLf (carriage return/line feed) is the most common option. If the data output is to be transmitted into a database or spreadsheet program the end of message character must be selected in accordance with the requirements of the application software. Proceed to Step 17 to input a custom end of message character.

Step 14 To use CrLf as the end of message character use the arrow keys to select the text "CrLf". When selected the text "CrLf" will flash.

End of message

CrLf Prog

Step 15 With the text CrLf flashing press the enter key.

ENT

The HHC-1 will return to pressure measurement and will transmit data to the terminal, acquisition device, computer or recorder as programmed. While communicating, engineering units may be changed or the HHC-1 may be changed between basic pressure measurement and flow measurement.

Important Note: Invoking set up functions or dedicated keypad functions will temporarily suspend the transmission of data during the setup process. For most functions data transmission will resume when the set up is complete. However, the RS232 interface must be re-enabled via the RS232 set up process to re-initiate data transmission after either automatic data logging or leak detection functions are activated.

Step 16 To select a programmable end of message character use the arrow keys to select the text "Prog".

End of message

CrLf Prog

Step 17 With the text Prog flashing press the enter key

ENT

The HHC-1 will respond by displaying:

EOM character

XX.XX

Step 18 Using the number keys enter the decimal code for the desired end of message character. A list of the decimal codes for the available ASCII characters can be found in Appendix B.

Step 19 With the decimal representation of the desired ASCII character displayed press the enter key.

ENT

The HHC-1 will return to the operation of pressure measurement and will transmit data to the terminal, acquisition device, computer or recorder as programmed. While communicating, engineering units may be changed or the HHC-1 may be changed between basic pressure measurement and flow measurement.

Important Note: Invoking set up functions or dedicated keypad functions will temporarily suspend the transmission of data during the setup process. For most functions data transmission will resume when the set up is complete. However, the RS232 interface must be re-enabled via the RS232 set up process to re-initiate data transmission after either automatic data logging or leak detection functions are activated.

Section 18.4 Setup of the RS232 Interface in the Inquiry Mode

To use the RS232 interface in the Inquiry Mode follow the steps below.

Step 1 With the HHC-1 on and reading pressure press the set up key.

SET
UP

Step 2 Using the up/down and left/right arrow keys move through the menu selection and highlight the text "RS232" so that it flashes on the display.

Owner Alarm
DateTime RS232

Step 3 With the text "RS232" flashing press the enter key.

ENT

This will activate the RS232 setup options sub menu.

The first screen that appears after the selection of RS232 from the main setup menu is:

RS232 interface
Disable Enable

The RS232 interface must be enabled (activated) for the HHC-1 to communicate with any RS232 device.

When the RS232 is not in use it is recommended that the RS232 interface be disabled to conserve on power use and maximize battery life.

Step 4 Use the arrow keys to select the word Enable. When selected the word Enable will flash.

RS232 interface
Disable Enable

Step 5 With the word Enable flashing press the enter key.

ENT

Step 6 After entering the Enable option the HHC-1 will respond with the following display.

Baud Rate
960024001200 300

The current Baud rate selection will flash on the display.

Step 7 Using the left/right arrow keys select the desired baud rate. The selected baud rate will flash on the display of the HHC-1.

Baud Rate

960024001200 300

In the above example the baud rate 9600 has been selected.

Step 8 With the desired baud rate selected and flashing press the enter key.

ENT

Step 9 After the desired baud rate has been entered the HHC-1 will display:

Disable ISO1745

Journal Inquiry

Step 10 Using the arrow keys select the word "Inquiry", when selected the word will flash.

Disable ISO1745

Journal Inquiry

Step 11 With the word Inquiry flashing press the enter key.

ENT

The HHC-1 will respond by displaying the following:

Inquiry Char.

XX.X

Step 12 Using the number keys enter the desired end of message character in decimal code. A list of the available ASCII characters and their corresponding decimal codes is provided in Appendix B. The inquiry character acts as a signal to the HHC-1 to transmit a data set. The inquiry character is transmitted to the HHC-1 from the computer or other device controlling the data transmission activities. Select an inquiry character to be used in programming as the transmission prompt.

Step 13 With the decimal representation for the desired inquiry character displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

End of message

CrLf Prog

Step 14 Select the desired end of message character. For data transmission to a screen on a dumb terminal the CrLf (carriage return/line feed) is the most common option. If the data output is to be transmitted into a database or spreadsheet program the end of message character must be selected in accordance with the requirements of the application software. Using the number keys enter the decimal code for the selected end of message character. A list of the decimal codes for the available ASCII characters can be found in Appendix B.

Step 15 With the desired decimal representation for the ASCII character entered and displayed press the enter key.

ENT

The HHC-1 will return to pressure measurement and will transmit data to the terminal, acquisition device, computer or recorder as programmed.

While communicating, engineering units may be changed or the HHC-1 may be changed between basic pressure measurement and flow measurement.

Important Note: Invoking set up functions or dedicated keypad functions will temporarily suspend the transmission of data during the setup process. For most functions data transmission will resume when the set up is complete. However, the RS232 interface must be re-enabled in the RS232 set up process to re-initiate data transmission after either automatic data logging or leak detection functions are activated.

Section 19.0 Status

The status selection provides a means to query the HHC-1 as to the revision of firmware, hardware and the last calibration date of the sensor(s) installed. The hardware and firmware revision numbers are for factory use in determining the level of firmware and hardware in the HHC-1. In addition, the ability to check calibration dates for installed Quick Select pressure modules simplifies the tracking of recertification requirements for the Quick Select pressure modules.

Section 19.1 Reviewing Instrument Status

To invoke the status selection follow the steps below.

Step 1 With the HHC-1 on and reading pressure press the set up key.

**SET
UP**

Step 2 Using the left/right and up/down arrow keys select the "Status" function from the setup menu. When selected the word Status will flash on the display.

**EvntTimr Dampen
LeakRate Status**

Step 3 With the word Status flashing press the enter key.

ENT

Step 4 After pressing ENT the display will read:

**snXXXXXXdd/dd/dd
fw = XX.XXhw = XX.XX**

where:

snXXXXXX: serial number of the base unit.
dd/dd/dd: provides the date of calibration of the base unit.
fw : revision level of the firmware
hw: revision level of the hardware

After reviewing this display and recording any desired information press the enter key to call up the second status screen.

ENT

Step 5 After pressing the enter key a second time, the HHC-1 will respond by displaying the following:

**LeftMod dd/dd/dd
Type x**

where:

dd/dd/dd: the date of the last calibration of the left module.
Type: provides information on the type of Quick Select pressure module.

Step 6 After reviewing this display and recording any desired information press the enter key to call up the third status screen. After pressing the enter key the HHC-1 will respond by displaying the following:

**RightMod dd/dd/dd
Type x**

where:

dd/dd/dd: date of the last calibration of the left module.

Type: provides information on the type of Quick Select pressure module.

Review the displayed information and record any desired information.

Step 7 Press the enter key to return to the basic pressure measurement mode.

ENT

Section 19.2 Battery Power Status Check

The battery check key, designated BAT CK, allows for easy tracking of the power level remaining in the 9 volt dc batteries that power the HHC-1.

To check the battery power level press the BAT CK key. The HHC-1 will respond by displaying the following:

+ X.XXV + XX%

where:

+X.XX V: battery voltage level.
+XX%: estimated battery life remaining as a percent of the 30 hours standard battery life provided by 2 fresh 9 Vdc batteries.

Two 9 Volt **alkaline** batteries will power the HHC-1 for approximately 30 hours. The HHC-1 display of percentage of battery life remaining is the % of 30 hours remaining. Use of non-alkaline batteries will render this percent value inaccurate.

The bottom line of the display is a bar graph of the remaining battery life.

Important Notes:

- 1- The bar graph must be reset when new batteries are installed. To reset the bar graph follow the steps below:
- 2- The percent life remaining is based on the characteristics of standard 9 Vdc **alkaline** batteries. Use of other batteries types, such as; zinc, lithium or rechargeable NiCad batteries, will result in

inaccurate estimation of remaining battery life in both percent indication and bar graph indication.

Step 1 Install new batteries as outlined in the base unit start up section of this manual (Section 3.1).

Step 2 Turn the HHC-1 on.

Step 3 With the HHC-1 operating and displaying pressure press the battery check key, designated BAT CK:

**BAT
CK**

The HHC-1 will respond by displaying:

+ X.XXV + XX%

Note: Installation of two new 9 Vdc alkaline batteries will produce an initial voltage measurement of 9.0-9.5 Volts on the calibrator. If the value measured is significantly below this level it is likely that the batteries have degraded in storage and that they will provide less than the 30 hours of operation expected from a set of fresh, fully charged batteries.

Step 4 Use the right arrow key to restore the bar graph to the full scale. The percentage value displayed will reflect the adjustments made to the bar graph.

The number of highlighted segments in the bar graph will automatically reduce as the remaining battery life is reduced through the use of the HHC-1.

Important Note: It is recommended that batteries be replaced when the low voltage icon appears on the instrument display. **Typical remaining battery life when the low battery icon appears is approximately 1 hour.**

Section 20.0 Dual Sensor Functions (Optional Built-in Firmware)

The calibrator can be equipped with optional firmware that can automatically add the measured pressure values from two installed Quick Select pressure modules or to subtract the value measured by the Quick Select module installed in the right sensor bay from the measured value of the Quick Select value in the left sensor bay. This optional firmware allows for the following:

- 1- The ability to subtract the measured value from the left sensor from the measured value derived from the right sensor allows for simplified measurement of what are commonly referred to as "high-line" or elevated static differential pressures. A complete description of this capability is provided in Section 20.2 entitled Dual Sensor Differential Pressure Measurement.
- 2- The ability to add the measured values of the two installed Quick Select pressure module allows for the addition of a measured barometric pressure from an absolute pressure module to the measured pressure from a gauge or differential pressure. This capability can come in handy and save money by allowing the use of gauge measurement Quick Select pressure modules for absolute pressure measurement activities.

Section 20.1 Accuracy of Dual Sensor Measurements

The accuracy of measurements made using the dual sensor approach measurement is a function of the full scale range of the Quick Select pressure modules used and, in the case of differential pressure measurements, the magnitude of the dp range.

For dual sensor summation measurements:

The worst case inaccuracy would be the sum of the inaccuracies of the two Quick Select modules used for the measurement. For example, if the measurement is made with two $\pm 0.1\%$ full scale modules the maximum inaccuracy would be $\pm 0.2\%$. In actual use, it is generally acceptable to use the Root Sum of the Square (RSS) method of determining the accuracy of a multiple component measurement system. Using the RSS method the accuracy of the dual sensor summation is approximately $\pm 0.14\%$ of span.

For dual sensor differential pressure measurement:

The accuracy of the dual sensor differential pressure measurement is a function of the full scale range of the Quick Select pressure modules used in the measurement process and the magnitude of the dp range. In general, the accuracy for the dp measurement for dp ranges less than 10% of the rated range of the Quick Select modules used is $\pm 0.37\%$ of dp range ± 1

count. For dp ranges greater than 10% of the range of the Quick Select pressure module installed the accuracy of the dp measurement is $\pm 0.37\%$ of the dp range $\pm 0.1(R1)$ where R1 equals the ratio of the sensor full scale to the dp full scale (Sensor full scale/dp full scale). Easy reference tables are included in the appendices of this manual with pre-calculated accuracies for all dual sensor dp measurement.

Section 20.2 Setting Up Dual Sensor Differential Pressure Measurement

Note: This is an optional capability. Only calibrators ordered with this option will be capable of performing this function. This capability can be added in the field by purchase and installation of a new EPROM memory chip programmed with this capability.

Step 1 With the calibrator off, install the two Quick Select pressure sensors in the calibrator. Be certain to install the module so that the sensors are in the desired sensor bays. The subtraction process is always defined as the subtraction of the measured value of the right sensor from that of the measured value of the left sensor (d/p= Left measurement value - right measurement value)

Step 2 With the modules installed, turn the calibrator on by pressing the on/off key.

ON
OFF

Step 3 With the calibrator on and displaying pressure measurement data from the two installed Quick Select modules press the Set Up key.

SET
UP

Step 4 Using the up/down and left/right arrow keys locate the section of the set up menu that includes dp measurement set up. This menu will appear on the calibrator screen as follows:

Calib Rtmodule
dp Meas

Step 5 Use the arrow keys to highlight the text "dp Meas". When highlighted the text will flash on the display.

Calib Rtmodule
dp Meas

Step 6 With the text "dp Meas" flashing press the enter key.

ENT

The calibrator will respond with the following display.

dp Meas Mode:
NONE L-R L+R

Step 7 To perform dual sensor differential pressure measurement select "L-R" to exit this dp set up and return to basic pressure measurement select "NONE". To proceed, use the arrow keys to select the text "L-R"

dp Meas Mode:
NONE L-R L+R

Step 8 With the text "L-R" flashing press the enter key.

ENT

After pressing the enter key the calibrator will return to basic pressure measurement.

Step 9 To activate the dual sensor dp mode of operation press the port select key one time after the set up has been complete. The calibrator will display the following text

L-R PSI	PSI
XXXX	XXXX

for a calibrator displaying measurement values in the psi engineering unit.

When the dual sensor differential firmware is active the following measurement sequence will result from pressing the PORT SELECT (PORT SEL) key.

First press of the port select key:

L-R PSI	PSI
XXXX	XXXX

Second press of the port select key:

PSI	L-R PSI
XXXX	XXXX

Third press of the port select key:

PSI	mA
XXXX	XXXX

Forth press of the port select key:

mA	PSI
XXXX	XXXX

Fifth press of the port select key:

PSI	PSI
XXXX	XXXX

The Sixth press of the port select key will return to the first dp screen as shown below and allow repeating the choice of available port select configurations

L-R PSI	PSI
XXXX	XXXX

****IMPORTANT****

When static pressure is being applied to both sensors at zero differential pressure press the TARE Key to eliminate any zero offset caused by the elevated static to optimize measurement accuracy.

Notes on interpreting the displayed measurement values:

- 1- On a display set up with an L-R indication on one side of the display and a straight engineering unit designation on the other side of the display the value under the L-R designation is the resulting value from the subtraction of the right Quick Select measurement from that of the left Quick Select measurement. The value on the opposite side of the display, under the engineering unit without the L-R prefix represents the pressure measurement from the Quick Select pressure module installed in the corresponding side of the calibrator. By using the port select function it is possible to read the differential pressure measurement value as well as either of the inputs independently.
- 2- Due to the length of the engineering unit designation when the d/p is expressed in a user engineering unit the L-R indication will not be present on the display. The display is limited to 16 characters/line and cannot display both the L-R and a U_XXXXXX engineering unit label.

Section 20.3 Setting Up Dual Sensor Summation Pressure Measurement

Note: This is an optional capability. Only calibrators ordered with this option will be capable of performing this function.

Step 1 With the calibrator off, install the two Quick Select pressure sensors in the calibrator. As this is a summation process the modules may be in either sensor bay.

Step 2 With the modules installed, turn the calibrator on by pressing the on/off key.

ON
OFF

Step 3 With the calibrator on and displaying pressure measurement data from the two installed Quick Select modules press the Set Up key.

SET
UP

Step 4 Using the up/down and left/right arrow keys locate the section of the set up menu that includes dp measurement set up. This menu will appear on the calibrator screen as follows:

Calib Rtmodule
dp Meas

Step 5 Use the arrow keys to highlight the text "dp Meas". When highlighted the text will flash on the display.

Calib Rtmodule
dp Meas

Step 6 With the text "dp Meas" flashing press the enter key.

ENT

The calibrator will respond with the following display.

dp Meas Mode:
NONE L-R L+R

Step 7 To perform pressure measurement using the dual sensor summation mode select "L+R" to exit this

dp set up and return to basic pressure measurement select "NONE". To proceed, with use the arrow keys to select the text "L+R"

dp Meas Mode:

NONE L-R L+R

Step 8 With the text "L+R" flashing press the enter key.

ENT

After pressing the enter key the calibrator will return to basic pressure measurement.

Step 9 To activate the dual sensor dp mode of operation press the port select key one time after the set up has been complete. The calibrator will display the following text

L + R PSI PSI

XXXX XXXX

for a calibrator displaying measurement values in the psi engineering unit.

When the dual sensor summation firmware is active the following measurement sequence will result from pressing the PORT SELECT key

First press of the port select key:

L + R PSI PSI

XXXX XXXX

Second press of the port select key:

PSI L + R PSI

XXXX XXXX

Third press of the port select key:

PSI mA

XXXX XXXX

Forth press of the port select key:

mA PSI

XXXX XXXX

Fifth press of the port select key:

PSI PSI

XXXX XXXX

The Sixth press of the port select key will return to the first dp screen as shown below and allow repeating the choice of available port select configurations

L + R PSI PSI

XXXX XXXX

Notes on interpreting the displayed measurement values:

- 1- On a display set up with an L+R indication on one side of the display and a straight engineering unit designation on the other side of the display the value under the L+R designation is the resulting measurement for the summation product of the left Quick Select measurement added to the measurement value of the right Quick Select module. The value on the opposite side of the display, under the engineering unit without the L+R prefix represents the pressure measurement from the Quick Select pressure module installed in the corresponding side of the calibrator. By using the port select function it is possible to read the summation pressure measurement value as well as either of the inputs independently.
- 2- Due to the length of the engineering unit designation when the d/p is expressed in a user engineering unit the L+R indication will not be present on the display. The display is limited to 16 characters/line and cannot display both the L+R and a U_XXXXXX engineering unit label.

Section 21.0 Data Logging Function (Optional)

The data logging capability of the HHC-1 allows for operator storage of specific measured values or automatic unattended monitoring and storage of pressure measurement data. The manual mode of data logging allows for the storage of measured pressure data at the push of a key. In the automatic data logging mode, unattended data logging can be programmed to occur at a time interval of from 0.1 to 65,000 seconds.

The data logging function has the capacity to store a maximum of 643 data sets with the time/date stamp function disabled. If the time date stamp is enabled the calibrator data logging memory can store a maximum of 346 data sets. Each data set includes the following; the record number, the measured value and the engineering units of the measurement value. If the time/date stamp is enabled the time (hours/minutes/

seconds) and date (Year/Month/Day) are included with the logged measurement data.

When used in conjunction with the Event Timer function (see Section 22) the HHC-1 can be set up to take data during a selected future time period at an operator programmed time interval. For example, the combination of data logging and event timer provides the ability to set up the HHC-1 to take pressure measurements from 9:00 PM to 11:00 PM at a timed interval of one data set every 10 seconds, without operator intervention.

The setup menu for the data logging function is accessed through a dedicated key on the keypad of the HHC-1. This key has the designation DATA LOG. Pressing the data log key provides access to the complete data logging set up menu.

DATA LOG

The complete setup menu for the data logging function is as follows:

Line 1	Auto	Manual
Line 2	Review	Off
Line 3	Label	Erase

The up/down and left/right arrows can be used to choose the desired selection from the data log set up menu. Information on the function of each of the above menu options follows.

Note: Base units equipped with optional data logging include a lithium battery to back up the Random Access Memory (RAM) used to store data logged values. If the battery voltage is low the following message will appear on the DATA LOG key pressed.

**Data Log Backup
Battery is Low**

When this message appears on the display the battery should be replaced as soon as possible. Consult Section 21.9 for details on battery replacement.

Section 21.1 Data Labeling Function

The label option allows the input of an alphanumeric label of up to 16 characters in length. Multiple labels can be used. For example, a label can be entered and data taken to be stored under the label. After completion of the measurement activities to be included

under the first label another label may be entered and the next data set will follow that label in the data storage and transmission sequence. Label information can be viewed on the HHC-1 display and is transmitted when stored values are reviewed via the computer upload program detailed in Section 21.5.

To enter a label follow the steps below.

Step 1 with the HHC-1 on and reading pressure press the data log key on the HHC-1 keypad.

DATA LOG

In response the HHC-1 will respond by displaying:
THE LAST DATA LOG MENU SCREEN USED

Step 2 Using the up/down and right/left arrows browse through the data log menu and locate the word "label". The menu line that contains the label function appears as:

Label Erase

Step 3 Using the left/right arrow keys select the word Label. When selected the word label will flash.

Label Erase

Step 4 With the word Label flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Enter Label

Step 5 Use the Up/down arrows to enter letters, numbers or a blank and the right/left arrows to move to the position in which the character is to be entered. After the label information has been input press the enter key.

ENT

The label is now stored and will appear in sequence with the corresponding data logged values when the stored information is viewed on the display or uploaded to a computer.

Section 21.2 Automatic Data Logging

The automatic data logging function allows for the automatic, unattended logging of pressure or flow measurement data. The data logging process com-

mences immediately after the completion of the set up of the automatic data function to be performed.

To perform automatic data logging follow the steps below.

Step 1 With the HHC-1 on and reading pressure press the data log key on the keypad.

DATA LOG

The HHC-1 will respond by displaying:

THE LAST DATA LOG MENU SCREEN USED.

Step 2 Using the up/down and right/left arrows browse through the data log menu and locate the word "Auto" The menu line with the word "Auto" appears as:

Auto Manual

To initiate automatic, time interval, data logging select the word "Auto" by using the arrow keys. When selected the word "Auto" will flash on the display. For manual, operator controlled, data entry proceed to Section 21.3.

Auto Manual

Step 3 With the word "Auto" flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Enter Interval
sec. xxxxxx**

Step 4 Using the number keys enter the desired time interval in seconds. The interval maybe from 0.1 seconds to 65,000 seconds.

**Enter Interval
sec. 12345**

Step 5 After the desired time interval is shown on the display press the enter key.

ENT

Step 6 The HHC-1 will respond by displaying the following:

**Readings to Log
NoneLeftRightBoth**

Step 7 Using the arrow key select the desired Quick Select pressure modules to be monitored and logged.

**Readings to Log
NoneLeftRightBoth**

In this example we have opted to log the output from both Quick Select pressure modules.

Step 8 With the Quick Select module(s) to be monitored selected and flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Date/Time Stamp
Disable Enable**

Note: If data storage is done with the time/date stamp option activated, the HHC-1 can store 387 sets of pressure measurements. If data storage is done without the time/date stamp option activated the HHC-1 can store 714 sets of pressure measurements. A data set is the full package of information defining the logged output from one module.

Using the arrow keys select the desired storage format. The desired format will flash when selected.

**Date/Time Stamp
Disable Enable**

In this example we have opted to forego the date/time stamp of the stored data values.

Step 9 With the desired format displayed press the enter key.

ENT

The HHC-1 will immediately begin storing the pressure data requested at the desired interval until instructed to stop the data logging process.

Step 10 To stop the data logging process press the Data Log key. The HHC-1 will respond by displaying:

**Auto Manual
Review Off**

Step 11 Using the arrow keys select the word off. When selected the word "Off" will flash on the display.

**Auto Manual
Review Off**

Step 12 With the word "Off" flashing press the enter key to disable the data log function.

ENT

Automatic, time interval based, data logging has now been terminated.

Section 21.3 Manual Data Logging

Follow the procedure below to conduct manual, operator controlled, data logging.

Step 1 With the HHC-1 on and reading pressure press the data log key.

**DATA
LOG**

The HHC-1 will respond by displaying the following:

THE LAST DATA LOG MENU SCREEN USED

Step 2 Using the up/down and right/left arrows browse through the data log menu and locate the word "Manual". The menu line with the word "Manual" appears as:

Auto Manual

To initiate manual data logging select the word "Manual" using the arrow keys. When selected the word "Manual" will flash on the display.

Auto Manual

Step 3 With the word "Manual" flashing press the enter key.

ENT

The HHC-1 will respond with the following display:

**Readings to Log
NoneLeftRghtBoth**

Step 4 Using the arrow key select the desired Quick Select modules to be monitored.

**Readings to Log
NoneLeftRghtBoth**

In this example we have opted to log the output from both Quick Select pressure modules.

Step 5 With the Quick Select module(s) to be monitored and logged selected and flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Date/Time Stamp
Disable Enable**

Note: If data storage is done with the time/date stamp option activated the HHC-1 can store 387 sets of pressure measurements. If data storage is done without the time/date stamp option the HHC-1 can store 714 sets of pressure measurements. Sets of pressure measurement data include all the data stored to define the output of one module.

Using the arrow keys select the desired storage format. The desired format will flash on the display when selected.

**Date/Time Stamp
Disable Enable**

In this example we have opted to forego the date/time stamp of the stored data values.

Step 6 With the desired format selected and flashing press the enter key.

ENT

Step 7 The HHC-1 is now ready to log data on command. To store a measured pressure, flow, leak test, switch test, min/max data set, current or voltage value press the data store key.

**DATA
STORE**

Step 8 To disable the manual data logging capability press the Data Log key.

**DATA
LOG**

The HHC-1 will respond by displaying:

**Auto Manual
Review Off**

Step 9 Using the arrow keys select the word "Off". When selected the word "Off" will flash.

**Auto Manual
Review Off**

Step 10 With the word "Off" flashing press the enter key to disable the data log function.

ENT

Manual, operator initiated, data logging has now been terminated.

Section 21.4 Review of Stored Data- On Instrument Display

Data stored in either the manual or automatic data logging functions can be reviewed on the display of the HHC-1 or up loaded to an IBM compatible PC. For information regarding uploading of stored data to a personal computer skip to Section 21.5.

The HHC-1 provides the ability to review, on the display, the data logged measurement values. To review stored values follow the procedure below.

Step 1 With the HHC-1 on and reading pressure press the data log key on the keypad.

DATA LOG

The HHC-1 will respond by displaying the following:

THE LAST DATA LOG MENU SCREEN USED

Step 2 Using the up/down and right/left arrows browse through the data log menu and locate the word "Review". The menu line with the word "Review" appears as:

Review Off

To initiate the review process select the word "Review" using the arrow keys. When selected the word "Review" will flash.

Review Off

Step 3 With the word "Review" flashing press the enter key.

ENT

Step 4 The HHC-1 will respond by displaying the last data logged value stored in memory. The display of the data logged value will appear as follows:

+xxx time
+123456 eng

where:

+xxx = the 1-3 digit number representing the record number for the data point in the sequence of logged data.
+12345 = stored measurement value.
eng = is the engineering unit of the stored value.
time = time pressure measurement taken, when date/time stamp was enabled.

Important Note: If both the left and right pressure/flow or electrical measurements are logged the HHC-1 will store the data from the left sensor or side of the display in the odd numbered records and the data from the right sensor or right side of the display in the even numbered records. There is no stored indication of right or left sensor for the stored data values.

Step 5 To review data logged values use the arrow keys to browse through the stored values. Pressing the corresponding arrow key will result in the following action in the data log review process.

Key	Result
<	brings the next lowest stored address value to the display.
>	brings the next highest stored address value to the display.
^	skips 10 stored values in increasing address direction.
v	skips 10 stored values in decreasing address direction.
%	brings first data point to display.
mA/V	brings last data point to display.

Step 6 When the review process is complete press the data log key to return to normal pressure measurement.

DATA LOG

Section 21.5 Calibrator Set Up for Uploading Stored Data Into an IBM Compatible PC

The following steps will allow you to upload stored data to an IBM compatible PC.

Step 1 Turn the power off on the base unit.

Step 2 Connect the 9 pin RS232 cable to the HHC-1 and to a serial port on the PC.

Step 3 Turn the power to the base unit on and with the HHC-1 on and reading pressure press the setup key.

SET UP

Step 4 Using the arrow keys locate and select the text RS232. When selected the text RS232 will flash.

Owner Alarm
DateTime RS232

Step 5 With the text RS232 flashing, press the enter key.

ENT

The HHC-1 will respond by displaying:

RS232 interface

Disable Enable

Step 6 Using the arrow keys select the word Enable. When selected the word Enable will flash.

RS232 interface

Disable *Enable*

Step 7 With the word Enable flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Baud Rate

9600 2400 1200 300

Step 8 Using the left/right arrow keys select the desired baud rate. When selected the baud rate will flash.

Baud Rate

9600 2400 1200 300

In the above example 9600 baud has been selected.

Step 9 With the desired baud rate flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Disable ISO1745

Journal Inquiry

Step 10 In order to use the upload software provided with the HHC-1 use the arrow keys to select the text ISO1745. When selected the text ISO1745 will flash.

Disable *ISO1745*

Journal Inquiry

Step 11 With the text ISO1745 flashing press the enter key.

ENT

The calibrator is now set up for data logging. Next, the computer to be used for uploading must be prepared.

Section 21.6 Installing and Operating Upload Software

Information regarding the installation and use of the upload utility software is provided in the supplemental software manual provided with the product. Please consult the Calibrator Software Installation and Operation Manual.

Section 21.7 Erasing of Selected Stored Data

In some instances the ability to delete specific stored data points can be useful. In particular, this can be the case when data of questionable integrity has been stored in the data log memory. The HHC-1 allows for the deletion of specific operator selected stored data points.

There are limitations to this capability. These limitations are as follows:

- 1) The remaining data will stay in the original sequence with blank data fields left where the stored data points have been deleted.
- 2) The HHC-1 will not compress the data to the new, smaller data set.
- 3) The newly erased fields cannot be used for the storage of new data values until a complete data erase has been done.

The process to delete selected data points is as follows:

Step 1 With the HHC-1 on and reading pressure press the datalog key on the HHC-1 keypad.

DATA LOG

In response the HHC-1 will respond by displaying:
THE LAST DATA LOG MENU SCREEN USED

Step 2 Using the up/down and right/left arrows browse through the data log menu and locate the word "Review" The menu line with the word Review appears as:

Review Off

Using the arrow keys select the word Review. When selected the word Review will flash.

Auto Manual
Review Off

Step 3 With the word review flashing press the enter key.

ENT

Step 4 Data points may be browsed through by using the keys as indicated below:

Key	Result
>	brings the next lowest stored address value to the display.
<	brings the next highest stored address value to the display.
^	skips 10 stored values in increasing address direction.
v	skips 10 stored values in decreasing address direction.
%	brings first data point to display.
mA/V	brings last data point to display.

To erase a stored data value press the clear entry key, designated CE, while the data to be deleted is displayed.

CE

The HHC-1 will respond by displaying:

Erase This Entry
Ent If OK

Step 5 To delete the displayed stored data point press the enter key.

ENT

The HHC-1 will respond by displaying:

+ XXX
Erased Entry

Step 6 Using the arrow keys additional data points can be reviewed and kept or deleted as desired.

Step 7 To exit this function press the data log key.

DATA
LOG

The HHC-1 will now resume normal pressure measurement activities.

Section 21.8 Erasing All Stored Data

Step 1 With the HHC-1 on and reading pressure press the data log key.

DATA
LOG

In response the HHC-1 will respond by displaying:

THE LAST DATA LOG MENU SCREEN USED

Step 2 Using the up/down and right/left arrows browse through the data log menu and locate the word "Erase". The menu line with the word Erase appears as:

Label Erase

Step 3 Using the left/right arrow keys select the word Erase. When selected the word Erase will flash.

Label Erase

Step 4 With the word Erase flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Erase ALL Entry's
Cancel Erase

The word cancel will be flashing. Selection of the word erase must be done via the arrow keys to erase stored data.

Step 5 Using the right arrow select the word Erase and press the enter key.

*****WARNING*****

PRESSING THE ENTER KEY WITH THE ERASE INSTRUCTION FLASHING WILL IRREVOCABLY DESTROY ALL STORED DATA. IF IT IS REQUIRED THAT ANY STORED DATA BE RETAINED SELECT THE WORD CANCEL AND PRESS THE ENTER KEY ON THE KEYPAD.

Erase ALL Entry's
Cancel Erase

Step 6 To erase all stored data press the enter key.

ENT

The HHC-1 will now resume standard pressure measurement activities.

Section 21.9 Battery Back Up Replacement

When the display indicates that the battery back up is low the lithium battery should be replaced as soon as possible. The battery is a standard 3 volt lithium battery. Replacement should be made with a Panasonic BR1225 or CR1220 battery.

WARNING

Replace battery with Panasonic Type BR1225 or CR1220 only. Use of another battery may present a risk of fire or explosion. Replacement batteries are available through most industrial supply and electronic supply distributors. Caution, battery may explode if mistreated. Do not recharge, disassemble or dispose of in fire.

CAUTION

This procedure should only be performed by a trained electronic technician. The HHC-1 incorporates CMOS components on the printed circuit boards. CMOS components can be damaged by electro static discharge. Technicians performing battery replacement must be properly grounded to avoid damaging sensitive electronic components.

Follow the procedures below to change the battery back up unit.

Note: The calibrator should be turned off prior to initiating battery replacement procedure.

Step 1 Following the steps in Section 3.5 remove any installed Quick Select pressure modules.

Step 2 Disconnect the cable in the sensor bay from the printed circuit board.

Step 3 As outlined in Section 3.1 open the battery enclosure on the underside of the base unit.

Step 4 Remove the two 9 volt alkaline batteries.

Step 5 Rest calibrator keypad side down on a level surface and remove the four (4) Phillips head screws accessed through holes in the back of the base unit.

Step 6 Lift the back section of the case from the end closest to the miniature banana jacks. The back portion interlocks with the front part of the case near

the sensor bay area.

Step 7 With the back of the case at an angle of approximately 45 degrees from the case front slide the back of the case out of the interlocking mechanism and set aside.

Step 8 Remove four (4) Phillips head screws used to secure board set.

Step 9 Lift board set slightly out of front portion of case and carefully disconnect cable between the keypad and the printed circuit board. (Connection slides out parallel to the printed circuit board.)

Step 10 Lift the board set out and place display side up on a level surface.

Step 11 Locate battery to be replaced. Battery unit is near connection P6, immediately to the right of pin 10.

Step 12 Remove depleted battery and install replacement unit. Be certain to install appropriate 3 volt lithium battery as outlined in introduction to this section.

Step 13 Remove jumper on connection P6 between pin 7 and pin 8. Wait 2-3 seconds and reinstall jumper in original location.

Step 14 Carefully reconnect cable between printed circuit board and keypad.

Step 15 Reinstall board set into front of case, checking that four (4) for mounting posts align properly with the board set.

Step 16 Replace four (4) screws used to retain board set.

Step 17 Replace back half of case first connect interlocking mechanism near sensor bays and then close case.

Step 18 Reinstall four (4) screws used to connect front and back sections of case.

Step 19 Reconnect cables in each sensor bay to the circuit board.

Step 20 Following steps in Section 3.1 reinstall the two 9 volt alkaline batteries.

Step 21 Follow steps in Section 3.5 to reinstall the desired Quick Select pressure modules.

Step 22 Power unit up and down three (3) times to enable the battery backup logic.

Battery replacement is now complete.

Section 22.0 Event Timer Function

The Event Timer allows for unattended data logging during a desired time period. For example, if it is necessary to monitor the pressure levels of a flue or HVAC duct during a specific time period the Event Timer, used in combination with the data logging function, can satisfy this requirement.

Delayed initiation of unattended measurement activities requires the set up of BOTH the Event Timer and data logging function.

Section 22.1 Event Timer Set-Up

To program the HHC-1 for delayed monitoring and data logging follow the steps below.

The event timer sets the starting and ending times for unattended monitoring to be performed during a future time period. The Event Timer function is programmed as follows.

Step 1 With the HHC-1 on and measuring pressure press the set up key.

**SET
UP**

Step 2 Using the arrow keys select the event timer, designated *EvntTimr*, option on the set up menu. When selected the text "*EvntTimr*" will flash on the display.

EvntTimr Dampen
LeakRate Status

Step 3 With the text *EvntTimr* selected and flashing on the display press the enter key.

ENT

The HHC-1 will respond by displaying:

HHMMSS Start
XXXXXX

where:

HH = hours in military time

MM = minutes (0-60)

SS = seconds (0-60)

Use the number keys to enter the hours, minutes and seconds in the corresponding entry fields to establish the start time.

Step 4 When entered the start time will look as follows for a time of 9:30 PM.

213000 Start
XXXXXX

Step 5 When the desired start time has been input and appears on the display press the enter key.

ENT

The HHC-1 will respond by displaying:

HHMMSS Stop
XXXXXX

Step 6 Enter the desired stop time using the number keys. When properly entered a stop time of 11:30 PM will look as follows:

HHMMSS stop
233000

Step 7 When the desired stop time has been input and appears on the display of the HHC-1 press the enter key.

ENT

The HHC-1 will respond by displaying:

Event Timer
Disable Enable

Step 8 Use the right arrow key to select the word Enable. When selected the word Enable will flash on the display.

Event Timer
Disable *Enable*

Step 9 With the word Enable flashing press the enter key.

ENT

Proceed to Section 22.2 for data log set up for operation with the event timer function.

Section 22.2 Data Log Set Up for Operation with the Event Timer

The data logging function must be set up to control the data logging parameters in time delayed data logging activities. For delayed data logging to function the data logging function must be set up as follows.

Step 1 With the HHC-1 on and reading pressure press the data log key.

DATA LOG

The HHC-1 will respond by displaying the following:

THE LAST DATA LOG MENU SCREEN USED

Step 2 To program the HHC-1 for time delayed data logging use the arrow keys to locate and select the word "Auto" in the data log menu. When selected the word Auto will flash on the display.

Auto Manual
Review Off

Step 3 With the word Auto flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Enter Interval
sec. XXXXXX

Step 4 Using the number keys enter the desired time interval in seconds. The interval may be from 0.1 seconds to 65,000 seconds.

Enter Interval
sec. 600

The above example shows an interval of 600 seconds or 10 minutes.

Step 5 After the desired time interval is entered and shown on the display press the enter key.

ENT

The HHC-1 will respond by displaying the following:

Readings to Log
NoneLeftRghtBoth

Step 6 Using the arrow key select the desired Quick Select Modules to be monitored.

Readings to Log
NoneLeftRghtBoth

In the above example the left sensor has been designated as the Quick Select Module to be monitored for data logging.

Step 7 With the Quick Select module(s) to be monitored selected and flashing press the ENT key.

ENT

After the Quick Select pressure module(s) to be monitored has been entered the HHC-1 will respond by displaying:

Date/Time Stamp
Disable Enable

Note: If data storage is done with the time/date stamp option the HHC-1 can store 387 sets of pressure measurements. Sets of pressure measurement data include pressure measurement from the left, right or both sensors.

If data storage is done without the time/date stamp option the HHC-1 can store 714 sets of pressure measurements. Sets of pressure measurement data include pressure measurement from the left, right or both sensors.

Step 8 Using the arrow keys select the desired storage format. The desired format will flash on the display when selected.

Date/Time Stamp
Disable Enable

In the above example the date time stamp function has been enabled and the stored data will be labeled with time date information in the database.

Step 9 With the desired format displayed press the enter key.

ENT

After pressing the enter key immediately turn the HHC-1 off.

When the event timer and data log functions are set up as outlined in Sections 22.1 and 22.2 the HHC-1 will automatically turn itself on and make the programmed measurements over the desired time interval. At the conclusion of the programmed monitoring period the HHC-1 will automatically turn itself off.

To review logged data or perform any other data logging functions such as data labeling or uploading to a personal computer see the main data logging section (Section 21) of this manual.

Section 23.0 Alarm Function- Overview (Optional Feature)

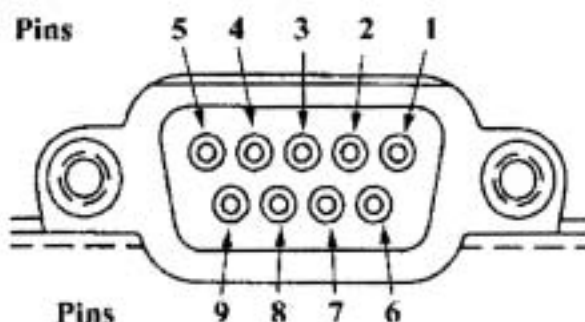
The HHC-1 can be equipped with a set of single pole single throw (SPST) relays for use in triggering annunciator lights, fans, sirens, etc. The relays have

the following specifications:

Relay Specifications

Parameter	Specification
Switch Arrangement:	Form C
Resistance (max):	50 micro ohms
Switching Power (max):	30 W, 62.5 VA (resistive load)
Switching Voltage (max):	110 V dc, 125 Vac
Switching Current (max):	1 Amp
Switching Capability (min):	10 micro amp, 10 mV dc

The relay contact closures are accessed through the 9 Pin female D connector on the right side of the HHC-1. Pin out information for set point contacts is as follows:



Pin 1 Relay 1 common

Pin 7 Relay 1 (normally open or normally closed)

Pin 8 Relay 2 common

Pin 9 Relay 2 (normally opened or normally closed)

Section 23.1 Alarm Set Up

The alarm level trip points can be programmed from the keypad as follows.

Step 1 With the HHC-1 on and reading pressure press the SET UP key.

**SET
UP**

Step 2 Using arrow keys select the alarm function from the setup menu. When selected the word "Alarm" will flash on the display.

Owner Alarm

DateTimeRS232

Step 3 With the word Alarm flashing press the enter key.

ENT

This is an optional feature, if the option is not installed the HHC-1 will respond with:

**Option not
installed**

If this message appears press any key to resume normal operation.

Step 4 After pressing the enter key the display will read:

**Alarm Relay
Enable Disable**

To set alarm levels, using the arrow keys, select the word Enable. When selected the word Enable will flash.

**Alarm Relay
Enable Disable**

Step 5 With the word "Enable" flashing press the enter key.

ENT

Step 6 After pressing the enter key the HHC-1 will respond:

**High Setpoint
????????**

Important Note: Set points must be entered for the specific engineering unit to be monitored. For example if a setpoint of 10 is entered the alarm relay will trip when measured and displayed pressure exceeds the numerical value of 10. The HHC-1 will not automatically convert the entered trip point to a new numerical value to reflect a change in engineering units.

Step 7 Using the number keys, enter the alarm level from left to right, including any decimal point. In this example a high setpoint of 10 has been selected.

High Setpoint
10.0

Step 8 After the desired alarm value has been keyed and is seen on the display press the enter key.

ENT

Step 9 The HHC-1 will respond by displaying the following:

High Contact
Open Close

If Open is selected, the high limit contact will be open when the measured pressure exceeds the setpoint value. If Close is selected, the contact will close if the setpoint is exceeded.

Step 10 Using the arrow keys select the desired mechanical configuration. When selected the configuration type will flash. In this example we have configured the system to close the relay contact when the alarm value is exceeded.

High Contact
Open Close

Step 11 When the desired configuration has been selected and the text is flashing on the display, press the enter key.

ENT

Step 12 After pressing the enter key the HHC-1 will respond.

Low Setpoint
????????

Step 13 Using the number keys on the keypad, enter the desired alarm level from left to right including decimal point. In this example a low setpoint of one (1) has been selected.

Low Setpoint
1.0

Step 14 After the desired alarm value has been keyed and appears on the display press the enter key.

ENT

Step 15 The HHC-1 will respond by displaying the following:

Low Contact
Open Close

If Open is selected, the low limit contact will be open when the measured pressure exceeds the setpoint value. If Close is selected, the contact will close if the setpoint is exceeded.

Step 16 Using the arrow keys select the desired mechanical configuration. In this example we have configured the system to close the relay contact when the alarm value is exceeded.

Low Contact
Open Close

Step 17 When the desired configuration has been selected and the text is flashing on the display, press the enter key.

ENT

Step 18 After the enter key has been pressed the HHC-1 will respond by displaying:

Monitor Function
Left Right

This will determine whether the HHC-1 is monitoring the left or right Quick Select pressure or temperature module. Using the arrow keys select the desired pressure module to be monitored.

Step 19 Use the left/right arrow keys to select the desired module to be monitored. In this example the left module has been identified for monitoring.

Monitor Function
Left Right

Step 20 With the desired module selected and flashing, press the enter key.

ENT

The alarm function is now armed and operating. This function is automatically disabled when the HHC-1 is turned off and must be re-initiated by enabling the alarms via the set up menu.

The calibrator will respond by displaying the following:

——— 1.0V
-.XXXXX RefCheck

*******WARNING*******

If the voltage standard is set to a level in excess of the recommended calibration input or is connected to incorrect pins or in contact with pins adjacent to the specified input pins during the calibration process the base unit electronics may be damaged. Use extreme caution when applying voltage signals to the base unit.

An accessory calibration module is available to simplify connection of the voltage standard to the base unit. This module is Model CQS Calibration Quick Select module. This module provides banana jack connections for the input of the voltage standard to the calibrator base unit.

Step 10 To check the measured voltage using a precision voltage source apply 1.00000 volt +50 microvolts, applied voltage should, at minimum be 1 Vdc. **Do not accept a voltage less than 1 Vdc or greater than 1 volt + 50 microvolts.** When the calibrator is ready to measure the reference voltage it will display:

Apply 1.00000V
to J3 pin 7

The referenced pins are located in the sensor bay on the left side of the base unit with the base unit upright and the miniature banana jacks nearest the operator. To apply the 1 Vdc signal to the calibrator connect the precision voltage generator so that the positive line is connected to pin 7 and the ground is connected to Pin 6.

Looking into the left sensor bay with the calibrator upright:

pin 7 is the 2nd pin in from the right side on the bottom row
pin 6 is the center pin on the top row.

Step 11 The value displayed under the dashed line represents the as received reading for the 1 Vdc measurement. The reading will look as follows:

——— 1.0V
+.99998 RefCheck

After taking note of the reading press the enter key to proceed to the next as received reading. The calibrator will respond by displaying the following

——— 0.1V
-.XXXXX RefCheck

Step 12 To check the measured voltage using a precision voltage source:

Apply 0.10000V
to J3 pin 7

To apply the 0.1 Vdc signal use the same procedure as outlined in steps 10 and 11 of this section.

Step 13 The value displayed under the dashed line represents the as received reading for the 1 Vdc measurement. The reading will look something like follows:

——— 0.1V
+.099998 RefCheck

Take note of the measured value.

Step 14 To repeat taking the as received readings press the enter key to return to the 1.0 Vdc as received reading screen. To exit the as received readings mode press the CE key.

CE

As received readings for the mA and Voltage measurements performed through the miniature banana jacks on the instrument keypad can be done by simply setting the base unit up to measure the electrical parameter (current or voltage) to be tested and inputting a series of known values to the correct jacks. Refer to Section 7.0 to determine the set up procedure for the measurement of current and/or voltage inputs.

As received readings are now completed.

Section 24.2 Adjustment/Calibration

Base unit Electronics

Step 1 With the HHC-1 on and displaying pressure measurement data press the set up key.

**SET
UP**

Section 24.0 Recertification of the HHC-1

Both the base unit electronics and the pressure measurement capabilities of the HHC-1 can be recertified in the field. The recertification procedure is menu driven and provides operator prompts to facilitate the recertification effort. The recertification program is accessed via the set up menu.

The calibration data is password protected and requires the operator to input the required calibration password code. The calibration password code is different than the owner password code. Both the owner and the calibration password codes were provided with the HHC-1 at the time of shipment. If the password has been lost contact the factory. Be prepared to provide the serial number of the base unit. The serial number of the base unit is located on the product label in the sensor bay section of the HHC-1. To locate the product label remove any installed pressure sensor modules, hold the HHC-1 keypad side down and look into the sensor bay enclosure. The label will be on the underside of the keypad/front panel section of the HHC-1.

Section 24.1 As Received Readings- of the Base Unit Electronics

Step 1 With the HHC-1 on and displaying pressure measurement data press the set up key.

**SET
UP**

Step 2 Using the arrow keys locate the text "Calib" in the set up menu.

Calib RTmodule

Using the appropriate arrow keys select the text "Calib" from the set up menu. When the calibration function has been selected it will flash on the display.

Step 3 With the text "Calib" displayed and flashing press the enter key.

ENT

Step 4 The HHC-1 will respond by displaying:

**Access code ?
.000000**

Step 5 Enter the 5 digit calibration access code provided with the HHC-1 base unit.

**Access code ?
12345**

Note: The access code is specific for the base unit being used. The code is provided on the certification sheet that accompanied the product shipment from the factory. If you cannot locate the access code, contact the customer service department at your calibrator supplier.

Step 6 With the correct access code displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

**Electrical
Pressure**

The electrical calibration process allows for the calibration of the current and voltage input measurement capability of the base unit as well as the calibration of the 0/1 vdc analog component of the interface between the base unit and the Quick Select module in use.

Step 7 When this screen appears, the word "Electrical" for electrical recertification is already flashing. Therefore, press the enter key to commence the electrical calibration.

ENT

The HHC-1 will respond by displaying:

**Calibration
Reference Check**

Step 8 To perform "as received" readings use the down arrow key to select Reference Check. When selected the text "Reference Check" will flash on the display. To skip as received readings and proceed immediately to calibration skip to Section 24.2.

**Calibration
Reference Check**

Step 9 With text Reference Check Flashing press the Enter Key.

ENT

Step 2 Using the arrow keys locate the text “Calib” in the set up menu.

Calib RTmodule

Using the appropriate arrow keys select the text “Calib” from the set up menu.

Step 3 When the calibration function has been selected it will flash on the display.

Calib RTmodule

Step 4 With the text “Calib” displayed and flashing press the enter key.

ENT

Step 5 The HHC-1 will respond by displaying:

Access code ?

.000000

Step 6 Enter the 5 digit calibration access code provided with the HHC-1 base unit.

Access code ?

12345

Step 7 With the correct access code displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

Electrical

Pressure

The electrical calibration process allows for the calibration of the current and voltage input measurement capability of the base unit as well as the calibration of the 0/1 Vdc analog component of the interface between the base unit and the Quick Select module in use.

Step 8 Use the arrow keys to select the word “electrical”. When selected the word will flash on the instrument display.

Electrical

Pressure

Step 9 When this screen appears, the word “Electrical” for electrical recertification is already flashing. Therefore, press the enter key to commence the electrical calibration.

ENT

The HHC-1 will respond by displaying:

Calibration

Reference Check

Step 10 Select the text “Calibration”, when selected the word calibrate will flash on the display of the calibrator.

Calibrate

Reference Check

Step 11 With the text “Calibrate” flashing press the enter key.

ENT

Step 12 Using a precision voltage source apply 1.00000 volt (+50 microvolts applied voltage should, at a minimum, equal 1.0 volt. Do not accept a voltage less than 1.0 volt or greater than 1.0 volt plus 50 microvolts) to pin 7 of the sensor connection plug located in the left (looking down on the HHC-1 with the unit in the upright position and the miniature banana jacks nearest the operator) sensor bay of the base unit. Connect the ground for the voltage source to pin 6.

Looking into the sensor bay with the calibrator upright:

pin 7 is the 2nd pin in from the right side on the bottom row

pin 6 is the center pin on the top row.

*******WARNING*******

If the voltage standard is at a level in excess of the recommended calibration input or is connected to incorrect pins or in contact with pins adjacent to the specified input pins during the calibration process the base unit electronics may be damaged. Use extreme caution when applying voltage signals to the base unit.

An accessory calibration module is available to simplify connection of the voltage standard to the base unit. This module is Model CQS Calibration Quick Select module. This module provides banana jack connections for the input of the voltage standard to the calibrator base unit.

Step 13 The calibrator will display the following:

Apply 1.00000V

to J3 pin 7

With 1.00000 volt (+50 microvolts) applied press the enter key.

ENT

The HHC-1 will respond by displaying:

xxxxx working

The word “working” flashes as the HHC-1 makes the necessary internal adjustment to calibrate the voltage measurement electronics to 1.0000 volts.

After completion of the adjustments for the 1.00000 volt input the HHC-1 will display:

Apply 0.100000V

to J3 pin 7

With 0.100000 volt (+50 microvolts) applied press the enter key.

ENT

The HHC-1 will respond by displaying:

xxxxx working

After the calibrator completes auto-adjusting the measured value it will display:

Apply 10.0000V

to volts jack

Step 14 Using a precision voltage generator apply a 10.0000 volt (± 500 microvolts) input to the miniature recessed banana jacks. Use the COM and V jacks on the HHC-1 keypad.

Step 15 When the proper voltage is being applied press the enter key.

ENT

The HHC-1 will respond by displaying:

xxxxx working

After completion of the adjustments for the 10.0000 volt input the HHC-1 will display:

Apply 30.0000V

to volts jack

Step 16 Using a precision voltage generator apply a 30.0000 volt (± 3 millivolts) input to the voltage jacks. Use the COM and V jacks on the HHC-1 keypad.

Step 17 When the proper voltage is being applied press the enter key.

ENT

When the proper voltage is being applied press the enter key.

The HHC-1 will respond by displaying:

xxxxx working

After completion of the adjustments for the 30.0000 volt input the HHC-1 will display:

Apply 20.0000 mA

to mA jack

Step 18 Using a precision current generator apply a 20.0000 mA (± 5 microamps) input to the mA jacks.

Use the COM and mA jacks on the HHC-1 keypad.

Step 19 When the proper current is being applied press the enter key.

ENT

The HHC-1 will respond by displaying:

xxxxx working

After completion of the 20 mA recertification the HHC-1 will display:

Calibration done

Save Cancel

Step 20 Using the left/right arrow keys select “Save” to write the new data to the EEPROM calibration storage. To discard the electrical readings select Cancel.

*****WARNING*****

Selecting and entering the word “Save” will overwrite the calibration data previously stored in EEPROM memory. Previously used calibration data will be permanently destroyed.

Step 21 With the desired selection flashing (Save or Cancel) press the enter key.

ENT

Step 22 Turn off the HHC-1 and install the desired Quick Select pressure module per instructions provided in Section 3.2.

Step 23 Turn on the HHC-1 to resume general pressure measurement activities.

Note: During electrical recertification any of the calibration ranges may be skipped by pressing the clear entry (CE) key. When the clear entry key is

pressed during the electrical calibration process the HHC-1 will advance to the next electrical input in the calibration sequence.

Section 24.3 Recertification of Quick Select Pressure Modules

The HHC-1 is available in a selection of accuracies from $\pm 0.25\%$ of span through $\pm 0.05\%$ of span, covering ranges from 0.25 inches of water to 7500 psi. Whereas, the HHC-1 can be calibrated in the field, appropriate pressure standards must be used to assure the accuracy of the HHC-1 system is not degraded by the calibration process. As recommended by standards organizations such as A.S.M.E., N.I.S.T and various U.S. and world government agencies calibration standards should be at least 4 times more accurate than the device to be calibrated.

Therefore, if you will be calibrating a $\pm 0.1\%$ of span Quick Select pressure module, a standard of equivalent range would have to have an accuracy of at least $\pm 0.025\%$ of span. If the standard to be used is of a higher range than the Quick Select pressure module to be calibrated, even greater accuracy is required. For example, if a $\pm 0.1\%$ of span Quick Select pressure module with a range of 50 psi is to be calibrated with a 100 psi standard, the calibrating standard should have a minimum accuracy of $\pm 0.0125\%$ of span. If you have any questions regarding the recommended standards to calibrate Quick Select Pressure Modules please contact the technical services department at your calibrator supplier.

To recertify a Quick Select pressure module follow the procedure outlined below.

Step 1 With the power to the HHC-1 off install the Quick Select pressure module to be calibrated in the left sensor bay (looking down on the unit with the keypad up and the display at the top).

Step 2 Power up the HHC-1 system by pressing the on/off key.

**ON
OFF**

Step 3 Set the left side of the display for the engineering units to be used for the calibration process. Information on engineering unit selection is provided in Section 8, Engineering Unit Selection.

Step 4 With the HHC-1 on and displaying pressure measurement data press the set up key.

**SET
UP**

Step 5 Using the arrow keys locate the text "Calib" in the set up menu.

Calib RTmodule

Select the text "Calib". When selected the text will flash on the display.

Step 6 With the text "Calib" displayed and flashing press the enter key.

ENT

Step 7 The HHC-1 will respond by displaying:

**Access code ?
.000000**

Step 8 Enter the 5 digit calibration access code provided with the HHC-1 base unit.

**Access code ?
12345**

Step 9 With the correct access code displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

**Electrical
Pressure**

Step 10 Using the down arrow key select the word "Pressure". When selected, the word Pressure will flash on the display:

**Electrical
Pressure**

Step 11 With the word "Pressure" flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

**Zero Cal
Yes No**

Step 12 To perform zero calibration (adjustment) select Yes and press the enter key.

ENT

To skip zero adjustment and proceed to full scale calibration (adjustment) select No and press the enter key.

Step 13 With the pressure module at zero pressure, press the enter key.

ENT

Note: The following should be done to zero each type of pressure module:

Pressure Type	Zero Source
Absolute	Apply absolute zero using vacuum pump.
Gauge	Vent to atmosphere
Compound	Vent to atmosphere
Differential	Vent both ports to atmosphere
Vacuum	Vent to atmosphere
DLP-1	All DLP-1 modules must have both ports vented to atmosphere in order to properly zero the module.

The HHC-1 will respond by displaying:

xxxxx working

Where xxxxxx is the voltage being read from the Quick Select pressure module and the flashing word “working” indicates that the HHC-1 is making the internal adjustments necessary for the recalibration.

After approximately 3 seconds the HHC-1 will display:

Full Scale Cal

Yes No

Step 14 To perform full scale calibration (adjustment) select Yes and press the enter key.

ENT

To skip full scale adjustment and proceed to re-linearization process select No and press the enter key.

Important Note: If full recalibration of the pressure module is desired the zero and span adjustment must be reset through these procedures prior to entering the linearization mode. The zero and span values established in these procedures will be used for the zero and span values of the new calibration data. If zero and span are not reset at this time the recalibration will use the values for zero and span stored in memory from the previous zero and span activities.

Step 15 Apply the full scale pressure for the Quick Select pressure module being calibrated. (Coming as close as possible to the full scale measurement range of the pressure module being calibrated) with the pressure applied press the enter key.

ENT

The HHC-1 will respond by displaying:

Enter pressure

applied .00000

Step 16 Using the keypad enter the *exact* value of the pressure applied to the Quick Select pressure module. Be certain to use the engineering unit in use for the left Quick Select module when calibration activities commenced.

Enter pressure

applied 100.01

In the above example a pressure of 100.01 is being applied to the left Quick Select pressure module.

Step 17 With the full scale (F.S.) pressure applied and the corresponding value shown on the display, press the enter key.

ENT

The HHC-1 will respond by displaying:

Linearity Cal

Yes No

Step 18 If calibration activity is to be limited to zero and span, using the arrow keys select the word No (when selected the word “No” will flash on the display). If linearity adjustment is to be performed proceed to Step 21.

Linearity Cal

Yes No

Step 19 With the word No flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Calibration done

Save Cancel

Step 20 To save the new zero and span values to memory, thereby overwriting the previously stored values in the EEPROM, select the word “Save” and

press the enter key. To discard information and retain the information currently in the EEPROM of the HHC-1 select "Cancel" and press the enter key.

Step 21 To re-linearize a Quick Select pressure module select the word "Yes" to the linearity query.

Important Note: If full recalibration of the pressure module is desired the zero and span adjustment must be reset through these procedures prior to entering the linearization mode. The zero and span values established in these procedures will be used for the zero and span values of the new calibration data. If zero and span are not reset at this time the recalibration will use the values for zero and span stored in memory from the previous zero and span activities.

Linearity Cal

Yes No

Step 22 With the word "Yes" flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Clr Old Lin Data

Cancel Proceed

Step 23 Use the arrow keys to select "Proceed" to continue the linearization process. Select "Cancel" using the arrow keys to discontinue the re-linearization process.

WARNING

Entering "Proceed" will destroy linearization data in the EEPROM of the HHC-1.

Clr Old Lin Data

Cancel Proceed

Step 24 To continue the linearization process, with the word "Proceed" flashing press the enter key.

ENT

The HHC-1 will respond by displaying:

Apply and enter

value 1.00000

Step 25 Apply the pressure required for point one and enter the numerical value, using the number keys of the exact pressure level applied. (Use the engineering unit in use for the left pressure module at the time the calibration process was started). When point 1 has been applied and entered the display will look as

follows for calibration point of 10.002.

Apply and enter

value 10.002

Step 26 With the applied pressure displayed press the enter key.

ENT

The HHC-1 will respond by displaying:

+xxxxx working

After 3-5 seconds the HHC-1 will request the next calibration point by displaying.

Apply and enter

value 2.00000

Step 27 Apply the pressure required for the next calibration point and enter the applied pressure value with the number keys. For the second point a pressure of 20.003 has been applied.

Apply and enter

value 20.003

Step 28 With the required pressure level applied and shown on the display press the enter key.

ENT

Step 29 Repeat steps 23-26 as many times as required to produce the desired number of linearization points.

A maximum of 18 linearization points plus the zero and span points may be programmed for Quick Select pressure modules. Factory calibration consists of a 10 point linearization combined with a 10 point upscale and 10 point down scale linearization and hysteresis check.

Important Note: Quick Select pressure modules should, at minimum, be recertified using the same calibration points as those used during factory calibration. In order to preserve the accuracy of the Quick Select pressure module the number of points should not be reduced and the distribution of the points over the calibration range of the sensor module should not be significantly altered.

Step 30 When the final linearization point to be performed has been completed press the clear entry key.

CE

The HHC-1 will respond by displaying:

Calibration done

Save Cancel

Step 31 To save the new linearization data to memory, thereby overwriting the previously stored values in the EEPROM, select "Save" and press enter. To discard the newly generated calibration information select "Cancel" and press enter.

Step 32 After pressing the enter key the calibrator will display:

To re-initiate pressure measurement functions use the port select key to reactivate the installed Quick Select pressure modules.

**PORT
SEL**

Section 25.0 Repair of the HHC-1

*****WARNING*****

This product has been approved by Underwriters Laboratories and optionally by Factory Mutual. Unauthorized repair, alteration or modification can void those approvals and result in serious personal injury, damage to plant and equipment, explosion hazard, shock hazard and diminished instrument performance.

There are no customer serviceable parts in the HHC-1. In the unexpected event that you should have a problem with your HHC-1 system please contact the Service Center at your calibrator supplier.

CONVERSION FACTORS FOR UNITS OF PRESSURE

TO CONVERT FROM - TO	PSI	MILLIBAR	BAR	ATM	PASCAL	KILO PASCAL	CM WATER*	IN. WATER*	FT. WATER	MM Hg AT 0° C	IN. Hg AT 0° C	GM/CM ³	KG/CM ³	IN. SEA WATER*	FT. SEA WATER*	METERS SEA WATER*
PSI	1	68.9476	0.0689476	0.000490	6894.76	0.00689476	70.433	27.730	2.3100	51.7149	2.03602	70.30696	0.07030696	28.9484	2.2457	0.684482
MILLIBAR	.0145038	1	.001	9.86923 x 10 ⁻⁴	100	.001	1.0215	.40218	.03352	.75006	.0295300	1.019716	.00101972	.36085	.032571	.0098276
BAR	14.5038	1000	1	.986923	100000	100	1001.5	402.18	33.52	750.06	29.5300	1019.716	1.019716	392.85	32.571	9.8276
ATM	14.6960	1013.25	1.01325	1	101325	101.325	1035.08	407.511	33.969	760.0	29.9213	1033.227	1.033227	396.031	33.000	10.0591
PASCAL	1.45038 x 10 ⁻⁴	.01	.00001	9.86923 x 10 ⁻⁵	1	.001	.010215	.0040218	.003352	.75006 x 10 ⁻³	.0295300 x 10 ⁻³	.01019716	1.019716 x 10 ⁻⁴	.36085 x 10 ⁻³	.032571 x 10 ⁻³	.0098276 x 10 ⁻³
KILOPASCAL	.145038	10.0	.010	.00986923	1000	1	10.215	4.0218	.3352	7.5006	.295300	10.19716	.0101972	.36085	.032571	.0098276
CM WATER*	.014158	.97891	9.7891 x 10 ⁻⁴	9.60105 x 10 ⁻⁴	97.891	.0097891	1	.3837	.030281	.73424	.028607	.96821	9.9821 x 10 ⁻⁴	.382613	.031884	.0097182
IN. WATER*	.036093	2.4864	.0024864	2.45382 x 10 ⁻³	248.64	.24864	2.5400	1	.083333	1.8650	.073424	2.5354	.0025354	.971840	.080986	.024684
FT. WATER*	.432758	29.8368	.0298368	.0294470	2983.68	2.98368	30.480	12	1	22.380	.861889	30.425	.030425	11.9621	.97183	2.9621
MM Hg AT 0° C	.0193368	1.33322	.00133322	.00131579	133.322	.133322	1.3619	.53620	.04488	1	.03937	1.35951	.00135951	.521066	.043424	.013236
IN. Hg AT 0° C	.491154	33.8639	.0338639	.0334211	3386.39	3.38639	34.560	13.619	1.13491	25.400	1	34.5316	.0345316	13.23501	1.1030	.33619
GM/CM ³	.0142233	.980665	9.80665 x 10 ⁻⁴	9.67842 x 10 ⁻⁴	98.0665	.0980665	1.0018	.39441	.032868	.73553	.028959	1	.001	.383292	.0319410	.0097355
KG/CM ³	14.2233	980.665	.980665	.967842	98066.5	98.0665	1001.8	394.41	32.868	735.53	28.958	1000	1	383.292	31.9410	9.7355
IN. SEA WATER*	.037168	2.55851	2.55851 x 10 ⁻⁴	2.52585 x 10 ⁻⁴	255.851	.255851	2.6136	1.02900	.08576	1.91900	.07555	2.60895	2.60895 x 10 ⁻⁴	1	.00333	.0254
FT. SEA WATER*	.4453	30.702	.030702	.030301	3070.2	3.0702	31.3638	12.3482	1.02900	23.029	.90664	31.308	.031308	12	1	.3040
METERS SEA WATER*	1.46096	100.730	.100730	.099409	10073.0	10.0730	102.90	40.512	3.3760	75.563	2.9745	102.716	.102716	39.37007	2.2808	1

Appendix A. – Pressure Conversion Factors

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Quick-Select Pressure Module Specifications

HQS-1 Sensor Module Ranges—

Inches of H₂O

Gauge and Differential

0/0.25	0/2.0	0/10	0/50	0/200
0/0.50	0/3.0	0/15	0/100	
0/1.0	0/5.0	0/25	0/150	

Compound

±0.125	±1.0	±5.0	±25	±100
±0.25	±1.5	±7.5	±50	
±0.50	±2.5	±12.5	±75	

Available Accuracies (% of span compared to standard):

±0.07% of span (ranges below 1 inH₂O)

±0.06% of span (from 0/1 through 0/200 inH₂O)

±0.1% of span (all ranges)

±0.25% of span (all ranges)

Calibration Standards:

±0.03% of reading secondary standards, traceable to NIST

Media Compatibility

Clean, dry, nonconductive, noncorrosive gases

Overpressure Capability

Positive Direction: 50 psi

Negative Direction: 15 psi

Maximum zero shift of less than 0.1% of span. No measurable span shift.

Maximum Static Pressure: 100 psi

(must not exceed overpressure specifications during testing)

HQS-2 Sensor Module Ranges—

Inches H₂O

0/10	0/15	0/25	0/50
------	------	------	------

for use on clean, dry, nonconductive, noncorrosive gases

PSI*

0/5"	0/30"	0/100"	0/250"	0/500	0/2000	0/5000
0/10"	0/50"	0/150"	0/300"	0/1000	0/2500	0/6000
0/15"	0/60"	0/200"	0/500	0/1500	0/3000	0/7500

* Standard: nonisolated for clean, dry, nonconductive, noncorrosive gas use.

Optional: ranges 0/10 through 0/300 psi isolated for use with any media compatible with 316 SS. All sensors with ranges of 500 psi and higher are isolated and can be used with any media compatible with 316 SS.

Available Accuracies:

±0.05% of span (psi ranges only)

±0.1% of span (psi ranges only)

±0.25% of span (all ranges)

Calibration Standards:

±0.01% of reading or better primary standards, traceable to NIST

Pressure Types:

Gauge to 300 psi (sealed gauge above 300 psi)

Absolute ranges from 5 to 7500 psia

Vacuum ranges of 0/5, 0/10 and 0/15 psiv

Overpressure Capability

0/2 psi and below: 5x range

0/5 psi through 1000 psi: 2x range

Above 1000 psi: 1.5x range

General Pressure Measurement Specifications

Repeatability: ranges 0/5 psi and above ±0.02% of span (typical)
ranges 0/2 psi and below ±0.05% of span

Sensitivity: ±0.002% of span with damping
1 part in 50,000 (max)

Temperature Effect Specifications:

Operating Range Standard: 32° to 120° F (0° to 49° C)

Operating Range Optional: 14° to 120° F (-10° to +49° C)

Compensated Range: 20° to 120° F (-7° to +49° C)

Reference Temperature: 70° ±3° F

Temperature Error: maximum of ±0.004% of span per °F over the compensated range for zero and span

Storage Limits: -4° F to ±158° F (-20° to +170° C)

Operating Characteristics

Engineering Units: inH₂O, psi, inHg, kPa, mbar, cmH₂O, mmHg and any single user-defined, field-programmable engineering unit

Damping: (Measurement Averaging) Programmable averaging from zero through 16 consecutive readings

Warm-Up: 5 minutes for rated accuracy (maximum)

Electrical Measurement Specification

Input (volts)	Accuracy	Input (mA)	Accuracy
0/10 Vdc	±0.025% fs	0/20 mA	±0.03% fs
0/30 Vdc	±0.10% fs	0/50 mA	±0.05% fs

Auto-ranging 10/30 Vdc and 20/50 mA

Temperature Effect Electrical Measurement:

±0.001% of span per °F over the compensated range

Physical Characteristics

Display: Alphanumeric LCD, 0.37 in. height per line
2 lines, 16 characters/line

Display Update: 100 ms

Process Connection: 1/8 NPT, internal thread

Electrical Connection: Miniature recessed banana jacks

Housing: Molded, high-impact ABS case, gray

Weight: Base unit: 2.2 lb (1.3 kg)

Pressure Module: 0.5lb (0.3kg) each

Dimensions: 7.88 x 4.24 x 3.25 (l x w x h) inches nominal

Power Supply:

Internal: 9 Vdc batteries (2 required)

External: ac adaptor 9 Vdc, 500 mA

Portable Operation: 30 hours on two 9 Vdc alkaline batteries

Serial Interface

Type: RS-232

Baud Rate: 300, 1200, 2400, 9600

Calibration

Both Quick-Select pressure modules and base unit electronics can be calibrated in the field.

Appendix C. – Product Specifications

APPENDIX B

ASCII CHARACTER CODE

This chart shows the ASCII character set and corresponding code numbers in decimal, hexadecimal and binary form.

Decimal	Binary	Hexa- decimal	ASCII Character	Decimal	Binary	Hexa- decimal	ASCII Character
0	00000000	00	(NUL)	43	00101011	2B	+
1	00000001	01	(SOH)	44	00101100	2C	,
2	00000010	02	(STX)	45	00101101	2D	-
3	00000011	03	(ETX)	46	00101110	2E	.
4	00000100	04	(EOT)	47	00101111	2F	/
5	00000101	05	(ENQ)	48	00110000	30	0
6	00000110	06	(ACK)	49	00110001	31	1
7	00000111	07	(BEL)	50	00110010	32	2
8	00001000	08	(BS)	51	00110011	33	3
9	00001001	09	(T)	52	00110100	34	4
10	00001010	0A	(LF)	53	00110101	35	5
11	00001011	0B	(VT)	54	00110110	36	6
12	00001100	0C	(FF)	55	00110111	37	7
13	00001101	0D	(CR)	56	00111000	38	8
14	00001110	0E	(SO)	57	00111001	39	9
15	00001111	0F	(SI)	58	00111010	3A	:
16	00010000	10	(DLE)	59	00111011	3B	;
17	00010001	11	(DC1)	60	00111100	3C	<
18	00010010	12	(DC2)	61	00111101	3D	=
19	00010011	13	(DC3)	62	00111110	3E	>
20	00010100	14	(DC4)	63	00111111	3F	?
21	00010101	15	(NAK)	64	01000000	40	@
22	00010110	16	(SYN)	65	01000001	41	A
23	00010111	17	(ETB)	66	01000010	42	B
24	00011000	18	(CAN)	67	01000011	43	C
25	00011001	19	(EM)	68	01000100	44	D
26	00011010	1A	(SUB)	69	01000101	45	E
27	00011011	1B	(ESC)	70	01000110	46	F
28	00011100	1C	(FS)	71	01000111	47	G
29	00011101	1D	(GS)	72	01001000	48	H
30	00011110	1E	(RS)	73	01001001	49	I
31	00011111	1F	(US)	74	01001010	4A	J
32	00100000	20	(SP)	75	01001011	4B	K
33	00100001	21	!	76	01001100	4C	L
34	00100010	22	"	77	01001101	4D	M
35	00100011	23	#	78	01001110	4E	N
36	00100100	24	\$	79	01001111	4F	O
37	00100101	25	%	80	01010000	50	P
38	00100110	26	&	81	01010001	51	Q
39	00100111	27	'	82	01010010	52	R
40	00101000	28	(	83	01010011	53	S
41	00101001	29	)	84	01010100	54	T
42	00101010	2A	*	85	01010101	55	U

Decimal	Binary	Hexa-decimal	ASCII Character	Decimal	Binary	Hexa-decimal	ASCII Character
86	01010110	56	V	138	10001010	8A	
87	01010111	57	W	139	10001011	8B	
88	01011000	58	X	140	10001100	8C	
89	01011001	59	y	141	10001101	8D	
90	01011010	5A	Z	142	10001110	8E	
91	01011011	5B	[	143	10001111	8F	
92	01011100	5C	\	144	10010000	90	
93	01011101	5D	]	145	10010001	91	
94	01011110	5E	^	146	10010010	92	
95	01011111	5F	-	147	10010011	93	
96	01100000	60	`	148	10010100	94	
97	01100001	61	a	149	10010101	95	
98	01100010	62	b	150	10010110	96	
99	01100011	63	c	151	10010111	97	
100	01100100	64	d	152	10011000	98	
101	01100101	65	e	153	10011001	99	
102	01100110	66	f	154	10011010	9A	
103	01100111	67	g	155	10011011	9B	
104	01101000	68	h	156	10011100	9C	
105	01101001	69	i	157	10011101	9D	
106	01101010	6A	j	158	10011110	9E	
107	01101011	6B	k	159	10011111	9F	
108	01101100	6C	l	160	10100000	A0	
109	01101101	6D	m	161	10100001	A1	
110	01101110	6E	n	162	10100010	A2	
111	01101111	6F	o	163	10100011	A3	
112	01110000	70	p	164	10100100	A4	
113	01110001	71	q	165	10100101	A5	
114	01110010	72	r	166	10100110	A6	
115	01110011	73	s	167	10100111	A7	
116	01110100	74	t	168	10101000	A8	
117	01110101	75	u	169	10101001	A9	
118	01110110	76	v	170	10101010	AA	
119	01110111	77	w	171	10101011	AB	
120	01111000	78	x	172	10101100	AC	
121	01111001	79	y	173	10101101	AD	
122	01111010	7A	z	174	10101110	AE	
123	01111011	7B	{	175	10101111	AF	
124	01111100	7C	|	176	10110000	B0	
125	01111101	7D	}	177	10110001	B1	
126	01111110	7E	~	178	10110010	B2	
127	01111111	7F	(DEL)	179	10110011	B3	
128	10000000	80		180	10110100	B4	
129	10000001	81		181	10110101	B5	
130	10000010	82		182	10110110	B6	
131	10000011	83		183	10110111	B7	
132	10000100	84		184	10111000	B8	
133	10000101	85		185	10111001	B9	
134	10000110	86		186	10111010	BA	
135	10000111	87		187	10111011	BB	
136	10001000	88		188	10111100	BC	
137	10001001	89		189	10111101	BD	

Decimal	Binary	Hexa-decimal	ASCII Character		Decimal	Binary	Hexa-decimal	ASCII Character
190	10111110	BE			242	11110010	F2	
191	10111111	BF			243	11110011	F3	
192	11000000	C0			244	11110100	F4	
193	11000001	C1			245	11110101	F5	
194	11000010	C2			248	11110000	F8	
195	11000011	C3			249	11110001	F9	
196	11000100	C4			250	11110100	FA	
197	11000101	C5			251	11110101	FB	
198	11000110	C6			252	11111000	FC	
199	11000111	C7			253	11111001	FD	
200	11001000	C8			254	11111100	FE	
201	11001001	C9			255	11111101	FF	
202	11001010	CA						
203	11001011	CB						
204	11001100	CC						
205	11001101	CD						
206	11001110	CE						
207	11001111	CF						
208	11010000	D0						
209	11010001	D1						
210	11010010	D2						
211	11000011	D3						
212	11010100	D4						
213	11010101	D5						
214	11010110	D6						
215	11010111	D7						
216	11011000	D8						
217	11011001	D9						
218	11011010	DA						
219	11011011	DB						
220	11011100	DC						
221	11011101	DD						
222	11011110	DE						
223	11011111	DF						
224	11100000	E0						
225	11100001	E1						
226	11100010	E2						
227	11100011	E3						
228	11100100	E4						
229	11100101	E5						
230	11100110	E6						
231	11100111	E7						
232	11101000	E8						
233	11101001	E9						
234	11101010	EA						
235	11101011	EB						
236	11101100	EC						
237	11101101	ED						
238	11101110	EE						
239	11101111	EF						
240	11110000	F0						
241	11110001	F1						

Appendix C

Specification: InH₂O Sensor Modules

Ranges

Gauge & Differential

0/0.25	0/2.0	0/10	0/50	0/150
0/0.50	0/3.0	0/15	0/75	0/200
0/1.0	0/5.0	0/25	0/100	

Compound

±0.125	±1.0	±5.0	±25	±100
±0.25	±1.5	±7.5	±50	
±0.50	±2.5	±12.5	±75	

Available Accuracies:

±0.06% of span (±0.07% ranges below 1 inch of H₂O)

±0.1% of span (all ranges)

±0.25% of span (all ranges)

Calibration Standards:

±0.03% of reading secondary standards, traceable to NIST

Media Compatibility:

clean, dry, non conductive, non corrosive gases

Repeatability: ±0.02% of span

Overpressure Capability

Positive Direction: 50 psi

Negative Direction: 15 psi

Maximum zero shift of less than 0.1% of span.

No measurable span shift.

Maximum Static Pressure: 100 psi

Specification: PSI Sensor Modules

Gauge/Absolute

0/5*	0/30*	0/100*	0/250	0/600
0/10*	0/50*	0/150*	0/300	0/1000
0/15*	0/60*	0/200*	0/500	

Vacuum

5	10	15
---	----	----

Compound

-5/+5	-10/+10	-15/+15
-15/+30	-15/+60	

* **standard:** non-isolated for clean dry, non conductive, non corrosive, gas use.

Optional: isolated for use with any media compatible with 316 stainless steel ranges 0/10 through 0/300 psi all ranges of 500 psi and higher are 316 SS isolated.

Available Accuracies:

±0.05% of span (psi ranges only)

±0.1% of span (psi ranges only)

±0.25% of span (all ranges)

Calibration Standards:

±0.01% of reading or better primary standards, traceable to NIST

Repeatability: psi ranges ±0.02% of span (min)

Overpressure Capability

0/2 psi and below: 5x range,

0/5 psi through 1000 psi: 2x range

Sensitivity: ± 0.002% of span with damping
1 part in 50,000 (max)

General Measurement Specifications

Temperature Effects

Operating Range standard: 32° to 120° F (0 to 49° C)

Temperature Error: ±0.004% of span (max)

Operating Range optional: 20° to 120° F (-7 to 49° C)
per degree F over the compensated range.

Compensated Range: 20° to 120° F (-7° to +49° C)
sated range.

Reference Temperature: 70 ± 3 degrees F

Storage Limits: -4° F to +158° F (-20° to +70°)

Engineering Units:

inH₂O, psi, inHg, kPa, mbar, cmH₂O, mmHg, ftSW, MPa, cmH₂O, mmH₂O, kgcm² or any single user defined engineering unit.

Damping (Measurement Averaging) Programmable averaging from zero through 16 consecutive readings.

Warm Up: 5 minutes for rated accuracy (maximum)

Electrical Measurement Specification

Input (volts)	Accuracy	Input (mA)	Accuracy
0/10 Vdc	±0.05% fs	0/20 mA	±0.05% fs
0/30 Vdc	±0.15% fs	0/50 mA	±0.05% fs
Auto-ranging 10/30 Vdc & 20/50 mA			

Temperature Effects Electrical Measurement

± 0.001% of span per degree F over the compensated range.

Physical Characteristics

Display: Alphanumeric LCD, 0.37 inch height
2 line, 16 characters/line
Pressure Module: 0.5 each

Display Update: 100 ms

Weight: Base unit: 2.2lbs (1.3 kg)
modules: 0.5lbs (nominal)

Dimensions: 8 x 4.25 x 4 inches (l x w x h) nominal

Housing: Molded, high impact ABS case, grey

Process Connection: 1/8 NPT, internal thread

Power Supply

External: AC adaptor 9 Vdc, 500 mA

Portable Operation: 30 hours on two 9 Vdc batteries

Electrical Connections: Miniature recessed banana jacks