PRECISION INSTRUMENTS & SYSTEMS

USER'S MANUAL
PN 0014736001 C

ENGINE
VANE
CONTROL
TEST SET

CODE ______________________

SN ______________________

VERSION ______________________

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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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. 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.

PLEASE NOTICE...

The product specifications and other information contained in this manual are subject to change without notice.

Mensor Corporation has made a concerted effort to provide complete and current information for the proper use of the equipment. If there are questions regarding this manual or the proper use of the equipment, contact Mensor Corporation at:

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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FCC RADIO FREQUENCY EMISSION NOTICE

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his or her own expense.

USE SHIELDED CABLES TO CONNECT EXTERNAL DEVICES TO THIS INSTRUMENT TO MINIMIZE RF RADIATION.

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. These products are used in metrology labs, calibration labs, research facilities, engineering offices, production test stands, and in other environments were 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.

User's Notes:

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INTRODUCTION

DID YOU GET EVERYTHING?

In addition to this manual you should have:

- Engine Vane Control Test Set
- Power cord
- 1/8 inch NPT fitting adapters
- Any accessories ordered
- Envelope containing a Calibration Certificate and a Warranty Certificate

INITIAL INSPECTION

Your new Mensor instrument was thoroughly tested and inspected at the factory, and it was free of dings, dents and scratches when it was packaged for shipment. Please examine it now for signs of shipping damage. Report any apparent damage to the carrier immediately.

MEET YOUR EVCTS

The Engine Vane Control Test Set (EVCTS) is a special purpose PCS 400 designed to calibrate jet engine pressure transducers. It consists of a self-contained, computerized, high accuracy two channel pressure management system integrated into a single, compact unit. The system is comprised of a front panel assembly, a rear panel, an electrical module, a pneumatic module, and a chassis to tie it all together. The system functions either as a bench-top or a rack mounted instrument. It can operate in local mode to accept front panel input, or in remote mode to communicate with external devices. The installed software is specifically designed to test Engine Vane Control parameters where numbers for the Pt3 and ΔP3 values are input, and the Ps3 and Pt3 pressures are output to the rear panel. Notice that Pt3 - Ps3 = ΔP3. A brief description of the major elements of the system follows.

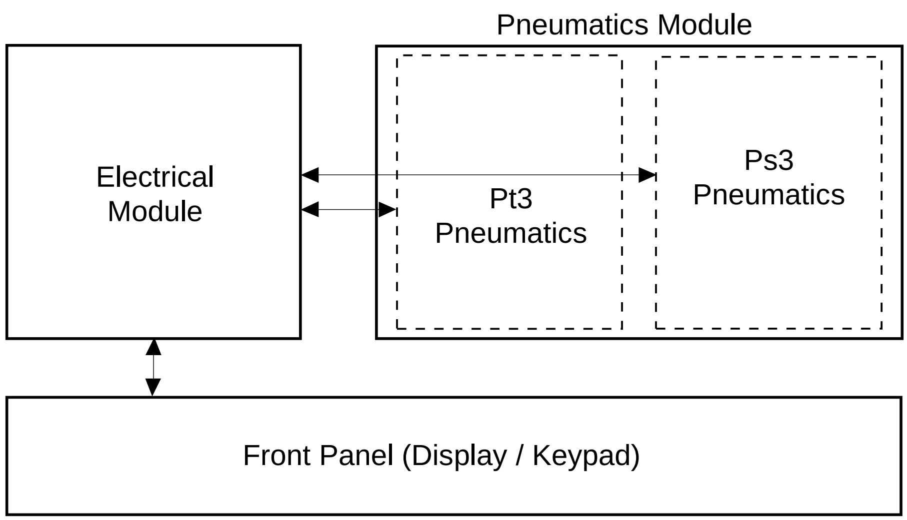


Figure 1.1 - System Block Diagram

Instrument Case

The instrument case is all aluminum construction with extruded aluminum frame members and vinyl clad cover and side panels. Front and rear panel assemblies attach to the case. These are described separately below.

Front Panel

The front panel (figure 1.2) includes a forty character per line, two line display, a four by four membrane keypad, and a transparent window for the pressure range label. The keypad includes fifteen dual-function keys, plus a sixteenth key, labeled 2nd, which toggles the function of the other fifteen. All sixteen keys include both tactile and audible feedback.

Rear Panel

The rear panel (figure 1.3) includes access to the voltage select switch, the line-fuse holder, the power cord socket, the system power switch, a ventilator fan opening, and several communication connectors. All of these items are grouped on the electrical module side of the rear panel. The pneumatic side exposes the six fitting ports of the pressure manifold.

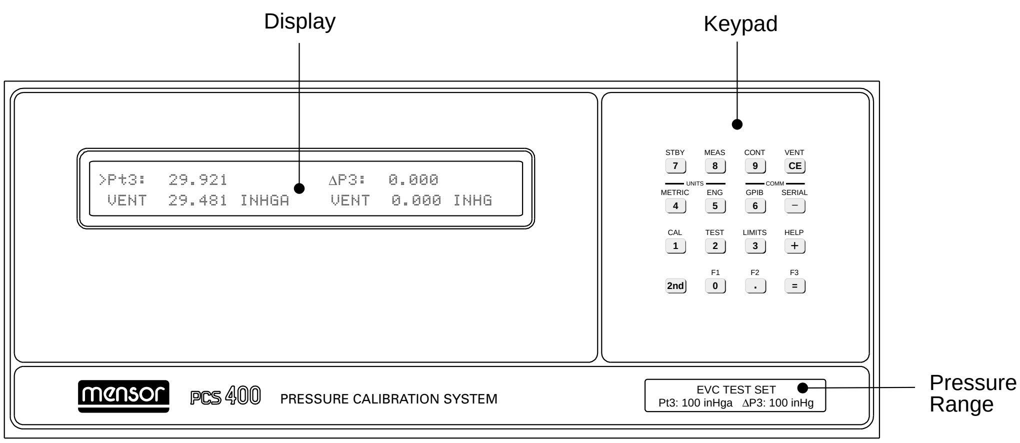


Figure 1.2 - Front Panel

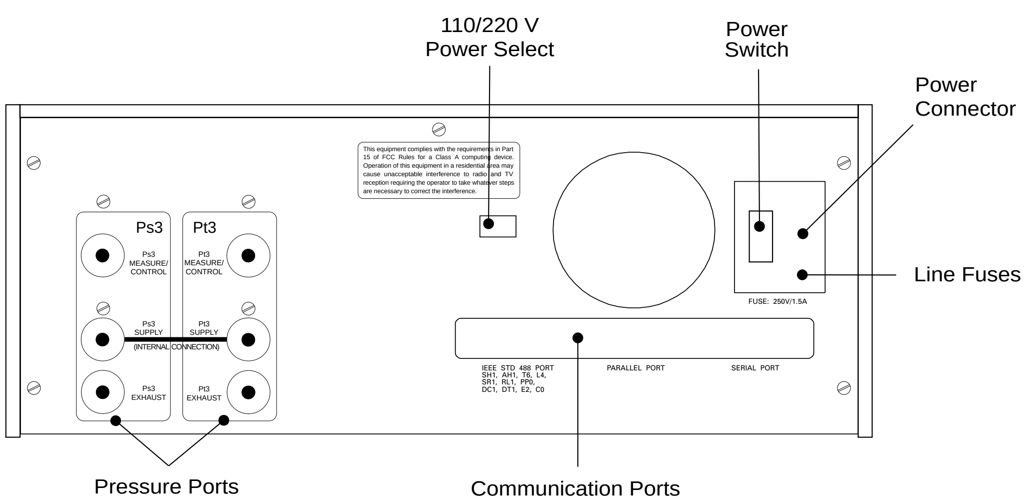


Figure 1.3 - Rear Panel

Electrical Module

The internal electrical module (figure 1.4) consists of the input power module, a fan, a power supply, an AT compatible computer assembly, and a 3.5 inch disk drive. Inside the drive is the disk which contains the program information to run the system. The disk can be removed or replaced by removing the rear panel which is attached by nine screws. Note that the plug-in printed circuit cards are not necessarily in the order illustrated.

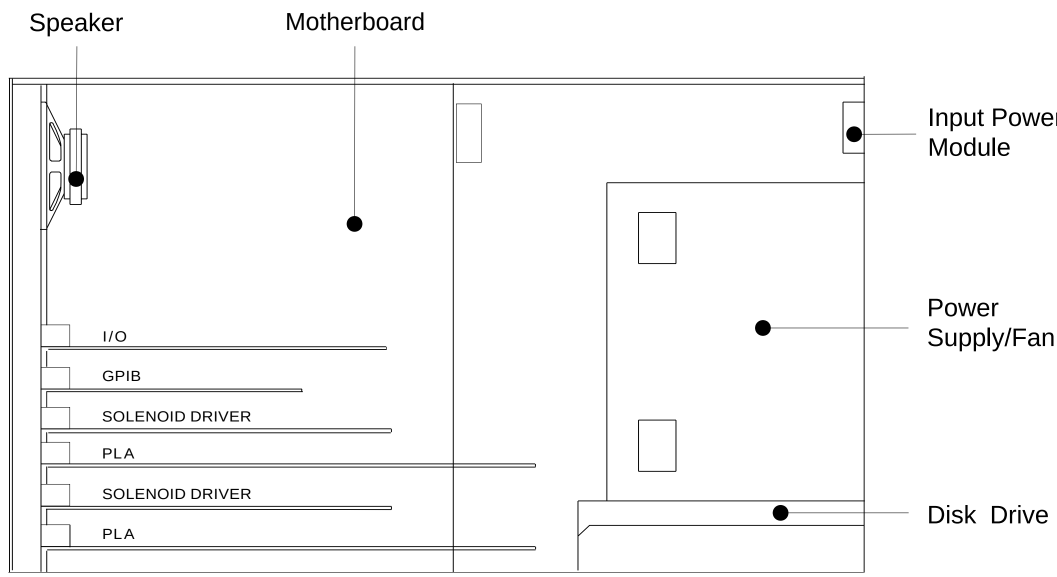


Figure 1.4 - Internal Electrical Module - Top View

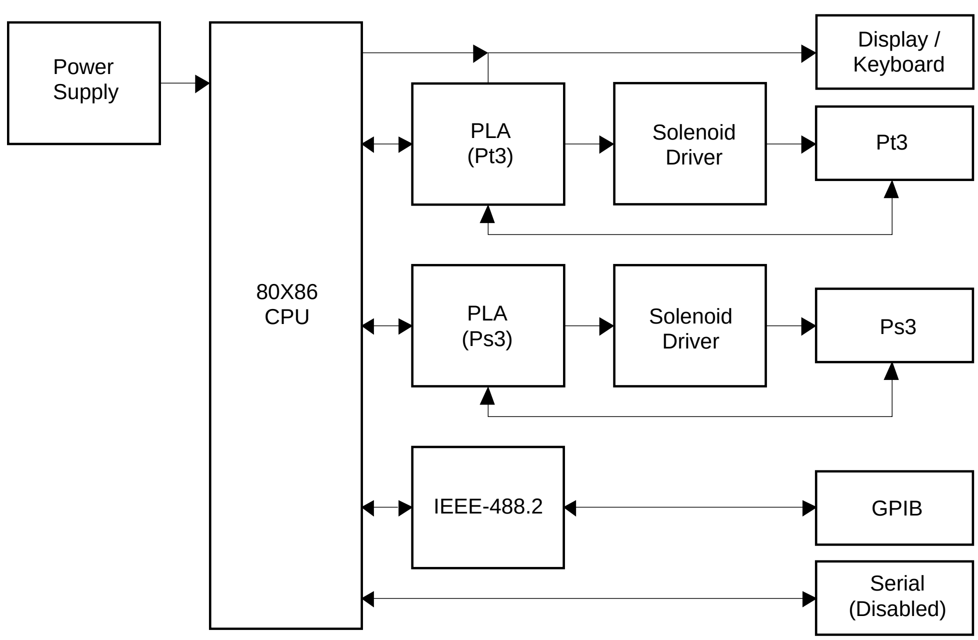


Figure 1.5 - Electrical Block Diagram

Pneumatic Module

The pneumatic module (figure 1.6) includes two internal high accuracy, low-drift pressure sensors which are traceable to NIST as secondary standards. These sensors are used in conjunction with two high resolution pressure regulators to produce two precise pressure outputs with a range of 0.1 to 100 inHga. The pneumatics module is set up at the factory to use a single supply pressure source, connected to either the Pt3 SUPPLY port (unplugged), or the Ps3 SUPPLY port (plugged). The EXHAUST ports are plumbed separately to accommodate two independent vacuum sources. The system is flexible enough that either set of ports can be reconfigured to use two supply sources, and/or a single vacuum source for both exhausts if the application will tolerate such conditions.

While the two pneumatic channels can function independently, the processor connects them digitally. The result is that pressure values for Pt3 and ΔP3 can be entered either from the keypad, or over the communications bus, and the system will respond by generating the Pt3 and Ps3 output pressures where Pt3 – Ps3 = ΔP3. The operator can toggle the right half of the display to show either the simulated value of ΔP3 or the actual pressure of Ps3.

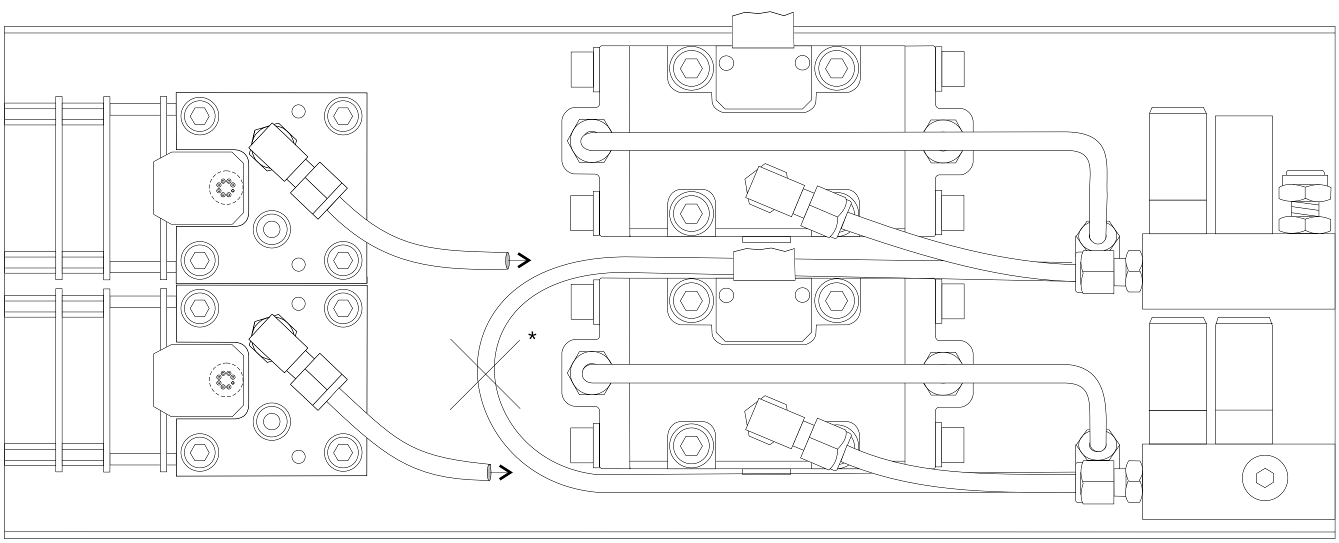
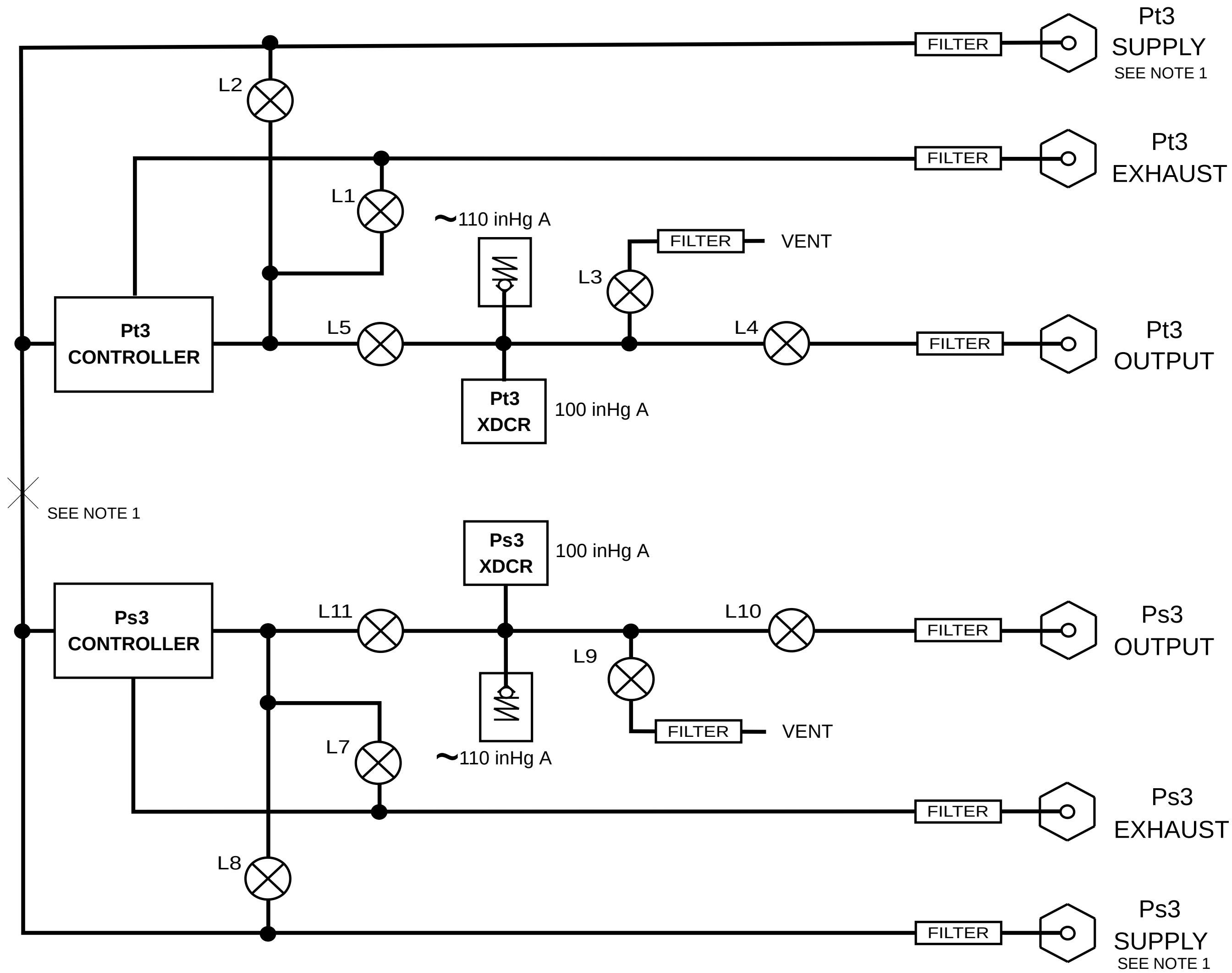


Figure 1.6 - Pneumatic Module - Top View



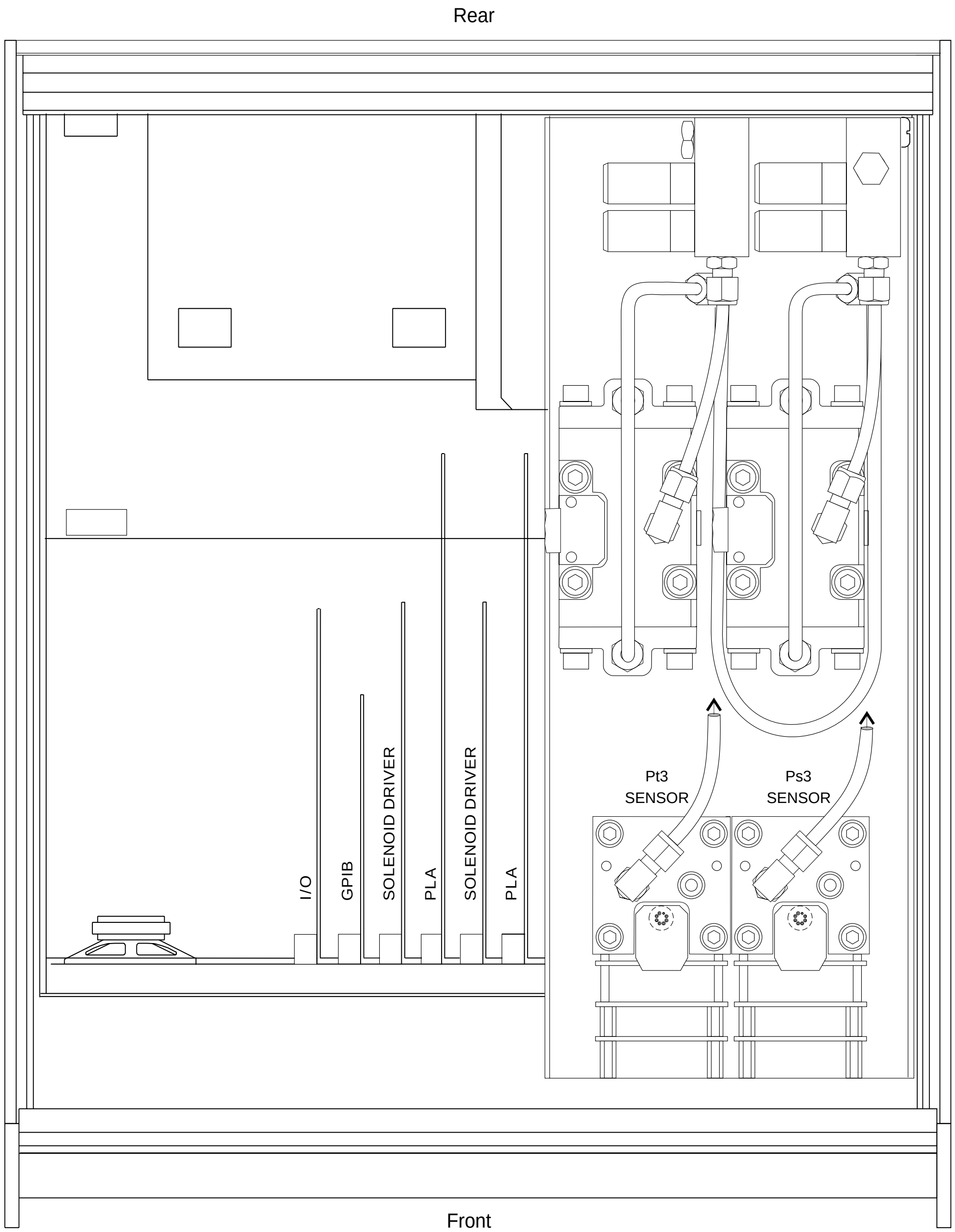
NOTES:
1. For single source pressure plug one of the two external SUPPLY ports, or for independent sources disconnect the internal tube marked "╳" which joins the two controllers.
2. Solenoid valves L1 through L11 are 5 vdc, 1.5 w, normally closed.
3. Solenoid valve L6 is unused, or not installed in some configurations.

Figure 1.7 - Pneumatic Schematic

Chassis Assembly

The chassis assembly acts as the housing for the system. The electrical and pneumatic modules are each self-contained and can be replaced individually using basic hand tools. System accuracy is maintained when either module is replaced because the transducers and their calibration data reside in the pneumatic module.

The only moving parts in the EVCTS are the fan, the disk drive mechanism, the pneumatic flow controller diaphragms and valves, and the solenoid valve plungers. There are no internal user adjustments or setup switches. The layout of the internal system is illustrated in figure 1.8.



Note: The electrical module is shown with its cover removed.

Figure 1.8 - Chassis Assembly - Top View

POWER UP!

You can confirm that your EVCTS is operational right now. Simply apply power to the power connector on the rear of the instrument, remove any plastic plugs from the rear panel pressure ports and turn the power switch ON. The system will go through a brief initialization process and then the display should appear similar to the following illustration:

```
>Pt3: 29.921            ΔP3: 0.000
 VENT 29.481 INHGA      VENT 0.005 INHG
```

On the left half of the display the “>“symbol on the top line indicates that Pt3 is the active channel, and this is followed by standard atmospheric pressure. Displayed directly under these are the current operating mode (default at power-up is VENT) and the local atmospheric pressure as measured by the Pt3 transducer. The right half of the display shows the value currently entered for ΔP3 (default at power-up is zero), and the bottom line again shows the current mode, and the calculated value of ΔP3 where ΔP3 is the difference between the Pt3 the Ps3 transducers.

Press the keys [2nd] then [0] (for the F1 function) and observe that the “>“ symbol moves to ΔP3 on the top line to indicate that this channel is now active. Press several number keys and notice that the ΔP3 top line numbers echo each number pressed. Do not press [=].

Press F1 again ([2nd] [0]) and the active symbol “>“ will toggle back to the Pt3 channel. Again, press several number keys and see the Pt3 top line numbers change. Changing the numbers on either channel takes effect only when followed by pressing [=]. The [=] key acts as the “Enter this command” key. Rather than [=], press the clear entry key [CE] several times to clear out the entered numbers. When the last digit is erased it is replaced with the previous setpoint which remains active.

Press [2nd], [+] (labeled HELP). This changes the display to show the instrument name on the top line and a prompt to press [CE] to return to the previous display. The bottom line shows the instrument serial number and software version number. This display is the only feature available from the HELP function at this time. Press [CE] to restore the display.

If all has gone well the EVCTS can be put into service by proceeding to the *Installation* section of the manual, which is next. Instructions for operating the instrument manually follow that in the *Local Operation* section.

IF YOU HAVE PROBLEMS ...

If you have problems using your EVCTS and you don’t find the answer in your manual, contact Mensor at 1-800-984-4200 (USA only), or 1-512-396-4200 for personal assistance, or at any of the on-line addresses listed in the front of the manual. We are ready to help.

Mensor’s concern with the welfare of this instrument is not limited to the warranty period. We provide complete repair services for the life of the instrument as explained in Section 5, *Maintenance*.

CALIBRATION SERVICES

In addition to servicing our own products Mensor can perform a complete pressure calibration service, up to 20,000 psi, for all of your pressure instruments. This service includes a Certificate of Compliance and Calibration and the record of traceability to the pressure standards of the National Institute of Standards and Technology (NIST).

User's Notes:

INSTALLATION

MOUNTING

The instrument can be set up on a table-top or it can be rack-mounted. For rack-mount installation, see the mounting instructions in Section 8, *Options*.

The special sensors used in the EVCTS are relatively insensitive to tilt and vibration. However to further assure stability and accuracy, excessive motor or machinery vibration of the mounting surface should be avoided.

PRESSURE CONNECTIONS

> ***NOTE:*** *When making up the connection to an o-ring adapter use a back-up wrench to prevent over-stressing the threads in the manifold block.*

All of the pressure ports on the rear 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 1/8 NPT adapter fittings with the instrument. The pressure connections can be made to 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 fitting. Do not use sealants 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. Figure 1.7 is a pneumatic schematic of the internal plumbing. Requirements for connecting to the various ports on the EVCTS manifold are given below.

SUPPLY Pressure Port

Each channel of the EVCTS has its own SUPPLY port. However, one of these is plugged on the rear panel since they are connected together inside the pneumatics module. Connect a source pressure of 55 to 60 psi (110 - 120 inHg) to the open SUPPLY port.

EXHAUST Pressure Ports

Connect a separate vacuum pump to each of the two EXHAUST ports. These ports must be evacuated in order to control at sub-atmospheric pressures. Although both channels can be connected to a single vacuum pump, doing so can create cross channel interference under some conditions, and is not recommended.

MEASURE/CONTROL Pressure Ports

Devices to be tested are normally connected to the two MEASURE/CONTROL ports (Ps3 and Pt3). In CONTROL mode these ports can output a precise, stable (static) pressure, or a pressure which climbs or falls in an orderly manner (pressure rate). The EVCTS is tuned for most efficient operation working into a one third to one half liter volume at the end of three feet of tubing connected to these ports.

In MEASURE mode the EVCTS will precisely measure the pressure present on a MEASURE/CONTROL port up to the full scale range of the sensor. Internal relief valves are provided to protect the system from overpressure, but this does not reduce the need for good safety practices.

POWER ON

After the pressure connections are secure, apply power to the power connector on the rear of the instrument. Turn the power switch to ON. The instrument will go through a quick initialization process and system check. As soon as the system check is completed the system will default to the VENT mode for both channels. The display will appear similar to the illustration that follows:

```
>Pt3:  29.9215          ΔP3: 0.000
 VENT  29.4814 INHGA  VENT   0.000 INHG
```

On the top line the ">" symbol indicates that Pt3 is the active channel. Local atmospheric pressure is shown on the bottom line of channel Pt3.

Press [2nd][+] which is labeled "HELP". The screen now shows the instrument name on the top line and a prompt to press [CE] to return to the previous display. The serial number and software version are displayed on the bottom line.

A warm-up period of at least 45 minutes is advised for greatest accuracy. The EVCTS is now ready for service.

User's Notes:

LOCAL OPERATION

This section describes the proper procedures for operating the EVCTS from the front panel. Instructions for operating the EVCTS from an external computer are covered in the next section. Following the procedures provided in these two sections and Section 6, *Calibration* will ensure maximum accuracy and dependability of your instrument.

SYSTEM OVERVIEW

The Engine Vane Control Test Set consists of two independent pressure measuring/pressure controlling sub-systems, or channels, on the pneumatics module. These two pressure channels are identified as Pt3 and Ps3. A third channel, identified as ΔP3, is a variable quantity that can be defined by the operator. With the system in CONTROL mode, the relationship of these three channels is Pt3 - ΔP3 = Ps3. In effect, a controlled pressure setpoint can be assigned to Pt3, another positive quantity can be assigned to ΔP3, and the EVCTS will respond with an output pressure on the Ps3 MEASURE/CONTROL port which is the difference between the Pt3 pressure and the ΔP3 value. Notice that P3 will accept only positive values within the range of Pt3.

KEYPAD

Local operation is accomplished through the keypad and by observing the display. The fifteen dual purpose function keys enter either the numeric *value* or *operation* printed on the key face or, if the [2nd] key is pressed first, then the key enters the *menu function* printed directly above the key.

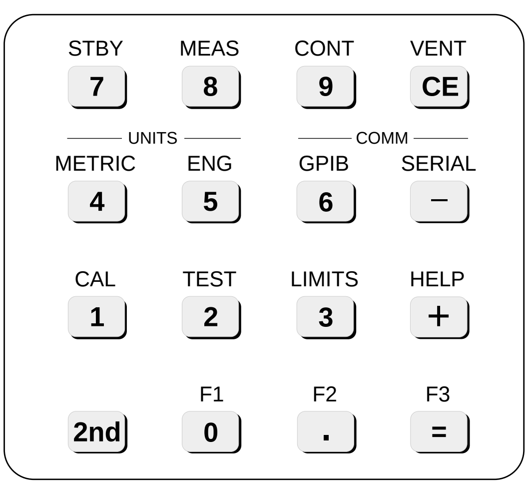


Figure 3.1 - Keypad

Pressing [2nd] causes the next key press to shift into the menu function mode.

Notice that throughout this manual characters enclosed in square brackets indicates a single key stroke. For example, [0] indicates pressing the zero key (unshifted), whereas [2nd], [F1] indicates pressing “2nd” then “0” to execute the F1 function. Where the text might say “Go to VENT mode” the meaning is press the two key sequence, [2nd] then [CE] to execute the VENT mode.

Functions

A description of each available function is presented below, followed by a table summary. A graphic menu tree is placed at the end of this section, and a larger, foldout of the same menu tree will be found in the rear cover pocket. It might prove helpful to have a photocopy of one of the menu trees near the instrument until operators are familiar with the various keystrokes and functions.

The following descriptions are of functions, and by inference, require pressing the [2nd] key prior to pressing the associated function key. Instructions for pressing the [2nd] key are omitted from this text in favor of brevity over redundancy. To back out of any menu or sub-menu press [CE] one or more times.

F1 The F1 function toggles between selecting the left (Pt3) or right (ΔP3 or Ps3) channels. The leading “>” symbol designates which channel is active. A channel must be “active” to change the output pressure setpoint (top line value). Changing the primary mode (STANDBY, MEASURE, CONTROL or VENT) on either channel forces the change to both channels. In addition, when in the calibration mode the active channel is the channel having its zero offset or span value changed. To change the output pressure setpoint simply make the appropriate channel active, then press the number keys for the desired value. The new value appears on the top line as the numbers are entered. When the displayed value is correct press [=]. Next, press [CONT] and the controller for that channel will immediately slew the output pressure to the newly commanded value.

F2 The F2 function toggles the display to show either Pt3 and ΔP3 (normal), or to show Pt3 and Ps3 (alternate). In the normal Pt3/ΔP3 display state selecting either STANDBY, MEASURE, CONTROL or VENT, will apply the selected mode to both channels. In the alternate, Pt3/Ps3 display state, both channels automatically lock into the MEASURE mode. STANDBY, CONTROL and VENT are locked out until the display is returned to the Pt3/ΔP3 state.

F3 Not used.

CAL CAL provides entry to the zero and span calibration functions, and to the change passwords function. After pressing [CAL] press [+] or [-] several times to step through the ZERO, SPAN and PASSWORD sub-menus. To enable any of these press [=] while the desired function is on the display.

ZERO: A zero password is required in order to change either channel's zero offset. When the system is ready to accept a change to the current zero offset a "?" prompt to enter the new value will appear in the display. See the Calibration section of the manual for instructions on determining the correct zero offset. *Note:* At the user's discretion the zero password can be disabled so that line operators can reset zero at will.

SPAN: A separate, master password is needed to change either channel's span value. When the system is ready to accept a change to the current span value a "?" prompt to enter the new value will appear in the display. See the Calibration section of the manual for instructions on calibrating the sensor's span. *Note:* The master password can be changed, but it cannot be disabled.

PASSWORDS: Enter this mode to change the current zero or master password, or to disable the zero password requirement. More information is given on passwords later in this section.

TEST Enter the TEST menu area to enable the various sub-menu tests available. Press [+] or [-] repeatedly to step through the various sub-menus listed below (exhaust, supply, etc.). To enable a specific test press [=] while the test is showing in the display.

EXHAUST: Tests for a vacuum on the Exhaust port of the current channel. A vacuum is required to control sub-atmospheric output pressure. The display will show a fail message for the test if it measures a vacuum pressure greater than 1 (one) inHgA.

SUPPLY: Tests for source pressure great enough to provide a controlled output pressure near the span of the selected channel. A Pass or Fail message is sent to the display.

SENSOR: Tests the communication link between the electrical module and the pressure sensors in the pneumatics module. The test returns a Pass or Fail message.

CONTROL VALVES: Tests for media flow through the pressure controller valves. A Pass or Fail message is sent to the display

PNEUMATICS: Tests the actuating coils of the solenoid valves. The test sends a Pass or Fail message to the display.

LIMITS The LIMITS menu provides access to three sub-menus. Press [+] or [-] repeatedly to step through the sub-menus. Press [=] to access a sub-menu appearing in the display.

CONTROL RATE MODE: This sub-menu will display the current RATE status as either slow, medium or fast by a closed circle indicator. The fast rate causes the controller output to slew at maximum speed from its current setting to a newly commanded setpoint. Press [+] or [-] to step through the choices, and [=] to enable the highlighted choice.

MEASURE FILTER: Allows the amount of filtering applied to the output reading to be selected for optimum performance. The available choices presented are Low, Normal or High which represent 50%, 90% and 99% filter rates respectively. The low filter rate is closest to real time pressure readings, but this can be noisy in the display. A more stable display of the numbers is obtained with Normal, or High. The display indicates the current choice with a filled circle. Step through to the desired value with the [+] or [-] key, then press [=] to enable the highlighted choice.

SYSTEM DEFAULTS: With SYSTEM DEFAULTS showing in the display press [=] to restore all default values to their factory settings. Which values are the factory default settings are identified in 'Menu Descriptions' listed in this section.

HELP The only display available from the HELP menu shows the instrument name, its serial number, and the software version number currently loaded into the system.

METRIC Entering the METRIC menu brings up three available metric units of measure, mBar, mmHg and kPa. Use the [=] or [-] key to step through to the desired units, then press [=]. The selected units will immediately be assigned to both channels.

ENG This menu function offers the two ENGLISH measurement units, inHg or psi. Again, use the [+] or [-] key to select the desired units. Press [=] to simultaneously assign the selected units to both channels.

GPIB Enter this menu to set the GPIB address of the EVCTS. Addresses of 0 to 30 are allowed.

SERIAL Not active for this unit.

STBY Enables STANDBY for both channels. Not available while Ps3 is displayed.

MEAS Places the EVCTS in MEASURE mode to accurately measure the pressure appearing on the MEASURE/CONTROL ports.

CONT Puts the EVCTS in CONTROL mode. The pressure value appearing on the top line of the display will be presented to that channel's MEASURE/CONTROL port. Not available while Ps3 is displayed.

VENT This function relieves the pressure from the EVCTS by venting the pneumatics to atmosphere within the EVCTS case. Not available while Ps3 is displayed.

Other Functions: The four operation keys [CE], [+], [-] and [=] are active while in the menu modes. They perform as follows:

[CE] [CE] acts as a backspace during numeric entry, or returns to the previous screen in menu mode. If a sub-menu is displayed then it will require pressing [CE] at least twice to get completely out of the menus and back to the primary display.

[+] The [+] key is a numeric sign (acceptable, but not required) if a positive number entry is appropriate at the time, or else a step forward into the sub-menus for each press when in a menu function. In CONTROL mode each press of the [+] key will increment the control setpoint by the pre-defined step value.

[-] The [-] key is a numeric sign (required) if a negative number entry is appropriate at the time, or else a step backward through the sub-menus for each press when in a menu function. In CONTROL mode each press of the [-] key will decrement the control setpoint by the pre-defined step value.

[=] The [=] key is the "Enter" or "Execute" key for either the value or function that is currently displayed.

Dual Passwords

There are two levels of passwords in the system. A line level or zero password allows access to Zero adjustments, and a master password that will access all protected functions, including changes to passwords. In order to change either password the current master password must be entered. Since passwords are seldom used they are easily forgotten. Please keep a written record of newly entered passwords.

The master password will work for any protected function until it is changed through the CAL/PASSWORD function. Either password can be from one to six digits long. To allow line technicians to easily make zero adjustments the zero password could be changed to the single character “0", for example. To change either password scroll down the menus to the appropriate password to be changed. Then, at the ENTER PASSWORD prompt simply enter the current master password. Then at the CHOOSE A NEW PASSWORD prompt enter the digit or digits desired, then press [=].

The requirement for a zero password can be turned off so that zero adjustments can be made more easily. To disable the zero password requirement merely exit the CHANGE PASSWORD function by pressing [=] without entering a zero password.

Both the zero and master passwords were set at the factory to 123456. Again, since passwords are seldom used, they are easily forgotten. Please keep a written record of the latest changes as they are entered. Contact Mensor Corporation if the master password is lost.

Keypad Functions List

Table 3.1 - Keypad Functions List

Function	Key Sequence	Description
Select channel to edit	[2nd] [F1]	Toggles between Pt3 and ΔP3.
ΔP3 (normal) or Ps3 (alternate) display mode	[2nd] [F2]	Toggles between Normal (ΔP3) mode and Ps3 in the right hand display.
Enter pressure output setpoints	Use number keys to enter a setpoint, use [CE] to back-space, use [=] to execute change.	Changes the setpoint of the CONTROL mode output.
Change mode to STANDBY	[2nd] [STBY]	Changes the mode to STANDBY.*
Change mode to MEASURE	[2nd] [MEAS]	Changes the mode to MEASURE.
Change mode to CONTROL	[2nd] [CONT]	Changes the mode to CONTROL.*
Change mode to VENT	[2nd] [VENT]	Changes the mode to VENT.*
Select METRIC units	[2nd] [METRIC] then [+] or [-] to select the desired units.	Changes the pressure units of both channels simultaneously.
Select ENGLISH units	[2nd] [ENG] then [+] or [-] to select the desired units.	Changes the pressure units of both channels simultaneously.
Change GPIB address	[2nd] [GPIB] and number keys to enter address, then press [=].	Changes the GPIB address of the instrument to the number entered.
Set transducer ZERO	[2nd] [CAL] Password may be required, then number keys to enter desired zero reading, then [=].	Sets the zero of the channel selected by [2nd] [F1].
Set transducer SPAN	[2nd] [CAL] [+] Password is required, then number keys to enter desired span reading, then [=].	Sets the span of the channel selected by [2nd] [F1].

* Available only in NORMAL (ΔP3) mode.

Menu Descriptions

The following table gives a brief description of the functions provided under each of the menu keys. Items shown in bold face type are default values.

Table 3.2 - Description of Menu Key Functions

Menu	Sub-Menu	Function
F1		Select channel to edit (Pt3 or Ps3/ΔP3 according to ">" symbol)
F2		Pt3/ΔP3 (normal) or Pt3/Ps3 (alternate) display
F3		Not Used
CAL	ZERO	Set zero on selected channel
	SPAN	Set span on selected channel
	PASSWORDS	Change Zero or Master Password
TEST	EXHAUST	Test exhaust
	SUPPLY	Test supply
	SENSOR	Test sensor
	CONTROL VALVES	Test regulator valves
	PNEUMATICS	Test pneumatic valves
LIMITS	CONTROL RATE MODE	Set RATE to Slow, Medium or **FAST**
	MEASURE FILTER	Set filter to Low, **NORMAL** or High
	SYSTEM DEFAULTS	Sets system parameters to default values
HELP		Shows instrument name, serial number and software version
METRIC		Change pressure units to **MBAR**, MMHG or KPA
ENGLISH		Change pressure units to **INHG** or PSI
GPIB		Change address
SERIAL		Disabled
STBY		Set system to STANDBY mode
MEAS		Set system to MEASURE mode
CONT		Set system to CONTROL mode
VENT		Set system to VENT mode

Menu Tree

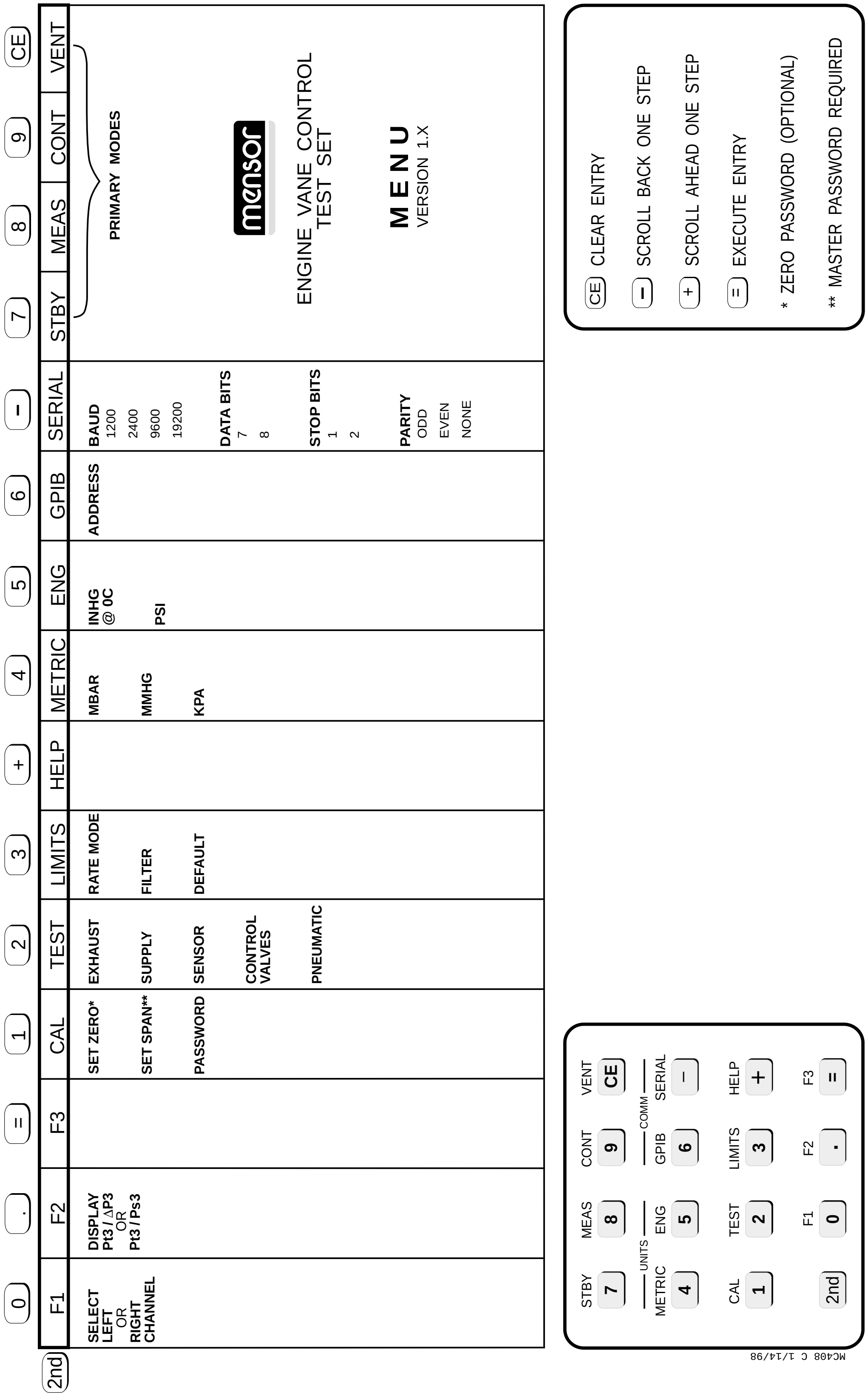


Figure 3.2 - EVCTS Menu Tree

REMOTE OPERATION

The Engine Vane Control Test System (EVCTS) may be operated from a remote computer using the IEEE-488 (GPIB) communication protocol. The host computer must contain an IEEE-488 Communications Board.

IEEE-488

The manufacturer of the host IEEE-488 interface board provides software to allow communication between the board and various programming languages. An interactive program for debugging is usually provided as well. Refer to the board manufacturer's documentation for more information.

EVCTS IEEE-488 Capability Codes:

SH1	Full source handshake capability
AH1	Full acceptor handshake capability
T6	Talker with serial poll and unaddress if MLA
L4	Listener with unaddress if MTA
SR1	Full service request capability
RL1	Full remote/local capability including LLO
PP0	No parallel poll capability
DC1	Full device clear capability
DT1	Full device trigger capability
C0	No controller capability
E2	Tri-state outputs

The EVCTS also contains many features of IEEE-488.2, the latest version of this protocol.

The EVCTS responds to the following IEEE-488 interface functions:

SRQ Service Request
The EVCTS asserts service request whenever an error is encountered. When the bus controller issues a serial poll the error will be cleared. If automatic serial polling is available with your IEEE-488 board, turn this feature off if you do not want to ignore errors. (see ERROR? command).

LLO Local Lockout
The front panel keyboard of the EVCTS may be locked by sending LLO or the command LOCK ON.

GET Group Execute Trigger
When this message is received, the EVCTS will save the current readings until the next time it is addressed as a talker.

GTL Go To Local
When this message is received, the EVCTS will return to local operation and unlock the keyboard.

DCL Device Clear
When this message is received, the EVCTS will clear all errors and buffers and remain in the REMOTE mode.

SDC Selected Device Clear
Responds as DCL.

EOI End or Identify
May be used to terminate a command or query in the place of or concurrent with the transmission of the terminating linefeed.

Command and Query Format

All commands (messages sent to the EVCTS) and queries (requests for messages from the EVCTS) follow a common format. The EVCTS accepts commands and queries in the form of ASCII strings. The strings are divided into two or three fields. All strings must terminate with a linefeed (<lf>, 0a hex, 10 dec). All fields must be separated with at least one whitespace character (20 hex <u>or less</u> except 0a hex). Normally an ASCII space (20 hex, 32 dec) is used for the field separator. Lower case letters are converted to uppercase by the EVCTS and may be used to improve readability.

Command/Query Field: Unless otherwise specified, commands are converted to queries by appending a question mark to the command. Detailed command and query functions are listed in table 4.1.

Data Field: The data field is either an ASCII string or numeric value. The data field is only used with commands, not with queries. If the data field is omitted in a command, the default value is used. In the case of multiple data fields, commas are used to separate the fields. String or numeric data are acceptable in any of the following formats:

Example ASCII string data:
ON
OFF
mBar
inHg

Example ASCII numeric data:
1
1.0
-5.678
25.68324e-5

Command Set Definitions

[White Space]:
any character code ≤ hex 0x20 (space) except hex 0x0a (<lf>)

[Command]:
any valid command (listed below)

[Data]:
ASCII representations of numeric or string data

[Termination]:
hex 0x0a (<lf>)

Commands are always sent in one of the following formats:
[Command][Termination]
[Command][White Space][Data][Termination]

Queries are special commands that contain the character '?'.

Queries always return an ASCII data string terminated with <cr><lf>.

Floating point data is always returned in the current engineering units in exponential format.

Outform Formats

The "Outform" command sets the output format that will be returned by a subsequent outform query. The formats are:

Outform Command	Outform Query Returns
1	Pt3 Pressure, Ps3 Pressure
2 (Default)	Pt3 Pressure, ΔP3
3	Pt3 Pressure, Ps3 Pressure, Pt3 Rate, Ps3 Rate

Command/Query Set

Table 4.1 - Command/Query Set

COMMAND	DATA	RESPONSE / FUNCTION
Pt3	None	Makes the left channel active.
Pt3?	None	Returns the left channel reading.
Ps3	None	Makes the right channel active in Ps3 pressure mode.
Ps3?	None	Returns the right channel pressure reading.
dP3	None	Makes the right channel active in ΔP3 mode.
dP3?	None	Returns the right channel ΔP3 reading.
Address	0-30	Sets the GPIB address.
Address?	None	Returns the GPIB address.
Chan?	None	Returns the active channel name.
Control	None	If modes are linked, all channels are placed in the Control mode, otherwise the active channel is placed in control.
Control?	None	Returns YES if active channel is in the Control mode; NO otherwise.
Date	mm/dd/yy	Sets the instrument date.
Date?	None	Returns the instrument date.
Default	None	Sets the default values (see table 3.2, *Local Operation*).
DOM?	None	Returns the date of manufacture.
Error?	None	Returns the next error in the error queue.
F1	None	Same as pressing F1 on keyboard.
F2	None	Same as pressing F2 on keyboard.
F3	None	Same as pressing F3 on keyboard.
Filter	0-99.99	Sets the measured reading exponential filter percent for all channels.
Filter?	None	Returns the filter percent.
Id?	None	Returns (s=sn, v=version) MENSOR,EVCTS,ssssss,v.vv.
Keylock	Yes or No	Locks or unlocks keyboard.
Keylock?	None	Returns YES or NO.
Linked	Yes or No	Links modes if YES; independent if NO.
Linked?	None	Returns YES or NO.
List?	None	Returns a list of valid channel names.
LowerLimit	within sensor range and less than upperlimit	Sets the lower control limit for the active channel.
LowerLimit?	None	Returns the lower control limit for the active channel.
Measure	None	If modes are linked, all channels are placed in the Measure mode, otherwise the active channel is placed in Measure.
Measure?	None	Returns YES if active channel is in the Measure mode; NO otherwise.
Outform	1, 2, or 3	Sets the output format.
Outform?	None	Returns the output format (see “Outform Formats” text).
Range?	None	Returns the range of the active channel.
Rate?	None	Returns the rate reading of the active channel.
RUnits	Sec, Min or Hour	Sets the rate units.
RUnits?	None	Returns the rate units.
Sbaud	300,1200, 2400,4800, 9600,1920	Sets the serial baud.
Sbaud?	None	Returns the serial baud.

Continued on next page...

Table 4.1 continued...

COMMAND	DATA	RESPONSE / FUNCTION
Sdata	7 or 8	Sets the serial data bits.
SData?	None	Returns the serial data bits.
Sparity	EVEN,ODD, or NONE	Sets the serial parity.
Sparity?	None	Returns the serial parity.
Sstop	1 or 2	Sets the serial stop bits.
Sstop?	None	Returns the serial stop bits.
Setpt	within lower and upper limits	Sets the control setpoint for the active channel.
Setpt?	None	Returns the control setpoint for the active channel.
Span	desired pressure or ?	Alters the span value so that the instrument reads the value sent when at the current pressure. ? clears previous value.
Span?	None	Returns span scale factor.
Stable?	None	Returns YES if current channel is stable.
StableTime	0-65535	Sets the stable time to the number of seconds specified.
StableTime?	None	Returns the stable time.
StableWin	within lower and upper limits	Sets the stable window.
StableWin?	None	Returns the stable window.
Standby	None	If modes are linked, all channels are placed in the Standby mode, otherwise the active channel is placed in Standby.
Standby?	None	Returns YES if active channel is in the Standby mode; NO otherwise.
Step Standby	within lower and upper limits None	Sets the control step for the active channel. If modes are linked, all channels are placed in the Standby mode, otherwise the active channel is placed in Standby.
Standby?	None	Returns YES if active channel is in the Standby mode; NO otherwise.
Step	within lower and upper limits	Sets the control step for the active channel in the current pressure units. Must be less than or equal to the sensor range.
Step?	None	Returns the control step for the active channel.
Time	hh:mm:ss	Sets the instrument time.
Time?	None	Returns the instrument time.
Units	psi,inHg, inH2O,mbar kpa,mmhg, or PCS 400 unit code	Sets the instrument engineering units.
Units?	None	Returns the instrument engineering units.
UpperLimit	within sensor range and more than lower limit	Sets the upper control limit for the active channel.
UpperLimit?	None	Returns upper control limit for active channel

Continued on next page...

Table 4.1 continued...

COMMAND	DATA	RESPONSE / FUNCTION
Vent	None	If modes are linked, all channels are placed in the vent mode, otherwise the active channel is placed in Vent.
Vent?	None	Returns YES if active channel is in the Vent mode, NO otherwise.
Window	within lower and upper limits	Sets the measured reading exponential filter window for all channels. This is a pressure value that the measured pressure must be within for the filter to be applied. No filtering is applied to pressure readings when the measured pressure is outside of the set window.
Window?	None	Returns the filter window.
Zero	desired pressure or ?	Alters the zero value so that the instrument reads the value sent when at the current pressure, ? clears previous value.
Zero?	None	Returns zero offset.

RS-232 SERIAL COMMUNICATION

This section of the manual applies to the serial communication capability. Refer to the GPIB portion at the beginning of this section of the manual for additional information relating to commands and responses.

The serial communication port allows the EVCTS to communicate with computers, terminals and modems (referred to as the host) in RS-232 interface format. Communicating over the serial port does NOT disable the front panel keypad. The “Keylock” command should be issued to avoid conflicts while operating over the bus.

Cable Requirements

RS-232 communications are transmitted over a three conductor, shielded cable terminated in a standard DB 25S connector on the instrument end, and usually the same DB25 connector on the host end. Figure 4.1 illustrates the proper pin connections to hook-up a host to an EVCTS.

Setup

Before putting the RS-232 interface into operation the various communication parameters must be selected from the SERIAL setup menu. Refer to the menu tree provided with this manual. The parameters selected must match the host computer. Commands must be sent in ASCII format and terminated with either a line feed (<lf>) or a carriage return (<cr>) termination character. Commands are not case sensitive, and both upper and lower case characters are accepted.

Parameters

Baud rate: Select the baud rate which matches that of the host. Available EVCTS baud rates are 1200, 2400, 9600, and 19200.

Data Bits: Select either 7 or 8 bits

Stop Bits: Select either 1 or 2 bits

Parity: Select either Odd, Even or None

Command Format

The command format for RS-232 commands is the same as those given for IEEE-488 operation.

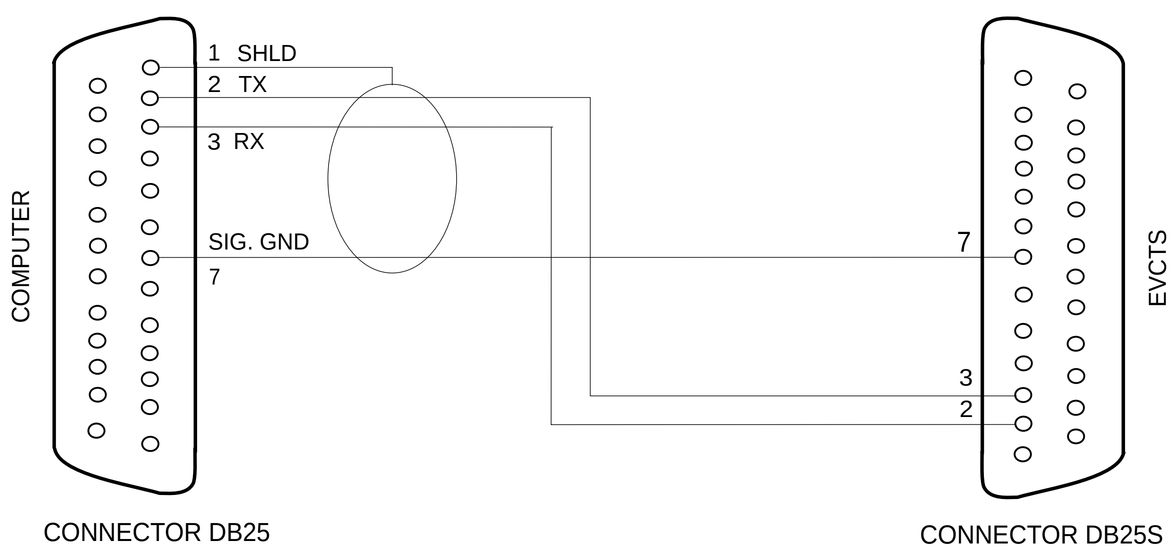


Figure 4.1 - RS-232 Cable

MAINTENANCE

The EVCTS was designed for maintenance-free operation. User maintenance is not recommended beyond replacement of parts listed in the 'Spare Parts List'. If you have questions not covered by this manual the Mensor team is ready to help. Call 1-800-984-4200 (USA only) or 1-512-396-4200 for assistance, or E-MAIL tech_support@mensor.com.

BEYOND THE WARRANTY

Take advantage of Mensor's expert product care. Mensor Corporation provides complete maintenance and calibration services, available for the life of the instrument for a nominal fee. Our service staff is knowledgeable in the innermost details of all of our instruments. We maintain units that are in operation in many different industries and in a variety of applications, and by users with a wide range of requirements. Many of these instruments have been in service for over twenty years, and continue to produce excellent results. Returning your instrument to Mensor for service benefits you in several ways:

a. Our intimate knowledge of the instrument assures you that it will receive expert care.

b. In many cases we can recommend for your consideration, upgrading to the latest enhancements.

c. Servicing our own instruments which are used in "real world" applications keeps us informed as to the most frequent services required. We use this knowledge in our continuing effort to design better and more robust instruments.

PROGRAM DISK REPLACEMENT

In order to replace the system program disk, first remove the power cord from the instrument. Then remove the rear panel by removing the five screws holding it to the frame and the four screws near the pressure ports. The disk drive is located in the upper center at the rear of the instrument. The disk is ejected by pressing the eject button.

Push the new disk into the disk slot until it locks in place. Replace the rear panel and restore the instrument power. Turning on the instrument will reboot the EVCTS and load the new program.

MODULE REPLACEMENT

To replace an electrical or a pneumatic module follow these steps:

1. Remove power cord.

2. Remove the top cover by removing the three screws on the top rear.

3. Remove the pressure fittings from the rear ports.

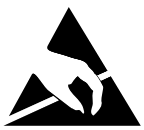
4. To remove the pneumatics module, remove the four screws on the rear panel that screw into the pressure manifold, and the two screws under the bottom plate that hold down the module. Disconnect all the pneumatic module cables from the electrical module. Then slide the pneumatic module forward slightly to disengage it from the keyhole slots in its base, and lift it out the top of the instrument.

5. To remove the electrical module, remove the cables to the pneumatic module and the front panel, and remove the two screws under the bottom plate that hold down the module. Slide the module forward slightly to disengage the key-hole slots in its base, and lift the module out the top.

6. Reverse the order to replace the module.

Electrical Module

To gain access to the circuit boards inside the electrical module without removing the module, remove the instrument top cover (3 screws), and the left side panel (2 screws). This allows access to the ten screws that secure the module cover to the module chassis; four screws at the top, and 2 screws each at the front, left and right sides. Remove these ten screws, then lift the module cover straight up to remove it.



CAUTION: ESD PROTECTION REQUIRED. The proper use of grounded work surfaces and personal wrist straps are required when coming into contact with exposed circuits (printed circuit boards) to prevent static discharge damage to sensitive electronic components.

All of the circuit boards in the module are compatible with IBM AT format Personal Computers (PC's). Most are purchased from various manufacturers; they may differ in appearance and position from one unit to the next but their functionality remains the same. The exceptions are that the Solenoid Driver and PLA boards are proprietary, designed and assembled by Mensor.

CMOS Memory Battery Replacement

Replacement of the CMOS memory backup battery (see figure 5.1) every two years is recommended in order to preclude its complete discharge. If the battery is allowed to discharge before it is replaced the Basic Input/Output System (BIOS) data stored in the CMOS Random Access Memory (RAM) will be lost. When this occurs the internal computer can not initialize until the BIOS data is restored. To restore BIOS data, first replace the battery with a fresh one, then run the CMOS setup routine to restore lost data as described in the *Appendix*, Section 9.

To replace the CMOS battery first gain access to the interior of the electrical module as stated above.

> ***NOTE:*** *The battery will be either a 3.6V or a 6V lithium battery. The replacement battery must be the same voltage level lithium battery as the one being replaced.*

1a. If the battery is already discharged it is not necessary to apply power to the unit before replacement; begin at step 2, below.

1b. If the battery is still functioning first apply power to the electrical module. This will hold the CMOS data in RAM while the battery is out of the circuit.

> **CAUTION: HIGH VOLTAGE IS PRESENT IN THE VICINITY OF THE POWER INPUT CONNECTOR**.

2. Before disconnecting the battery note the location and orientation of its connector by making a sketch of the pin numbers and wire colors in relation to the battery + and – terminals.

3. Disconnect the battery connector and remove the battery/connector assembly from the module.

4. Confirm that the replacement battery is the same voltage as the removed battery.

5. Pay attention to the + and – sides of the two batteries, and install the connector and wiring on the new battery to match the old battery.

6. Connect the battery connector to the motherboard in the same orientation as when it was removed.

7. Cycle the power off, then back on. The system should initialize the same as it normally does.

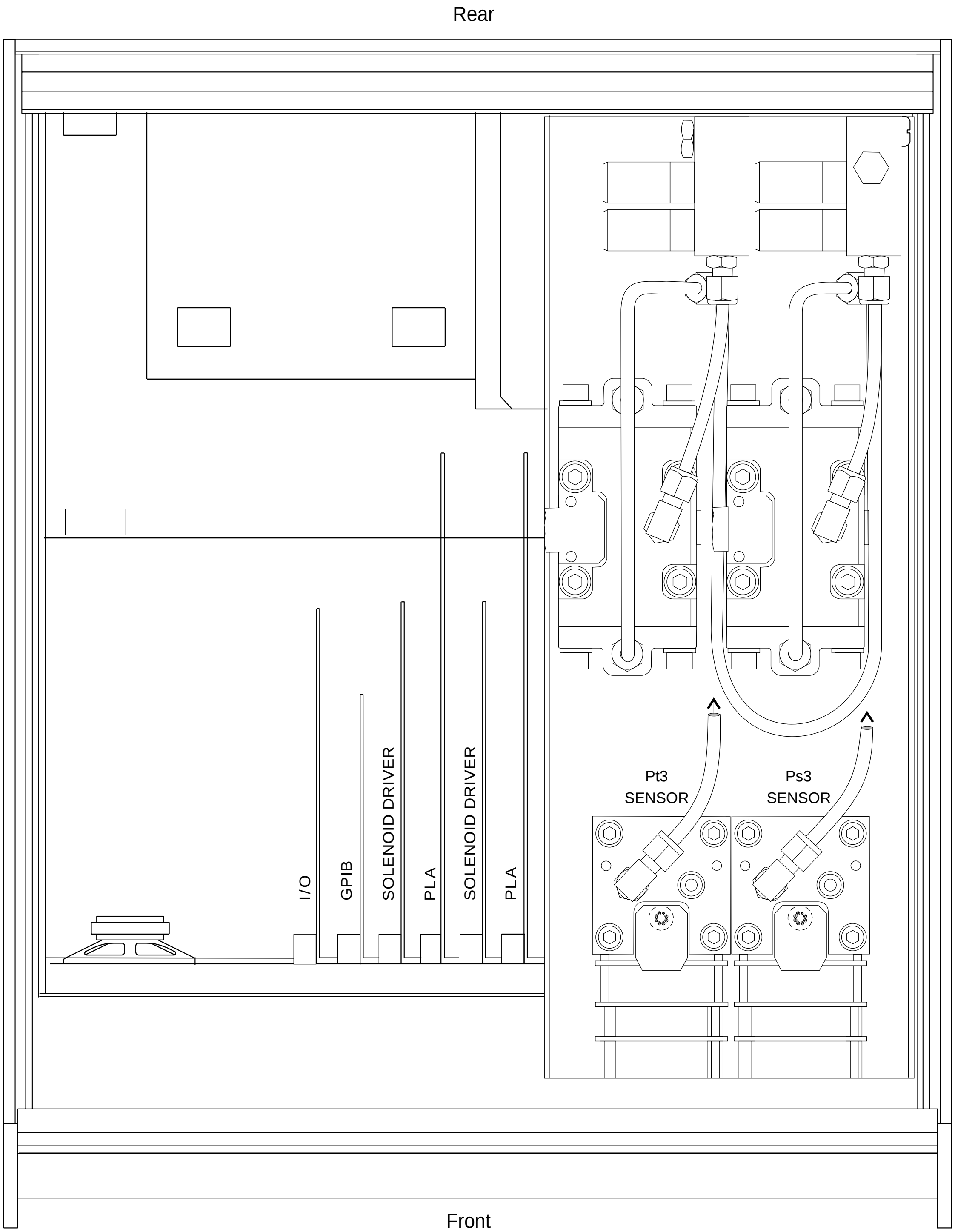
If the system hangs up with a cursor in the upper left corner of the display, first check that the system disk is seated in the disk drive. If the system disk is in place then refer to the 'CMOS Setup' instructions in the *Appendix*, Section 9.

SPARE PARTS LIST

Below is a table showing EVCTS spare parts that can be ordered from Mensor.

Table 5.1 – Spare Parts

Part Description	Part Number
Miscellaneous	
Manual	0014736001
Fuses	4100111150
Power Cord	4000400002
Rubber Feet	3201300001
Front Panel Assembly	0014181001
Display Module	5000400012
Electrical Module	0014812001
Multi I/O Board	4904000029
GPIB Board	4904000015
Solenoid Driver Board - Modified	0014813001
PLA Board (Specify for Pt3 or Ps3)	0014293001
Floppy Drive	4907000002
Power Supply (modified)	0014168001
CMOS Backup Battery - 6 V	4100400015
Pneumatics	
LP Regulator Top Cap Assembly (Std)	0014266002
Fitting Adapter - 7/16-20 to 1/8 NPT Female	6000602015
Fitting Adapter - 7/16-20 to 1/4 NPT Female	6000604001
O-ring seals for 7/16-20 Fitting	4250010020



Note: The electrical module is shown with its cover removed.

Figure 5.1 - Chassis Assembly -Top View

CALIBRATION

The EVCTS automatically adjusts the pressure reading for the effects of temperature and non-linearity within the calibrated temperature range of 15-45°C. The process is referred to as dynamic compensation because each reading is so adjusted before it is output to the display or to a communication bus. Thus, a calibrated EVCTS operated within its temperature band, and with proper zero and span adjustments, will provide accurate pressure measurements.

The EVCTS should have the span verified periodically on each of its transducers (channels) to insure their stability. Initially, the recommended period between calibrations is three months. This period may be extended as confidence is gained in the span stability.

CALIBRATION ENVIRONMENT

For maximum accuracy, allow both channels of the EVCTS to warm up in the MEASURE mode for a minimum of 45 minutes in an ambient temperature which is in the specified calibration range, and stable. In addition the instrument should be at rest on a stable platform which is free of excessive vibration and shock.

CALIBRATION PRESSURE STANDARD

The recommended calibration standard is a piston gauge type (deadweight gauge) with an uncertainty of 0.01% of reading or better. For measuring vacuum a diaphragm type vacuum gauge with an accuracy of 0.05% of reading at 250 to 300 millitorr is recommended.

CALIBRATION MEDIUM

The recommended calibration medium is dry nitrogen or clean dry instrument air. For low pressure ranges (< 20 psi) head pressure differences between the standard and the EVCTS can cause errors. See 'Head Pressure Correction' in the *Appendix*.

CALIBRATION PROCEDURES

Figure 6.1 (Calibration Setup) illustrates a typical setup for either local or remote calibration. In the figure the additional equipment required for remote calibration is shown as optional.

In the calibration setup illustration the "Pressure Standard" is normally a deadweight test instru-

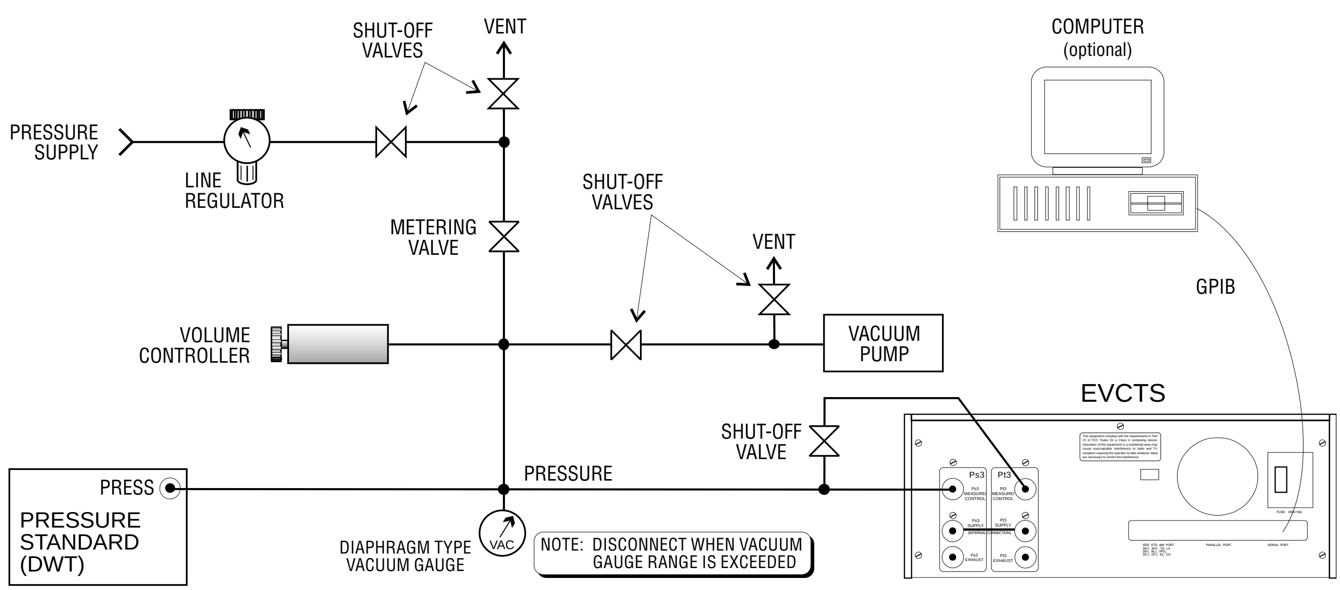


Figure 6.1 - Calibration Setup

ment, and the “volume controller” refers to a hand operated variable-volume pressure vernier device. A diaphragm type vacuum gauge is recommended over the gauge tube type of vacuum sensor for calibrating sub-atmospheric pressures. A vacuum source with a minimum capacity of 21 liters per minute is recommended.
NOTE: *The recommended units for making zero or span adjustments are psi. Other engineering units might add a small roundoff error.*

> ***CAUTION: DO NOT APPLY MORE THAN THE MANUFACTURERS RECOMMENDED MAXIMUM PRESSURE TO THE VACUUM GAUGE TUBE OR IT MAY EXPLODE.*** *The maximum pressure for the Hastings gauge tubes provided by Mensor is 50 psia. But, energizing the gauge tube at pressures above atmosphere (15-50 psia) will decrease the life and accuracy of the tube.*

With the EVCTS connected to the Calibration Setup, close both vent shut-off valves and set both channels to MEASURE mode.

Evacuate the transducers to a low pressure that will still maintain a viscous flow, typically 250 to 300 millitorr. (At pressures lower than this the actual pressure at any particular point in the system is questionable.) Allow from two to five minutes for the target pressure to stabilize, then convert the millitorr reading to an equivalent instrument reading for the active measurement units. Millitorr conversion factors are provided in table 9.2 in the Appendix.

The current calibration of the active sensor can now be checked at a number of pressure points from zero to full scale. If recalibration is needed, proceed with the following.

Setting Sensor Zero

With both channels in the MEASURE mode and the output ports at about 300 millitorr, convert the millitorr reading into the current displayed engineering units. From the keypad push: [2nd], [CAL], [=], enter password, [=], [=]. At the “?” prompt, type in the true absolute pressure, [XXX], and [=] to enter the reading into memory. The display should now indicate the current “zero” pressure reading for the active channel. Press [2nd], [F1] to toggle the alternate channel and again, enter the true pressure at the “?” prompt, and then [=]. Each channel has a maximum zero offset of 10% of full scale. Zero values higher than 10% of FS will not be accepted. When finished with setting zeros press [CE] then [+] or [-] to set span or press [CE] again to exit calibration mode.

An alternate to entering a new zero value is to just press [=] at the “?” prompt. This will remove the current zero value and re-establish the factory entered zero offset for the active channel.

To set zero over the GPIB, send the command ‘*Channel* ZERO *value*‘, where *Channel* is Pt3 or Ps3, and *value* is the true pressure, (XXX).

To re-establish the factory entered zero over the bus send ‘CHANNEL(space)ZERO(space)?‘. (Notice that the only difference between this and the Zero query command is the space added between zero and the question mark.)

Setting Sensor Span

With both channels warmed up and in MEASURE mode, apply a known absolute pressure equal to or near the span of the sensor. The value must be equal to or greater than 50% of the transducer range or the system will not accept the entry.

The range of span adjustment available is ±10% of the transducer full scale value. From the keypad, push [2nd], [CAL], [+], [=] enter password [=] [=]. At the SENSOR SPAN prompt, type in the true pressure and then [=] to enter the reading. The display should now indicate the new true pressure for each channel. Press [2nd] [F1] to toggle to the alternate channel and check that the shut-off valve is in the proper state as described above. Set the applied known pressure equal to or near the full scale value for this sensor. Type in the true pressure and [=]. Both channels are now spanned to the new values. Press [CE] two times to back out of the calibration functions.

To set span over the GPIB, send the command ‘*Channel* SPAN *value*‘, where *channel* is Pt3 or Ps3 and *value* is the true pressure applied to the sensor. The recalibration is now complete.

An alternate to entering a new span value while in LOCAL mode is to just press [=] at the “?” prompt. This will remove the current span value and re-establish the factory entered span value for the active channel. The same thing can be accomplished in REMOTE mode by sending ‘CHANNEL(space)ZERO(space)?’ over the bus for each channel.

SPECIFICATIONS

Accuracy specifications presented herein are obtained by comparison with primary standards traceable to the National Institute of Standards and Technology (NIST, formerly NBS). The uncertainties of these standards are 0.006% of reading or 0.0001 psi, whichever is greater.

Mensor does not use RMS or RSS techniques to make specifications appear any better than they actually are. Primary standard uncertainties should be used in the evaluation of equipment performance. The specifications shown by Mensor are worst case conditions and allow the user to make an honest evaluation of the instrument. Mensor reserves the right to change specifications without notice.

GENERAL SPECIFICATIONS

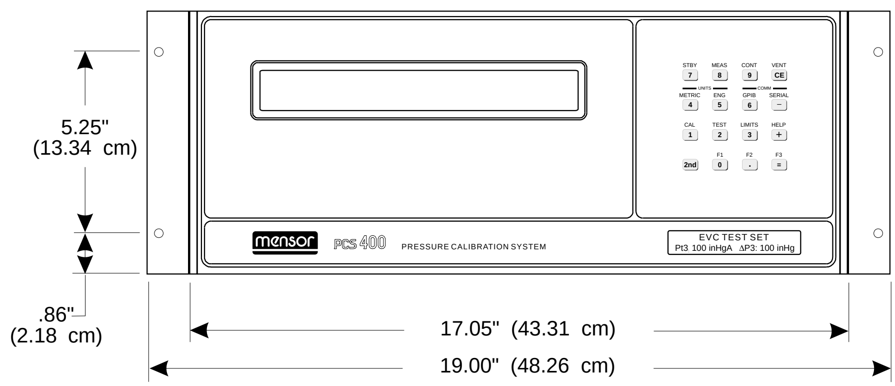
Size

Width: . . . . 17.05 inches (43.31 cm)
. . . . . . 19.00 inches (48.26) with rack adapter
Height: . . . . 6.97 inches (17.70 cm)
Depth: . . 20.00 inches (51.0 cm) without fittings

Weight

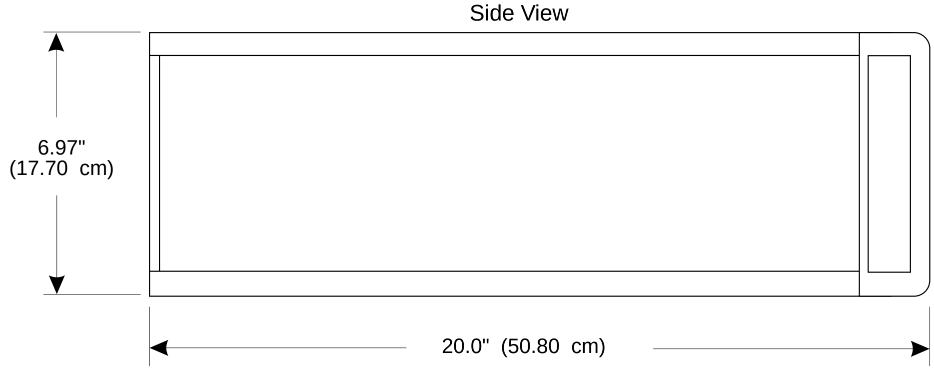
50.00 lbs (22.68 kg) . . . . standard
54.00 lbs (24.49 kg) . . . . . . with rack adapter
70.70 lbs. (32.07 kg) . . . . . . shipping w/rack kit

Front View



Overall width with Rack Mount Flanges attached.

Side View



Add 0.45 inches (1.14 cm) to height with feet attached.

Figure 7.1 - Dimensional Outline

Display
Vacuum fluorescent, 2 lines of 40 characters

Keypad
15 dual-function keys and one shift (2nd) key.

Power
Standard: 115 vac, 60 Hz, 125 VA typical. 90–132 or 180–264 vac, 47–463 Hz, 175 VA max.

Operating Environment
Temperature: 0°C to 50°C. (*Note*: This is not the compensated temperature range.)
Humidity: 5% to 95% RH non-condensing humidity.

Shipping, Storage And Handling Environment
–20 to 70°C.
Minimal vibration.
5 gravities acceleration maximum.
Non-condensing humidity.

Gravity/Orientation Effect
Negligible effect on span, linearity and zero in any attitude.

Mechanical Shock
5 gravities maximum.

Pressure Medium
Clean, dry non-corrosive gases. See the table 'Materials in Contact with Pressure Medium' in the *Appendix*.

Filters
Internal replaceable 20 micron filters are in line with all rear panel ports.

CPU
80386 or higher.

Communications
IEEE-488.1 and IEEE-488.2

Fittings
7/16" - 20 SAE/MS (female)
(1/8" Female NPT adapters provided)

Mounting
Standard: Table model.
Optional: Rack Mount Kit with slides is available for mounting in 19 inch rack.

Pressure (maximum)
200 inHga (atmosphere to any port)

MEASUREMENT SPECIFICATIONS

Accuracy
Pt3: 0.01 inHga
Ps3: 0.01 inHga

Resolution
Pt3: 0.001 inHga
Ps3: 0.001 inHga

Response Time
33 milliseconds.

Warm-up
Approximately 45 minutes to achieve full accuracy.

Zero Drift
Time: (after warm-up)
0.01% FS maximum 30 days.
Zero may be reset without affecting span or linearity.

Span Drift
Time: 0.01% FS max. 90 days.
Span may be reset without affecting zero or linearity.

Internal Pneumatic Volume (Measure/Control Ports)
Measure Mode: 30 cc
Control Mode: 238 cc

External Pneumatic Volume
Maximum: 1 liter
Minimum: 0.1 liter (100 cc)

CONTROL SPECIFICATIONS

Standard Pressure Ranges

Pt3: 0 –100 inHga
Ps3: 0 –100 inHga

Source Pressure

Instrument air or dry nitrogen. Recommended pressure at the Supply port:

Table 7.1
Recommended Pressure at the Supply Port

Channel	Supply Port Pressure
Pt3	0 – 110 inHga
Ps3	0 – 110 inHga

Accurate external regulation not required. *Note:* Pt3 and Ps3 Supply ports are internally connected.

Exhaust Pressure

Vacuum pump required for absolute pressure control. A minimum pump capacity of 21 liters per minute recommended. One pump per channel recommended.

Reference Pressure

Permanent vacuum

Stability of Controlled Pressure

Pt3: 0.004 inHga
Ps3: 0.004 inHga

Minimum Controlled Pressure

0.1 inHga

Pressure Rate Limit Mode

A pressure rate of slow or fast may be selected to set the maximum slew speed between selected control points. The default value is 'Fast'. Maximum and minimum slew speed is dependent upon pressure range per the following table:

Table 7.2
Minimum/Maximum Slew Speed

Full Scale (FS)	Slow	Medium	Fast
Pt3	0.1 inHg/sec	0.5 inHg/sec	1.0 inHg/sec
Ps3	0.1 inHg/sec	0.5 inHg/sec	1.0 inHg/sec

Dynamic Response (slew time for Fast Response mode)

160 seconds maximum between any two pressure points from 0.5% FS above the EXHAUST pressure to FS, to within 0.1% FS of the set point into a 1/2 liter volume. A larger volume will lengthen the stated time.

Settling Time

15 seconds after the slew time as indicated above (for pressure to remain within ± 0.01% FS of the set control point). External volume will lengthen the stated time.

Overshoot

Pt3: 0.01 inHga
Ps3: 0.01 inHga

User's Notes:

OPTIONS

This section lists options available for the EVCTS. Users might consider letting the factory install a special feature not listed here. Mensor welcomes the opportunity to quote on such requests. The cost of adding an enhancement frequently will amortize itself in a very short time because of improved process efficiency.

RELIEF VALVES

There are several types of relief valves available:

- One-way differential
- Two-way differential
- One-way absolute
- One-way absolute with vacuum gauge tube

Relief valves are available for pressure ranges from 0.5 psi to 1020 psi. Over time, contaminants in the system may enter the valves and prevent proper operations. Servicing the valves by the user is not recommended.

TRANSPORT CASE (PN 0011159001)

A wheeled Transport Case is available suitable for moving the EVCTS between sites, or as an air-freight (or other) shipping container. The case is constructed of a high impact plastic with a silver-grey exterior. It includes two keys, locks, a piano hinge, an anodized interlocking tongue and groove opening with a 90 degree stop, various nickel-chrome and stainless steel fixtures, a vinyl satchel style handle and a fold-out metal “push” handle with a vinyl grip. The interior is filled with high density polyurethane foam with a die-cut cavity to cradle the instrument with fitting adapters in place, and an additional cavity to store related accessories. Rugged and weather resistant, the case makes an attractive, practical shipping and moving container. The case weighs approximately 29 pounds (13.15 kg) unloaded, and can support a load of up to 150 pounds (68.04 kg). Nominal dimensions are 15 inches by 24 inches by 26 inches (38.10 cm x 60.96 cm x 66.04).

RACK MOUNT KIT

The EVCTS is easily mounted into a 7 inch opening of a 19 inch wide rack. The rack used should satisfy the dimensional requirements shown below. It should be free of vibration and excessive heat, as noted below.

Install the chassis slide, being sure to allow the proper spacing above and below the EVCTS. An EVCTS with the rack mount option is then installed from the front of the rack. Before installing the EVCTS, remove the four feet from the bottom of the instrument. Slide the EVCTS all the way into position and secure the instrument to the rack before connecting power and pneumatic lines to the rear panel.

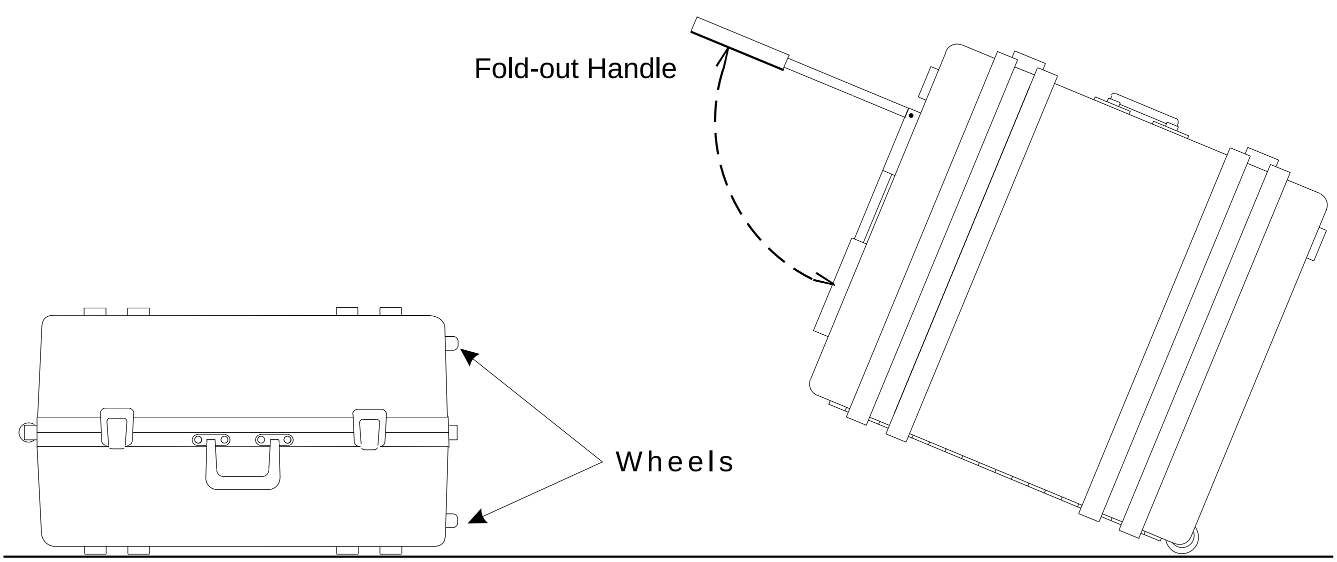


Figure 8.1 - Transport Case

After all equipment is installed, check to see that the temperature inside the rack does not exceed 38°C. If it does, additional rack spacing and/or ventilation must be considered.

CAUTION: MOTORS OR VIBRATING DEVICES SHOULD BE MOUNTED SO AS TO MINIMIZE THE VIBRATIONS AT THE EVCTS.

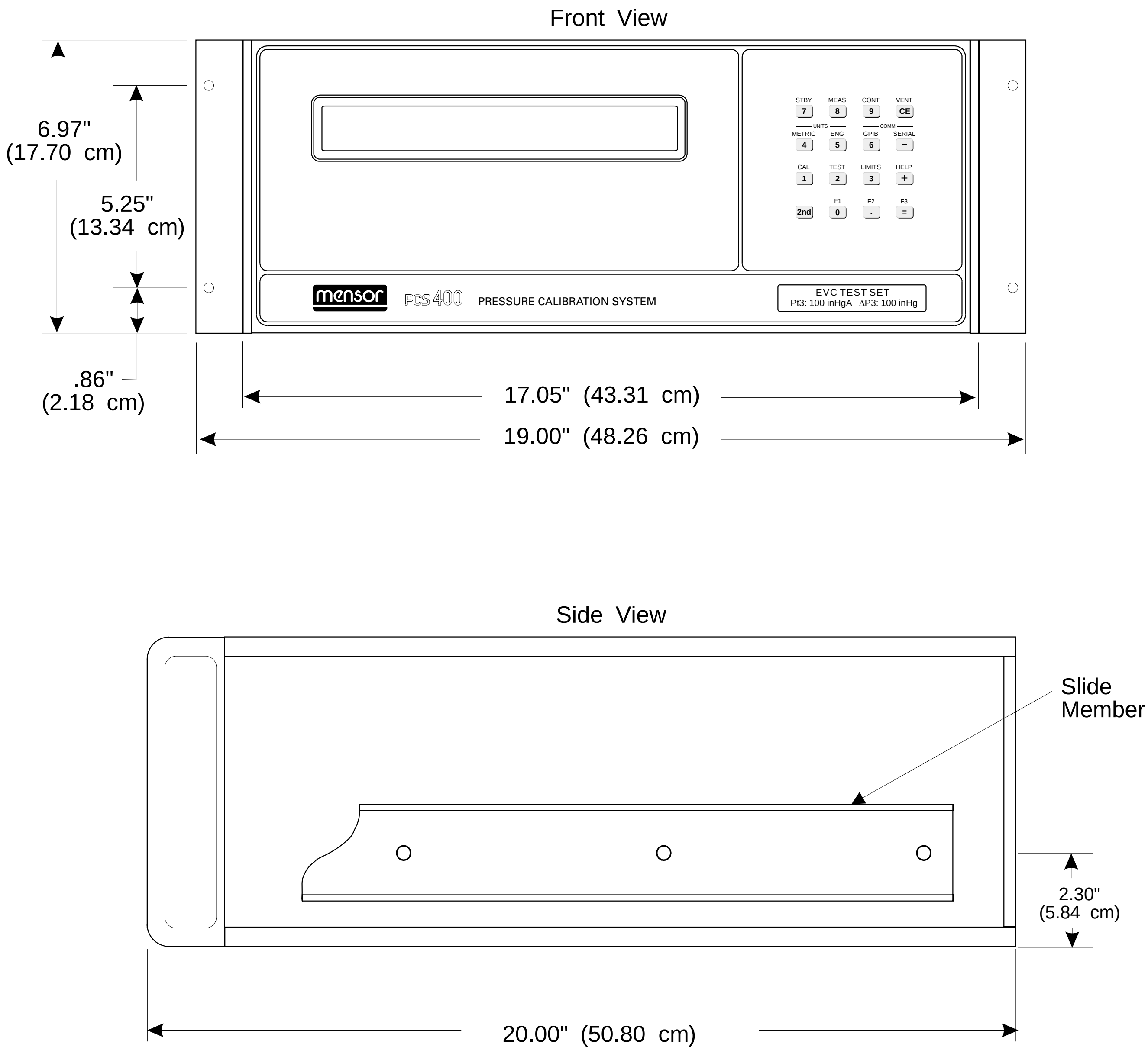


Figure 8.2 - Rack Mount Dimensions

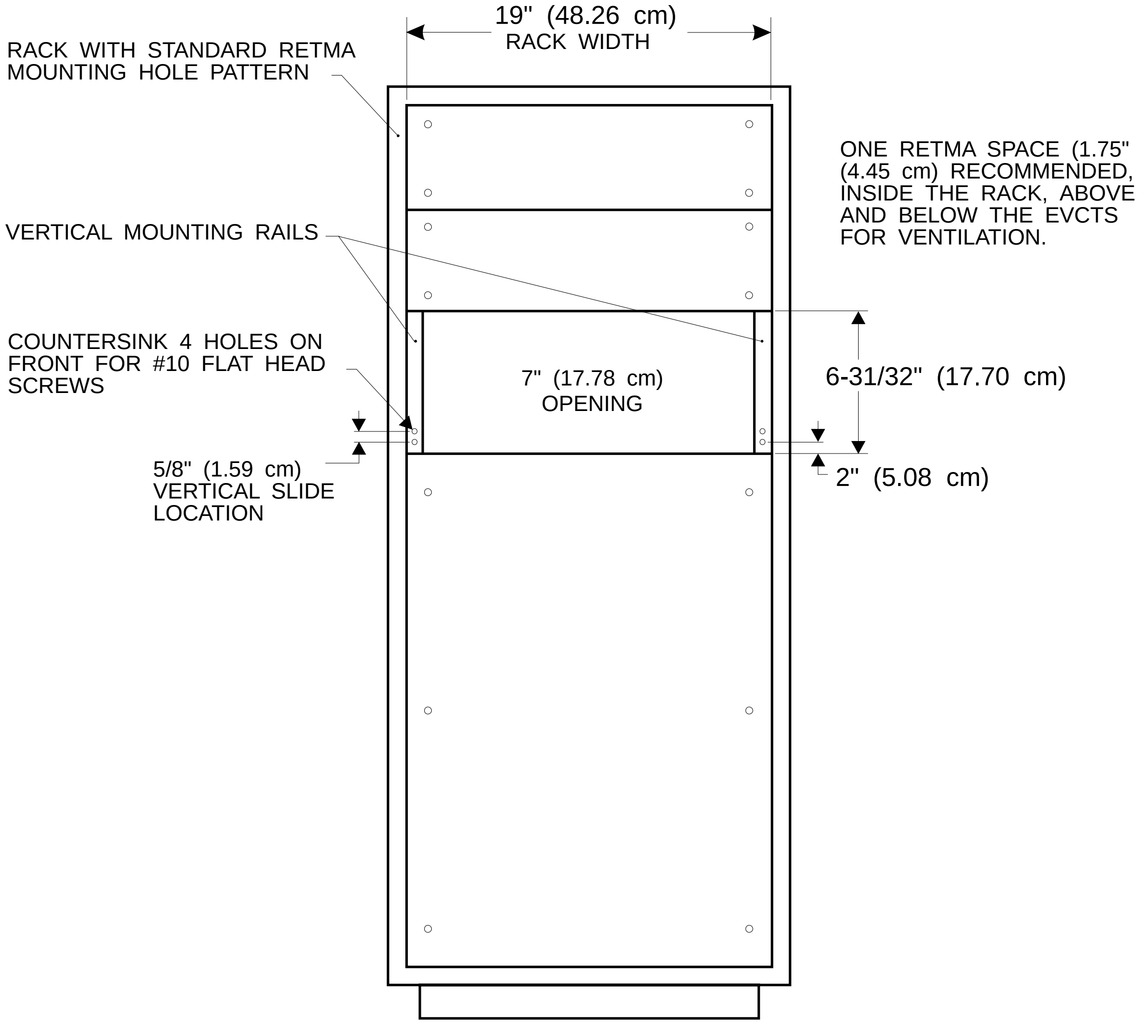


Figure 8.3 - Rack Specifications

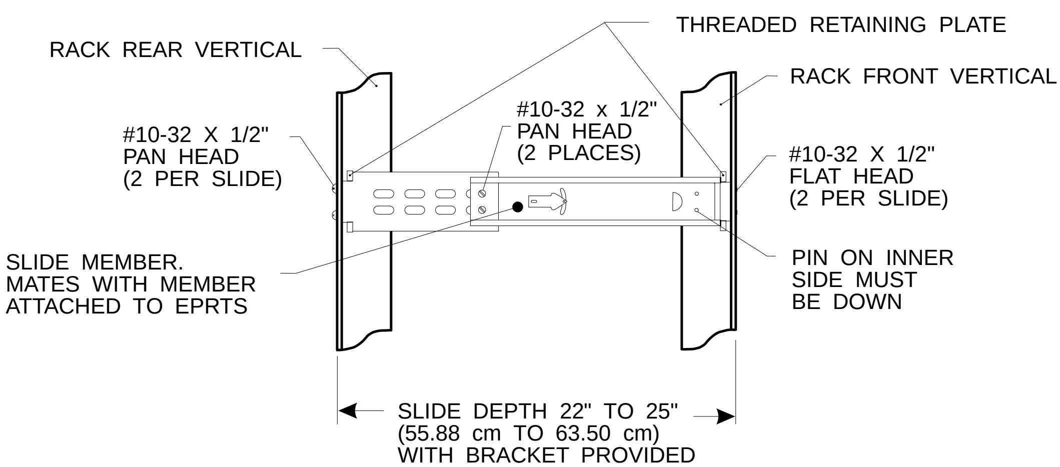


Figure 8.4 - Slide Specifications

User's Notes:

APPENDIX

TABLE OF CONTENTS

CONVERSION FACTORS, PRESSURE

Table 9.1 – Conversion Factors, psi

Units	Pressure Unit	To convert from Psi	To convert to Psi
1	PSI	1	1
2	INHG @ 0C	2.036020	0.4911544
15	MBAR	68.94757	0.01450377
19	MMHG @ 0C	51.71508	0.01933672
22	KPA	6.894757	0.1450377

Table 9.2 – Conversion Factors, millitorr

Units	Pressure Unit	To Convert From Millitorr	To Convert To Millitorr
1	PSI	0.0000193367	51715.1
2	INHG @ 0C	0.0000393701	25400.0
15	MBAR	0.00133322	750.064
19	MMHG @ 0C	0.001	1000.00
22	KPA	0.000133322	7500.64

TEMPERATURE CONVERSION

Table 9.3 – 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
-17.78	**0**	32.00
-17.22	**1**	33.80
-16.67	**2**	35.60
-16.11	**3**	37.40
-15.56	**4**	39.20
-15.00	**5**	41.00
-14.44	**6**	42.80
-13.89	**7**	44.60
-13.33	**8**	46.40
-12.78	**9**	48.20
-12.22	**10**	50.00
-11.67	**11**	51.80
-11.11	**12**	53.60
-10.56	**13**	55.40
-10.00	**14**	57.20
-9.44	**15**	59.00
-8.89	**16**	60.80
-8.33	**17**	62.60
-7.78	**18**	64.40
-7.22	**19**	66.20
-6.67	**20**	68.00
-6.11	**21**	69.80
-5.56	**22**	71.60
-5.00	**23**	73.40
-4.44	**24**	75.20
-3.89	**25**	77.00
-3.33	**26**	78.80
-2.78	**27**	80.60
-2.22	**28**	82.40
-1.67	**29**	84.20
-1.11	**30**	86.00
-0.56	**31**	87.80
0.00	**32**	89.60
0.56	**33**	91.40
1.11	**34**	93.20
1.67	**35**	95.00
2.22	**36**	96.80
2.78	**37**	98.60
3.33	**38**	100.40
3.89	**39**	102.20
4.44	**40**	104.00
5.00	**41**	105.80
5.56	**42**	107.60
6.11	**43**	109.40
6.67	**44**	111.20
7.22	**45**	113.00
7.78	**46**	114.80
8.33	**47**	116.60
8.89	**48**	118.40
9.44	**49**	120.20

°C		°F
10.00	**50**	122.00
10.56	**51**	123.80
11.11	**52**	125.60
11.67	**53**	127.40
12.22	**54**	129.20
12.78	**55**	131.00
13.33	**56**	132.80
13.89	**57**	134.60
14.44	**58**	136.40
15.00	**59**	138.20
15.56	**60**	140.00
16.11	**61**	141.80
16.67	**62**	143.60
17.22	**63**	145.40
17.78	**64**	147.20
18.33	**65**	149.00
18.89	**66**	150.80
19.44	**67**	152.60
20.00	**68**	154.40
20.56	**69**	156.20
21.11	**70**	158.00
21.67	**71**	159.80
22.22	**72**	161.60
22.78	**73**	163.40
23.33	**74**	165.20
23.89	**75**	167.00
24.44	**76**	168.80
25.00	**77**	170.60
25.56	**78**	172.40
26.11	**79**	174.20
26.67	**80**	176.00
27.22	**81**	177.80
27.78	**82**	179.60
28.33	**83**	181.40
28.89	**84**	183.20
29.44	**85**	185.00
30.00	**86**	186.80
30.56	**87**	188.60
31.11	**88**	190.40
31.67	**89**	192.20
32.22	**90**	194.00
32.78	**91**	295.80
33.33	**92**	197.60
33.89	**93**	199.40
34.44	**94**	201.20
35.00	**95**	203.00
35.56	**96**	204.80
36.11	**97**	206.60
36.67	**98**	208.40
37.22	**99**	210.20

°C		°F
37.78	**100**	212.00
38.33	**101**	213.80
38.89	**102**	215.60
39.44	**103**	217.40
40.00	**104**	219.20
40.56	**105**	221.00
41.11	**106**	222.80
41.67	**107**	224.60
42.22	**108**	226.40
42.78	**109**	228.20
43.33	**110**	230.00
43.89	**111**	231.80
44.44	**112**	233.60
45.00	**113**	235.40
45.56	**114**	237.20
46.11	**115**	239.00
46.67	**116**	240.80
47.22	**117**	242.60
47.78	**118**	244.40
48.33	**119**	246.20
48.89	**120**	248.00
49.44	**121**	249.80
50.00	**122**	251.60
50.56	**123**	253.40
51.11	**124**	255.20
51.67	**125**	257.00
52.22	**126**	258.80
52.78	**127**	260.60
53.33	**128**	262.40
53.89	**129**	264.20
54.44	**130**	266.00
55.00	**131**	267.80
55.56	**132**	269.60
56.11	**133**	271.40
56.67	**134**	273.20
57.22	**135**	275.00
57.78	**136**	276.80
58.33	**137**	278.60
58.89	**138**	280.40
59.44	**139**	282.20
60.00	**140**	284.00
60.56	**141**	285.80
61.11	**142**	287.60
61.67	**143**	289.40
62.22	**144**	291.20
62.78	**145**	293.00
63.33	**146**	294.80
63.89	**147**	296.60
64.44	**148**	298.40
65.00	**149**	300.20

°C		°F
65.56	**150**	302.00
66.11	**151**	303.80
66.67	**152**	305.60
67.22	**153**	307.40
67.78	**154**	309.20
68.33	**155**	311.00
68.89	**156**	312.80
69.44	**157**	314.60
70.00	**158**	316.40
70.56	**159**	318.20
71.11	**160**	320.00
71.67	**161**	321.80
72.22	**162**	323.60
72.78	**163**	325.40
73.33	**164**	327.20
73.89	**165**	329.00
74.44	**166**	330.80
75.00	**167**	332.60
75.56	**168**	334.40
76.11	**169**	336.20
76.67	**170**	338.00
77.22	**171**	339.80
77.78	**172**	341.60
78.33	**173**	343.40
78.99	**174**	345.20
79.44	**175**	347.00
80.00	**176**	348.80
80.56	**177**	350.60
81.11	**178**	352.40
81.67	**179**	354.20
82.22	**180**	356.00
82.78	**181**	357.80
83.33	**182**	359.60
83.89	**183**	361.40
84.44	**184**	363.20
85.00	**185**	365.00
85.56	**186**	366.80
86.11	**187**	368.60
86.67	**188**	370.40
87.22	**189**	372.20
87.78	**190**	374.00
88.33	**191**	375.80
88.89	**192**	377.60
89.44	**193**	379.40
90.00	**194**	381.20
90.56	**195**	383.00
91.11	**196**	384.80
91.67	**197**	386.60
92.22	**198**	388.40
92.78	**199**	390.20

MEASUREMENT UNITS (Number)

The unitno command selects the measurement units to be output on the bus and the display. The syntax for the unitno command is **UNITS N** where **N** is a number from the 'Units' column in the following table.

Table 9.4 – Measurement Units

Number	Units	Output Format
1	pounds per square inch	PSI
2	inches of mercury @ 0°C	INHG @ 0C
15	millibar	MBAR
19	millimeters of mercury @ 0°C	MMHG @ 0C
22	kilopascals	KPA

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.

Table 9.5 – Materials in Contact with Pressure Medium

	Chamber	
Gauge Unit	**Pressure**	**Reference**
Absolute Units	**Pressure**	**N/A**
Metallics		
Aluminum	X	X
Brass	X	X
Copper		X
Gold		X
Solder (60/40)		X
Stainless Steel (300 Series)	X	X
Non-Metallics		
Buna-N Rubber	X	X
Silicon		X
Loctite Sealant	X	X
PVC		X
Silicone Grease	X	X
Silicone Rubber		X
Teflon		X
Fluorocarbon	X	X

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 some cases the offset may be insignificant, and it may be ignored. The following information provides instructions for determining the density of the pressure medium and how to calculate the head pressure effect.

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.

Table 9.6 – Gas Density

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

Head Pressure Calculation

The pressure at the input port (P_2 of figure 9.1) of the Device Under Test (DUT) will be a positive number if the 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 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).

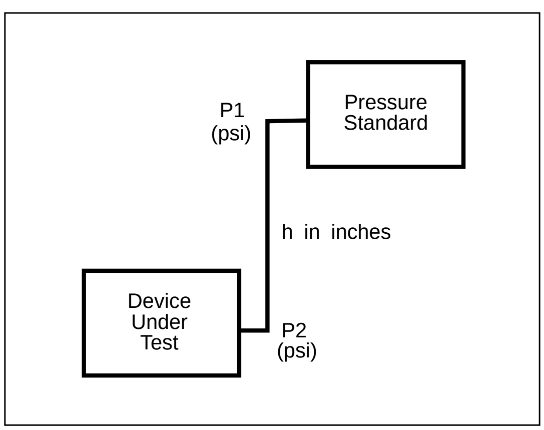
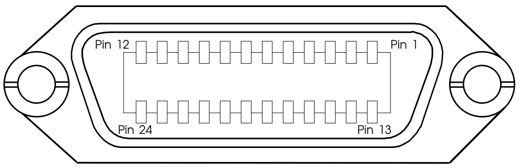


Figure 9.1 - Head Pressure Calculation

IEEE CONNECTOR AND PIN FUNCTIONS



24-pin Female Connector
viewed from rear of instrument

PIN	DESCRIPTION
1	D101
2	D102
3	D103
4	D104
5	EOI
6	DAV
7	NRFD
8	NDAC
9	IFC
10	SRQ
11	ATN
12	SHIELD - Connect to Earth GND
13	D105
14	D106
15	D107
16	D108
17	REN
18	PAIRED WITH 6
19	PAIRED WITH 7*
20	PAIRED WITH 8
21	PAIRED WITH 9*
22	PAIRED WITH 10
23	PAIRED WITH 11*
24	GND

* PINS 19, 21, AND 23 ARE PART OF TWISTED PAIRS WITH OPPOSING PINS. TO BE GROUNDED NEAR TERMINATION OF OTHER WIRE.

Figure 9.2 - IEEE Connector and Pin Functions

CMOS SETUP

Before proceeding with the CMOS Setup routine, determine the condition of the CMOS backup battery on the CPU Board. **If it is not fresh and viable, or if it is suspect, replace it**. In order to proceed with this routine the following additional equipment is required:

1. An AT compatible Computer Keyboard
2. Most electrical modules come with a combination video driver/printer driver card capable of running a Hercules type monochrome graphics monitor. If this is the case there will be an unoccupied 9 pin D-sub female connector available on the front of the electrical module (see figure 9.2). Otherwise, it is necessary for the user to provide a video driver and compatible monitor.

CAUTION: DO NOT CONNECT A MONITOR TO THE 9 PIN D-SUB CONNECTOR ON THE SOLENOID DRIVER BOARD THAT HAS THE SOLENOID DRIVER LINES PLUGGED INTO IT. DOING SO COULD SEVERELY DAMAGE THE MONITOR.

3. A graphics monitor compatible with the above video driver card. A Hercules compatible monochrome monitor is adequate.

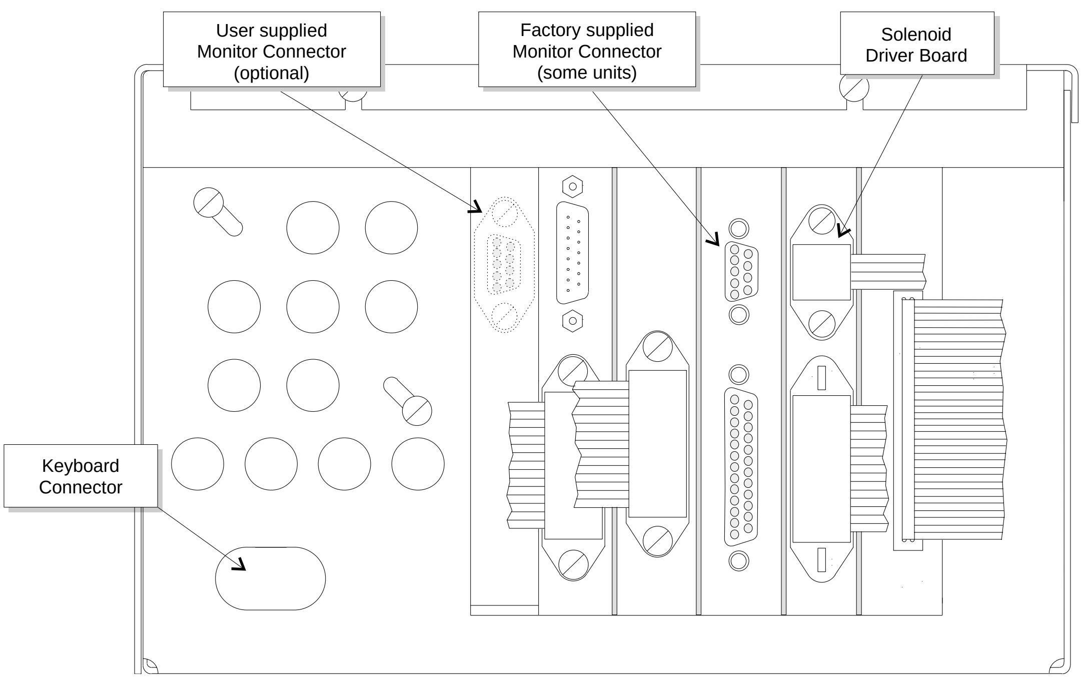


Figure 9.3 - Electrical Module Front View

To restore the BIOS data (CMOS Setup):

1. Turn off power to the electrical module.

CAUTION: ESD PROTECTION REQUIRED.
The proper use of grounded work surfaces and personal wrist straps are required when coming into contact with exposed circuits (printed circuit boards) to prevent static discharge damage to sensitive electronic components.

2. If necessary, install the video driver into an available slot on the motherboard. (To gain access to the interior of the electrical module refer to the text under the headings 'Module Replacement' and 'Electrical Module' in Section 5, *Maintenance*.)
3. Connect the monitor to the video driver board.
4. Connect the keyboard to the keyboard connector on the front of the electrical module (see figure 9.3).
5. Apply power to the electrical module and monitor, and watch the screen.

After a few seconds the monitor will display instructions on how to continue, or it will display an error message such as:

693"Press the <F1> key to continue..."
or
"Hit <Del> if you want to run SETUP"

Follow the instructions on the screen to get to the BIOS setup menu. Figures 9.4, 9.5, and 9.6. are examples of the screens displayed for CMOS setup routine with a 1992 version of American Megatrends Inc (AMI) BIOS and one specific motherboard. These are typical but may vary for different software and hardware configurations. Enter the data into both the standard and the advanced CMOS setup screens as shown in the examples, or as appropriate for the specific installation. After all of the data is entered and checked, press F10 from screen 9.4 to save these settings and exit to DOS. Cycle the EVCTS power off and back on. Contact Mensor if there are still problems initializing the system.

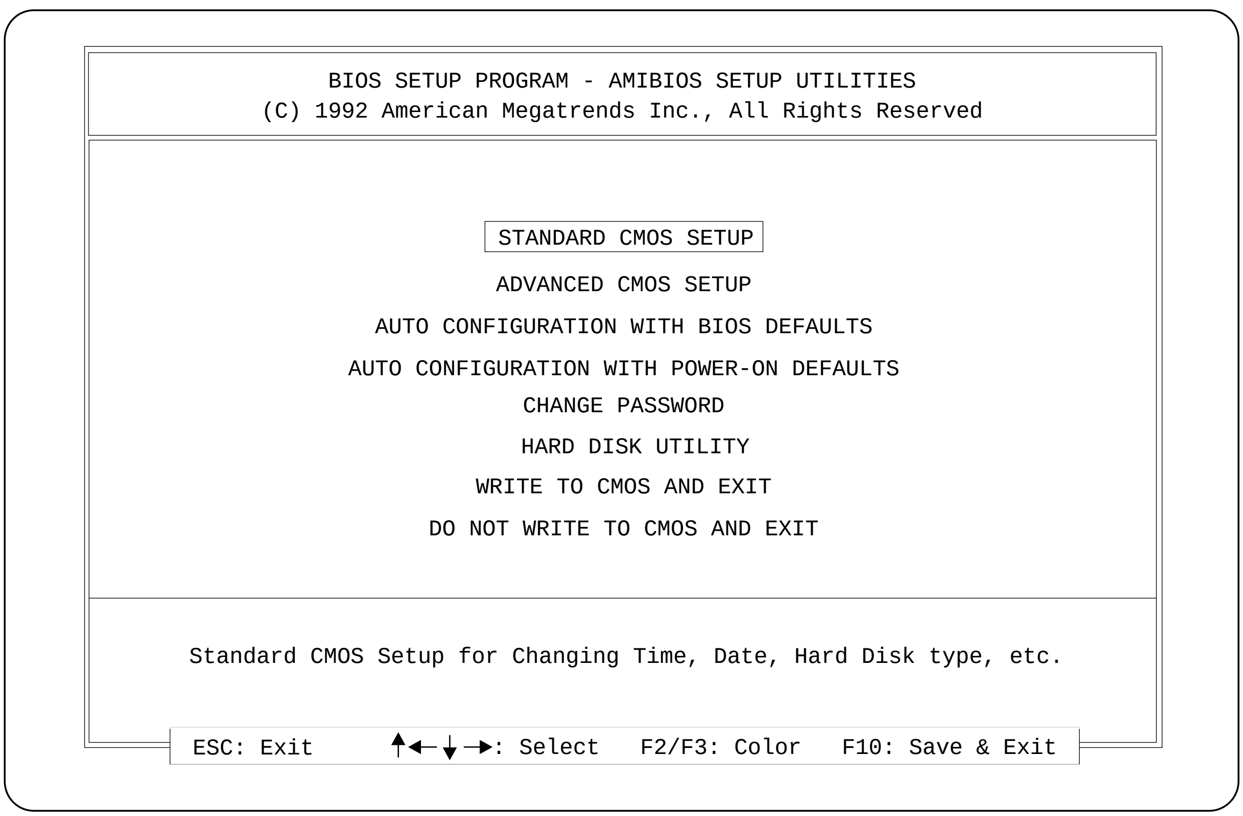


Figure 9.4 - BIOS Setup Opening Screen

```
BIOS SETUP PROGRAM - STANDARD CMOS SETUP
(C) 1992 American Megatrends Inc., All Rights Reserved

Date (mm/date/year): Mon, Nov 30, 1992          Base memory : 640 KB
Time (hour/min/sec): 12 : 47 : 22               Ext. memory : 0 KB
                                    Cyln  Head  Wpcom  LZone  Sect  Size
Hard disk C: type  : Not Installed
Hard disk D: type  : Not Installed
Floppy Drive A:    : 1.4 MB, 3 1/2"
Floppy Drive B:    : Not Installed
Primary Display    : Not Installed
Keyboard           : Not Installed

Month : Jan, Feb,...Dec
Date : 01, 02, 03,...31
Year : 1901, 1902,...2099

ESC:Exit ↑← ↓ →:Select F2/F3:Color Pu/Pd:Modify
```

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5
6	7	8	9	10	11	12

Figure 9.5 - Standard CMOS Setup Screen

```
BIOS SETUP PROGRAM - ADVANCED CMOS SETUP
(C) 1992 American Megatrends Inc., All Rights Reserved

Above 1 MB Memory           : Disabled
Hard Disk Type 47 RAM Area  : 0:300
Numeric Processor Test      : Enabled
Floppy Drive Seek At Boot   : Enabled
System Boot Up Sequence     : A:, C:
Fast Gate A20 Option        : Enabled
Password Checking Option    : Setup
Video ROM Shadow C000,32K   : Enabled
System ROM Shadow F000,64K  : Enabled
Fast reset                  : Enabled
Cyrix cache                 : Disabled
ATBUS Stepping              : Enabled
Write wait state            : 0W 2CLK2

ESC:Exit  ↑← ↓ →:Sel  (Ctrl)Pu/Pd:Modify  F1:Help  F2/F3:Color
 F5:Old Values   F6:BIOS Setup Defaults    F7:Power-On Defaults
```

Figure 9.6 - Advanced CMOS Setup Screen

COMMANDS, QUERIES AND DEFAULT VALUES

Table 9.7 lists all the instrument specific commands and queries, and lists factory-set default values in the center column.

Table 9.7 – Commands, Queries And Default Values

Command	Default	Query
ADDRESS	1	ADDRESS?
X	none	CHAN?
CONTROL	ON	CONTROL?
DEFAULT	none	X
X	X	DOM?
ENGLISH	none	X
X		ERROR?
F1		F1?
F2		F2?
FILTER	90	FILTER?
X		ID?
LOCK		LOCK?
LOWERLIMIT		LOWERLIMIT?
X		MAXRANGE?
MEASURE		MEASURE?
METRIC	none	X
X		MINRANGE?
OUTFORM	NORMAL	OUTFORM?
PASSWORD	none	X
SETPT	none	SETPT?
SPAN	none	SPAN?
X		STABLE?
STABLETIME	2	STABLETIME?
STABLEWIN	0.004 inHg	STABLEWIN?
STANDBY	none	STANDBY?
STEP		STEP?
UNITS		UNITS?
UPPERLIMIT		UPPERLIMIT?
VENT	none	VENT?
WINDOW	0.025 inHgA	WINDOW?
ZERO	none	ZERO?

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*.

Air Speed
The distance a body moves through the air per unit of time. Air speed is related to the free-stream total pressure (ram air pressure) and the static (or barometric) pressure.

Altitude
The vertical distance above mean sea level expressed in units of length (meters or feet). Mensor uses the ICAO Standard Atmosphere 1964 to relate absolute pressure (14.696145 psia) to altitude.

Altitude Rate
The change in altitude per unit time expressed as meters or feet per minute or per second.

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.

Attitude Error
The error due to the orientation of the sensor relative to the direction in which gravity acts upon the sensor.

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 corresponding 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
The relationship of an instrument calibration, through a specified step-by-step process, to national standards or nationally accepted measurement systems through an unbroken chain of comparisons.

Calibration Uncertainty
The maximum calculated error in the output values, shown in a calibration record, due to causes not attributable to the instrument being calibrated.

Command Message
See *Interface Message*.

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

Data Message
Same as Device Dependent Message.

DCL (Device Clear)
A GPIB interface message used to reset the internal functions of all devices on the bus.

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

Device Dependent Message
A message sent from one device to another that is specific to that device, i.e., to set up parameters unique to that device or to transfer data.

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.

EOI
A GPIB line that is used to signal the end of a device dependent message.

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*.

GET (Group Execute Trigger)
A GPIB interface message that causes all devices with the **GET** capability and are currently addressed to listen to initiate a programmed action, for example to store the current reading, take a sweep on an oscilloscope, etc. The **GET** command provides a means of triggering multiple devices simultaneously.

GPIB (General Purpose Interface Bus)
A common name for the communication system defined in IEEE 488.1-1987. It is also known by the following names; IEEE 488.1, IEEE bus, HP-IB, ASCII bus, PLUS bus. The international version of the GPIB is defined in the IEC 625-1 standard, and is identical to the GPIB except for the connector.

GPIB Address
The address of a device on the GPIB, composed of a primary and possibly a secondary address. The EPRTS does not support secondary addressing.

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

GTL (Go To Local)
A GPIB interface message that causes the addressed listener(s) to go to the LOCAL (front panel) mode.

HP-IB (Hewlett-Packard Interface Bus)
Another name for the GPIB referring to the originator of the bus.

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.

IEC 625-1
International version of the GPIB.

IEEE 488.1-1987
The standard defining the GPIB.

Interface Message
A message from the GPIB controller to all devices used to manage the bus and provide some control over the devices on the bus. See *Device Dependent Message*.

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*.

Listener
A GPIB device that receives device dependent messages from a talker.

LLO (Local Lockout)
A GPIB interface message that causes all devices that respond to the Local Lockout command to ignore local control.

MLA (My Listen Address)
A GPIB interface message used to command a device to be addressed as a listener.

MTA (My Talker Address)
A GPIB interface message used to command a device to be addressed as a talker.

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.

Parallel Poll
The process of polling all configured devices at once and returning a composite poll response. The EVCTS does not support Parallel Polling. See *Serial Poll*.

Peak Pressure
The greatest (or if desired, the least) pressure sensed during a measurement session.

Precision
The ability of an instrument to repeat an output when measuring a given quantity under identical conditions.

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

Pressure Rate
An orderly change in pressure over a specified time.

Pressure Relationships
The relationship of various pressure terms are illustrated below in figure 10.1.

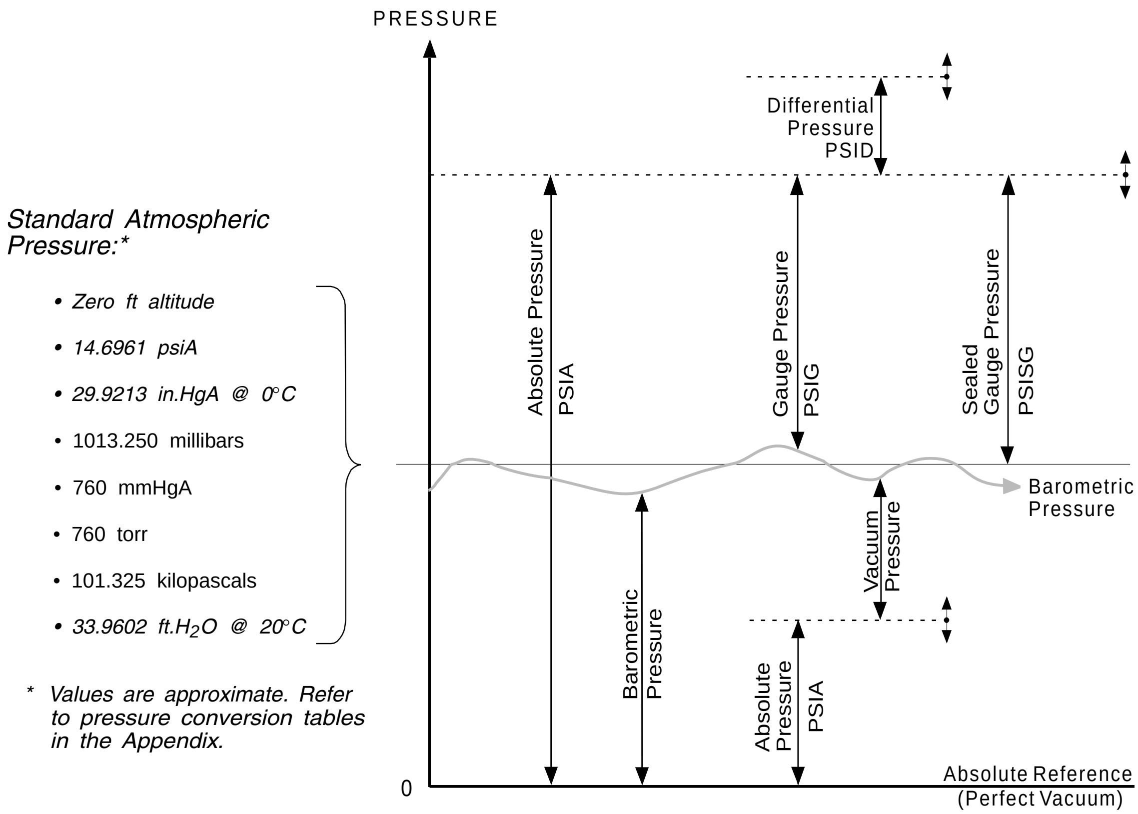


Figure 10.1 - Pressure Relationships

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.

SDC (Selected Device Clear)
A command used to reset the internal functions of an addressed listener.

Serial Poll
The process of polling and reading the status of one specified device on the bus.

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

SRQ (Service Request)
A GPIB line that a device asserts to notify the controller that the device needs service.

Stability
The ability of an instrument to retain its performance characteristics for an extended period of time.

Status Byte
The data byte sent by a device when it is serially polled.

Talker
A GPIB device that sends device dependent messages to listeners.

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 permanent change in characteristics.

Uncertainty
The maximum credible limits for the difference between the true value and the measured value of the pressure under consideration.

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.

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