GE Sensing
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Users Manual Printing & Assembly Instructions

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GE Infrastructure
Sensing

Model 722X-723X

Precision Pressure Indicator

imagination at work

PRECISION PRESSURE INDICATOR

MODEL 722X/723X

USER'S MANUAL

RUSKA INSTRUMENT CORPORATION
10311 WESTPARK DRIVE, HOUSTON, TEXAS 77042
713-975-0547 FAX: 713-975-6338
e-mail: ruska@ruska.com

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Date: January 2, 2002

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REVISION NOTICE

RELEASE NUMBER	REV.	DATE OF RELEASE	DESCRIPTION
722X/723X	A		Original Release DC/RO #22739
722X/723X	B	06/25/01	Changes per ECO 21283
722X/723X	C	01/02/02	Changes per DC/RO-23193

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RELEASE 72XX-1D01 **Revision B (06/25/01)**
Released per ECO 21283

RELEASE 72XX-1D01 **Revision C (01/02/02)**
Released per DC/RO-23193

WARNING

PRESSURIZED VESSELS AND ASSOCIATED EQUIPMENT ARE POTENTIALLY DANGEROUS. THE APPARATUS DESCRIBED IN THIS MANUAL SHOULD BE OPERATED ONLY BY PERSONNEL TRAINED IN PROCEDURES THAT WILL ASSURE SAFETY TO THEMSELVES, TO OTHERS, AND TO THE EQUIPMENT.

BEFORE PERFORMING ANY MAINTENANCE, TURN OFF POWER AND DISCONNECT POWER CORD FROM POWER SOURCE.

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SECTION 1.0
GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains operation and preventive maintenance instructions for the Series 722X/723X Precision Pressure Indicator (PPI), manufactured by Ruska Instrument Corporation, Houston, Texas.

> **NOTE:** The "X" character in "722X" is a place holder for a specific number which determine model numbers. The X is "0" if one sensor is installed and "2" if two sensors are installed. Example: 7222 = 0.01% accuracy, two sensors.

1.2 GENERAL INFORMATION

The Ruska Series 722X/723X Precision Pressure Indicator (PPI) is used to measure absolute, tare pressure, and rate-of-change of pressure. The measured pressure can be displayed in one of twenty different pressure units. These include units of altitude which also allows the PPI to be used with altimeters and rate of climb indicators.

The instrument is designed to operate with one or two sensors and is extremely easy to operate and maintain, and its light weight makes it very portable. Its serial interface and optional IEEE-488 interface allow it to communicate with computers and other suitably equipped instruments. These and the unit's other features are discussed below.

1.3 FEATURES

The following features are standard on the PPI.

Ease of Calibration: A three point calibration can be performed either remotely or entirely from the front panel, requiring minimal operator interaction. With a triple range 7230 or 7232 multiple calibration points are required.

Ease of Setting Zero: Once a suitable pressure has been applied to the input port, zero is set simply by pressing a sequence of buttons on the front panel.

Choice of Medium: See Appendix C.

Choice of Display Units: Standard units include inches of mercury (inHg), kiloPascals (kPa), pounds per square inch (psi), millimeters of water (mmH_2O), inches of water (inH_2O), kilograms per square centimeter (kg/cm^2), millimeters of mercury (mmHg), millibars (mbar), pounds per square foot (psf), feet, and meters. In addition, four user-defined units are also available.

Adjustable Pressure Display: The pressure display can be adjusted to show the desired number of digits after the decimal point.

Adjustable Rate Display: Rate-of-change of pressure can be displayed in either change per second or change per minute, allowing measurement of leak rate and rate-of-climb. In addition, the user can also adjust the interval at which the rate display updates as well as the time it takes for the rate display to respond to a step change in the rate.

Tare Mode: After a reference pressure has been established at the test port, tare mode instructs the PPI's software to subtract this reference pressure from all subsequent pressures detected at the test port. In this way, the PPI with absolute transducers can simulate gauge pressure.

Serial Interface: An RS-232 communication syntax allows the PPI to be used in automated measurement systems for easy data acquisition.

Lightweight: Weighing less than 9 lbs. the PPI can easily be carried between measurement sites.

Adjustable LCD Brightness: The user selects the desired level of brightness for the front panel LCD's. This feature allows the user to conserve battery life in applications where only battery power is available.

Choice of Pressure Range: The PPI is currently available in many full-scale ranges from 19 to 40,000 psia. Consult Ruska's Sales Literature for a current list of available ranges.

Self-Test: Upon power up, the PPI performs a brief self-test to ensure that all hardware and software are operating properly.

Ease of Operation: All local operations are accessed through a menu-style interface. Frequently used selections such as the display units are maintained in memory through power off and on.

1.4 OPTIONS

A standard PPI comes with one of three available pressure transducers, a plug-in power supply and a user's manual. Although the PPI is fully functional with just these items, the following options are also available.

> **WARNING:** Do not connect RS-232 or IEEE-488 cables to the PPI while power is applied to either the PPI or the device at the other end of the cable. In either case, improper insertion or a defective connector could cause a power disturbance which could damage the PPI or the connected device, or cause the loss of stored calibration constants.

IEEE-488 Interface: All models of the PPI accommodate an IEEE-488 card. This card is installed in the main board of the PPI.

Battery Operation: All models of the PPI accommodate a NiMH battery. This battery is easy to install and provides the user with over 8 hours of operation in most circumstances.

Battery Charger: This battery charger is specially designed to charge the sealed NiMH battery mentioned above. VAC operation of the PPI will charge the battery in 2-3 hours.

> **CAUTION:** Chargers not designed to charge sealed NiMH batteries may lead to battery failure or reduce battery life.

Calibration Report: In addition to the standard certificate of compliance, calibration per MIL-STD-45662, traceable to the National Institute of Standards and Technology (NIST), is available.

Carrying Case: This soft-sided case holds the PPI, the power supply, the manual, two batteries, the charger and small tools. This case is padded to protect its contents and fits easily under an airplane seat.

Rack Mount Kit: This rack mount kit is 7" high and can be used to mount the PPI in a standard 19" rack. The ANSI/EIA AS-310-C-77 standard refers to this type of rack mount kit as a 3U.

The options available are summarized in Table 1-1. Ruska periodically introduces new features and options, most of which can be retrofitted into existing units. Contact your Ruska sales representative for further information.

TABLE 1-1
PRECISION PRESSURE INDICATOR OPTIONS

ITEM	RUSKA PART NUMBER
Sealed NiMH Battery	4-722
Battery Charger	7220-CHG
Carrying Case	7220-CASE
IEEE-488 Interface	13-981
Additional Manuals	72XX-1D01
Rack Mount Kit	7220-RMK

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SECTION 2.0
THEORY OF OPERATION

2.1 INTRODUCTION

The Ruska Series 722X/723X Precision Pressure Indicator (PPI) uses state of the art sensor and electronics technology to provide a highly accurate and flexible pressure instrument. This portion of the manual reduces the PPI to its individual function blocks and explains the relationship of each subsystem to the system as a whole.

2.2 THE PPI: A FUNCTIONAL DIAGRAM

Figure 2-1 on page 2-2 shows a simplified block diagram of the PPI. Each subsystem will be addressed in the following sections.

2.2.1 THE VOLTAGE SOURCE

The PPI is designed to accept two different sources of power. The sources include the plug-in AC-to-DC power converter provided with the unit and the optional 12-volt battery. For more information on these products, see either Section 1.0, "General Information" or Section 3.4, "Getting Started".

2.2.2 THE VOLTAGE REGULATOR

The switching voltage regulator located on the PPI's main power board generates the various voltages required for system operation. The input to the voltage regulator is the DC supplied by the voltage source. A switching regulator is used because of its ability to efficiently generate several different voltages while producing very little heat. This minimizes thermal disturbances to the sensor and maximizes battery life if a battery is being used as the voltage source.

The main output from the switching voltage regulator is the +5 VDC used by the microcomputer, displays, and other logic circuitry. Two secondary outputs of + and - 12 VDC are used by the sensor. A reference voltage of 2.500 VDC is also reduced for the analog-to-digital (A/D) converter on the main board.

2.2.3 THE SENSOR(s)

The available sensors have frequency output(s) for measuring pressure and temperature. The PPI has two 24-bit A/D inputs for voltage measurement and four inputs for frequency measurements and a high-accuracy, temperature-compensated, 20 MHz crystal oscillator as a reference. There are two independent sets of counters to measure the four frequencies, therefore, more than two frequency signals require multiplexing.

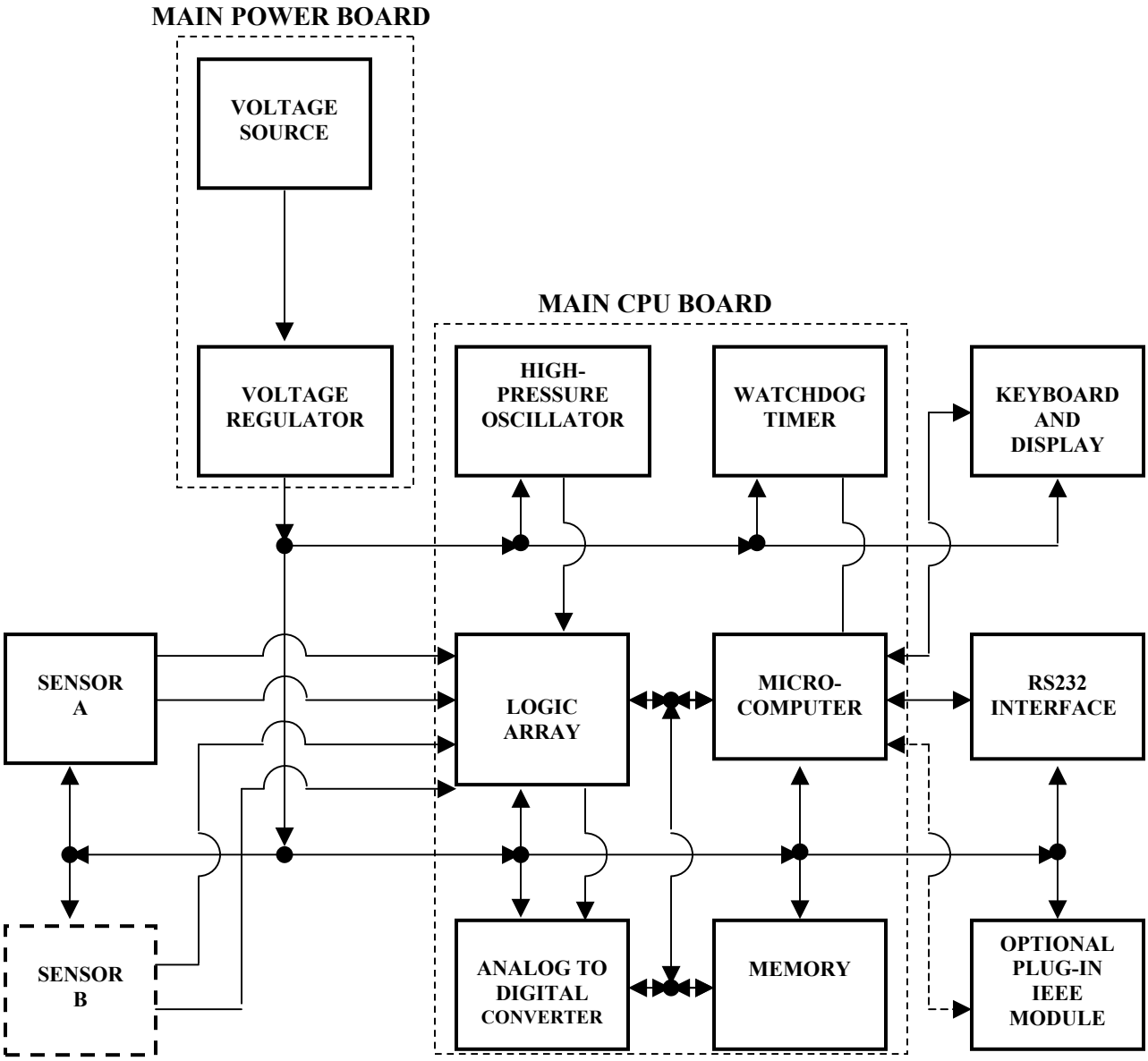

FIGURE 2-1
FUNCTIONAL DIAGRAM OF THE PPI

The starting edge of the transducer frequency signal starts a 24-bit counter which counts the 20MHz clock, and stops the counter on the first falling edge after a 0.1 second time interval. The counter value will be approximately (20 MHz x 0.1 second) or 2 million which gives an accuracy of 1 count in 2 million. A second counter counts the exact number of cycles of the transducer's output frequency within the same time interval. The frequency is then determined as follows:

Frequency = (20 MHz) * (signal counter) / (crystal counter)

Pressure values are calculated every 0.1 second from the frequencies (and voltage) according to the equation and coefficients supplied by the manufacturer of the transducer. Two pressure values are calculated every 0.1 second for dual sensor PPIs with one frequency output per sensor. Dual sensors with two frequency signals per sensor updates one pressure value in 0.1 second then the other. This is due to the multiplexing required for four inputs. See Appendix C for signal outputs of sensors.

The coefficients are empirically determined by the transducer manufacturer, and the values differ slightly from one transducer to the next. Ruska stores these coefficients in the main microcomputer's memory after the sensor is installed in the instrument. The main microcomputer uses the polynomial equation with the stored coefficients and values of period and temperature to calculate the transducer's pressure.

2.2.3.1 CONVERSION FACTORS

Once the pressure has been calculated, the factors shown in Table 2-1 are used to convert the pressure in kPa to the units requested by the user.

2.2.4 THE LOGIC ARRAY (FIELD PROGRAMMABLE LOGIC ARRAY)

One function of the logic array is to perform all of the conventional address decoding and "glue logic" functions normally required for support of a microcomputer. As discussed above, two presettable counters are also implemented in the logic array. Under control of the microprocessor, these counters are used to determine the frequency of the sensor's square wave output. Using a single-chip logic array greatly reduces the number of parts on the main circuit board, and this in turn increases reliability.

2.2.5 THE ANALOG-TO-DIGITAL CONVERTER

The single-chip analog-to-digital (A/D) converter also includes a differential 4-input analog multiplexer. One input is used to measure the amplitude of the input voltage source. When this source is a battery, the microcomputer is able to determine when the battery is nearing the end of its discharge cycle.

The entire operation of the A/D converter is controlled by the microcomputer, and the microcomputer is the user of the A/D converter's output information.

TABLE 2-1 CONVERSION FACTORS		
InHg	inches of Mercury (0°C)	= kPa x 0.2952998
kPa	kiloPascals	= kPa x 1.0
mbar	millibars	= kPa x 10.00000
psi	pounds per inch^2	= kPa x 0.1450377
psf	pounds per foot^2	= kPa x 20.88543
"H_2O	inches of water (4°C)	= kPa x 4.014742
kgcm	kilograms per cm^2	= kPa x 0.0101972
mmHg	millimeters of Hg (0°C)	= kPa x 7.500605
mH_2O	millimeters of H_2O (4°C)	= kPa x 101.9744
feet	feet of altitude	per MIL-STD-859A
mtrs	meters of altitude	per MIL-STD-859A
usr[1]		= kPa x User defined
usr[2]		= kPa x User defined
usr[3]		= kPa x User defined
usr[4]		= kPa x User defined

2.2.6 THE MICROCOMPUTER

The microcomputer located on the main CPU board controls all of the system's operations. It controls the presettable counters which are used to determine the sensor's output frequency. It also controls the A/D converter. The microcomputer calculates the sensor pressure P given by the polynomial mentioned in Section 2.2.2. The results of this calculation are then sent to the display, where they are presented to the user.

The main microcomputer also handles all communications with other systems connected to the PPI, via the RS-232 or optional IEEE-488 interface. Using these communications links, the microcomputer can receive commands, reconfigure the system, and supply information in response to requests received.

The main microcomputer also performs diagnostic tests within the system. It always performs a self-diagnostic routine when power is first applied, and it can be commanded to execute other built-in tests at the user's request.

2.2.7 MEMORY

The main board has EPROM FLASH MEMORY for program storage, RAM for work area, and EEPROM for transducer coefficient and system configuration storage.

When the user of the PPI changes the system's configuration, relevant information is stored in the EEPROM. Such information includes the active units of measure, the user-defined units of measure and the RS-232 configuration. When power is subsequently removed and later reapplied, the microcomputer reads this system configuration information from the EEPROM and restores the system to its previous configuration.

2.2.8 THE WATCHDOG TIMER

A watchdog timer is utilized to reset the microprocessor if it should suffer certain temporary operational problems. The microcomputer's program instructs it to periodically reset the watchdog timer. Should the processor cease operation of its main program, it would cease resetting the watchdog timer. The watchdog timer would then time out, and reset the processor. In this event, the processor would begin operating its program from the start, beginning with the self-diagnostics tests. Detectable errors are reported to the user.

2.2.9 THE KEYBOARD AND DISPLAY

The Keyboard and Display are controlled by the software of the main CPU Board.

The display is a graphics LCD which displays one or both pressure ranges, the units of measure and all alphanumeric information associated with each of the displayed functions. The display can be placed in screen saver-backlight time out mode. In this mode, the screen will go blank in a user addressable amount of time (1 to 999 min). A stroke of any key will restore the screen display. The power saver mode is recommended for battery operation. Setting the display to 0 minutes turns off the screen saver-backlight time out mode.

Operation of the PPI is locally controlled by the use of 6 function keys, 4 directional keys (up, down, left, right), an "ENTER" key and a "PREVIOUS" key. The 6 function keys respond to the command on the LCD display directly above each key. The directional keys move the highlight bar around and change the numeric values (where applicable). The "ENTER" key accepts the current value and the "PREVIOUS" key returns the user to the previously displayed screen.

All of the operations available at the front panel can also be commanded through the RS-232 or optional IEEE-488 interface.

2.2.10 THE RS-232 INTERFACE

A standard feature of Ruska's Series 722X/723X Precision Pressure Indicator is an RS-232 serial data communication link. This can be used for such operations as accepting commands from external systems, configuring the system, or sending data to remote computers. Detailed operational information and a discussion of commands and data formats for the RS-232 link are discussed in Section 5.1.2

2.2.11 THE PLUG-IN INTERFACES

The IEEE-488 interface is optional on the PPI. It is recommended that it be installed at the factory. Like the RS-232 interface, it can be used for such operations as receiving commands, configuring the system, and sending data to external systems. Detailed operational information and a discussion of commands and data formats for IEEE-488 interface are discussed in Section 5.1.1.

WARNING: Do not install or remove IEEE-488, or other option while power is applied to the PPI. Do not connect RS-232 or IEEE-488 cables to the PPI while power is applied to either the PPI or the device at the other end of the cable. In either case, improper insertion or a defective connector could cause a power disturbance which could damage the PPI or the connected device, or cause the loss of stored calibration constants.

SECTION 3.0
PREPARATION FOR USE

3.1 INTRODUCTION

This portion of the manual covers initial installation. Front and rear diagrams are presented in Sections 3.2 and 3.3. Alternate power sources are discussed in Section 3.4, and battery operation is covered Section 3.5. Section 3.6 explains connecting a test pressure to the PPI, and Section 3.7 tells the user what to expect during the power-up procedure.

3.2 THE FRONT PANEL

All indicators and function keys are provided on the front panel of the instrument, as shown in Figure 3-1.

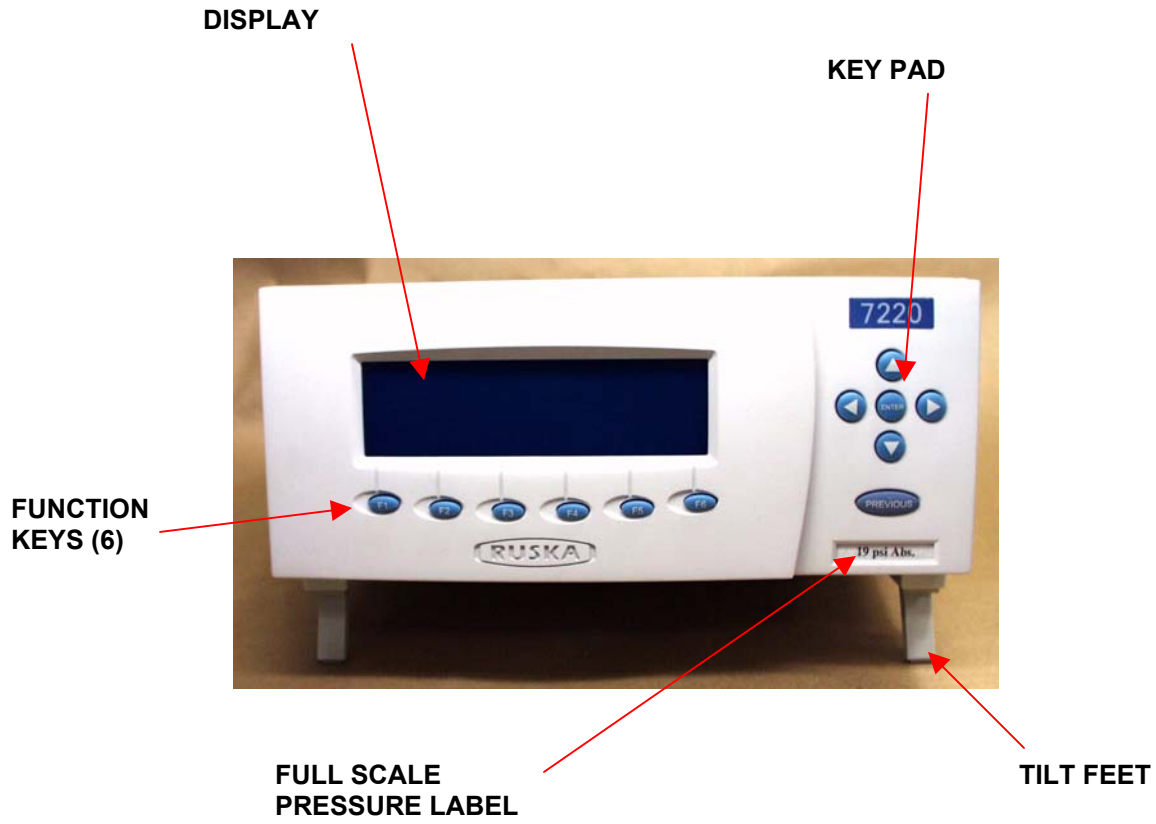

Figure 3-1
The Front Panel

3.3 THE REAR PANEL

All connections and interface options are accessible through the rear panel of the instrument (see Figure 3-2).

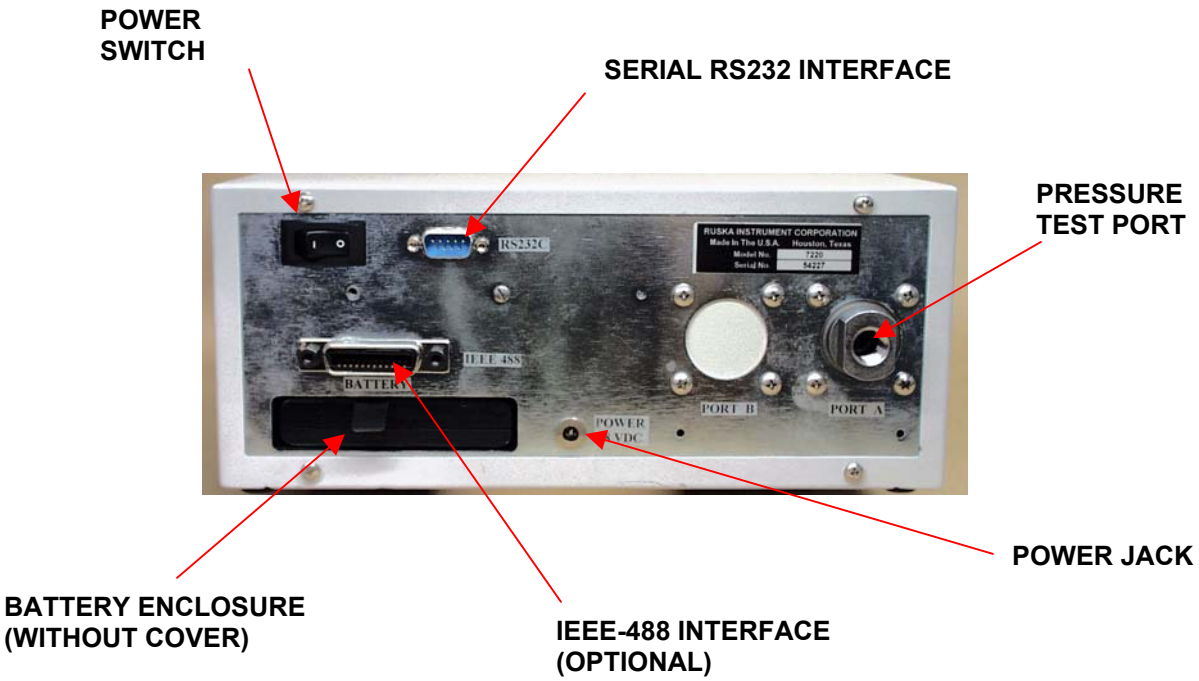

Figure 3-2
The Rear Panel

3.3.1 TEST PORTS

The following table defines the pressure connection fittings for the PPI.

PRESSURE RANGE	FITTINGS
Up to 6000 psi	1/4" NPFT
6,001 psi to 10,000 psi	1/8" NPTF
Above 10,000 psi	1/4" NBSF

3.4 GETTING STARTED

Unpack the PPI and retain the packaging if possible. A standard PPI comes with the pressure transducer of the customer's choice, an AC adapter, power cord and a user's manual. After the PPI has been unpacked, the following checklist should be completed.

1. Inspect the PPI for any visible signs of damage.

2. Locate the full-scale pressure label on the front panel of the PPI (Figure 3-1). Verify that the unit is rated for the range of pressure desired.

3. PPI operates on 18 VDC. The AC adapter's output is 18 VDC, 2 amp, 36 Watts and input supply is 100-240 VAC, 50-60 Hz. Plug the AC adapter into the power jack located on the rear panel of the PPI (Figure 3-3). The input of the AC adapter is plugged to the wall with a cord (country appropriate) into an outlet rated for 100-240 VAC at 50-60 Hz.

Figure 3-3
Power Connection

3.5 BATTERY OPERATION (OPTIONAL)

All models of the PPI are fully operational when used with the optional rechargeable NiMH battery, Ruska part number 4-722. CAUTION: Only use the Ruska supplied battery. Other batteries may damage the PPI. This battery will not leak and therefore can be used in any position. It is approved for air travel by the Department of Transportation (DOT) and the International Air Transport Association (IATA). This battery is easy to install and typically provides the user with over 8 hours of operation.

3.5.1 INSTALLING THE BATTERY

To install the battery, first remove the battery cover located on the rear panel of the PPI (Figure 3-2). Slide the battery into the power source enclosure. Push the battery until it snaps into place. Notice that the battery will not go into the enclosure if it is upside down. Put the battery cover back.

3.5.2 LOW BATTERY INDICATION

When the battery voltage drops below 14 VDC, the battery needs recharging. If this occurs, recharge the battery as explained in the following Section. 3.5.3

3.5.3 CHARGING THE BATTERY

There are 2 ways to charge the battery:

1. When the battery is not in the PPI, use the optional battery charger to charge the battery.
2. Battery can be charged inside the PPI.

These options are discussed below.

3.5.3.1 Battery Charger

For charging the NiMN battery, when the battery is not in the PPI, Ruska recommends the optional battery charger Ruska part number 7220-CHG (Figure 3-4). CAUTION: Use only Ruska supplied charger to charge the PPI battery. Any other charger may damage the battery. This charger accepts 100-240 VAC at 47-63 Hz and outputs 24 VDC at 2.5A. The red light will come on when it is charging the battery. Light will turn green when battery is fully charged.

Figure 3-4
Battery & Battery Charger

3.5.3.2 Charging in the PPI

PPI has a built in charger. To charge the battery while it is installed in the PPI, the AC adapter supplied with the PPI must be connected. The PPI is capable of simultaneously operating the PPI and properly charging its battery. Note that this connection can be used to provide an uninterruptible power supply for the PPI. While AC power is available, the PPI will draw power from the AC power supply. If AC power fails, the battery will automatically take over until AC power is restored. Typical battery life is 6 to 8 hours.

3.5.4 STORING THE BATTERY

To prolong the life of the battery, it should be thoroughly charged before it is stored. Once it has been fully charged, it should hold its charge for six to nine months. Temperatures at or below 50°F (10°C) are ideal for battery storage.

3.6 CONNECTING A TEST PRESSURE

A test pressure may be connected to the pressure test port prior to turning the unit on. To connect a test pressure to the PPI, first locate the pressure test port on the rear of the unit

(see Figure 3-2). Use appropriate fittings (see Section 3.3.1) to connect the test pressure to the PPI, and tighten to the specifications provided by the manufacturer of the fittings.

WARNING: In order to avoid damage to the unit, test pressures applied to the test port must be well within 120% of full-scale.

3.7 POWER-UP

Turn on the PPI by activating the rocker switch on the rear panel.

Once the PPI passes its self-test, the upper display will show the pressure measured at the test port in one of the display units listed in Section 1.3. If an error code should appear, refer to Appendix A, Error Messages.

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SECTION 4.0
LOCAL OPERATION

This section of the manual describes the operation of the Precision Pressure Indicator from the front panel. The local interface (front panel) consists of a LCD display and a set of keys. The display shows the system status and the menu options. The keys are grouped according to function.

Figure 4-1
Model 7200 Front Panel

4.1 FRONT PANEL

DISPLAY AND KEYS

Display: The 722X/723X is set-up such that the display is separated into three primary sections. This is the upper and lower primary sensor display sections (able to accommodate displaying two sensors simultaneously) and the function label section which is located on the lowest line in the display just above the six function keys.

Function Keys: The **[F1]** through **[F6]** keys are used to navigate the menus and performed predefined functions. The name of the function is displayed above the key on the bottom line of the display.

Arrow Keys: The up and down arrow keys select a field for editing and can be used to scroll through numbers in order to edit a numerical value such as a limit setting. The left and right arrow keys select between multiple choice options for the selected field.

Enter Key: The enter key accepts the entered number or confirms a command.

Previous Key: The previous key is used to move to the previous menu. Selecting the previous key multiple times would move towards the main menu.

Figure 4-2 is a menu tree showing the relationship between all of the menus in the system. Refer to it for selections available under the menu. To move to a lower menu, press the function key with the correct label displayed on the front display. To move towards the main menu, press the **[PREV.]** key.

4.2 LOCAL DISPLAY – MENU STRUCTURE

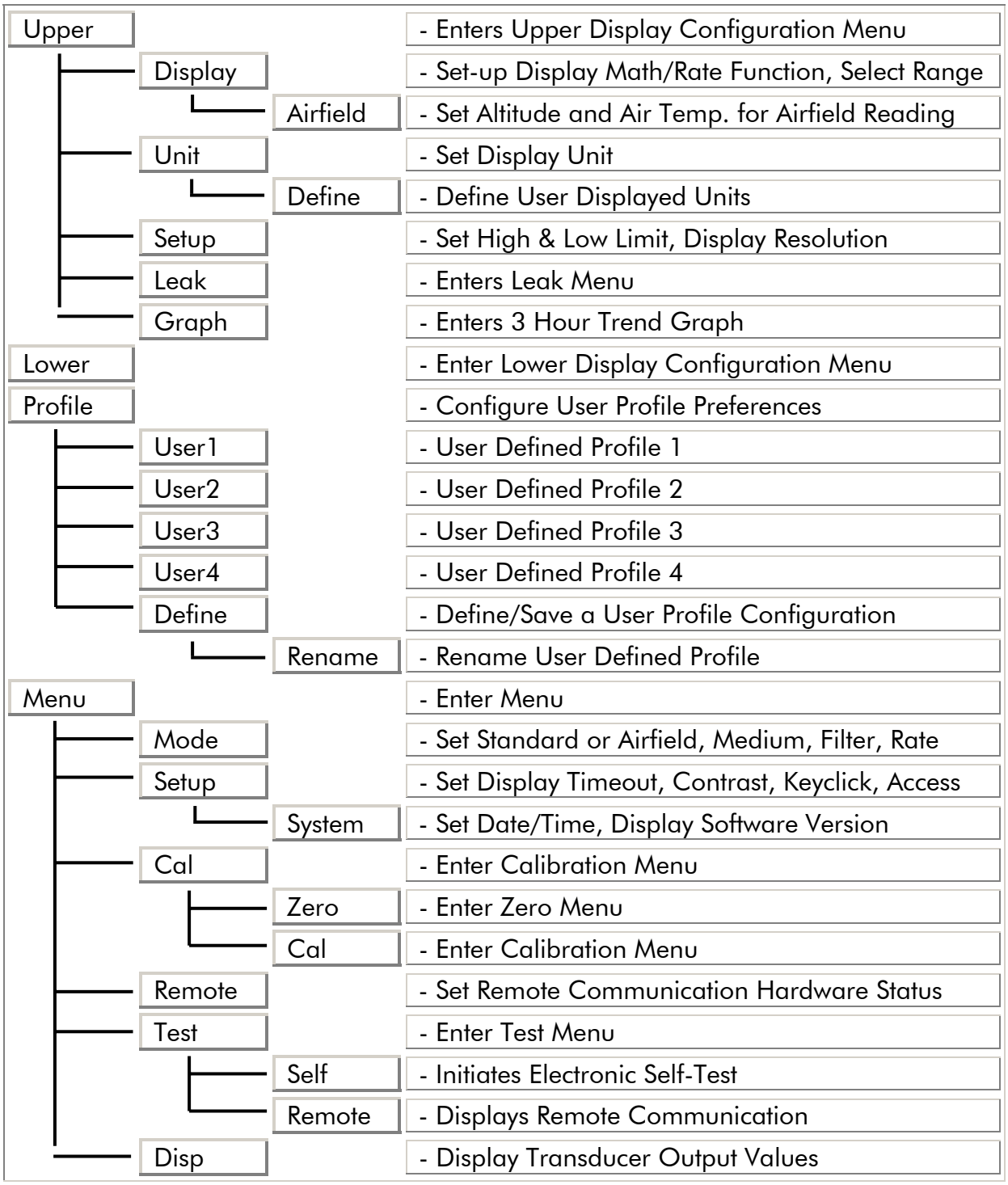

Figure 4-2
Model 7200 Menu Structure

4.3 MAIN MENU

The information displayed on the main menu varies based on the instrument set-up. In general, it denotes the current pressure reading in the current unit of measure. It identifies the sensor (or mathematical relationship between two sensors, e.g. A-B) that is being actively displayed and if the sensors pressure has a tare applied to its reading. For multi-ranged sensors, the current active range is also denoted below the pressure reading. The function key **[F1]** labeled 'Upper" enters the menu that allows the operator to change what is being displayed in the upper half of the display. The function key **[F2]** allows the operator to set-up the lower portion of the display. The **[F4]** function key enters the menu that allows the operator to quickly move from various user configured display settings that the operator has previously saved. Finally, the **[F6]** Function key enters into further menu options that are available to the operator.

Figure 4-3

4.4 UPPER AND LOWER DISPLAY

Although the PPI has a single graphics display, it is designed to display two primary lines of information simultaneously. Each line can be set-up independently by the operator and is identified as the Upper and the Lower displays. To modify the format of the upper display, the operator would select the Upper **[F1]** function key and then modify this display as required. The lower display would be modified by pressing the Lower **[F2]** function key.

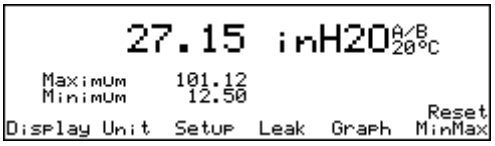

Figure 4-4

4.4.1 DISPLAY SETTINGS IN THE STANDARD MODE

When the PPI is set up to display in the Standard Mode (for Airfield Mode, see Section 4.6.1) the following type of display configurations are available. Please note, the display screen (see Figure 4.5) will vary based on the number of transducers that are installed in the PPI and the options that were included with the PPI. Not all systems will display all of the information shown in Figure 4.5.

Figure 4-5

4.4.1.1 Selecting Which Sensor to Display

With a PPI that has two pressure sensors installed, the operator has the option of displaying either sensors reading, or a variety of mathematical relationships between the two sensors in either the upper or lower display. The sensor is selected from the Upper (or Lower) Display Menu. From the Main Menu (press **[PREV.]** until the Main Menu appears) press either Upper **[F1]** or Lower **[F2],** and then Display **[F1].**

1. Use the up and down arrow keys to highlight Display.
2. Use the left and right arrow keys to highlight which sensor (sensor A or B) to display or the mathematical relationship between A and B. When selecting the sensor range, the full scale of that sensor is displayed in current units of measure above the Display line. Additionally, if the sensor has the triple range option, the three available sub-ranges are shown below the Rate line. The current range that the instrument is set to operate is highlighted. To change the sub-range of a sensor, see section 4.4.1.3.
3. Press **[PREV.]** to return to the Main Menu.

4.4.1.2 Display a Rate-of-Change

To display the rate of pressure change, the operator will turn the Rate from the off position to either the /Min or /Sec position. The PPI will then display rate-of-change on the selected sensor. The rate is activated from the Upper (or Lower) Display Menu. From the Main Menu (press **[PREV.]** until the Main Menu appears) press either Upper **[F1]** or Lower **[F2],** and then Display **[F1].**

1. Use the up and down arrow keys to highlight Rate.
2. Use the left and right arrow keys to highlight /Min or /Sec.
3. Press **[PREV.]** to return to the Units Menu.

4.4.1.3 Changing Ranges on a Tripled Range Sensor

Note, this function is only available on units that were purchased with the triple range option. The Active Range on a triple range sensor is selected as follows;

1. Select the Upper **[F1]** or lower **[F2],** and the display **[F1].**
2. Select the sensor to be displayed (see section 4.4.1.1), e.g. Display set to Sensor A.
3. Select the Active Range;
    a. Use the up and down arrow key to highlight Range A or Range B.
    b. Use the left and right arrow key to highlight the desired Active Range.
4. Press the **[PREV.]** key several times to return to the main menu. The active range should now be displayed below the pressure reading on the main display.

NOTE: In order to change the active pressure range on a sensor, the pressure as measured by that sensor must be open to atmosphere.

4.4.1.4 Tare a Sensor Reading

The PPI is provided with the capability to "tare" out a sensor reading. This capability is used for a wide variety of purposes. The most common would be to allow an absolute sensor to display the pressure in the gauge mode. The other common application is to set the zero when two sensors are used to display a differential pressure. As an example, if the math function of A-B was selected, unless both sensors were reading the exact same pressure, the result of subtracting these two sensor reading from one another would be a reading other than zero. The "Tare" key can be used to zero the output between these two sensors.

To tare an absolute sensor for gauge readings;

1. Open the test port to atmosphere (the PPI should read barometric pressure).
2. Select the Upper **[F1]** or Lower **[F2],** and then display **[F1].**
3. Press the tare key.
4. Press the **[PREV.]** key to return to the main menu.

The display denotes that it is in the tare mode by displaying –Tr above the unit of measure. The pressure displayed by this sensor should now be reading zero as opposed to the barometric pressure that was previously displayed.

4.4.2 DISPLAYING PRESSURE CORRECTED FOR FIELD ELEVATION IN THE AIRFIELD MODE

The PPI is capable of displaying pressure in QFE and QNH to display pressure corrected for field elevation. To operate as an Airfield Barometer, the unit must first be set up as an airfield barometer. This is performed from the main menu by pressing the Menu **[F6],** Mode **[F1],** then with the highlight on the **Mode** option, use the left or right arrow key to highlight **Airfield** (see Figure 4-6).

From the Main Menu (press **[PREV.]** until the Main Menu appears) press either Upper **[F1]** or Lower **[F2],** and then Display **[F1].**

1. Use the up and down arrow keys to highlight Display.
2. Use the left and right arrow keys to highlight QFE or QNH.
3. To set up the Airfield Elevation and Temperature;
    a. Press the Airfield **[F2]** function key.
    b. To change the elevation unit of measure, press the Feet **[F1],** or the Meters **[F2]** function key.
    c. Enter the Altitude (See Figure 4.7);
        i. Use the up and down arrow key to highlight Altitude.
        ii. Press the **Enter** key.
        iii. Use the up and down arrow keys to scroll through a list of choices including a decimal, negative sign and numerical numbers representing the desired value.

iv. Use the left and right arrow keys to increment to the next digit.
v. Repeat steps iii and iv until the entire value is entered.
vi. Hit the **Enter** key to accept the entry.

d. Enter the Temperature (See Figure 4.7);
i. Use the up and down arrow key to highlight Temperature.
ii. Press the **Enter** key.
iii. Use the up and down arrow keys to scroll through a list of choices including a decimal, negative sign and numerical numbers representing the desired value.
iv. Use the left and right arrow keys to increment to the next digit.
v. Repeat steps iii and iv until the entire value is entered.
vi. Hit the **Enter** key to accept the entry

4. Press **[PREV.]** to return to the main menu.

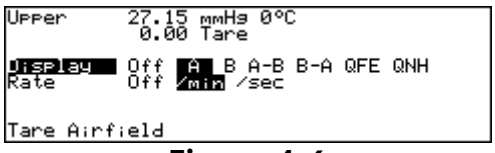

Figure 4-6

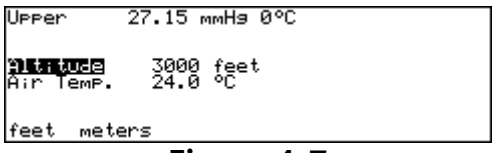

Figure 4-7

4.4.3 SELECTING PRESSURE UNIT OF MEASURE

1. The pressure units are selected from the Units Menu for either the upper or lower display. To change the unit of measure for the Upper or Lower display, from the Main Menu (press **[PREV.]** until the Main Menu appears), press Upper **[F1]** (or Lower **[F2]),** and then the Units **[F2].** The current units will be highlighted.
2. Use the arrow keys to highlight the desired pressure unit. Figure 4.8 shows the unit of measure of "psi" being selected.
3. Press **[ENTER]** to accept the change. Press **[PREV.]** to exit without changing the units.

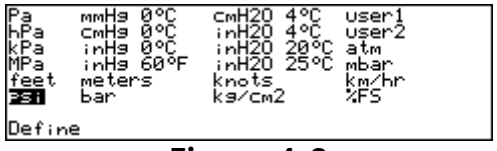

Figure 4-8

The PPI uses the conversion factors listed in table 2-1 to translate the pressure from kilopascal to one of the PPI's units of measure.

In addition to the predefined units offered in the Units menu, there are four user-defined units available. **USER 1** and **USER 2** are directly available. The units of measure of **atm** and **mbar** are preset and will default, but can be edited if additional user defined units are needed.

4.4.3.1 Defining a New Pressure Unit

In addition to the standard units of measure provided by the PPI, four user-defined units are available. To create or modify one of these units, the user enters a name that is one to ten characters long and a conversion factor that is a multiple of kiloPascal (kPa).

For example, using the information from Table 2-1, the conversion factor for millitorr or one micron of mercury at 0°C is calculated as follows;

$$\mathbf{mTorr} = kPa\ x\ \frac{1000 mTorr}{1 Torr}\ x\ \frac{1 mmH_2}{.0193368}\ x\ \frac{.1450377}{1 kPa}$$

thus the conversion factor simplifies to

$$\mathbf{mTorr} = \mathbf{kPa}\ x\ 7500.6051$$

1. The pressure units are defined from the Units Define Menu. From the Main Menu (press **[PREV.]** until the Main Menu appears) press either Upper **[F1]** (or Lower **[F2]),** then Unit **[F2],** and then Define **[F1].** The screen of Figure 4-9 will be available.
2. Press Next **[F2]** until the desired user-defined unit is highlighted.
3. The following sequence is used to change the name of the selected unit.
   a. Use the arrow keys to highlight the desired character in the matrix.
   b. Press Add **[F3]** to add the character to the name entry box.
   c. Repeat a and b until the desired name is entered. Press Clear **[F4]** to start over.
   d. Press Enter **[F5]** to accept the name.
4. The following sequence is used to enter the conversion factor.
   a. Press the right arrow key until the conversion factor to be modified is highlighted.
   b. Press the **Enter** Key.
   c. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
   d. Use the left and right arrow keys to increment to the next digit.
   e. Repeat steps c and d until the entire value is entered.
   f. Hit the **Enter** key to accept the entry.
5. Press **[PREV.]** to return to the Units Menu. The new unit definition may be selected.

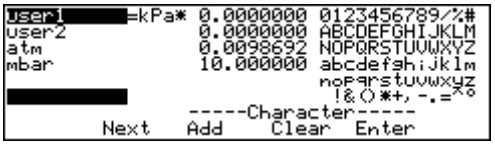

Figure 4-9

4.4.4 SET-UP

The set up menu is used to define pressure limits and to define the display resolution.

4.4.4.1 Changing High and Low Pressure Limits

The operator can store a High and Low pressure limit into the PPI. When these limits are exceeded, an audible alarm will sound.

1. The Limits are set from the Upper (or Lower) Set-Up Menu. From the Main Menu (press **[PREV.]** until the Main Menu appears), press Upper **[F1]** (or Lower **[F2]),** and then Setup **[F3].**
2. Press the up or down arrow key until the label "High or Low Limit" is highlighted.
3. Press the **Enter** Key.
4. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
5. Use the left and right arrow keys to increment to the next digit.
6. Repeat steps 4 and 5 until the entire value is entered.
7. Hit the **Enter** key to accept the entry.
8. Press **[PREV.]** to exit the menu.

4.4.4.2 Changing the Number of Decimals

Each unit has a default number of decimal places used for pressure display based on the full-scale pressure range of the transducer that is installed into the PPI. This may be adjusted up or down by one decimal place.

1. The decimal digits are set from the Upper (or Lower) Set-Up Menu. From the Main Menu (press **[PREV.]** until the Main Menu appears), press Upper **[F1]** (or Lower **[F2]),** and then Setup **[F3].**
2. Press the down arrow key until the label "Decimals" is highlighted.
3. Use the left and right arrow keys to change the number of decimal digits.
4. Press **[PREV.]** to exit the menu.

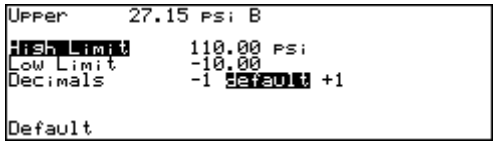

Figure 4-10

4.4.5 PERFORMING A LEAK TEST

The PPI can perform leak tests on a system. The operator can define a wait or dwell time prior to initiating the test along with a test time.

To perform a leak test, from the Main Menu (press **[PREV.]** until the Main Menu appears);

1. Press either Upper **[F1]** (or Lower **[F2]),** and then Leak **[F4].**
2. Set the Wait and Test times, or if okay, go to step 3.
   a. Using the up and down arrow keys to highlight the variable you wish to edit.
   b. Press the **Enter** key.
   c. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
   d. Use the left and right arrow keys to increment to the next digit.

e. Repeat steps c and d until the entire value is entered.
f. Hit the **Enter** key to accept the entry.

3. To start the leak test, press the Run **[F2]** function key.

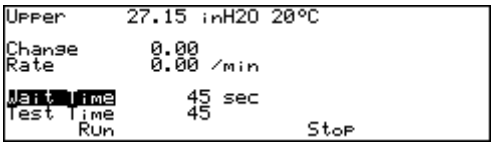

Figure 4-11

When the test is completed, the PPI will display both the change in pressure in current pressure units and the rate of change in the current unit per minute. The operator must apply a rationale to the rate of change of pressure to evaluate or determine a leak condition. Pressure changes due to thermal affects or volume creep may result in a rate of change of pressure that decays with time.

4.4.6 DISPLAYING A THREE-HOUR TREND GRAPH

The PPI has the ability of displaying a three-hour trend graph as shown in figure 4.12. The Graph scaling occurs automatically with the x-axis set at 3 hours and the y-axis set at the maximum and minimum pressures that occurred during the previous 3 hours. To Display the graph, from the Main Menu (press **[PREV.]** until the Main Menu appears) press either Upper **[F1]** or Lower **[F2],** and then Graph **[F5]** and the PPI will display the three-hour trend in the current unit of measure.

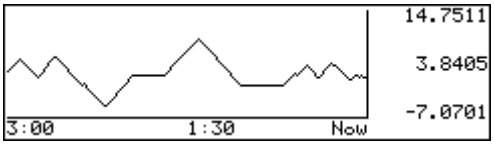

Figure 4-12

4.4.7 PEAK HOLD

The PPI can display the maximum and minimum pressure that occurred since the last reset. This allows the PPI to be readily used to test relief valves. To get to this display, from the main menu (press **[PREV]** multiple times to get to the main menu), press either Upper **[F1]** or Lower **[F2]** depending on which sensor is to be used.

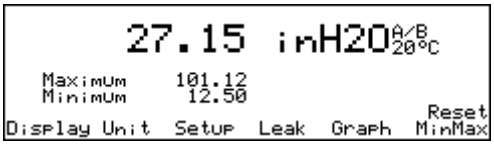

Figure 4-13

The operator can increase pressure to the system and the PPI will display the maximum pressure that was achieved prior to the relief valve opening. The Reset MinMax **[F6]** function key is used to reset the maximum and minimum pressure values. The PPI can be used in this mode for relief valve testing.

4.5 SETTING UP A USER-DEFINED PROFILE

The PPI is capable of storing up to 4 user-defined profiles. A profile is used by the PPI to save the display configuration for future recall. This way, the most commonly used configurations can be stored and easily reconfigured with minimum key strokes. As an example, a user may have a dual channel PPI that is used in two primary applications. One may be as a measure mode Air Data Test Set (ADTS) to perform air data measurements in units of Feet of Altitude and Airspeed in knots. The second may be to perform pressure calibrations in units of inHg. The user could set the PPI up as an ADTS and then save this configuration under the name of ADTS. The PPI could then be set up to display pressures in units of inHg and saved as a profile named inHg. To switch from the inHg mode to the ADTS mode from the main menu, the operator would press the Profile **[F3]** key followed by the user key the user labeled ADTS.

4.5.1 SELECTING USER PROFILES

After the user has defined a profile, (see 4.5.2) he can readily switch between various profiles. To select a profile,

1. From the Main Menu (press **[PREV.]** until the Main Menu appears).
2. Press the Profile **[F3]** function key.
3. Press the function key below the user-define profile that is desired.
4. Press **[PREV.]** to return to the previous Menu.

Figure 4-14

4.5.2 DEFINING PROFILES

To define a profile,

1. Set-up the PPI as desired by the operator.
2. From the Main Menu (press **[PREV.]** until the Main Menu appears), press the Profile **[F3]** function key.
3. Use the up and down arrow keys to highlight the name of the profile under which you wish to save the current configuration.
4. Press the Store **[F2]** function key.
5. Press **[PREV.]** to return to the previous Menu.

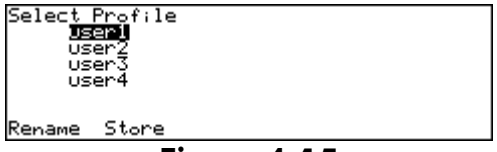

Figure 4-15

4.5.3 RENAMING A PROFILE

To change the profile name,

1. From the Main Menu (press **[PREV.]** until the Main Menu appears, press Profile **[F3],**
2. Press the Define **[F6]** function key.
3. Use the up and down arrow keys to highlight the profile name to be changed.
4. Press the Rename **[F1]** function key.
5. Use the arrow keys to highlight the desired character in the matrix.
6. Press Add **[F3]** to add the character to the name entry box.
7. Repeat 4 and 5 until the desired name is entered. Press Clear **[F4]** to start over.
8. Press Enter **[F5]** to accept the name.
9. Press **[PREV.]** to return to the previous Menu.

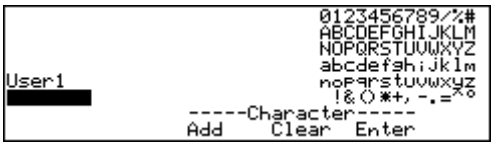

Figure 4-16

4.6 MENU

The Menu **[F6]** screen enters the operator into the more advanced but less frequently used functions and setup screens.

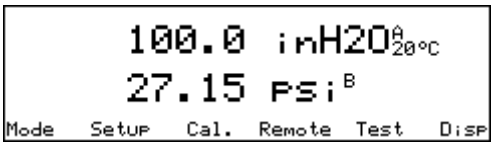

Figure 4-17

4.6.1 SETTING THE MODE OF OPERATION

The Menu Mode menu is utilized to set up the mode, medium, display filter variable and rate of change variables.

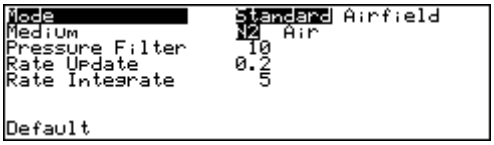

Figure 4-18

4.6.1.1 Setting the PPI in a Standard or Airfield Mode

The PPI can be set up to operate in either a Standard or an Airfield mode of operation. The standard mode would be utilized for the majority of applications. The Airfield mode is used in field barometer applications where the operator wishes to correct the pressure output for an airfield elevation and air temperature.

4.6.1.2 Setting the Gas Medium

The PPI is designed to incorporate a variety of different types of pressure sensors. Some of these, specifically the sensor based on vibrating cylinder technology, is sensitive to the density of the gas medium. On these type of sensors, it is important to set the gas medium to the same medium that the PPI is being calibrated or operated. On all other sensor types, this variable has no effect.

4.6.1.3 Setting Up the Pressure Display Filter

The amount of filtering that occurs on the front display can be varied. The default value is set to 10. Entering a larger number increases the amount of filtering and results in a smoother display output. A smaller number decreases the amount of filtering on the displayed pressure valve.

4.6.1.4 Setting the Rate Update Coefficient

The PPI's rate display can be adjusted to update as quickly as 5 times a second or as slowly as every 2 seconds. To adjust how often the display updates;

1. From the Main Menu (press **[PREV.]** until the Main Menu appears) press Menu **[F6],** and then Mode **[F1].**
2. Use the up and down arrow key to highlight "Rate Update".
3. Hit the **Enter** key.
4. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value. The Rate update can range from 0.2 to 2 seconds.
5. Use the left and right arrow keys to increment to the next digit.
6. Repeat steps 4 and 5 until the entire value is entered.
7. Hit the **Enter** key to accept the entry.

4.6.1.5 Setting the Rate Integration Coefficient

In addition to selecting the interval at which the rate display updates (see 4.6.1.4), the user can also adjust the time it takes for the rate display to respond to a step change in the rate. This feature can be used to "smooth" the rate reading and is called Rate Integration. By adjusting the rate integration value, the rate display can be made to respond to a step change in a rate in as quickly as 1 second (Rate Integration set at 1) or as slow as 20 seconds (Rate Integration set to 20).

1. From the Main Menu (press **[PREV.]** until the Main Menu appears) press Menu **[F6],** and then Mode **[F1].**
2. Use the up and down arrow key to highlight "Rate Integrate".
3. Hit the **Enter** key.
4. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value. The rate integration can range from 1 to 20 seconds.
5. Use the left and right arrow keys to increment to the next digit.

6. Repeat steps 4 and 5 until the entire value is entered.
7. Hit the **Enter** key to accept the entry.

When the Rate Integration is set to 3, the rate display takes about 3 seconds to match the change in rate. When this variable is set to 10, it takes about 10 seconds to match the same step change in rate. Thus, when a step change occurs in the rate, a lower rate integrate value might cause the rate reading to instantly "jump" and therefore look noisy, whereas with a higher integrate value, the response is smoother.

NOTE: The Rate Update and Rate Integration feature does not affect the displayed pressure reading it only effects the displayed "rate" value. Response time on the pressure is almost immediate (see Section 4.6.1.3), with filtering occurring for a very small change in pressure.

4.6.2 DISPLAY SETUP

The Menu Setup menu is used to set the display timeout, display contrast, key click and access password.

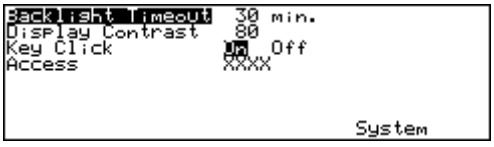

Figure 4-19

4.6.2.1 Screen Saver Backlight Timeout

The display timeout defines the amount of time that must pass without a key selection on the PPI before to the backlight on the display turns off. This function is used as a screensaver and to extend the battery life when operating by battery. Setting this variable to 0 disables this function. Hitting any key will turn the backlight on.

4.6.2.2 Display Contrast

The display contrast can be varied to improve viewing properties in various lighting conditions. The user may want to vary the default value to develop the preferred contrast.

4.6.2.3 Key Click

The PPI can be configured to click each time a key is pressed.

The key click is set from the Menu Setup menu. From the Main Menu (press **[PREV.]** until the Main Menu appears), press Menu **[F6],** and then Setup **[F2].**

1. Use the up and down arrow key's to highlight "Key click."
2. Use the left and right arrow keys to select on or off.
3. Press **[PREV.]** to return to the previous Menu.

4.6.2.4 Calibration Password

The calibration password allows the operator to protect access to the PPI's calibration constants and the calibration procedure. If the calibration password is set to any number other than zero, it is required before the user is allowed to calibrate the PPI or manually change the calibration constants.

NOTE: Document the calibration password, as it is not retrievable from the PPI.

1. The calibration password is set from the Menu Setup menu. From the Main Menu (press **[PREV.]** until the Main Menu appears), press Menu **[F6],** then setup **[F2].**
2. Use the up and down arrow keys to highlight "Access."
3. Enter the new calibration password. Setting the calibration password to zero allows access to PPI calibration and constants.
   a. Using the left and right arrow keys to highlight the variable you wish to edit.
   b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
   c. Repeat steps a and b until the entire value is entered.
   d. Hit the **Enter** key to accept the entry.
4. Press Yes **[F4]** to acknowledge changing the calibration password. Press No **[F5]** to reject changing the calibration password.

4.6.2.5 System Setup

The system setup is used to view the current revision of software operating in the PPI and to view or set the date and time.

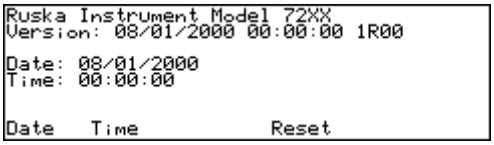

Figure 4-20

4.6.2.5.1 Setting the System Date and Time

The PPI's system clock is continuously updated even through power off and on.

1. The date and time are set from the Menu Setup System menu. From the Main Menu (press **[PREV.]** until the Main Menu appears). Press Menu **[F6],** then Setup **[F2],** and then System **[F5].**
2. To set the system date, press Date **[F1].**
   a. Use the left and right arrow keys to highlight the variable you wish to edit. The date format is month, date, and four-digit year (mmddyyyy). All digits must be entered.
   b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
   c. Use the left and right arrow keys to increment to the next digit.
   d. Repeat steps b and c until the entire value is entered.
   e. Hit the **[Enter]** key to accept the entry.
3. To set the system time, press Time **[F2].** Use the numeric keypad to enter the current time. All digits must be entered. Press **[ENTER]** to accept.
   a. Use the left and right arrow keys to highlight the variable you wish to edit. The time format is hour, minute, and second (hhmmss). All digits must be entered.

b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
c. Use the left and right arrow keys to increment to the next digit.
d. Repeat steps b and c until the entire value is entered.
e. Hit the **[Enter]** key to accept the entry.

4.6.3 CALIBRATION

To keep the PPI operating within its specification, the calibration procedure described below should be performed periodically. The recalibration interval should be based on the stability of the instrument as obtained from its past calibration history or from the Ruska product specification.

CAUTION: The calibration procedure automatically generates coefficients that are stored in the PPI's memory. If these constants are "lost" for any reason, the calibration procedure must be performed, regardless of the last calibration date. If the calibration coefficients have been recorded, they may be restored to the PPI at any time by editing the coefficients (see Section 4.6.3.2) without performing a new calibration on the PPI.

The calibration menu allows the operator to zero, calibrate or edit the calibration coefficients. When any of these procedures are performed, the PPI automatically date-stamps this function to provide proof that this event occurred. If the access code is enabled, it must be entered in order to perform these functions.

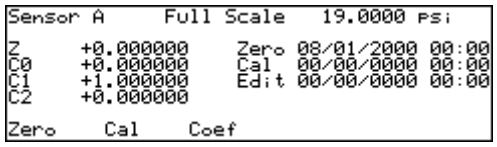

Figure 4-21

There will be separate coefficients for each pressure sensor that is present in the PPI. Additionally, if a sensor is triple-scaled, then there will be a set of coefficients for each sub-range.

4.6.3.1 Zeroing Procedure

The zeroing procedure is performed to correct for system zero shift and does not require a full calibration. The most important requirement for performing a valid zeroing procedure is to know what the actual pressure is at the test port. Pressure gradients in the system must be accounted for when comparing the PPI to another standard to determine the zero reading.

NOTE: When the sensor is calibrated using the calibration procedure (see Section 4.6.3.2), a zero is performed in the first step of this procedure. Therefore, it is not required to perform this zeroing procedure prior to performing the full calibration procedure.

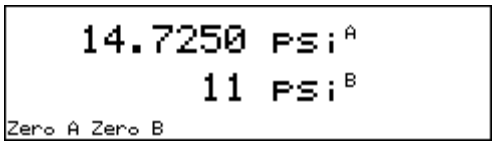

Figure 4-22

Figure 4-23

4.6.3.1.1 Zeroing Gauge Mode Sensors

When zeroing a PPI with a sensor reference to atmosphere;

1. Open the test port to atmosphere. Assure that all pressure heads are accounted for in determining the actual pressure that exist at the test port of the PPI.
2. From the Main Menu (press **[PREV.]** until the Main Menu appears) press the Menu **[F6],** Cal **[F3],** Zero **[F1].**
3. For Dual Sensor PPI's, select the sensor to be zeroed, press Zero A **[F1]** to zero sensor A or Zero B **[F2]** for sensor B (see Figure 4.22).
4. Enter the actual pressure that exist at the test port.
   a. Use the left and right arrow keys to highlight the variable you wish to edit.
   b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
   c. Use the left and right arrow keys to increment to the next digit.
   d. Repeat steps b and c until the entire value is entered.
   e. Hit the **[Enter]** key to accept the entry.
5. Press the **[PREV]** key multiple times to return to the main menu.

4.6.3.1.2 Zeroing Absolute Mode Sensors

When zeroing a PPI with an absolute sensor, there are three commonly used methods. The method selected should be based on the pressure range and accuracy requirements of the PPI.

Method One: Connect the test port of the PPI to a suitable standard and compare the two instruments at the lower pressure limit of the PPI. The PPI would be zeroed to the reading obtained from the standard. This is commonly used on PPI's with sensors that have a minimum pressure range that is greater than 0 psia. (i.e. a sensor with a defined pressure range of 0.4 to 19 psia should not be zeroed at a pressure less than the minimum pressure of 0.4 psia in this example.)

Method Two: Connect a vacuum sensor and a vacuum pump to the test port of the PPI. Pull a hard vacuum (less than 200 mtorr) on the test port. Convert the reading from the vacuum sensor into the same unit of measure as the current PPI unit of measure selection. Enter this vacuum reading into the PPI as the zero offset. Example, if the vacuum pump pulled the test port down to a vacuum gauge reading of 100 mtorr, the value entered into the PPI for this zero reading would be 0.0019 psia.

$$100\ mtorr\ x\frac{0.0000193368\,psi}{1mtorr}=0.0019\,psi$$

This method tends to be the most accurate method for sensors that are designed to operate at these hard vacuum levels. If the pressure sensor in the PPI has a minimum

pressure range (i.e. Range 0.4 to 19 psia, the minimum range is 0.4 psia) that is higher than a hard vacuum this method should not be used.

Method Three: Compare the PPI to a barometer (with both instruments at the same height to correct for pressure heads) and enter the barometers reading as the zero reading to the PPI. This method would only be suggested if the uncertainty of the barometer would not negatively influence the uncertainty of the PPI.

Whichever method is selected, the following steps would be required to zero the PPI;

1. Select one of the zeroing methods described above and connect the PPI accordingly.
2. From the Main Menu (press **[PREV.]** until the Main Menu appears) press the Menu **[F6],** Cal **[F3],** Zero **[F1].**
3. For a Dual Sensor PPI, select the sensor to be zeroed, press Zero A **[F1]** to zero sensor A or Zero B **[F2]** for sensor B (see Figure 4.22).
4. Enter the actual pressure that exist at the test port.
   a. Use the left and right arrow keys to highlight the variable you wish to edit.
   b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
   c. Use the left and right arrow keys to increment to the next digit.
   d. Repeat steps b and c until the entire value is entered.
   e. Hit the **[Enter]** key to accept the entry.
5. Press the **[PREV]** key multiple times to return to the main menu.

4.6.3.2 Calibration Instructions

To calibrate the PPI, the user connects a calibration standard, such as a Ruska Model 2465 for pneumatic pressures or the Model 2485 deadweight gauge for hydraulic pressures, to the PPI test port. Follow the menu driven procedure as shown on the front display. The number of pressure points and the recommended pressures to be generated will be displayed by the PPI's menu driven calibration procedure. On a standard single range sensor, this will be a three-point calibration at 0 (or near zero), 50% and 100% of the PPI's Full Scale. No disassembly is required and there are no potentiometers to adjust to calibrate the PPI.

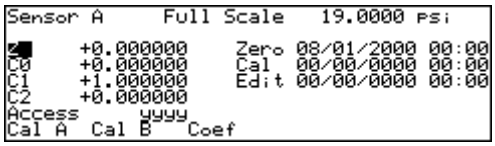

Figure 4-24

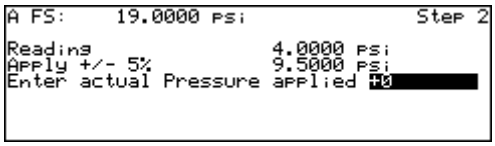

Figure 4-25

Preparation

1. Verify that the PPI has been at a stable environmental temperature and that the PPI has been warmed up for a minimum of 30 minutes.
2. If desired, change the unit of measure (see section 4.4.3) to match that of the standard.

3. Enter the calibration screen. From the Main Menu (press **[PREV.]** until the Main Menu appears) press the Menu **[F6],** Cal **[F3],** Cal **[F2].**
4. For Dual Sensor PPI's, select the sensor to be calibrated, press Cal A **[F1]** to Calibrate sensor A or Cal B **[F2]** for sensor B (see Figure 4.24).
5. If the user has invoked the PPI password protection, enter the password.

NOTE: To exit the calibration procedure before the calibration coefficients have been changed, press **[PREV]** multiple times. Canceling restores all previous calibration values.

Step 1

1.1 Step one sets the zero on the PPI. Please refer to the zeroing section (section 4.6.3.1) for details on zeroing methods.

1.2 Enter the actual pressure that exist at the test port of the PPI.

1.3 If the actual pressure applied by the standard is within the indicated tolerance, the second calibration screen will appear.

Step 2

2.1 To begin step 2, use a calibration standard to apply 50%, +/- 5% of the full scale pressure requested by the **Apply Line** of the PPI (see figure 4.25). As pressure is admitted into the test port, the measured pressure on the PPI's screen will change accordingly on the **Reading Line** of the PPI display.

2.2 When the measured pressure stabilizes, enter the applied pressure value. *Do not enter the measured pressure reported by the PPI*.

a. Use the left and right arrow keys to highlight the variable you wish to edit.
b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
c. Use the left and right arrow keys to increment to the next digit.
d. Repeat steps b and c until the entire value is entered.
e. Hit the **[Enter]** key to accept the entry.

2.3 If the actual pressure applied by the standard is within the indicated tolerance, the third calibration screen will appear.

NOTE: The actual pressure is outside of the tolerance for the requested mid-point pressure, error -222 Data Out of Range will occur. Acknowledge this error by selecting OK, then re-enter the actual pressure, repeat Step 2.2 if necessary.

Step 3

3.1 To begin step 3, use a calibration standard to apply 100%, +/- 5% of the full scale pressure requested by the **Apply Line** of the PPI (see figure 4.25). As pressure is admitted into the test port, the measured pressure on the PPI's screen will change accordingly on the **Reading Line** of the PPI display.

3.2 When the measured pressure stabilizes, enter the applied pressure value. *Do not enter the measured pressure reported by the PPI.*

a. Use the left and right arrow keys to highlight the variable you wish to edit.
b. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
c. Use the left and right arrow keys to increment to the next digit.
d. Repeat steps b and c until the entire value is entered.
e. Hit the **[Enter]** key to accept the entry.

3.3 If the actual pressure applied by the standard is within the indicated tolerance, the calibration complete screen will appear.

NOTE: On some high pressure sensor versions of the Model 7230, a fourth pressure point may be requested. This would be identified in the menu-driven calibration procedure. Typically, this point would be to reproduce the 50% pressure point but approaching this pressure in a downward approach from the full scale pressure of the sensor.

NOTE: If the actual pressure is outside of the tolerance for the requested mid-point pressure, error -222 Data Out of Range will occur. Acknowledge this error by selecting OK, then re-enter the actual pressure, repeat Step 2.2 if necessary.

Step 4

Calibration is complete. To store the calibration coefficients in memory, select OK **[F6].**

Step 5

Press **[PREV.]** to return to the main menu.

This completes the adjustment portion of the calibration. It is recommended that a number of verification points are evaluated in order to assure that the calibration was performed properly and that the instrument is performing as expected.

NOTE: In addition to saving the calibration coefficients to the PPI's memory, the user is advised to separately record the calibration coefficients and store this "backup" in a safe place.

4.6.3.3 Triple Range Sensor Option

For a PPI that includes the optional triple range calibration, the calibration procedure is identical to the single range sensor calibration procedure except it will be performed three times, one per sensor range. At the beginning of the procedure, the user will define which sensor range is being calibrated, and then follow the menu-driven calibration procedure.

The operator has the option of calibrating anywhere from one to all three of the sub-ranges. To perform a complete calibration of the PPI, all three ranges would need to be calibrated.

When performing a calibration on a triple range sensor, the user also has the option of selecting the number of pressure points they wish to include in the calibration sequence. The default number of calibration points is 3 points up (0, 50% and 100%) and 1 point down (50%). This should be all that is required on the typical pressure sensor. Increasing the number of calibration adjustment points can increase the performance of the sensor. The maximum number of calibration adjustment points that the operator can select is 10.

4.6.3.4 Editing the Calibration Coefficients

If the PPI's memory is erased but the calibration coefficients are known, the user can restore the coefficients to the PPI by following the directions below.

> **CAUTION:** Never randomly adjust the calibration coefficients. Only qualified personnel with valid backup data should be allowed to edit the coefficients. If the backup coefficients are questionable, perform the calibration procedure in its entirety.

To edit the calibration coefficients press Menu **[F6],** Cal **[F3],** Coef **[F3].** If the access code is enabled, enter it at the access code prompt.

1. Use the up and down arrow keys to highlight the coefficient to be edited.
2. Use the left and right arrow keys to highlight the variable you wish to edit.
3. Use the up and down arrow keys to scroll through a list including a decimal, negative sign and numerical numbers representing the desired value.
4. Use the left and right arrow keys to increment to the next digit.
5. Repeat steps 3 and 4 until the entire value is entered.
6. Hit the **[Enter]** key to accept the entry.

Once the calibration coefficients are input, it is recommended that the user should verify several pressure readings. If there are any variances beyond the stated precision at these points, then the calibration procedure should be performed.

4.6.4 REMOTE

The remote menu is used to set-up the remote interface. This menu is utilized to set up the IEEE-488 interface address and the RS-232 interface variables.

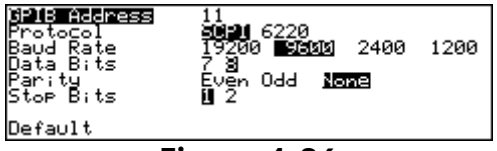

Figure 4-26

4.6.4.1 SETTING THE PPI TO EMULATE A RUSKA MODEL 62XX

The Protocol is set from the Menu Remote menu. From the Main Menu (press **[PREV.]** until the Main Menu appears), press Menu **[F6],** and then Remote **[F4].**

1. Use the up and down arrow key's to highlight "Protocol".

2. Use the left and right arrow keys to select SCPI or 6220. The SCPI is the standard interface, the 6220 is the Ruska Series 6200 emulation protocol.
3. Press **[PREV.]** to return to the previous Menu.

4.6.5 TEST

The self-test function initiates the same electrical self-test that is performed upon power-up. This can be useful to assure that the system is operating properly.

4.6.5.1 Testing Remote Interface

When connecting the PPI to a remote IEEE-488 interface, the Remote Testing screen can provide the user with a variety of remote troubleshooting capabilities. This screen will display both the remote input and output lines that are being transmitted across the interface.

4.6.6 DISPLAY

The Menu Display screen provides raw data of the system sensors as well as the corrected values in engineering units of measure. This screen is generally utilized for troubleshooting the instrument. When operating on a battery, this screen is useful in viewing the current voltage level of the battery.

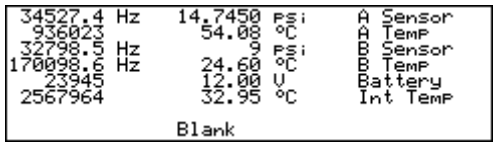

Figure 4-27

4.6.6.1 Blanking Out the Front Display

To conserve battery power and to act as a screen saver, the front display backlight will blank out after the time has expired that is set in the display screen saver - backlight timeout (see Section 4.6.2.1). The display can also be blanked by selecting the Menu **[F6],** Disp. **[F6],** Blank **[F3].**

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SECTION 5.0
REMOTE OPERATION

5.1 CAPABILITIES

The PPI can be operated remotely by a computer. Two interfaces are supported: IEEE-488 and RS-232. Both interfaces support SCPI (Standard Commands for Programmable Instruments) and emulation of a Ruska 62XX PPI. The IEEE-488 interface conforms to the following standards:

ANSI/IEEE Std 488.1-1987	IEEE Standard Digital Interface for Programmable Instrumentation
ANSI/IEEE Std 488.2-1987	IEEE Standard Codes, Formats, Protocols, and Common Commands
SCPI 1991.0	Standard Commands for Programmable Instruments

5.1.1 IEEE-488

The following identification codes define the interface capabilities of the PPI. Identification codes are described in the IEEE-488 standard.

SH1	Source Handshake, Complete Capability
AH1	Acceptor Handshake, Complete Capability
T5	Talker
L3	Listener
SR1	Service Request, Complete Capability
RL1	Remote-Local, Complete Capability
PP0	Parallel Poll, No Capability
DC1	Device Clear, Complete Capability
DT0	Device Trigger, No Capability
C0	Controller, No Capability

The IEEE-488 interface is installed next to the processor board. The interface is identified by the IEEE-488 standard connector on the back panel of the unit.

NOTE: Do not change any jumpers or switch settings on the IEEE-488 interface board. The IEEE-488 address is set by the MENU/REMOTE screen.

5.1.2 RS-232

The RS-232 interface supports standard serial operation from a computer to a single PPI. RS-232 supports the IEEE-488.2 and SCPI commands. The PPI allows the following port setups:

Baud Rate:	1200, 2400, 9600, or 19200
Data Bits:	7 or 8
Parity:	Even, Odd, or None
Stop Bits	1 or 2
Handshaking	XON/XOFF

The RS-232 connection is a DB-9P connector found on the back panel of the PPI. The following pins are used; all other pins are reserved.

Pin #	Direction	Signal	
2	In	RXD	Receive Data
3	Out	TXD	Transmit Data
5	——	GND	Ground
7	Out	RTS	Request to Send

5.2 REMOTE/LOCAL OPERATION

In Local mode, the PPI is operated manually through the front panel. Section 4 of this manual covers Local mode operation. The PPI always powers up in the Local mode. In Remote mode, the PPI is operated by a computer connected to an interface. Most functions that can be performed in Local mode can also be performed remotely.

Remote mode does not automatically disable local operation. The remote interface may be active while local operations are being done. In cases where full remote control is required, the following methods may be used.

1. Issue a Local Lockout (LLO) interface message via the IEEE-488 interface. The PPI will disable the local keyboard until the Go To Local (GTL) interface message is received or the REN (Remote Enable) line is unasserted. This method cannot be used on the serial interface.
2. Issue the SCPI command "SYSTEM:KLOCK ON" to lock the local keyboard. The PPI will disable the local keyboard until the command "SYSTEM:KLOCK OFF" is received.
3. Issue the SCPI command "DISPLAY:ENABLE OFF" or "DISPLAY:TEXT <string>." These commands will disable the local display in addition to locking the keyboard. The command "DISPLAY:ENABLE ON" will restore the local display and keyboard operation.

Local operation may also be restored by turning the PPI off and back on.

5.3 CONFIGURATION

The remote interface must be configured before it is connected. The remote interface is configured using the local interface. The parameters needed vary with the interface used.

IEEE-488	Address, Protocol
RS-232	Protocol, Baud Rate, Data Bits, Parity, Stop Bits

To configure the remote interface:

1. The remote interface is configured from the **Remote Menu**. From the **Main Menu** (press **[PREV.]** until the Main Menu appears), press **Menu [F6],** then **Remote [F4].**
2. Use the up and down arrows to highlight the desired parameter.
3. Use the left and right arrows to change the parameters. The **[ENTER]** key may be used to change the address.
4. Repeat steps 2 and 3 to set all parameters needed.

5.4 DEVICE MESSAGES

5.4.1 SCPI COMMAND FORMAT

SCPI mnemonics have two forms: long and short. SCPI ignores case: uppercase and lowercase are equivalent. The short form is shown in the summary and is all in capital letters. The long form is the entire mnemonic. Commands may use either the short form or the entire long form. No other forms are accepted.

A SCPI command is made by following the command tree as presented in the command summary. Each level adds a mnemonic to the command separated by colons (:). Mnemonics enclosed in square brackets are optional and may be omitted.

Some mnemonics are followed by an optional numeric suffix. If omitted, the suffix defaults to 1.

Multiple commands may be placed in a single message separated by semicolons (;). Each command starts at the same level of tree where the last command stopped, unless the command starts with a colon. The first command in a message and any commands starting with a colon start at the root of the command tree. IEEE 488.2 commands may occur between SCPI commands without affecting the tree level.

Command parameters are separated from the command name by one or more spaces. Multiple parameters are separated by commas (,). SCPI accepts numeric parameters with optional sign, decimal point, and exponent. OFF is equivalent to zero and ON is equivalent to one. Floating point numbers are rounded to the nearest integer for commands accepting integer values only.

A message is terminated by a line feed (hexadecimal 0A). Carriage returns, tabs, and other control characters are ignored.

5.4.2 SCPI RESPONSE FORMAT

Only commands ending in a question mark (?) have responses. Multiple values from a single command are separated by commas. Responses from different commands in the same message are separated by semicolons (;). The response message is terminated by a line feed (hexadecimal 0A).

Integer responses are returned as one or more digits. Boolean values (ON and OFF values) are always returned as numbers, with zero for OFF and one for ON. Floating point values are returned in the format "+d.ddddddddE+dd."

5.4.3 ANSI/IEEE 488.2-1987 COMMAND SUMMARY

*CLS		Clear Status
*ESE?		Event Status Enable Query
*ESE	<number>	Event Status Enable
*ESR?		Event Status Register
*IDN?		Identification
*OPC?		Operation Complete Query (Returns 1)
*OPC		Operation Complete
*RST		Reset
*SRE?		Service Request Enable Query
*SRE	<number>	Service Request Enable

*STB?	Status Byte Query
*TST?	Self-Test Query
*WAI	Wait (No operation)

5.4.4 SCPI COMMAND SUMMARY

The current value associated with a SCPI command may be read by appending a question mark to the command. For example CALC:LIM:UPP? will return the current upper pressure limit.

MEASure	
[:PRESsure]?	Read sensor A
[:PRESsure]2?	Read sensor B
:DISPlay?	Read upper display value
:DISPlay2?	Read lower display value
:TEMPerature?	Read sensor A temperature
:TEMPerature2?	Read sensor B temperature
:TEMPerature3?	Read internal temperature
:VOLTage?	Read battery voltage
CALCulate	
:TARE	
[:DISPlay]	
:VALue <number>	Set tare amount for upper display
:STATe ON|OFF|1|0	Set tare state for upper display
:DISPlay2	
:VALue <number>	Set tare amount for lower display
:STATe ON|OFF|1|0	Set tare state for lower display
:LIMit	
[:DISPlay]	
:LOWer <number>	Set lower limit on upper display
:UPPer <number>	Set upper limit on upper display
:DISPlay2	
:LOWer <number>	Set lower limit on lower display
:UPPer <number>	Set upper limit on lower display
CALibration	
[:PRESsure]	*The following commands are for both sensors*
:DATA	
:POINts?	Read number of calibration constants
:VALue<n>?	Read calibration constant (id, value)
:VALue<n> <number>	Set calibration constant
[:PRESsure]	*The following commands are for Sensor A*
:DATA <number>,<number>,<number>	Set calibration constants (C0,C1,C2)
:VALue<n> <number>	Perform calibration point
:CALibration	
:VALue<n>?	Read nominal calibration point
:POINts?	Read number of calibration points

```
        :POINts <up>,<down>          Set number of triple calibration points
    :DATE?                           Read date of last calibration
    :TIME?                           Read time of last calibration
    :ZERO
        :DATE?                       Read date of last zero
        :TIME?                       Read time of last zero
        :VALue <number>              Enter actual pressure for zeroing (before RUN)
        :RUN                         Perform zero
  [:PRESsure]2      Sensor B commands are the same as Sensor A
    ...
  :TEMPerature                       Sensor A temperature
    :DATA <number>,<number>                Set C0, C1
    :VALue <number>                        Calibrate to value (1 point cal)
  :TEMPerature2                      Sensor B temperature
                    Same as :TEMP
  :TEMPerature3                      Oscillator temperature
                    Same as :TEMP
  :VOLTage                           Battery voltage
    :DATA <number>,<number>          Set C0, C1 for Battery voltage
    :VALue <number>                  Calibrate to value (1 point cal)
  :MODE ON|OFF|1|0                   Request calibration edit (must be on to
                                     cal or change constants)

DISPlay
  :ENABle ON|OFF|1|0                 Turn front panel display on/off
  :TEXT "<text>"                     Display message on front panel
  :CONTrast <number>                 Set display contrast (0.0 - 1.0)
  :LIGHt
    :TIMeout
        :TIME <number>               Backlight timeout in seconds
        :STATe ON|OFF|1|0            Enable/disable backlight timeout
    :STATe ON|OFF|1|0                Turn backlight on/off
SENSe
  [:PRESsure]
    [:DISPlay]
        [:RESolution] <number>       Set upper display resolution
            :AUTO ONCE               Set resolution to default
    :DISPlay2
        [:RESolution] <number>       Set lower display resolution
            :AUTO ONCE               Set resolution to default
    :RANGe      Sensor A
        [:UPPer]?                    Read current maximum for sensor
        [:UPPer] <number>            Set triple range
        :LOWer?                      Read pressure minimum
    :REFerence
        :MEDium N2|AIR
```

```
   [:PRESsure]2
     :RANGe      Sensor B
          ...
STATus
   :OPERation
     [:EVENT]?                          Read and clear operation event register
     :CONDition                         Read operation condition register
     :ENABle <number>                   Set operation enable mask
   :QUEStionable
     [:EVENT]?                          Read and clear questionable event register
     :CONDition?                        Read questionable condition register
     :ENABle                            Set questionable enable mask
   :PRESet                              Clear enable masks
:SYSTem
   :DATE <year>,<month>,<day>           Set system date
   :ERRor?                              returns <error#,"descr;info"> or 0,"No
   Error"
   :KLOCk ON|OFF|1|0                    Set keyboard lock
   :TIME <hour>,<minute>,<sec>          Set system time
   :VERSion?                            SCPI protocol version (returns 1991.0)
   :LANGuage "COMP"|"SCPI"|"6220"       Set remote protocol
   :COMMunicate
     :SERial
          :RECeive
          :TRANsmit
               :BAUD <number>           Set remote baud rate
               :PARITY EVEN|ODD|NONE    Set remote parity
               :BITS 7|8                Set remote data bits
               :SBITs 1|2               Set remote stop bits
     :GPIB
          :ADDRess <number>             Set remote address
   :SET <block>                         Set profile data
TEST
   :ELECtronic?                         Perform electronic self-test
UNIT
   :DEFine<n> <name>,<number>           Create unit
   [:PRESsure] <name>                   Set pressure units for SCPI commands
                                        Valid unit names are KPA, BAR, PSI,
                                        KG/CM2, MMHG0C, CMHG0C,
                                        INHG0C, INHG60F CMH2O4C,
                                        INH2O20C, INH2O25C, %FS, FT, M,
                                        KNOT, KM/HR, MPA, PA
     :DISPlay <name>                    Set upper display pressure units
     :DISPlay2 <name>                   Set lower display pressure units
```

5.4.5 EXAMPLE SCPI COMMANDS

To request the current pressure reading, all of the following commands are equivalent:

:MEASURE:PRESSURE?
:measure:pressure?
:MeAsUrE:pReSsUrE?
:meas:pres?
:measure?
:meas?
MEAS?

5.4.6 SCPI STATUS REGISTERS

Status Byte Register (STB), Service Request Enable Register (SRE)

Bit 7 Operation status summary. Set when an event enabled in OPER:ENABLE occurs.
Bit 6 Service request. Set when an event enabled in SRE occurs. (This bit is not used in SRE.)
Bit 5 EBS - Event status bit. Set when an event enabled in ESE occurs.
Bit 4 MAV - Message available. Set when a response is ready to be sent.
Bit 3 Questionable status summary. Set when an event enabled in QUES:ENABLE occurs.
Bit 2 Error/event queue not empty.
Bit 1 Reserved.
Bit 0 Reserved.

Standard Event Status Register (ESR), Standard Event Status Enable Register (ESE)

Bit 7 Power-on. Set at power-up.
Bit 6 Reserved.
Bit 5 Command error. Error in command syntax.
Bit 4 Execution error. Error in command execution.
Bit 3 Device dependent error. Device error independent of commands.
Bit 2 Reserved.
Bit 1 Reserved.
Bit 0 Operation complete. Set for *OPC command.

Operation Status (OPER:EVENT, OPER:CONDITION, OPER:ENABLE)

Bit 0 Reserved.
Bit 1 Reserved.
Bit 2 Reserved.
Bit 3 Reserved..
Bit 4 Measuring. The instrument is actively measuring.
Bit 5 Reserved.
Bit 7 Reserved.
Bit 8 Reserved.
Bit 9 Reserved.
Bit 10 Reserved.
Bit 11 Reserved.
Bit 12 Reserved.
Bit 13 Reserved.
Bit 14 Reserved.
Bit 15 Reserved.

Questionable Status (QUES:EVENT, QUES:CONDITION, QUES:ENABLE)

Bit 0 Reserved.
Bit 1 Reserved.
Bit 2 Time is questionable. Set when the clock has not been set.
Bit 3. Reserved.
Bit 4 Reserved.
Bit 5 Reserved.
Bit 6 Reserved.
Bit 7 Calibration is questionable. Set when the unit has not been calibrated.
Bit 8 Reserved.
Bit 9 Reserved.
Bit 10 Reserved.
Bit 11 Reserved.
Bit 12 Reserved.
Bit 13 Reserved.
Bit 14 Command warning. Set whenever a command ignores a parameter.
Bit 15 Reserved.

5.5 62XX PPI EMULATION

The PPI may be configured to emulate the Ruska 62XX PPI. See the 62XX PPI User's Manual for a description of the protocol. The PPI emulation has the following differences:

1. The commands do not affect the local display.
2. No calibration commands are supported.

To change from SCPI to Interface Panel Emulation via the remote interface, send the following message: :SYSTem:LANGuage "6220".
To change from Interface Panel Emulation to SCPI via the remote interface send the following message: :SYSTem:LANGuage "SCPI".

5.6 SERIAL OPERATION

The RS-232 port accepts the same SCPI commands as the IEEE-488 port. The commands can be terminated by a carriage return (hexadecimal 0D) or a line feed (hexadecimal 0A). The responses are always terminated by a carriage return followed by a line feed.

The serial port also supports XON/XOFF. When the XOFF (hexadecimal 13) command is received, the PPI will stop transmitting. Transmission is restarted when the XON (hexadecimal 11) command is received.

When only one unit is attached, the Control-C (hexadecimal 03) command will clear the transmit and receive buffers and disable addressing. When addressing is disabled, the unit will respond to commands without being addressed.

SECTION 6.0
PREVENTIVE MAINTENANCE

6.1 INTRODUCTION

The PPI contains no user-serviceable parts and is virtually maintenance free. In fact, re-zeroing and calibration of the unit are the only routine processes needed to keep the PPI operating within specifications. The re-zeroing and calibration procedures, along with recommended intervals, are discussed in Section 4.6.3

If instrument failure is suspected, the user is advised to perform the **SELF TEST** described in Section 6.2.

If there is any other failure in the instrument, do not attempt to correct it. Instead, contact Ruska to report the problem.

> **NOTE:** When contacting Ruska, be prepared to furnish the model number, serial number, pressure rating, and software version (see Section 4.6.2.5, "System Set-up").

6.2 SYSTEM SELF TEST

The PPI software has a **SELF TEST** feature which checks the function of the following items. To perform the System **SELF TEST** press **MENU [F6],** then **TEST [F5],** then **SELF [F3].**

1. Coprocessor - This test checks for function of the processor and reports pass/fail condition to the screen.
2. Clock - This test checks the on-board computer BIOS. The processor board memory, config, check sum, memory size, and time are checked. Any failure is reported to the screen.
3. Timer - The interrupt is intended to operate at 100 Hz. Any significant deviation from that is reported as the actual frequency noted.
4. EEPROM - This tests the contents of the EEPROM for changes and reports pass/fail to the screen.

To exit the **SELF TEST** screen, press **PREV** twice.

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SECTION 7.0
SPECIFICATIONS

7.1 INTRODUCTION

This portion of the manual discusses the parameters which can affect the unit's precision of measurement. Sections 7.2 through 7.7 discuss parameters such as warm-up time and tilt sensitivity.

7.2 WARM-UP TIME

After the instrument has been removed from storage, it is important to maintain the instrument within the operating temperature range for at least one hour.

After the instrument has been turned on, it will take less than 30 minutes for it to indicate pressure to rated accuracy. Typically, at room temperature, the instrument will exhibit the specified accuracy within 15 to 20 minutes.

7.3 TILT SENSITIVITY

If the instrument is calibrated in the same position that it is used, then there will be no additional errors introduced due to positioning.

7.4 CALIBRATION PERIOD

It is recommended that the instrument be calibrated against a suitable pressure standard at least once per year.

7.5 TEMPERATURE EFFECTS

The instrument will measure pressure to within rated accuracy if operated between 0 and 50°C. There is no temperature compensation for the user needs to calculate.

The instrument may not indicate pressure to rated accuracy if the ambient temperature is changing by more than 20 Celsius degrees per hour or more than 1 Celsius degree per 3 minutes.

When the instrument is subjected to a temperature shock of more than 5 Celsius degrees, a "soak time" of 15 minutes for every 5°C temperature shock must be allowed. Thus, for a temperature shock of 20 Celsius degrees, a soak time of 1 hour must be allowed.

7.6 LONG-TERM STORAGE

The PPI should be stored in a cool, dry place, with the battery or power supply removed. Refer to Section 8 for instructions.

7.7 SENSOR SPECIFICATION

See Appendix C for sensor specifications.

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SECTION 8.0
PREPARATION FOR STORAGE/SHIPMENT

8.1 DISCONNECT INSTRUCTIONS

NOTE: It is essential that the procedures mentioned in Sections 8.1 through 8.3 be strictly adhered to in order to prevent damage to the instrument. Failure to follow these procedures may result in damage during shipment that will not be covered by the carrier's insurance.

1. Relieve all pressure from the PPI.
2. Turn the power switch off.
3. Disconnect the power cable from the power receptacle.
4. Remove the battery or power supply from the power source enclosure.
5. Plug or cap ports.

8.2 PACKING INSTRUCTIONS

The instructions below must be strictly followed in order to prevent damage to the instrument.

The main principle behind a successful shipment is that of minimizing shocks to the pressure transducers. This is accomplished by cradling the device within a box such that the PPI is restrained but still has resilience. The two most successful materials for this purpose are rubber foam and flexible polyurethane foams. Styrofoam, poured "foam in place" mixtures, and other rigid foams are not suitable. Even polyfoam or rubber foam should be cut into strips so that it will not present a large rigid surface to the PPI.

Ruska has found that corrugated cardboard boxes provide the best packing. The boxes sometimes arrive damaged, but the contents are usually intact. A minimum of 1 inch of foam should separate the inner surface of the box and any portion of the PPI.

If the original packing and shipping materials were retained, use them for packing the PPI. If the PPI is being packed for long-term storage (more than 30 days), place a desiccant bag with the unit inside a plastic bag. The PPI should be stored in a cool, dry place, with the battery or power supply removed.

8.3 PREPARATION FOR SHIPMENT

In general, prepare the PPI for shipment as follows.

1. In order to minimize turn-around time, Ruska should be notified of the return of equipment prior to shipment (contact customer service department). When notifying Ruska please include the part number, serial number, billing and ship to address, and the user's name and phone number. Ruska will supply an RMA (Return Material Authorization) number. Please include this RMA number in all paper work. This information should be duplicated and included with the

shipment when the goods are returned. There will be a minimal charge for inspection and/or evaluation of returned goods.

2. Enclose the PPI in plastic or any good water barrier material. Anti-static material is advisable.
3. Cover top, bottom and sides with polyfoam.
4. Inside the carton, include the following:
   a. Statement of the problem or service needed. Be specific. Include any local or remote error codes that occurred during operation, and if possible, mention the component suspected of failure. Also include the name and telephone number of a knowledgeable technician for consultation.
   b. The part number, serial number, return address, and Ruska RMA number.
5. Seal the carton, using gummed tape.
6. Address the carton to:

RUSKA INSTRUMENT CORPORATION
10311 Westpark Drive
Houston, Texas 77042

7. Labels recommended are THIS SIDE UP, HANDLE WITH CARE, DO NOT DROP and FRAGILE.

8.4 SHIPPING INSTRUCTIONS

Ruska recommends the use of air freight for transportation. Surface transportation subjects the shipment to more frequent handling and much more intense shock.

Again, it is essential that the procedures mentioned in Sections 8.1 through 8.4 be strictly adhered to in order to prevent damage to the instrument.

APPENDIX A
ERROR MESSAGES

Number	Message	Description
0	No Error	
-103	Invalid Separator	Commas must be used to separate SCPI parameters, semi-colons to separate SCPI commands. Also check for extra characters on the end of a command.
-104	Data Type	The SCPI command parameter is the wrong type i.e. a string where a number is expected.
-109	Missing Parameter	The SCPI command requires a parameter.
-110	Command Header	All SCPI command words start with alphabetic characters.
-113	Command Unknown	The SCPI command or format is not supported.
-114	Header Suffix	The numeric suffix at the end of the command name is out of range.
-221	Settings Conflict	The command is not valid in the current mode of the instrument i.e. Range setting without a triple ranged sensor.
-222	Out of Range	The value entered is outside the expected range.
-313	Calibration Data Lost	The calibration constants stored in the instrument have been lost. Check the values before using the instrument.
-315	Configuration Data Lost	Some of the instrument setup has been lost.
-330	Self-Test Failed	The self-test has failed. Check the screen for further details.
-350	Queue Overflow	One or more errors could not be stored because the error queue is full.
-501	High Limit Exceeded	The reading has exceeded the high limit.
-502	Low Limit Exceeded	The reading has exceeded the low limit.
-522	Pressure Over, Range Invalid	A triple-ranged sensor has exceeded 110% of the current range. The pressure must be reduced to below 100 psi before the reading is valid again.
-600	Factory Data Lost	The factory setup of the instrument has been lost.
-601	Calibration Mode	Calibration mode (CAL:MODE) must be entered before a remote calibration will be accepted.
-707	Pressure Too High	Pressure must be below 100 psi to change ranges on a triple-ranged sensor.

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APPENDIX B
OPENING THE ENCLOSURE

Normally, the user should not need to open the PPI enclosure. However, if it becomes appropriate to open the unit, the following procedure is recommended. (Note that software is uploaded, through the RS232 COM port.)

A. Remove the four 6-32 screws on the rear of the outer case and set it aside for later use.

B. Pull the inner case from the front. The inner case will slide out. Place the inner case on the workbench.

To reassemble, reverse this procedure.

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APPENDIX C
SENSOR SPECIFICATIONS

MODELS 7220 AND 7222 SPECIFICATIONS (IN % FULL SCALE)					
Ranges **psia** **kPaa**	**0.5-19** **3.5-130**	**0.5-38** **3.5-260**	**0.5-50** **3.5-345**	**0-150** **0-1034**	**0-750** **0-5000**
Accuracy*	≤ 0.01	≤ 0.01	≤ 0.01	≤ 0.02	≤ 0.02
Overpressure	1.2 X FS	1.2 X FS	1.2 X FS	1.2 X FS	1.2 X FS
Stability/year	0.01	0.01	0.01	0.02	0.02
Maximum Error	0.02	0.02	0.02	0.02	0.02
Output Signals					
Medium	Non-Corrosive Gas			Air or Nitrogen **only**	

* Defined as the combined effects of linearity, hysteresis, and repeatability.

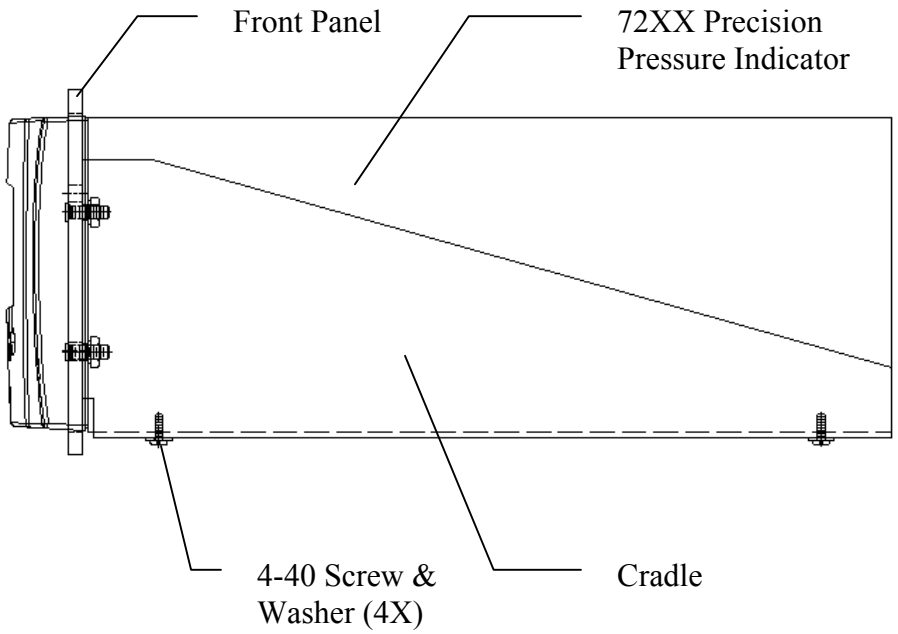
MODELS 7230 AND 7232 SPECIFICATIONS (IN % FULL SCALE)		
Ranges **psi** **SI**	**15 - 20,000 psi** **100 kPa - 140 MPa**	**30,000 - 40,000 psi** **210 - 280 MPa**
Accuracy*	< .01	< 0.02
Overpressure	1.2 x FS	1.2 x FS
Stability/year	0.01	0.02
Maximum Error/year	0.02	0.03
Operating Temperature	0-50 deg C	0-50 deg C
Wetted Materials	304L, 316L SS, Nickel, Gold, Solder	304L, 316L SS, Inconel 718

* Defined as the combined effects of linearity, hysteresis, and repeatability.

APPENDIX D
INSTALLATION INSTRUCTIONS FOR RACK MOUNT KIT

RACK MOUNT KIT FOR 72XX SERIES PRECISION PRESSURE INDICATOR

INTRODUCTION: The Rack Mount Kit, Ruska part number 7220-RMK, provides a convenient method of installing the 72XX Series Precision Pressure Indicator into a standard nineteen inches equipment rack. There is some assembly required in order to adapt the gage unit to the kit. Please follow the instructions in the order presented to facilitate proper installation.



Rack Mount Assembly

INSTALLATION:

1. Assure that power is off and any cabling and plumbing is disconnected from the pressure gage.
2. Place the unit upside down on a soft surface to protect its finish.
3. Remove the rectangular rubber feet from the two front tilt-up feet to expose the screw. Remove the screw securing the tilt-up feet to the unit.
4. Remove the screws securing the two rear soft rubber feet to the unit.
5. Place the Precision Pressure Indicator in the cradle of the Rack Mount Assembly 7220-RMK. Align the threaded holes of the feet to the four holes on the base of the cradle. Secure the Precision Pressure Indicator with four 4-40 screws and washers as shown in the figure above.

The rack mount installation is complete and ready for insertion into a suitable EIA Standard (RS-310-C) rack. Hardware for attachment of the rack to the equipment has not been provided. Hook up electrical and plumbing connections after installation into the rack equipment.

PARTS LIST

PART NUMBER	DESCRIPTION	QUANTITY
72XX-1D02	INSTRUCTION SHEET	1.0
7220-RMK	RACK MOUNT ASSEMBLY	1.0
70-119-1201	SCREW, PHILLIPS 4-40 x 3/8 SS	4.0
91-246	WASHER #4	4.0

U.S.A.
10311 Westpark Drive
Houston, TX 77042
T 713 975 0547
F 713 975 6338

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72XX-1D01, Revision C,
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