PRECISION INSTRUMENTS & SYSTEMS

USER'S MANUAL

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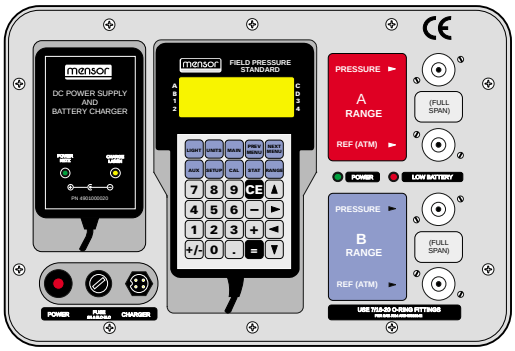

FIELD PRESSURE STANDARD

14603-F
Apr, 2001
Version 1.3

CODE _____

SN _____

RANGE A _____

RANGE B _____

MENSOR® CORPORATION
201 BARNES DRIVE
SAN MARCOS, TEXAS 78666
512-396-4200, FAX 512-396-1820
WEB SITE http://www.mensor.com

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Pressures from 600 psig and up can generate sound levels above 100 db for brief periods when they are exhausted directly to atmosphere. If no muffling devices are attached to the EXHAUST port, then ear protection is advised for personnel in the vicinity of instruments that will be operated under such conditions.

WARNING: NOT EXPLOSION PROOF!
Installation of this instrument in an area requiring devices rated as intrinsically safe is not recommended.

WARNING: POSSIBLE INJURY!
The tubing, valves and other apparatus attached to the gauge must be adequate for the maximum pressure which will be applied, otherwise physical injury to the operator or bystanders is possible.

CAUTION: USE THE PROPER PRESSURE MEDIUM. USE ONLY CLEAN, DRY NON-CORROSIVE GASES UNLESS OTHERWISE SPECIFIED BY MENSOR. THIS INSTRUMENT IS NOT DESIGNED FOR OXYGEN USE.

ATTENTION
STATIC SENSITIVE DEVICES
HANDLING PRECAUTIONS REQUIRED

CAUTION: The proper use of grounded work surfaces and personnel are required when coming into contact with printed circuit boards in order to prevent static discharge damage to sensitive electronic components.

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TEL	1-512-396-4200
TEL	1-800-984-4200 (USA only)
FAX	1-512-396-1820
WEB SITE	http://www.mensor.com
E-MAIL	sales@mensor.com
	tech.support@mensor.com

PACKAGING FOR SHIPMENT

If the product must be shipped to a different location or returned to Mensor for any reason through a common carrier it must be packaged properly to minimize the risk of damage.

The recommended method of packing is to place the instrument in a container, surrounded on all sides with at least four inches of shock attenuation material such as styrofoam peanuts.

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MENSOR BACKGROUND

HISTORY: Mensor was established in 1969 in Houston, Texas as an independent spin-off from the Texas Instruments (TI) Pressure Instrument Group. As a private corporation, Mensor's objective was to design and produce high accuracy, high quality, easy to use pressure instruments. In 1978 Mensor moved to its present location in San Marcos, on Interstate 35 (the Austin-San Antonio corridor). Two and a half years after the move, the plant was destroyed by fire on Friday, February 13, 1981. Mensor resolved to come back, and almost before the ashes had cooled, construction of a new building began on the same site. Six months after the disaster Mensor moved into its present facility and began shipping products to customers who had waited patiently for the recovery.

PEOPLE: The key to Mensor's strength in the marketplace is the concentration of experienced people in the field of precision pressure measurement and control. The company's founders previously worked in various capacities in the Pressure Instrument Group of Texas Instruments, including engineering, production and marketing. These founders were involved in the design of the original quartz bourdon pressure gauge at TI. Mensor's CEO, Jerry Fruit, is co-holder of the patent on using a fused quartz bourdon tube to accurately measure pressure. The 50 current full time Mensor employees have an average longevity of fourteen years. That's a lot of pressure experience!

PRODUCTS: Mensor's portfolio of products consists of an extensive line of precision pressure instruments, including digital gauges, pressure controllers, transducers and pressure calibrations systems. All of these products feature computer interface capability. Mensor products are used in metrology labs, calibration labs, research facilities, engineering offices, production test stands, and in other environments where high accuracy pressure measurement and/or control is required. Many of these products include customized features to meet a customer's specific requirement. Mensor products range from about $900 to $30,000.

CUSTOMERS: Typical Mensor customers are pressure sensor manufacturers, aerospace firms, jet engine manufacturers, electric utilities, nuclear power plants, pharmaceutical firms, calibration laboratories, government agencies and research organizations.

APPLICATIONS: In many facilities the highest accuracy pressure measuring or pressure controlling instrument is a Mensor product. A typical application for these Mensor instruments is the calibration of other pressure devices, such as sensors, transducers, transmitters, gauges and pressure switches. The Mensor product is used as the pressure standard to verify pressure calibrations or outputs of the device being produced, checked, tested or certified.

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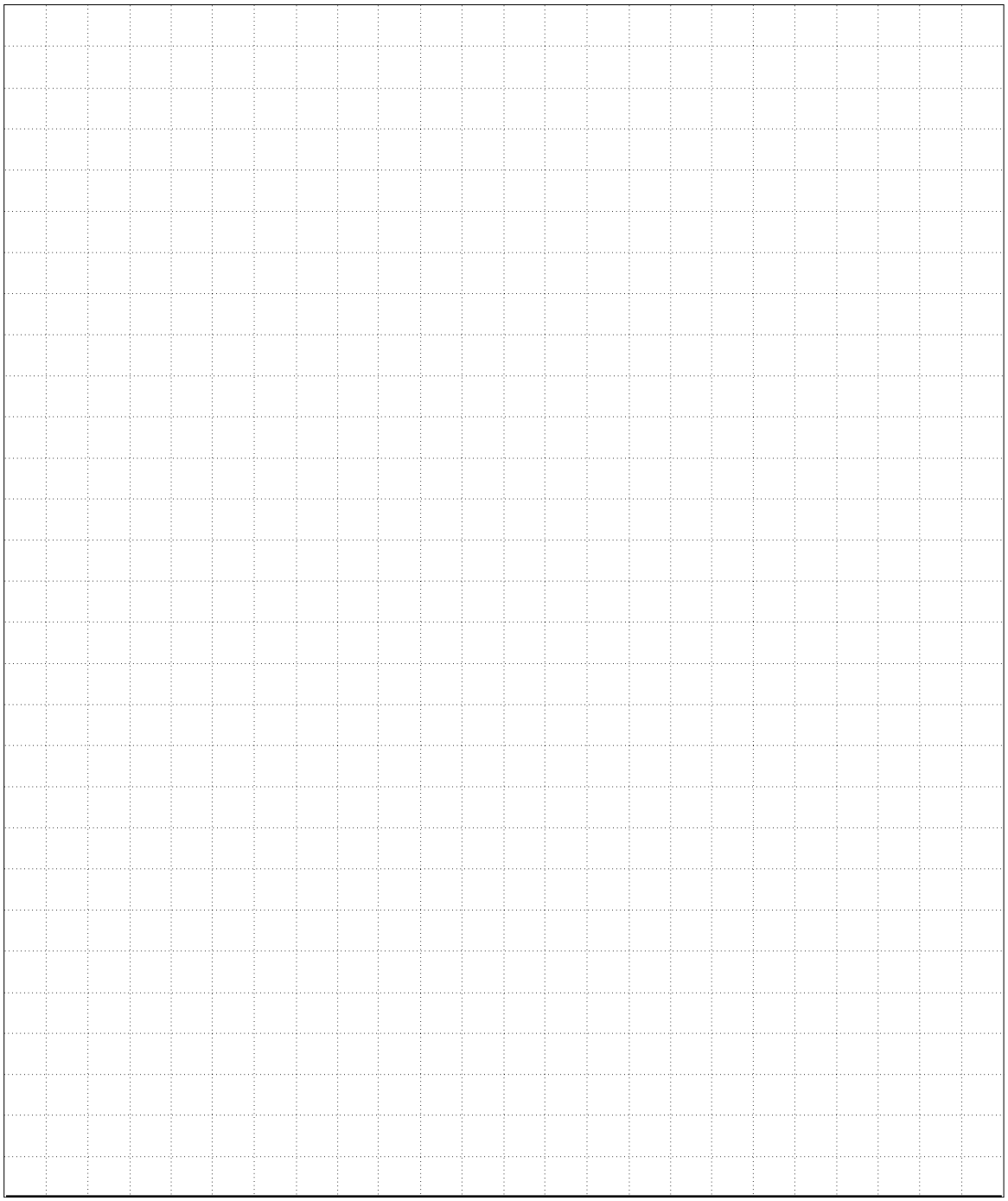


INTRODUCTION

GENERAL

The MENSOR Field Pressure Standard (FPS) is designed to take accurate pressure measurements under adverse conditions. To accomplish this task the FPS combines many outstanding features, including:

- High accuracy (0.025% or 0.01% full scale)
- Rugged construction for field use
- Battery operated portability
- One or two custom pressure ranges
- Sensors which are insensitive to tilt and vibration
- Pressure readings are temperature compensated
- Unambiguous digital pressure display
- LCD display easily read in sunlight
- Back lighted display can be read in total darkness
- Recharge batteries without removal from instrument
- Instrument is usable during recharge from 120V ac source
- A color keyed Quick Reference graphic chart included inside unit
- CE certification

The FPS is available with either one or two pressure ranges (channels). A two channel FPS includes two pressure transducers, designated as A RANGE and B RANGE. The transducers share a display, a processor and a power source, and they are mounted in a common carrying case. Otherwise they are independent of each other. The upper pressure limit and the default pressure units for each range is shown on the instrument panel in the inset between the PRESSURE port and the REF (ATM) port for each channel.

Figure 1.1 shows the operating panel of a dual channel instrument as seen when the cover of the carrying case is opened. The operating terminal resting in the center section is a Control Display Unit (CDU). Operation of the CDU can be either in its resting position, raised up in its built-in tilt stand, or it can be lifted out for hand-held operation. To use the tilt stand lift out the CDU and raise the two rails it was resting on by grasping the front edge of each and pivoting them up. Simply slide the CDU into the two rail channels for convenient viewing and one-handed operation.

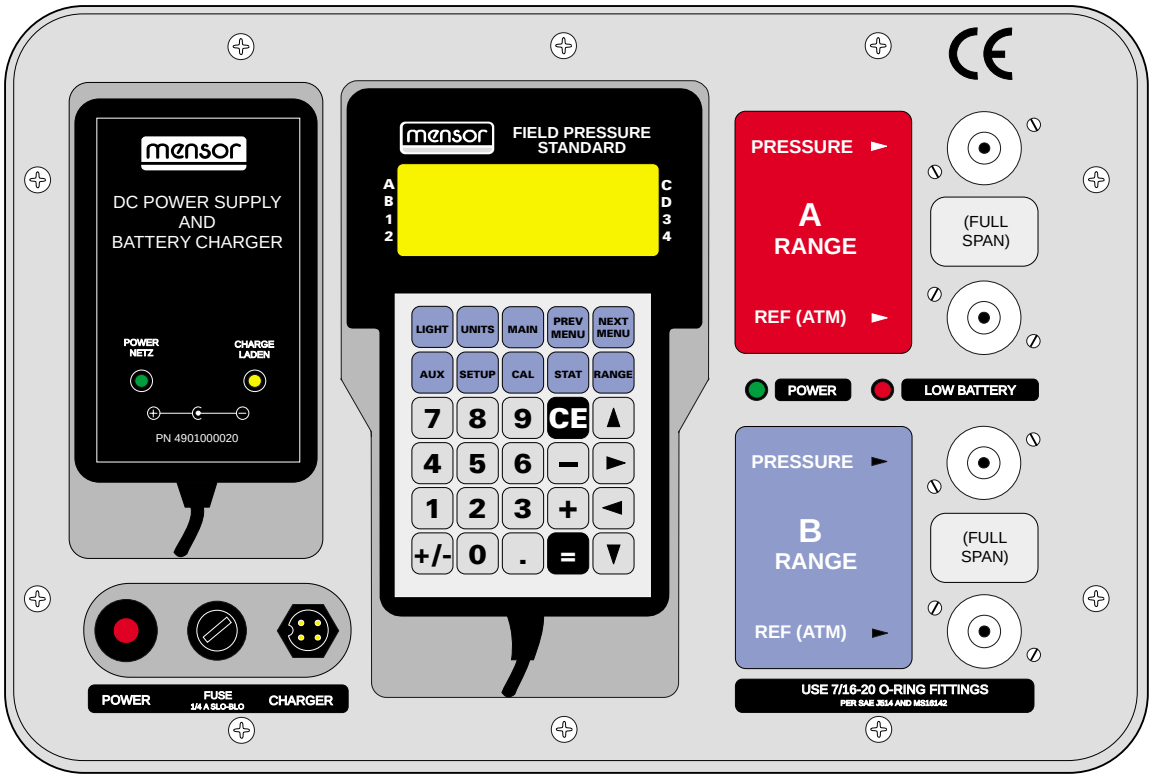


Figure 1.1 - Front View

Figure 1.2 is a map of the instrument panel, with a quick reference guide to the keys on the CDU. A similar, but color keyed chart is included inside the instrument.

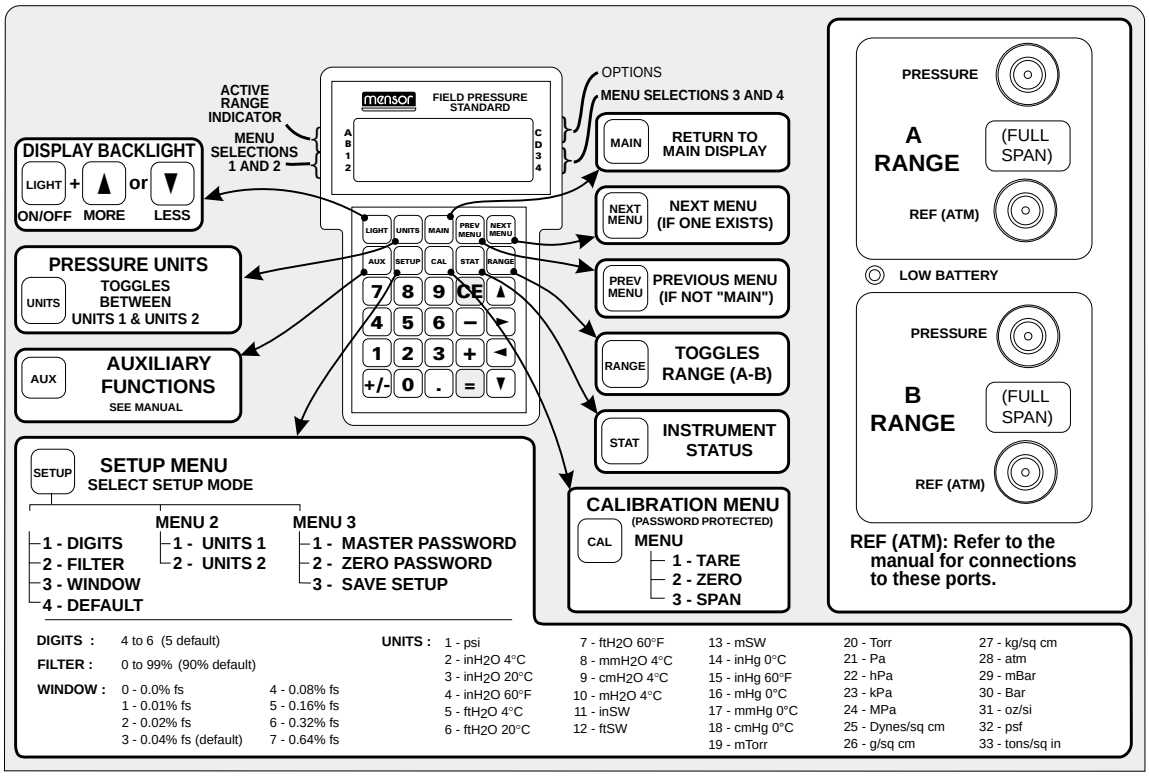


Figure 1.2 - Quick Reference Chart

MODELS

A standard FPS can be configured in several ways. There are choices of one or two pressure ranges, and uncertainties (accuracy) of either 0.025 or 0.01 percent of full scale, and compensated temperature ranges of either 15 to 45 degrees or 0 to 50 degrees Celsius. The model number inscribed on the serial number plate identifies the configuration of each FPS according to the following table.

Table 1.1 – Instrument Model Number Code

Position	Number	Description	
Left Digit	5	All FPS instruments	
2nd Digit	0	All FPS at this time	
3rd Digit	1	Two pressure channels	
	5	Single pressure channel	
Right Digit	0	15 to 45 deg C temp compensation–all channels	0.025% fs accuracy on both channels
	1	0 to 50 deg C temp compensation–all channels	
	4	15 to 45 deg C temp compensation–all channels	0.01% fs accuracy on both channels
	5	0 to 50 deg C temp compensation–all channels	
	6	15 to 45 deg C temp compensation–all channels	One channel 0.025% and one channel 0.01% accuracy
	7	0 to 50 deg C temp compensation–all channels	

ABOUT THIS MANUAL

Any discussion in this manual of an operation or technique which involves one of the FPS transducers (A RANGE or B RANGE) is automatically extended to both transducers. The CDU will display which of the two transducers is active as explained below and in Section 2, *Operation*.

The following conventions will apply throughout this manual:

Text that appears in the CDU display is in bold, in the letter style shown as:

MAIN DISPLAY or **+10.0000 PSI**

Keys to be pressed are shown in the same style, but inside square brackets:

[PREV MENU], **[CE]**, **[5]**, **[>]**, etc.

Other printed legends or labels on the FPS operating panel are shown in the same style, all capital letters, but not bold:

HI RANGE, REF (ATM), POWER, LO, etc.

The 'active' or 'selected' sensor, transducer or RANGE, all refer to the current A or B pressure channel as indicated by the pointer (<) at the top left side of the display.

Although the transducers in the instrument will be configured for either absolute, differential, or gauge pressure measurement, commonly abbreviated as a, d, or g, this distinction will be ignored here unless the distinction is important to the message. A user can select any two pressure units for each channel from an internal list of 35 units. In general psi is used for illustration purposes in this manual.

Some common abbreviations appearing in this manual are:

A = A range transducer
B = B range transducer
CDU = Control-Display Unit (hand held terminal)
FS = Full Scale pressure
n or nn.nnnn = Each n represents a digit from 0 to 9
psi = Pounds per square inch

PRESSURE CONNECTIONS

The PRESSURE ports on the FPS are female 7/16-20 SAE/MS straight threads per MS 16142 and SAE J514, table 14. They require a tube fitting boss seal with an o-ring per MS33656. Mensor provides female 1/4 NPT and 1/8 NPT adapter fittings with the instrument. The pressure connection can be made to either of these adapters with the proper mating hardware. We recommend the use of either Loctite Hydraulic Sealant or fresh teflon tape on the threads of the male pipe (NPT) fitting. (Do not use thread sealant on fittings sealed with an o-ring). The integrity of the seal is particularly important since even microscopic leaks can cause errors in pressure measurements. A leak test is advised after all connections are made.

NOTE: *When making up connections to the o-ring adapter use a back-up wrench to prevent over-stressing the threads in the aluminum block.*

The pressures to be measured are applied to the A and B RANGE "PRESSURE" ports on the right side of the instrument.

CAUTION: THE PRESSURE APPLIED TO THESE PORTS SHOULD NOT EXCEED THE FULL SPAN SHOWN ON THE RANGE LABEL IMMEDIATELY BELOW EACH PRESSURE PORT!

Apply only clean, dry, non-corrosive gases unless the instrument was specifically ordered for hydraulic measurement. A table in the *Appendix* lists all of the materials inside the FPS which the pressure medium will contact.

The REF (ATM) ports are normally left open to atmosphere. Connecting to these ports with vacuum lines or small positive pressures is explained in the manual where the **[CAL]** functions are discussed.

OPERATION

The case can be opened by laying the unit on its wide side and pulling outward on the clasps located on either side of the handle. Since the case is airtight, changes in ambient pressure may keep the case from opening. In such an event unscrew the thumbscrew next to the handle to release the internal pressure/vacuum. Refer to the Case Pressure Relief Vent in figure 4.1 in the *Specifications* section.

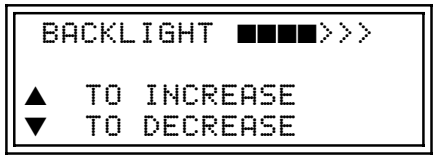
POWER UP

The Field Pressure Standard (FPS) was shipped with a fully charged internal battery. Once opened, the instrument can be powered on with or without pressure applied. The recessed red button in the lower left corner of the instrument is the power switch which will cycle the power on or off each time it is pressed. Turn the power ON and in about two seconds the FPS will beep and the **MAIN DISPLAY** will indicate the current pressure reading of the current active transducer.

This display appears at power up showing the pressure for the last saved range. Power up sets the UNITS, DIGITS, FILTER and WINDOW to their last saved values (see SAVE command).

BACKLIGHT

The backlight is off at power up. If the display is difficult to read after the beep press **[LIGHT]** to turn on the backlight for the display:



[LIGHT] *toggled ON,* **[▲]** *is brighter and* **[▼]** *is dimmer. The solid blocks show the present brightness level: four blocks means the intensity is set to step four of seven.*

The backlight is adjustable through seven steps of brightness plus OFF. Each press of **[LIGHT]** cycles the backlight on and off. With the backlight ON the **[▲]** and **[▼]** keys step up or down the brightness. Notice that more power is needed for each step up in brightness. Battery drain is minimized with the backlight OFF.

MAIN DISPLAY

See the illustration of the **MAIN DISPLAY** under POWER UP, above. The A and B printed to the left of the top two lines of the **MAIN DISPLAY** refer to the A RANGE and B RANGE sensors. The first character in the display is a '**<**' pointer to indicate which sensor is now active. The A RANGE is the factory default when power is first turned on. To change to B RANGE press the **[RANGE]** button. The pointer in the upper left corner of the display will immediately move down one line to B, and the numbers (nn.nnnn) on the third line will change to show the output of the B RANGE sensor. Press **[RANGE]** again to return to A RANGE. SETUP and SAVE can be used to cause the B RANGE to appear first at power up.

All of the information shown in the rest of the menus is in regard to the selected active range regardless of which screen is currently in view. The **[RANGE]** key will toggle between the two sensors in most modes, and the pointer will follow to show which range is active.

The **MAIN DISPLAY** can be brought to the screen in three ways: a), by turning on the power; b), by pressing **[MAIN]**; or c), by pressing **[PREV MENU]** one or more times. **[PREV MENU]** backs up one screen with each press until **MAIN DISPLAY** is showing.

UNITS

There are two pre-selected pressure units of measure assigned to each range. For example, the A RANGE might have PSI and inches of water (inH2O) assigned as its pressure units, while B RANGE might be assigned milli-Bar (mBar) and millimeters of mercury (mmHg) for its two units. Or again, both ranges might be assigned identical units. The selection of units by pressing the **[UNITS]** key is dependent on which range is active, whereas the range is selected by pressing the **[RANGE]** key. The **[UNITS]** key works on any display that shows a pressure value (except in the calibration section). When a pressure value is showing in the display press **[UNITS]** and the alternate pressure units will appear. Press **[UNITS]** again and the display will switch back to the first units. The pressure value displayed is always corrected for the pressure units showing.

Assign any two pressure units to display from a list of 35 units available through the **SETUP MENU #2**. This procedure is explained later under **SETUP**.

SETUP MENUS

The following descriptions and operations pertaining to setup apply only to the active range. To change the parameters for both ranges requires going through the setup routine two times, once for each range.

There are three menus provided which allow the user to change the factory set parameters. Press the **[SETUP]** key to see **SETUP MENU #1** which displays four choices available for change. Select 1 through 4, or use the **[NEXT MENU]** key to see **SETUP MENU #2** with two more changeable parameters. From **SETUP MENU #2** press either **[NEXT MENU]** to advance to **SETUP MENU #3**, or press **[PREV MENU]** to return to **SETUP MENU #1**. Any changes made using these three menus are in volatile memory only, and will be lost at power down. These changes can be saved to non-volatile memory by using the SAVE option under **SETUP MENU #3**. SAVEd parameters are automatically initiated at each future power up until other changes are SAVEd to displace them.

*Choose one of the four menu items to change on the A range, or press **[NEXT MENU]** to select units.*

From **SETUP MENU #1** choose one of the four menu items to alter.

1 - **DIGITS**: Press **[1]** to change the resolution of pressure reading for the active range. Next enter **[4]**, **[5]** or **[6]** then **[=]** to set the number of **DIGITS** to show for pressure in that range. Default is 5 digits. For example, selecting 4 digits for a 100 psi range would display 100.0 at full scale, or selecting 6 digits would display 100.000 at full scale.

2 - **FILTER**: Press **[2]** to set the amount of filtering of the pressure reading for the active range. Press a number from **[0]** to **[99]** then **[=]** for the desired %. 0% is no filter, 99% is maximum filter, and default is 90%. See the text DIGITAL FILTER in the *Appendix* for additional information.

3 - **WINDOW**: Press **[3]** to select the filter window for the active range. A menu of seven values and off is offered. If the pressure is outside this window no filter (2 above) is applied to the reading. See the text DIGITAL FILTER in the *Appendix* for additional information.

4 - **DEFAULT**: Press **[4]** to return the selected transducer to factory default values of 5 digits of resolution, 90% filter and 0.04% FS filter window.

With **SETUP MENU #1** on the screen press **[NEXT MENU]** and **SETUP MENU #2** will appear. This menu lets the user select the two pressure units the **[UNITS]** key will display for the selected transducer.

*The units selected for **UNITS 1** become the default units for the indicated range. If SAVEd these pressure units will appear in the display when power is applied.*

1 - **A UNITS 1: PSI** Press **[1]** to select new **A UNITS 1** (the default units for **A RANGE**). Then enter a number from 1 to 35 from the master **UNITS** list, and press **[=]**.

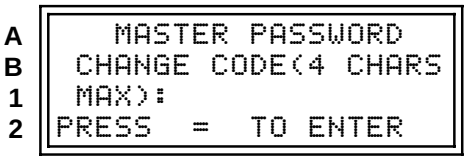
2 - **A UNITS 2: INH20@4C** Press **[2]** to select new **A UNITS 2** (the secondary units for **A RANGE**). Then enter a number from 1 to 35 from the master **UNITS** list and press **[=]**.

Press **[RANGE]** to select the B RANGE sensor and set the default and secondary pressure units using the same method as above. During a SAVE command the range pointer in this display determines which range will be active on future power ups.

Press **[NEXT MENU]** to advance to **SETUP MENU #3**. This menu is used to change the calibration passwords, and to save setup and calibration changes to non-volatile memory so that they remain in effect after a power-down.

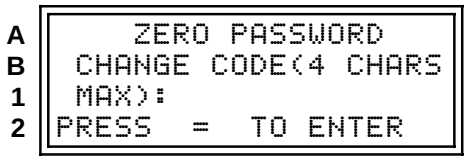
*Select any of three functions from this screen by pressing **[1]** or **[2]** to change one of the passwords, or **[3]** to save the latest changes to non-volatile memory. All current parameters in effect when SAVE is commanded will remain in effect after a power-down.*

1 - **MASTER PW**: The master password is a one, two, three or four digit code which can be used to access all password protected functions. The factory loaded master password is 1234 (4 digits maximum). The **MASTER PW** menu selection is used to change the master password. After entering this menu the master password change screen appears:



Key in the *current* master password code and **[=]** to enter it. Next key in the *new* master password code, and again press **[=]** to enter this new code. The old password has now been displaced by the new code in volatile memory. Next, proceed to change the zero password, (item 2 on **SETUP MENU #3**), or leave it as is and go to **SAVE** (item 3 on the **SETUP MENU #3**) to make the master password change permanent.

2 - **ZERO PW**: The ZERO password is a one, two, three or four digit code which can be used to change the zero or tare values for either range. The factory loaded zero password is the single digit '0'. The ZERO PW menu selection is used to change the zero password. After entering this menu the zero password change screen appears:



*For gauge pressure sensors, if the zero password is set to the single character 0, then the **[AUX]** key is enabled as a one-stroke, zero reset button. Setting the zero*

password to any other value disables this auto-zero function.

Key in the *current* zero password code and **[=]** to enter it. Next key in the *new* zero password code, and again press **[=]** to enter this new code. The old password has now been displaced by the new code in volatile memory. Next, go to **SAVE** (item 3 on the **SETUP MENU #3**) to make the zero password change permanent.

3 - **SAVE**: Press **[3]** to SAVE any changes from the SETUP menus, or any changes to calibration parameters. Saved changes are the new settings for the next and future power ups. If not saved the changes remain in effect only until the next power off.

AUXILIARY

When the zero password is 0 and the active sensor is a gauge type sensor the **[AUX]** key is an auto-zero key for the selected range sensor. This function must be used with caution since it will also reset zero even if a transducer has pressure applied to it.

If the zero password is anything other than 0, or if the selected sensor is an absolute type, then the auto-zero function is disabled. The **[AUX]** key has no other function.

PREVIOUS MENU

Press the **[PREV MENU]** key one or more times to back up one menu per step until the **MAIN DISPLAY** is showing. Pressing **[PREV MENU]** again will do nothing from this display.

NEXT MENU

From **SETUP MENU** #1 screen press **[NEXT MENU]** to display the **SETUP MENU #2** screen, and so on. Pressing **[NEXT MENU]** does nothing if there is not a logical next menu to display.

CALIBRATION

Press **[CAL]** to enter the calibration functions:

*Select any of three functions to perform next by pressing the corresponding number key. Pressing **[1]**, **[2]** or **[3]** will bring up a password entry screen.*

1 - **TARE**: Press **[1]** to add a TARE value to the zero offset. A password entry screen will be displayed. See 'Enter Password' for details.

2 - **ZERO**: Press **[2]** to reset the ZERO offset. A password entry screen will be displayed. See 'Enter Password' for details.

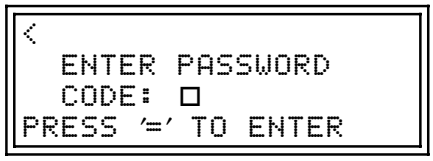
3 - **SPAN**: Press **[3]** to enter a new span correction factor. A password entry screen will be displayed. See 'Enter Password' for details.

When the password is accepted the calibration screen appears showing the acceptable range of numbers to enter for that calibration menu item. Enter a positive or negative number within the range shown to bring that item to its correct value, then press **[=]**.

The techniques required to perform a full calibration are explained in detail in the *Calibration* section of the manual.

ENTER PASSWORD

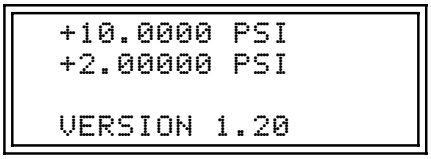
Before a change can be made to the **TARE** (item 1), **ZERO** (item 2), or **SPAN** (item 3). the **ENTER PASSWORD** screen appears:



*Enter the password. Originally the codes were **[0]** and **[=]** for **ZERO** or **TARE**, or **[1]**, **[2]**, **[3]**, **[4]** and **[=]*** to access any function.

STATUS

Press **[STAT]** to see the status display. This screen shows the upper limit of the **A RANGE** and **B RANGE** sensors in their current #1 units on the first and second line. The software version number appears on the bottom line:



BATTERY POWER

The power source for the FPS is an internal, rechargeable sealed lead acid battery. The FPS will run for well over twelve hours on a fresh, fully charged battery. The FPS will shut down when the battery voltage drops to about 10 volts, which is about 30% battery discharge. Typical life expectancy is 1000 to 1200 discharge/recharge cycles. The batteries used in the FPS are considered as safe as dry cells, and have been approved for shipment by air by both DOT and IATA.

Low Battery Indicator

The LOW BATTERY indicator will glow when the battery voltage drops to 11.5 volts. When the indicator comes on there is about three more hours of operating time (at room temperature) before the system shuts down. The operating time will be shorter at higher temperatures.

Battery Charger

The battery charger supplied with the FPS is designed to recharge the battery either with the FPS turned off, or while it remains in use. Plug the charger into a 120 volt 50/60 Hz source, then plug the two pin connector into the mating connector marked 'CHARGER' just below the cavity which holds the charger. (See figure 1.1 in the *Introduction* section).

With the FPS power off, and the battery discharged to the 10 volt level, the battery will fully charge in about six hours. The red FAST CHARGE light will glow while the battery is coming up to its full voltage. When it is fully charged the red light will go off and the charger will switch to trickle charge mode to maintain the charge. The charger can be left on and connected to the battery without overcharging it.

The charging time will be much longer if the FPS is in use while charging. In fact, the red FAST CHARGE light will remain on while the FPS is on, and cannot go into trickle charge mode.

CAUTION: DO NOT ATTEMPT TO RECHARGE AT TEMPERATURES BELOW FREEZING, OR ABOVE 40°C (104°f).

Battery Replacement

REMOVAL: To get to the battery lift out the display terminal (CDU) from the center of the FPS. Remove the ten phillips-head screws from the main assembly, then lift the assembly out of the carrying case. Turn the assembly upside down on a cushioned surface and remove the metal backplate from the bottom. Next, remove the smaller battery retainer plate and pull the battery from its well. Disconnect the red (positive) and green (negative) leads from the battery.

REPLACEMENT: Connect the replacement battery in the same polarity as the removed battery. Replace the battery retainer plate, and the bottom plate, and replace the main assembly into the carrying case. Apply power to the FPS to check that the battery and the installation are in working order. If the FPS powers up properly, turn the power off and re-install the ten phillips-head screws.

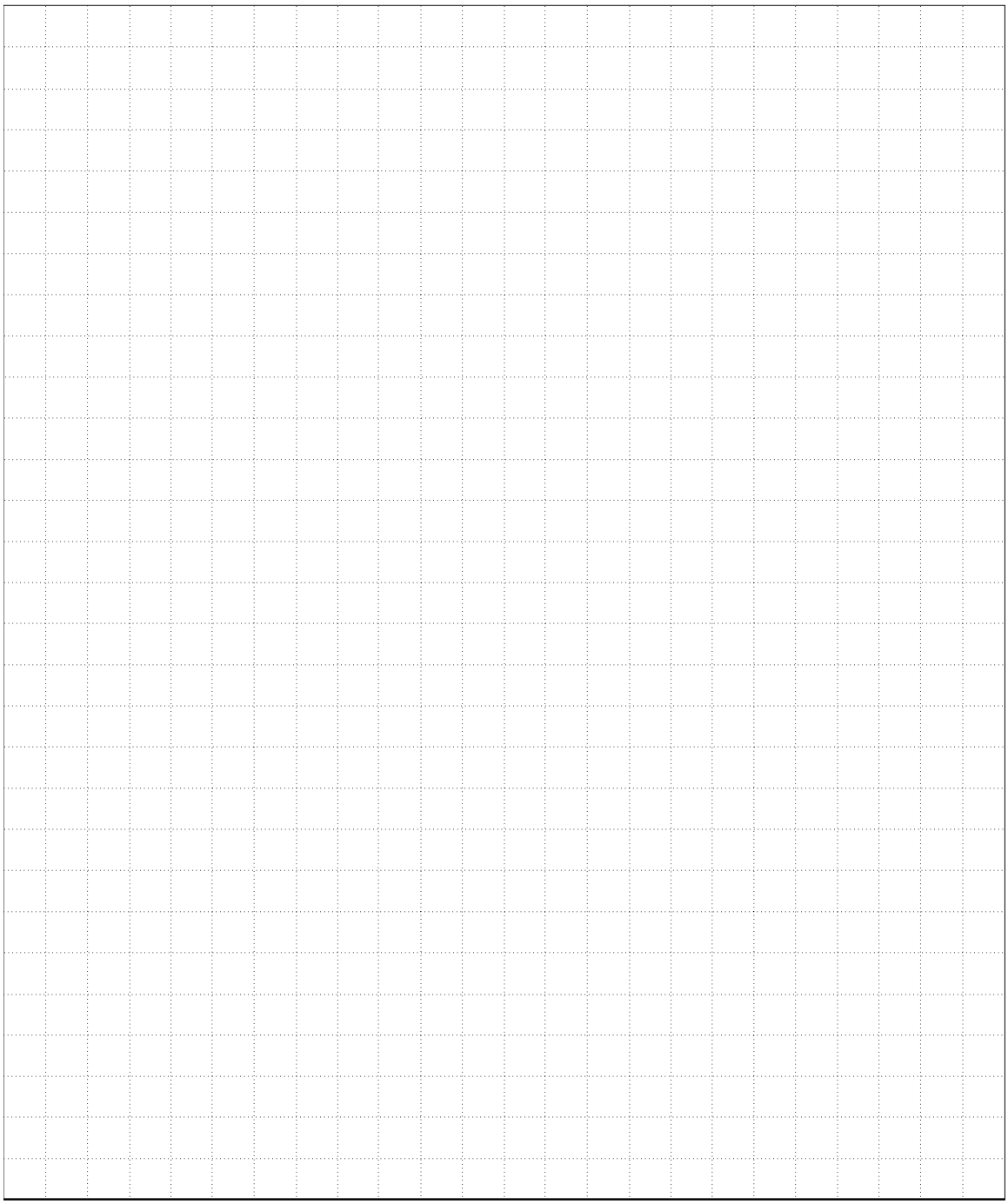
Battery Storage

A battery will self-discharge during storage. Self-discharge rate is very much dependent on the storage temperature, where lower temperatures allow the battery to be stored for longer periods. For example, each ten degree centigrade temperature drop cuts the self-discharge rate in half and doubles the effective storage time.

CAUTION: Connect the battery to a charger if it will be stored for an extended period. Otherwise, the battery can discharge so low that it will erase the setup data in the hand-held CDU.

If the CDU loses its memory it will be necessary to re-program it. CDU setup instructions are included in the *Appendix*, Section 6.

User's Notes:



CALIBRATION

The FPS automatically adjusts the pressure reading for the effects of temperature and non-linearity within the calibrated temperature range. The process is referred to as dynamic compensation because each reading is so computed before it is output to the display. Thus, a calibrated FPS operated within its temperature band, and with the proper zero and span adjustments, will provide accurate pressure measurements.

ENVIRONMENT

For maximum accuracy the FPS should be operated in an ambient temperature which is within the specified calibration range, and which is stable. In addition, the instrument should be at rest on a platform which is free of vibration and shock.

PRESSURE STANDARD

Mensor recommends the use of appropriate accurate primary pressure standards when calibrating this instrument. Such standards should be sufficient so that when the techniques of the ISO *Guide to the Expression of Uncertainty in Measurement (GUM)* are applied, the instrument meets its accuracy statements as required by ANSI/NCSL-*Z540*, or other applicable standards.

MEDIUM

The recommended calibration medium is dry nitrogen.

PROCEDURES

Set up the instrument to be calibrated as shown in figure 3.1 – Gauge/Differential Calibration Setup. In the calibration setup illustration the 'Pressure Standard' is normally a deadweight test instrument, and the 'Volume Controller' refers to a hand operated variable-volume pressure vernier device. For best results use psi units for the calibration. Other measurement units may introduce a small round-off error.

When the FPS was calibrated at the factory the zero and span corrections were stored in non-volatile memory. If these values are changed and then SAVEd, the new values will immediately displace the factory values. It is recommended that for each transducer a permanent record be maintained of the 'as received' values

as well as the values that result from each subsequent zero and span update. Such a record can provide a long term history of the performance and reliablility of each transducer.

CAUTION: THE TUBING, VALVES AND OTHER APPARATUS MUST BE ADEQUATE FOR THE PRESSURE RANGE. OTHERWISE PHYSICAL INJURY TO THE OPERATOR OR BYSTANDERS IS POSSIBLE.

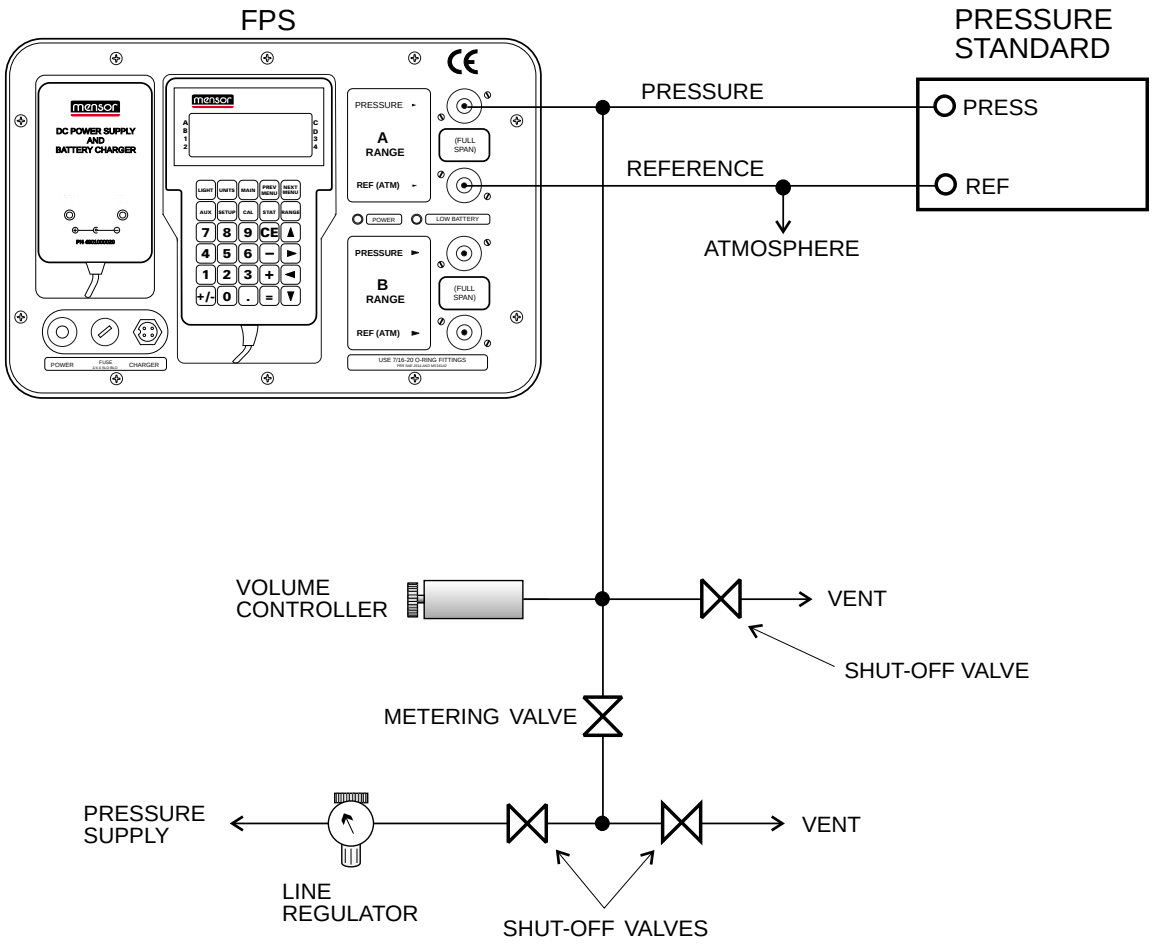


Figure 3.1 - Gauge/Differential Calibration Setup

ZERO ADJUSTMENT – GAUGE OR DIFFERENTIAL SENSOR

To set zero on a gauge or differential instrument merely vent both the PRESSURE and REF (ATM) ports to atmosphere, then:

1. Press **[CAL]**;
2. Press **[1]** for TARE (TARE must be set to '0' before setting the ZERO value);
3. Enter either the zero or the master password to access the TARE offset menu;
4. Press **[0]**, then **[=]** to ensure that the TARE offset is set to '0';

5a. If the zero password is '0' press **[AUX]** and zero is set for this transducer, then go to 7 below, or;

5b. If the zero password is something other than '0', enter the zero password and **[=]**;

6. Finally, enter **[0]** for the zero value, and **[=]**.
7. This ends the zero adjustment for a gauge or differential sensor. Next, either a), press **[MAIN]** to return to the main display; or b), go to the SAVE function under the SETUP menus to preserve the new zero setting in non-volatile memory; or c), continue on to the span calibration, which is explained next.

SPAN ADJUSTMENT

The transducer to be calibrated must be hooked up to a source of known pressure as illustrated in figure 3.1. After the zero adjustment has been made, then:

1. Apply a known pressure near the full scale value of the sensor to the PRESSURE port, preferably in psi;
2. With the sensor set to the same pressure units as the source pressure, press **[CAL]**, then **[3]** to access the SPAN calibration function;
3. Enter the master password, **[1], [2], [3]** and **[4]** (or the new password if it has been changed), then **[=]**;
4. Enter the pressure value that is being applied to the PRESSURE port. This value must be within +/– 10% of the full scale range of the sensor, and in the same pressure units as the known pressure;
5. Enter **[=]** to complete the calibration. Press **[MAIN]** to return to the main display, or continue on to enter a TARE value if such is desired.

TARE ADJUSTMENT

A tare offset can be entered into the sensor's calibration values. A tare offset is a deduction from true zero to account for some constant that is not to be considered, such as deducting the weight of a container as a tare value so that only the contents are weighed. The value for the tare offset should be entered only after zero and span for the sensor have been established. To enter a tare offset:

1. Press **[CAL];**
2. Press **[1]** to enter the TARE function of the calibration menu;
3. Enter either the zero or the master password and **[=]**;
4. Enter the desired tare value within the range of +/– 17 psi;
5. Press **[=]** to complete the process.

Notice that once a tare has been entered the sensor zero is displayed as the addition of the tare and any zero offset in the sensor. The sensor cannot be re-zeroed if the current tare is any value other than '0'.

SUMMARY

The above ZERO, SPAN and TARE calibrations can be repeated for the second sensor in the FPS. If any of the three values for either sensor has been changed, and the intent is to preserve the new values through the next power down, then they must be saved using the SAVE function as described under 'Setup' in the *Operation* section of the manual.

A complete calibration sequence is:

1. Remove any TARE offset;
2. Set ZERO pressure to 0;
3. Set the full scale pressure with the **[CAL]** SPAN function;
4. Re-set a TARE value if desired;
5. Save the new values with the SAVE function.

SPECIFICATIONS

Accuracy specifications presented herein are obtained by comparison with primary standards traceable to the National Institute of Standards and Technology (NIST). These specifications are obtained in accordance with the ISO *Guide to the Expression of Uncertainty in Measurement (GUM)*. Mensor also adheres to ANSI/NCSL-*Z540*. If there is an exception to the requirements and recommendations of *Z540* during a calibration the exception is noted on the individual calibration certificate.

Mensor reserves the right to change these specifications without notice.

GENERAL

These specifications apply to a Mensor Field Pressure Standard, Single or Dual Range Measuring System. These specifications are subject to change without notice. For more information see "Functional Specifications" in this section.

Operating Environment

Temperature: 0°C to 50°C.
Note: This might not be the compensated temperature range.
Humidity: 5% to 95% RH non-condensing humidity.

Shipping, Storage and Handling Environment

–20°C to +70°C with battery removed.
–20°C to +40°C with battery installed.
Minimal vibration.
5 gravities acceleration maximum.
Non-condensing humidity.

> ***NOTE:*** *The internal battery will self-discharge during storage. The discharge rate is temperature related; higher temperatures accelerate the discharge rate. Avoid storing the battery above 40°C or below 0°C for extended periods.*

Compensated Temperature Range

15°C to 45°C or 0°C to 50°C (refer to table 1.1 for model number).

Reference Port Pressure

±1 atmosphere, maximum.

Pressure Ranges

Table 4.1 – FPS Ranges

TYPE	MINIMUM PSI	MAXIMUM PSI
Absolute	0 to 5.0	0 to 6,000
Gauge	0 to 0.36	0 to 1,200
Sealed Gauge (psisg)	0 to 1,201	0 to 6,000
Bi-directional Gauge	–0.36 to +0.36	–atm to +6,000 psisg

Pressure Media

Clean, dry non-corrosive gases.
Liquid media available as an option on some ranges.
Not for oxygen service.
(See table 6.4 for a list of materials in contact with the pressure medium.)

Pressure Connections

The pressure ports are female 7/16–20 SAE/MS straight threads per MS16142 and SAE J514 table 14. They require a tube fitting boss seal with an o-ring per MS33656. Mensor provides female 1/4 NPT and 1/8 NPT adapters with the FPS. Connections can be made to these adapters or directly to the transducer ports with the proper fittings.

Display/Keypad

Hand held control display unit. See separate specifications for the CDU beginning on page 4-6.

PHYSICAL SPECIFICATIONS

Weight

Approximately 15 pounds (6.8 kg) with manual and standard accessories.

Size

6.5 x 10.6 x 14.0 inches (16.5 x 26.9 x 35.6 cm).

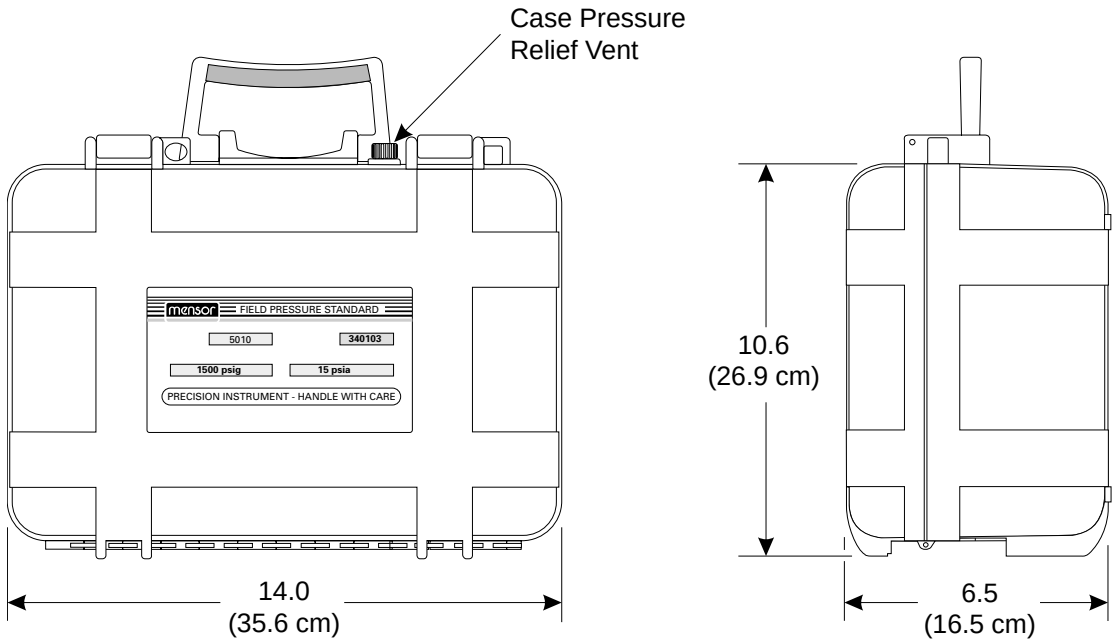


Figure 4.1 - Case Dimensions

FUNCTIONAL SPECIFICATIONS

Instrument Uncertainty

Instrument uncertainty includes combined linearity, hysteresis and repeatability over the compensated temperature range.

0.025% of full scale or 0.01% of full scale. (Refer to table 1.1 for model number.)

Overpressure Rating of Pressure Port

Table 4.2 – Overpressure Rating of Pressure Port

Sensor Range	Overpressure
.26 to 2.0 psi	5 psi
2.1 to 7.5 psi	20 psi
7.6 to 16 psi	45 psi
17 to 40 psi	60 psi
41 to 100 psi	200 psi
101 to 250 psi	500 psi
251 to 500 psi	1000 psi
501 to 1000 psi	2000 psi
1001 to 2500 psi	5000 psi
2501 to 5000 psi	7500 psi

Transducer Conversion Rate

Sensor Response to full scale pressure step: 0.25 seconds.
Update Rate: 10 readings per second (maximum).

Reading Noise

Less than 0.01% of full scale. (No reading greater than ±0.01% of full scale when 1000 readings are taken under static pressure and temperature conditions and in a typical electrical operating environment.)

Gravity/Orientation Effects

Zero: negligible.
Span: negligible.
Linearity: negligible.

Zero Drift

0.01% full scale max. in 30 days.
Zero may be reset without affecting span or linearity.

Span Drift

0.01% full scale max. in 90 days.
Span may be reset without affecting zero or linearity.

Warm-up Time

Approximately 5 minutes to rated accuracy.

Power

Voltage: 12V dc nominal (10.5 to 14.9 V dc).
Current: 150 mA nominal, 170 mA max.
Backlight: Add 10 mA average; 15 mA peak.
Fuse: 1/4 Amp Slo-Blo - accessible from the front panel.
Battery: 12 volts nominal, capable of operating unit continuously for 12 hours and be recharged in less than 8 hours.
Battery Charger: 115V ac, 170 ma
230V ac, 85 ma

Resolution

User selectable over EIA-232 bus:

4, 5 or 6 significant digits, plus decimal point and positive or negative sign, if required (up to 2 PPM for some ranges).

CONTROL DISPLAY UNIT SPECIFICATIONS

Mechanical

Dimensions: 6.4 x 4.3 x 1.0 inches max (16.26 x 10.92 x 2.54 cm).
Weight: 10 oz.

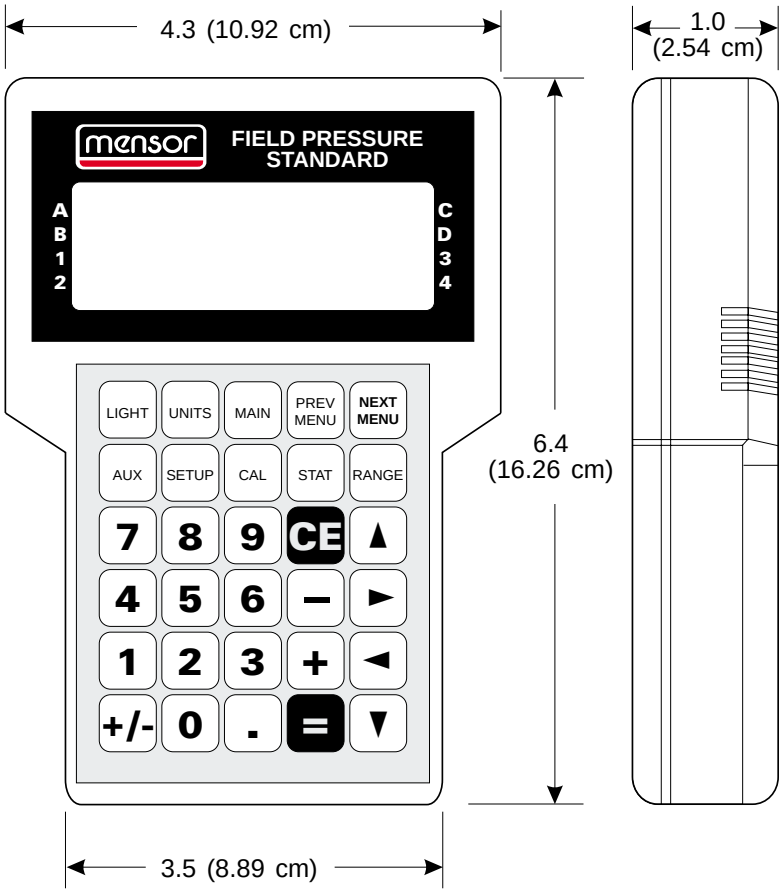


Figure 4.2 - CDU Dimensions

Electrical

Voltage: +5V dc ± 5%.
Current: EIA-232-C. 40 mA maximum.

Keyboard

Type: Sealed Membrane, 5 column x 6 row keypad.
Switch type: momentary, normally open.
Tactile feel: snap action tactile dome with simultaneous "snap" circuit closure.
Actuation force: 12 ± 4 oz.
Switch life: 1,000,000 actuations.

Display

Type: 4 lines x 20 characters twisted nematic fluid LCD.
Format: 5 x 7 dot matrix character cells.
Character size: 0.187" H x 0.116" W.
Viewing angle: 6 o'clock.

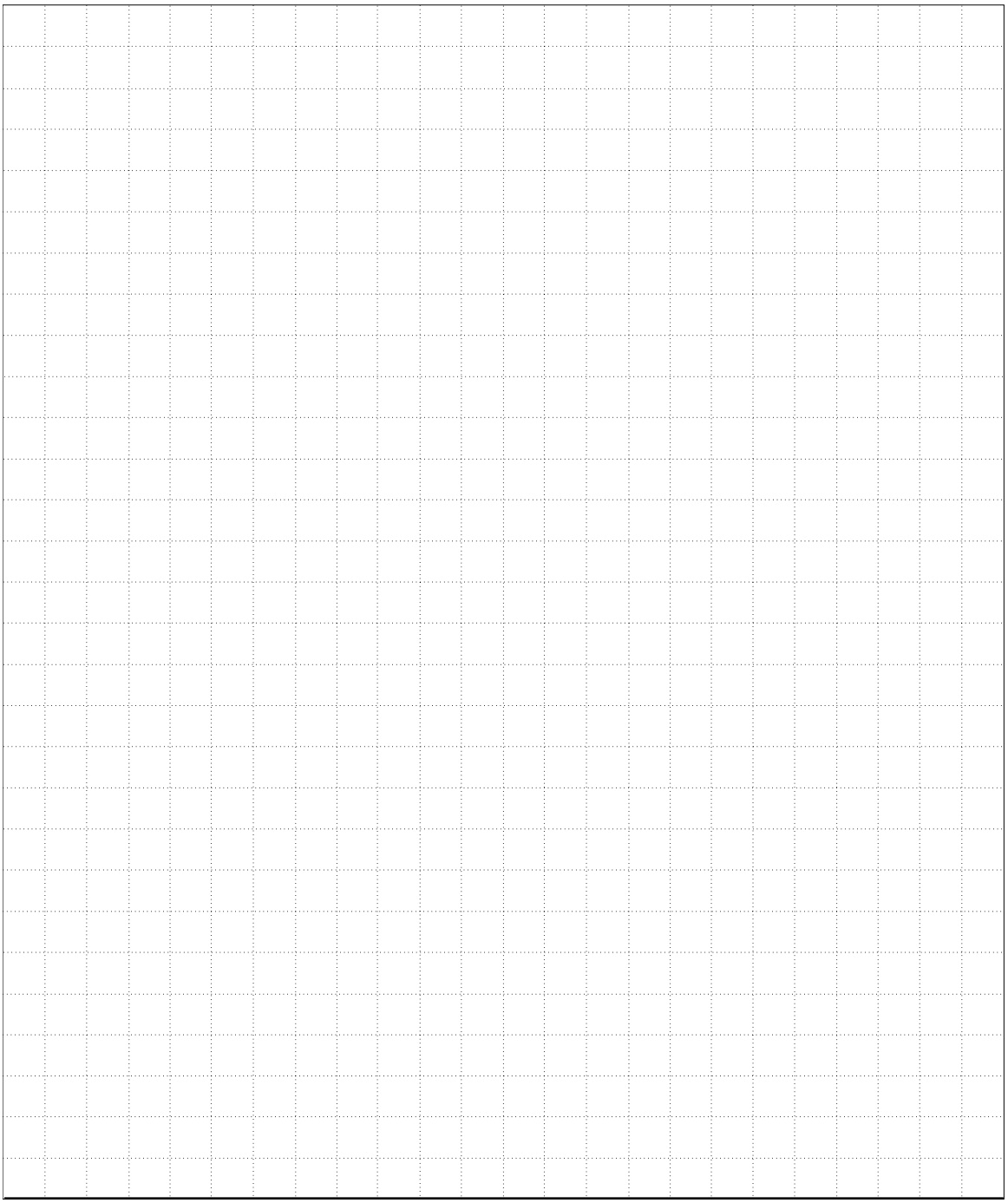
Environmental

Operating Temperature Range:
Standard: 0°C to 50°C.
Optional: –20°C to 50°C.
Storage Temperature Range: –20°C to +70°C.
Humidity: 5% to 95% RH non-condensing.

Backlighting

Type: Electroluminescent panel.
Color: White.
Wavelength: 490 nm.
Intensity levels: 8 including OFF.

User's Notes:



OPTIONS and SPARES

The following optional and spare/replacement items are available. Contact Mensor for current pricing and delivery information.

Power Cord, 12V dc/Automotive	0014634001
Battery	4100400016
Battery Charger	4901000020
Fuse (box of five)	4100110251
Hand Operated Pressure/Vacuum Pump	6100700011

HAND OPERATED PRESSURE/VACUUM PUMP

A Combo-Pump 500 (figure 5.1) is available as an accessory for use with pneumatic systems (not suitable for use with liquids). This device can be either a pressure or a vacuum source during on-site calibrations or comparisons. The pump is capable of generating pressures up to 500 psi (34 bar), and converts to generating vacuum down to -12 psi (24" Hg) simply by pressing a button. This hand pump features dual output ports and a vernier adjustment. Operating instructions are supplied with the Combo-Pump.

Specifications

Range: 24" Hg vacuum to +500 psi

Output Ports: Dual, 1/8" female NPT

Size: 9.5"h x 2"w x 2"d
(24.13 x 5.08 x 5.08 cm)

Weight: 1.1 lbs (0.5 kg)

Materials: Aluminum, stainless steel, acetal, moly-filled nylon

NOTE: *This pump will not fit inside FPS case.*

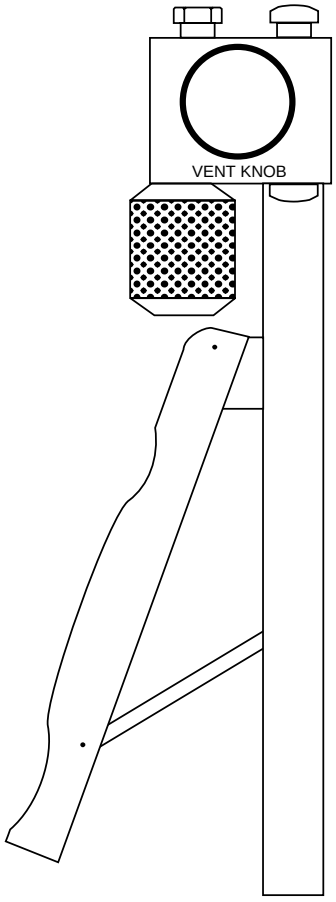


Figure 5.1 - Hand Pump

APPENDIX

TABLE OF CONTENTS

TABLE 6.1 – CONVERSION FACTORS, PSI

The following table lists conversion factors which should be used as multipliers of the pressure to be converted to or from psi.

Code	Pressure Unit	To Convert From Psi	To Convert To Psi
1	psi	1	1
2	inH_2O @ 4°C	27.68067	0.03612629
3	inH_2O @ 20°C	27.72977	0.03606233
4	inH_2O @ 60°F	27.70759	0.03609119
5	ftH_2O @ 4°C	2.306726	0.4335149
6	ftH_2O @ 20°C	2.310814	0.4327480
7	ftH_2O @ 60°F	2.308966	0.4330943
8	mm H_2O @ 4°C	703.089	0.001422295
9	cm H_2O @ 4°C	70.3089	0.01422295
10	m H_2O @ 4°C	0.703089	1.422295
11	in seawater @ 0°C	26.92334	0.03714250
12	ft seawater @ 0°C	2.243611	0.445710
13	M seawater @ 0°C	0.6838528	1.462303
14	inHg @ 0°C	2.03602	0.491144
15	inHg @ 60°F	2.041772	0.4897707
16	µHg @ 0°C	51715.08	0.00001933672
17	mm Hg @ 0°C	51.71508	0.01933672
18	cm Hg @ 0°C	5.171508	0.1933672
19	mTorr	51715.08	0.00001933672
20	Torr	51.71508	0.01933672
21	Pa	6894.757	0.0001450377
22	hPa	68.94757	0.01450377

Continued on next page...

Table 6.1 continued...

Code	Pressure Unit	To Convert From Psi	To Convert To Psi
23	kPa	6.894757	0.1450377
24	MPa	0.006894757	145.0377
25	dynes/cm^2	68947.57	0.00001450377
26	g/cm^2	70.30697	0.01422334
27	kg/cm^2	0.07030697	14.22334
28	atm	0.06804596	14.69595
29	mBar	68.94757	0.01450377
30	Bar	0.06894757	14.50377
31	oz/in^2	16.0000	0.06250000
32	psf	144.000	0.006944444
33	tsi	0.000500	2000.0
34	tsf	0.072000	13.88889
35	% fs	(psi / range) x 100	(% fs x range) / 100

TABLE 6.2 – CONVERSION FACTORS, MILLITORR

The following table lists conversion factors which should be used as multipliers of the pressure to be converted to or from millitorr.

Code	Pressure Unit	To Convert From Millitorr	To Convert To Millitorr
1	psi	0.0000193367	51715.1
2	inH_2O @ 4°C	0.000535253	1868.27
3	inH_2O @ 20°C	0.000536201	1864.97
4	inH_2O @ 60°F	0.000535774	1866.5
5	ftH_2O @ 4°C	0.0000446045	22419.3
6	ftH_2O @ 20°C	0.0000446834	22379.6
7	ftH_2O @ 60°F	0.0000446478	22398
8	mm H_2O @ 4°C	0.0135954	73.5541
9	cm H_2O @ 4°C	0.00135954	735.541
10	m H_2O @ 4°C	0.0000135954	73554.1
11	in seawater	0.000521442	1918
12	ft seawater	0.0000434535	23010
13	M seawater	0.0000132446	75500
14	inHg @ 0°C	0.0000393701	25400.0
15	inHg @ 60°F	0.0000394812	25328.5
16	µHg @ 0°C	1	1
17	mm Hg @ 0°C	0.001	1000.00
18	cm Hg @ 0°C	0.0001	10000.0
19	mTorr	1	1
20	Torr	0.001	1000.00
21	Pa	0.133322	7.50064
22	hPa	0.00133322	750.064

Continued on next page...

Table 6.2 continued...

Code	Pressure Unit	To Convert From Millitorr	To Convert To Millitorr
23	kPa	0.000133322	7500.64
24	MPa	0.000000133322	7500640
25	dynes/cm^2	1.33322	0.750064
26	g/cm^2	0.00135951	735.561
27	kg/cm^2	0.00000135951	735561
28	atm	0.00000131579	760002
29	mBar	0.00133322	750.064
30	Bar	0.00000133322	750064
31	oz/in^2	0.000309388	3232.19
32	psf	0.00278449	359.132
33	tsi	0.00000000967	103430147
34	tsf	0.00000139224	718265
35	% fs	(psi / range) x 100	(% fs x range) / 100

TABLE 6.3 – TEMPERATURE CONVERSION

Find the known value in a center (shaded) column. If the known value is in °C, then the equivalent value is found in the °F column, or if the known value is in °F then the conversion is found in the °C column.

°C		°F	°C		°F	°C		°F	°C		°F
-17.78	**0**	32.00	10.00	**50**	122.00	37.78	**100**	212.00	65.56	**150**	302.00
-17.22	**1**	33.80	10.56	**51**	123.80	38.33	**101**	213.80	66.11	**151**	303.80
-16.67	**2**	35.60	11.11	**52**	125.60	38.89	**102**	215.60	66.67	**152**	305.60
-16.11	**3**	37.40	11.67	**53**	127.40	39.44	**103**	217.40	67.22	**153**	307.40
-15.56	**4**	39.20	12.22	**54**	129.20	40.00	**104**	219.20	67.78	**154**	309.20
-15.00	**5**	41.00	12.78	**55**	131.00	40.56	**105**	221.00	68.33	**155**	311.00
-14.44	**6**	42.80	13.33	**56**	132.80	41.11	**106**	222.80	68.89	**156**	312.80
-13.89	**7**	44.60	13.89	**57**	134.60	41.67	**107**	224.60	69.44	**157**	314.60
-13.33	**8**	46.40	14.44	**58**	136.40	42.22	**108**	226.40	70.00	**158**	316.40
-12.78	**9**	48.20	15.00	**59**	138.20	42.78	**109**	228.20	70.56	**159**	318.20
-12.22	**10**	50.00	15.56	**60**	140.00	43.33	**110**	230.00	71.11	**160**	320.00
-11.67	**11**	51.80	16.11	**61**	141.80	43.89	**111**	231.80	71.67	**161**	321.80
-11.11	**12**	53.60	16.67	**62**	143.60	44.44	**112**	233.60	72.22	**162**	323.60
-10.56	**13**	55.40	17.22	**63**	145.40	45.00	**113**	235.40	72.78	**163**	325.40
-10.00	**14**	57.20	17.78	**64**	147.20	45.56	**114**	237.20	73.33	**164**	327.20
-9.44	**15**	59.00	18.33	**65**	149.00	46.11	**115**	239.00	73.89	**165**	329.00
-8.89	**16**	60.80	18.89	**66**	150.80	46.67	**116**	240.80	74.44	**166**	330.80
-8.33	**17**	62.60	19.44	**67**	152.60	47.22	**117**	242.60	75.00	**167**	332.60
-7.78	**18**	64.40	20.00	**68**	154.40	47.78	**118**	244.40	75.56	**168**	334.40
-7.22	**19**	66.20	20.56	**69**	156.20	48.33	**119**	246.20	76.11	**169**	336.20
-6.67	**20**	68.00	21.11	**70**	158.00	48.89	**120**	248.00	76.67	**170**	338.00
-6.11	**21**	69.80	21.67	**71**	159.80	49.44	**121**	249.80	77.22	**171**	339.80
-5.56	**22**	71.60	22.22	**72**	161.60	50.00	**122**	251.60	77.78	**172**	341.60
-5.00	**23**	73.40	22.78	**73**	163.40	50.56	**123**	253.40	78.33	**173**	343.40
-4.44	**24**	75.20	23.33	**74**	165.20	51.11	**124**	255.20	78.99	**174**	345.20
-3.89	**25**	77.00	23.89	**75**	167.00	51.67	**125**	257.00	79.44	**175**	347.00
-3.33	**26**	78.80	24.44	**76**	168.80	52.22	**126**	258.80	80.00	**176**	348.80
-2.78	**27**	80.60	25.00	**77**	170.60	52.78	**127**	260.60	80.56	**177**	350.60
-2.22	**28**	82.40	25.56	**78**	172.40	53.33	**128**	262.40	81.11	**178**	352.40
-1.67	**29**	84.20	26.11	**79**	174.20	53.89	**129**	264.20	81.67	**179**	354.20
-1.11	**30**	86.00	26.67	**80**	176.00	54.44	**130**	266.00	82.22	**180**	356.00
-0.56	**31**	87.80	27.22	**81**	177.80	55.00	**131**	267.80	82.78	**181**	357.80
0.00	**32**	89.60	27.78	**82**	179.60	55.56	**132**	269.60	83.33	**182**	359.60
0.56	**33**	91.40	28.33	**83**	181.40	56.11	**133**	271.40	83.89	**183**	361.40
1.11	**34**	93.20	28.89	**84**	183.20	56.67	**134**	273.20	84.44	**184**	363.20
1.67	**35**	95.00	29.44	**85**	185.00	57.22	**135**	275.00	85.00	**185**	365.00
2.22	**36**	96.80	30.00	**86**	186.80	57.78	**136**	276.80	85.56	**186**	366.80
2.78	**37**	98.60	30.56	**87**	188.60	58.33	**137**	278.60	86.11	**187**	368.60
3.33	**38**	100.40	31.11	**88**	190.40	58.89	**138**	280.40	86.67	**188**	370.40
3.89	**39**	102.20	31.67	**89**	192.20	59.44	**139**	282.20	87.22	**189**	372.20
4.44	**40**	104.00	32.22	**90**	194.00	60.00	**140**	284.00	87.78	**190**	374.00
5.00	**41**	105.80	32.78	**91**	295.80	60.56	**141**	285.80	88.33	**191**	375.80
5.56	**42**	107.60	33.33	**92**	197.60	61.11	**142**	287.60	88.89	**192**	377.60
6.11	**43**	109.40	33.89	**93**	199.40	61.67	**143**	289.40	89.44	**193**	379.40
6.67	**44**	111.20	34.44	**94**	201.20	62.22	**144**	291.20	90.00	**194**	381.20
7.22	**45**	113.00	35.00	**95**	203.00	62.78	**145**	293.00	90.56	**195**	383.00
7.78	**46**	114.80	35.56	**96**	204.80	63.33	**146**	294.80	91.11	**196**	384.80
8.33	**47**	116.60	36.11	**97**	206.60	63.89	**147**	296.60	91.67	**197**	386.60
8.89	**48**	118.40	36.67	**98**	208.40	64.44	**148**	298.40	92.22	**198**	388.40
9.44	**49**	120.20	37.22	**99**	210.20	65.00	**149**	300.20	92.78	**199**	390.20

TABLE 6.4 – MATERIALS IN CONTACT WITH PRESSURE MEDIUM

The recommended pressure medium is clean, dry, non-corrosive gases. Consult Mensor Corporation for applications requiring liquid-filled pressure sensors.

Materials in Contact with Pressure Medium	
Metallics	Non-Metallics
Aluminum	Buna-N Rubber
Brass	Silicon
	Silicone Grease
	Epoxy
	Polyester

HEAD PRESSURE CORRECTION

The accuracy of pressure measurement depends on several factors, one of which is the consideration of the head pressure in the system. The pressure medium, whether a gas or liquid, can cause an error in the measurement if not considered. In many cases the offset is insignificant, and it can be ignored. The following information provides instructions for determining the density of the pressure medium and how to calculate the head pressure effect.

TABLE 6.5 – Gas Density

Liquids and gases have mass and are affected by gravity. The extent of the effect is dependent upon the density of the pressure medium. Liquids normally have a constant density that does not change with pressure. Gases however, increase in density as the pressure increases. To determine the density of a gas at a specific pressure multiply the absolute pressure by the density from the following table. For gas the head pressure difference due to temperature changes within the compensated temperature range will be insignificant.

Gas @ 23°C		Density per psi in pounds/in^3 (D_{psi})
Air,Dry		2.9315×10^{-6}
Argon	(A)	4.0443×10^{-6}
Carbon Dioxide	(CO_2)	4.4824×10^{-6}
Helium	(He)	4.0466×10^{-7}
Hydrogen	(H_2)	2.0379×10^{-7}
Nitrogen	(N_2)	2.8355×10^{-6}

TABLE 6.6 - Liquid Density

In the table below, the density of water at various temperatures is given. The density of a liquid is commonly specified in grams per milliliter (

Head Pressure Calculation

The pressure at the input port (P2 in figure 6.1) of the Device Under Test (DUT) will be a positive number if the pressure standard is positioned higher than the DUT. If the standard is lower than the DUT the head pressure correction will be a negative value. The equation used to calculate the head pressure for a gas medium is:

$$P2 = P1 (1 + h \times Dpsi)$$

h = Difference in vertical height between the center lines of the two pressure ports.

Dpsi = Gas density (refer to the "Gas Density" table).

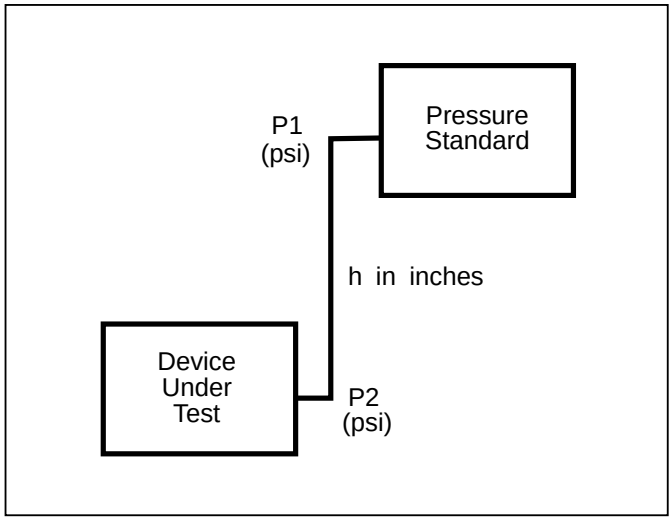


Figure 6.1 - Head Pressure Calculation

DIGITAL FILTER

Digital filtering in the FPS simulates the output of a single pole, low pass (RC) filter. This type filter is also referred to as an exponential smoothing filter. It may be enabled, disabled, or used only within a reading window. (See 'Filter Window' below.)

It is mathematically calculated as:

$$\text{Result} = \text{Reading} - (\text{Reading} - \text{Previous Reading}) \times \%\ \text{filter}$$

or

$$\text{Result} = \text{Previous Reading} + (\text{Reading} - \text{Previous Reading}) \times (1 - \%\ \text{filter})$$

Where:

Previous Reading is initially set to the value of the first reading and thereafter is set to the Result of the filter calculation.

% filter is the entered degree of filtering expressed as a percentage. Allowed values are integers between 0 and 99. This equates to % filter values of 0.00 to 0.99. The higher the % filter value, the more filtering applied and the less nervous the displayed reading. A value of 0 disables the filtering. The default filter value is 90 for a 90% (0.90) filter.

This type filter reduces the effects of random noise while preserving long-term trends. Its actual effect on the output is determined by the filter % value in memory and the update rate of the instrument. To determine the equivalent electrical RC time constant:

$$\text{time constant} = t / \ln((\%\ \text{filter} - 1) / \%\ \text{filter})$$

Where:

t equals the time between readings,
ln is the logarithm, and
% filter is the filter value expressed as a percentage (0.00 to 0.99)

Generally, selecting the appropriate filter setting and filter window (see below) is a matter of modifying the default values.

FILTER WINDOW

In addition to adjusting the amount of filtering to be applied to each reading, a filter window is provided to define when the filtering is applied. This feature allows fast response during rapid pressure transitions, but reduces the noise when the reading is stable or changing slowly. The filter window value is entered as a percent of full scale. The default value is 0.04% of full scale. Whenever the difference between the current reading and the previous reading is less than the filter window, filtering is applied. If the value is greater than the window, no filtering is applied and the current reading is immediately displayed.

This feature can be especially helpful where relatively large pressure surges could go undetected if filtered, providing the window is set so the change is greater than the window.

An Example

Assume a previous reading of 5 psi. The current pressure is 5.01 psi. What is the current filtered output reading with a 10% filter if the pressure change is within the filter window.

Result = Previous Reading + (Reading – Previous Reading) x (1 – % filter)

= 5.000 + (5.010 – 5.000) x (1 – 0.10)
= 5.000 + (5.010 – 5.000) x 0.90
= 5.000 + (0.010 x 0.90)
= 5.000 + (0.009)
= 5.009

Result = 5.009 psi (which is now the 'previous reading' for the next calculation)

A 90% filter would be calculated as:

= 5.000 + (5.010 – 5.000) x (1 – 0.90)
= 5.000 + (0.010) x (0.10)
= 5.001

CDU SETUP

The CDU was programmed for the FPS before it left the factory. Should the CDU ever fail to initialize, power down the unit and check that all connectors between the case and the CDU are secure; then cycle the power back on. If the CDU still fails to initialize then it may be necessary to perform the setup procedure to re-program the CDU.

Setup

For setup hold both the **[+/–]** and **[▼]** keys down during power-up until 'MAIN MENU' is displayed. Then set all parameters to the settings shown below:

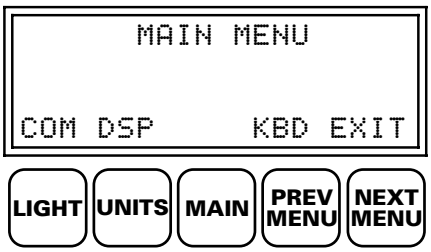
STEP	PARAMETER	SETTING
COMMUNICATION SETUP:		
1.	Baud Rate	9600
2.	Parity	none
3.	Data, Stop Bits	8,1
4.	Display Serial Errors	no
5.	Audible Serial Errors	no
6.	Support XON/XOFF	yes
DISPLAY SETUP:		
7.	Display Control Characters	no
8.	Display Escape Character	no
9.	Cursor Visible	no
10.	Auto Line Wrap	no
11.	New Line on CR	no
12.	Display Self-Test	no
13.	Backlight ON	no
KEYBOARD SETUP;		
14.	Local Echo	no
15.	Key Repeat	off
16.	Audible Keys	no
17.	Simple Keyboard	yes
18.	Function Key 1	A (flashing)
19.	Function Key 2	B (flashing)
20.	Function Key 3	C (flashing)
21.	Function Key 4	D (flashing)
22.	Store Changes	yes

In order to save the setup after it is entered it is necessary to complete step 22 by pressing the **[LIGHT]** key directly under YES on the display. If the setup is not

saved then the next time the FPS is powered on the CDU will again come on in its previous condition.

The following examples show the screens and key presses necessary to achieve the correct settings for the FPS. In these examples the screen illustrations show the function that is achieved by pressing the key directly under the displayed label. In the text the actual key label to be pressed is shown (text inside square brackets) rather than the display label of its function. If problems with the CDU persist after attempting to re-install the setup contact Mensor Customer Service for assistance.

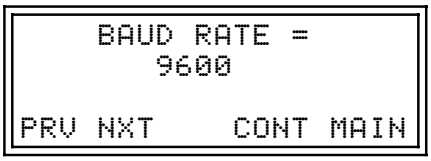
EXAMPLES



[LIGHT] = Setup COMMUNICATIONS
[UNITS] = Setup DISPLAY
[PREV MENU] = Setup KEYBOARD
[NEXT MENU] = EXIT Setup

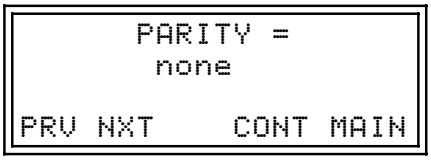
COMMUNICATION SETUP

Press [LIGHT] to set COMMUNICATION PARAMETERS:



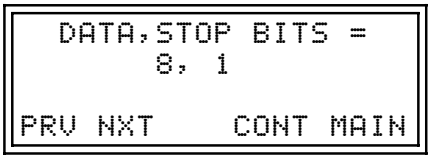
[LIGHT] = Steps Down to next lower BAUD RATE
[UNITS] = Steps Up to next higher BAUD RATE
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With '9600' showing press [PREV MENU] to CONTINUE:



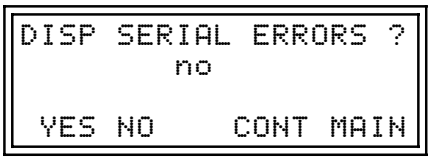
[LIGHT] = Steps Down to next lower PARITY selection
[UNITS] = Steps Up to next higher PARITY selection
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'none' showing press [PREV MENU] to CONTINUE:



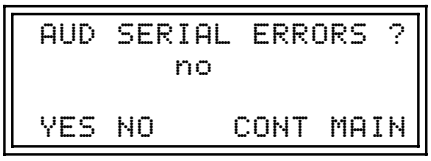
[LIGHT] = Steps Down to next lower DATA, STOP value
[UNITS] = Steps Up to next higher DATA, STOP value
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With '8,1' showing press [PREV MENU] to CONTINUE:



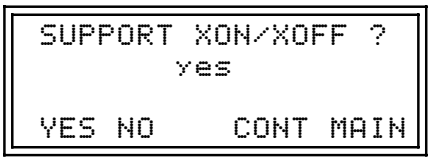
[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO, do not DISPLAY SERIAL ERRORS
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO, no AUDIBLE on SERIAL ERRORS
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:

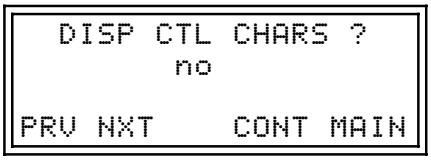


[LIGHT] = Answers YES for X ON/X OFF support
[UNITS] = Answers NO; does not apply to FPS
[PREV MENU] = CONTINUE now returns to MAIN MENU
[NEXT MENU] = Return to MAIN MENU

With 'yes' showing [PREV MENU] returns to MAIN MENU:

DISPLAY SETUP

From MAIN MENU press [UNITS]:

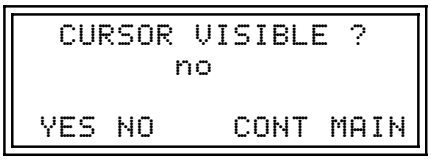


[LIGHT] = Steps Down to next lower DISPLAY option
[UNITS] = Steps Up to next higher DISPLAY option
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:

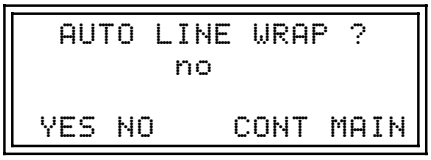
[LIGHT] = Steps Down to next lower DISPLAY option
[UNITS] = Steps Up to next higher DISPLAY option
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



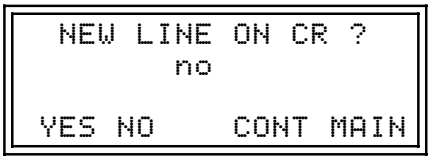
[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO for not VISIBLE CURSOR
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



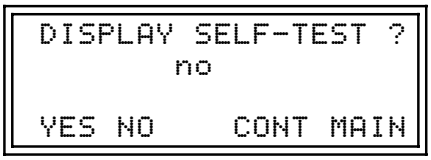
[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO for not AUTO LINE WRAP
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



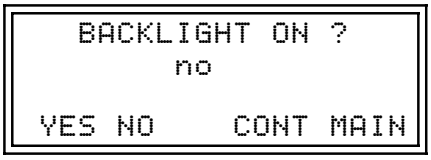
[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO for not AUTO LINE WRAP
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO for no SELF-TEST display
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:

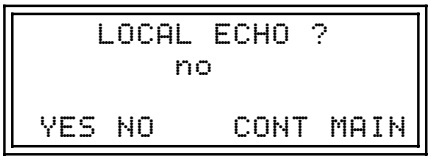


[LIGHT] = Answers YES; does not apply to this unit
[UNITS] = Answers NO for BACKLIGHT OFF
[PREV MENU] = CONTINUE now returns to MAIN MENU
[NEXT MENU] = Also returns to MAIN MENU

With 'no' showing press [PREV MENU] or [NEXT MENU]:

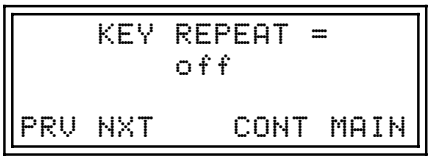
KEYBOARD SETUP

From MAIN MENU press [PREV MENU]:



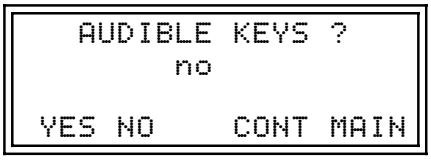
[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO for ECHO OFF
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



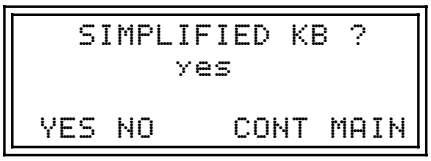
[LIGHT] = Steps Down to next lower KEY option
[UNITS] = Steps Up to next higher KEY option
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'off' showing press [PREV MENU] to CONTINUE:



[LIGHT] = Answers YES; does not apply to FPS
[UNITS] = Answers NO for not AUDIBLE KEYS
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'no' showing press [PREV MENU] to CONTINUE:



[LIGHT] = Answers YES for SIMPLIFIED KEYBOARD
[UNITS] = Answers NO; does not apply to FPS
[PREV MENU] = CONTINUE to next parameter
[NEXT MENU] = Return to MAIN MENU

With 'yes' showing press [PREV MENU] to CONTINUE:

[LIGHT] = Steps to NEXT F#
[UNITS] = Answers YES to view or reset the displayed F#;
[NEXT MENU] = Return to MAIN MENU

With any F# displayed press [UNITS] to see the setting for this F key, or to reset its value, or; press [NEXT MENU] to return to MAIN MENU:

When **[UNITS]** is pressed for any function key displayed the display will change to show the current setting for that key, and provide an opportunity to change it. Each of the four keys, F1, F2, F3 and F4, should show a flashing square cursor in the top left character cell, and a single flashing letter A, B, C or D respectively, directly under the cursor, similar to this:

[LIGHT] = Steps BACK; Disabled for FPS
[UNITS] = Steps FORWARD; Disabled for FPS
[PREV MENU] = SAVES the current F KEY setting
[NEXT MENU] = Exit to MAIN MENU

F1 program shown; press [PREV MENU] to save it, then [LIGHT] for F2, etc.

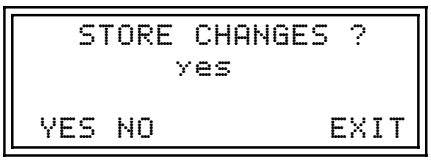
If any of the four function keys do not have the proper cursor location and the correct single letter flashing below it, then program that function key as shown in the following table:

Table 6.7 – Function Key Programming

F-KEY	PRESS: 1st	2nd	3rd	4th	5th
F1	[0]	[+/-]	[LIGHT]	[PREV MENU]	[UNITS]
F2	[0]	[+/-]	[UNITS]	[PREV MENU]	[UNITS]
F3	[0]	[+/-]	[MAIN]	[PREV MENU]	[UNITS]
F4	[0]	[+/-]	[PREV MENU]	[PREV MENU]	[UNITS]

Notice that when **[0]** is pressed the cursor changes from a square to a rectangle; when **[+/-]** is pressed the rectangle changes to the 'CT' control symbol, and when the third key is pressed the cursor returns to a flashing square with the flashing correct letter to its immediate left. There may be other symbols or letters on the screen, but these will disappear after the 4th key press **[PREV MENU]** to save the keyed sequence. Press **[UNITS]** after each SAVE to see that the proper control letter appears in the display.

With all four function keys correctly programmed press **[NEXT MENU]** to return to the MAIN MENU. Press **[NEXT MENU]** again to EXIT. This will bring up the final screen:



[LIGHT] = Answers YES to STORE CHANGES
[UNITS] = Answers NO, does not apply to FPS
[NEXT MENU] = Return to FPS environment

Press [LIGHT] for YES to save any changes. This locks in the current CDU setup. Finally, press [NEXT MENU] to return the system to its normal FPS operation.

GLOSSARY

Absolute Pressure
A pressure that is referenced to the absence of all other pressure, that is, referenced to true zero pressure. See *Pressure Relationships*.

Accuracy
The difference between the average of multiple measurements of a value and the true value. See *Uncertainty*.

Ambient Conditions
The conditions (pressure, temperature, etc.) surrounding the case of the instrument.

Attitude
The orientation of the instrument represented by its angles of inclination to three orthogonal axes.

Barometric Pressure
Atmospheric pressure at the point of measurement, frequently stated in terms of the height of a column of mercury. See *Pressure Relationships*.

Calibration
A test during which known values of pressure are applied to the instrument and resulting output readings are recorded under specified conditions.

Calibration Curve
A graphical representation of the calibration points.

Calibration Cycle
The application of known values of pressure, and recording of corresponding output readings, over a full (or specified portion) of the range of an instrument in an ascending and descending direction.

Calibration Record
A record of the measured relationship of the instrument output to the applied pressure over the instrument range.

Calibration Traceability
See *Traceability.*

Calibration Uncertainty
See *Uncertainty.*

Compensation
An addition of specific materials, processes or devices to counteract a known cause of error.

Dead Band
The change through which the input to an instrument can vary without causing a change to the instrument output.

Differential Pressure
The difference between the measured pressure and a fixed reference pressure. See *Pressure Relationships*.

Drift
Any change in output over a period of time, which change is not a function of the pressure being measured. See *Stability*.

Elevation
The vertical height from mean sea level, especially of a point on the earth's surface, used in making local corrections to barometric readings.

Environmental Conditions
Specified external conditions (shock, vibration, temperature, etc.) to which an instrument may be exposed during shipping, storage, handling, and operation.

Error
The algebraic difference between the indicated value and the true value of the pressure, usually expressed in percent of full scale.

FS
See *Full Scale*.

Full Scale
The upper limit of the device range, frequently noted as "FS". See also *Range* and *Span*.

Gauge Pressure
The difference between atmospheric pressure and a variable pressure. See *Pressure Relationships*.

Gravity Correction
The correction factor applied to measurement processes involving mass to account for the gravity constant exerted at the site of the measurement.

Hysteresis

The maximum difference in output, at any pressure value within the specified range, when the value is approached first with increasing and then decreasing pressure.

Linearity

The closeness of a calibration curve to a specified straight line expressed as a percentage of full scale deviation.

Line/ Pressure

The highest pressure within a system which can be present at the pressure sensor. See *Reference Pressure*.

Offset

A known relatively constant difference between a measurement reading and its true value. Zero offset can be nulled out with a switch or valve in some types of measurement processes.

Operating Conditions

See *Environmental Conditions*.

Output

The electrical or digital quantity, produced by an instrument, which is a function of the applied pressure.

Overpressure Rating

The pressure which may be applied to the sensing element or the case (as specified) of a sensor without damage to either the sensing element or sensor case as specified.

Precision

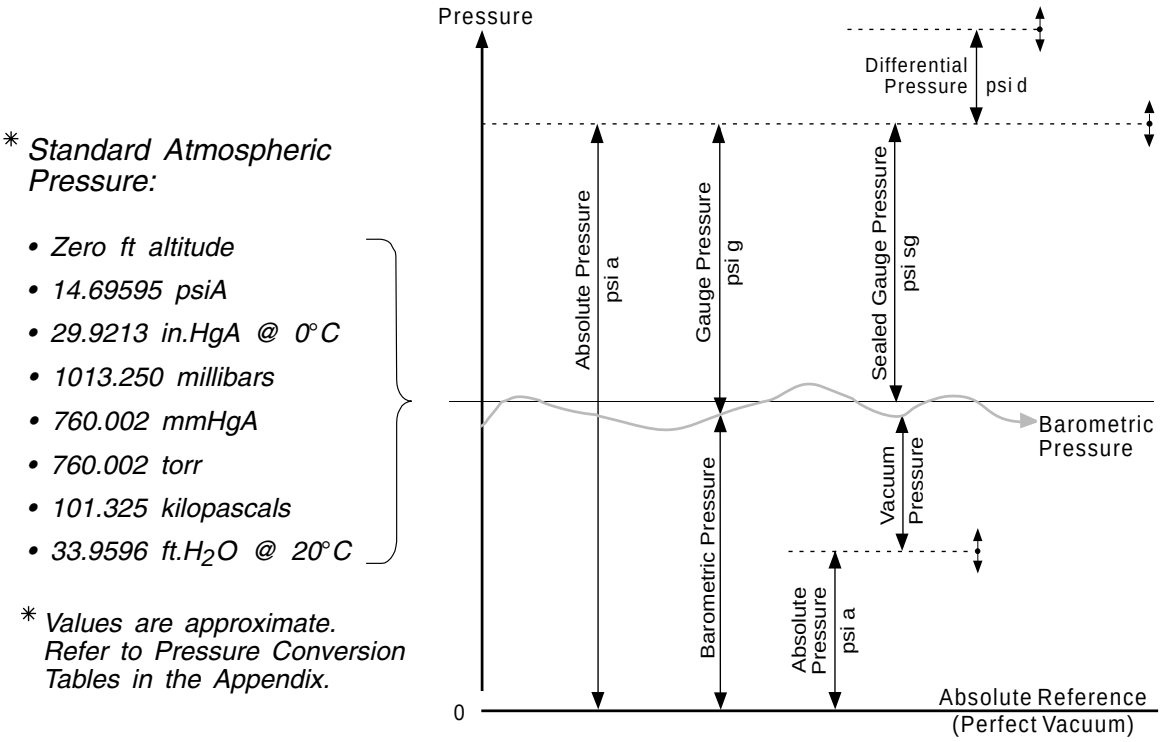
The closeness of agreement between independent test results obtained under stipulated conditions.

Pressure Medium

The fluid (gas or liquid) which comes in contact with the sensing element in the pressure chamber.

Pressure Relationships

The relationship of various pressure terms are illustrated in figure 7.1, below:



✳ *Standard Atmospheric Pressure:*

- *Zero ft altitude*
- *14.69595 psiA*
- *29.9213 in.HgA @ 0°C*
- *1013.250 millibars*
- *760.002 mmHgA*
- *760.002 torr*
- *101.325 kilopascals*
- *33.9596 ft.H_2O @ 20°C*

✳ *Values are approximate. Refer to Pressure Conversion Tables in the Appendix.*

Figure 7.1 - Pressure Relationships

Range

The measurand values over which the measuring device is intended to measure, specified by the lower and upper limits. See also *Full Scale* and *Span.*

Rate

See *Altitude Rate* or *Pressure Rate.*

Reference Pressure

The pressure relative to which a differential pressure instrument measures pressure.

Repeatability

The ability of an instrument to reproduce output readings when the same pressure value is applied repeatedly, under the same conditions, and in the same direction.

Resolution, Output

The maximum number of distinguishable values of output over the range of the instrument. Stated another way, the least detectable magnitude of change in the pressure.

Response Time

The length of time required for the output of the instrument to rise to a specified percentage of its final value as a result of a step change of pressure.

RS-232

A serial data communication path between instruments which conforms to the standards defined by ANSI/RS-232-D-1986, "Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) Employing Serial Binary Data Interchange". The standard is available from Electronic Industries Association, Engineering Dept., 2001 Eye Street N.W., Washington, D.C. 20006.

Span

The algebraic difference between the lower and upper limits of the range. See also *Full Scale* and *Range.*

Stability

The ability of an instrument to retain its performance characteristics for a specified period of time.

Temperature Error

The maximum change in output, at any pressure value within the specified range, when the transducer temperature is changed from the nominal compensated temperature (mid-range of the stated compensated temperature range) to the compensated temperature extremes.

Temperature Range, Compensated

The temperature range over which the instrument specifications are specified.

Temperature Range, Operating

The range of ambient temperatures within which the instrument will function and not suffer any damage or change in characteristics.

Temperature Range, Storage

The range of ambient temperatures over which the instrument may be stored for an extended period of time without suffering any damage or change in characteristics.

Uncertainty

The maximum credible limits for the difference between the true value and the measured value of the pressure under consideration, usually expresses as a percent of full scale (%FS), or as a percent of reading (%R).

Vacuum Pressure

A pressure less than ambient barometric pressure. See *Pressure Relationships*.

Warm-up

The period of time from the application of power until the instrument has reached its operating temperature, required to assure that the instrument will perform within all specified tolerances.

Zero Drift

A change in the zero-pressure output over a specified period of time.

Zero Offset

See *Offset*.

Zero Shift

A permanent change to the indicated output with zero pressure applied. If the shift is beyond the range of the zero adjustment then re-calibration is required.

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