FLUKE®
Calibration

RUSKA 7050, 7050i & 7050LP

Precision Pressure Indicator

Users Manual

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7050 – Change Language

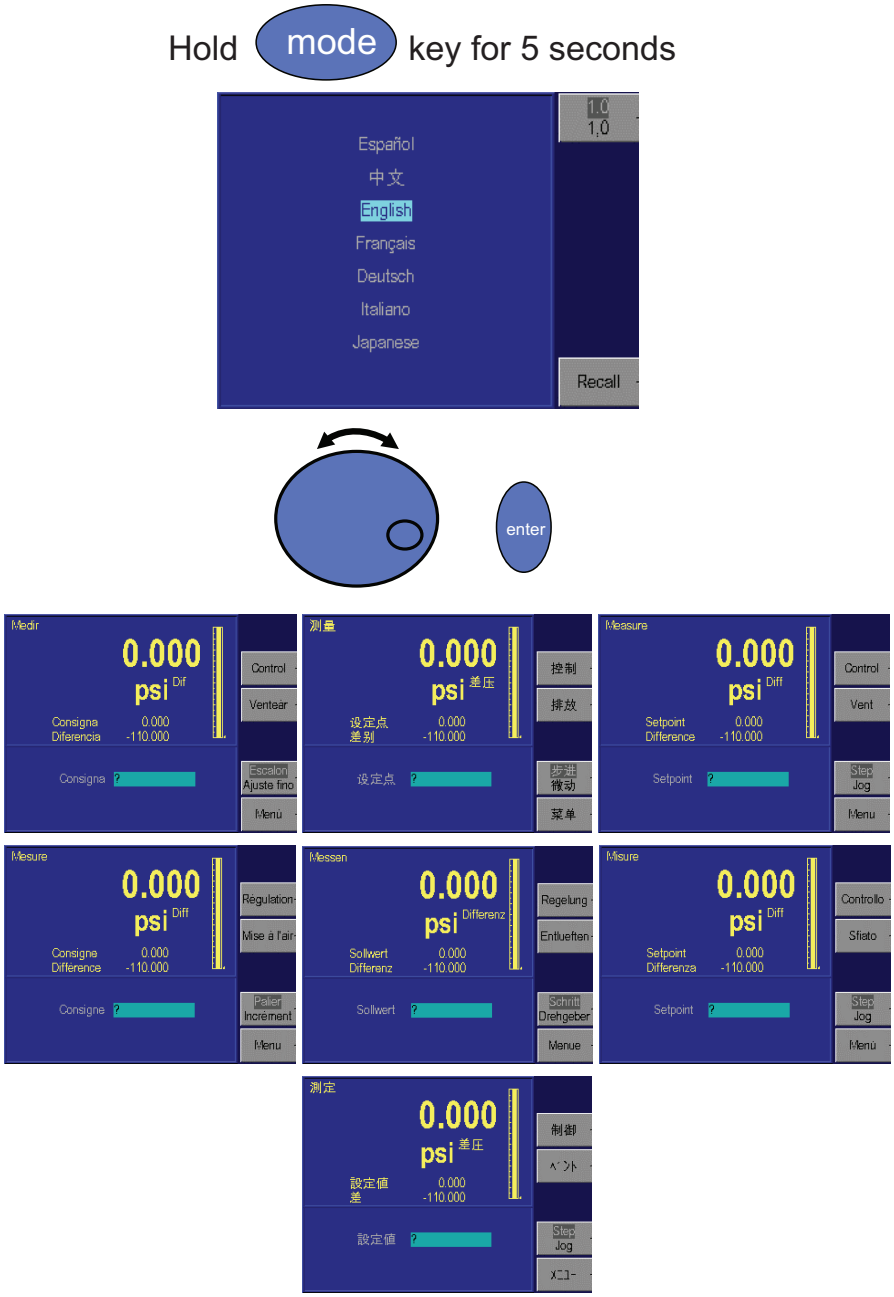


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Chapter 1
General Information

Introduction

This manual contains operation and routine and preventive maintenance instructions for the RUSKA 7050, RUSKA 7050i and RUSKA 7050LP Precision Pressure Indicator (PPI) manufactured by Fluke. This section of the manual provides general information about the PPI and presents its features and options.

How to Contact Fluke

To order accessories, receive operating assistance, or get the location of the nearest Fluke distributor or Service Center, call:

- Technical Support USA: 1-800-99-FLUKE (1-800-993-5853)
- Calibration/Repair USA: 1-888-99-FLUKE (1-888-993-5853)
- Canada: 1-800-36-FLUKE (1-800-363-5853)
- Europe: +31-402-675-200
- China: +86-400-810-3435
- Japan: +81-3-3434-0181
- Singapore: +65-738-5655
- Anywhere in the world: +1-425-446-5500

Or, visit Fluke's website at www.fluke.com.

To register your product, visit http://register.fluke.com.

To view, print, or download the latest manual supplement, visit http://us.fluke.com/usen/support/manuals.

Safety Information

Safety Summary

The following are general safety precautions that are not related to any specific procedures and do not appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during equipment operation and maintenance to ensure safety and health and protection of property.

Keep Away from Live Circuits

Operating personnel must at all times observe safety regulations. Do not replace components or make adjustments inside the equipment with the voltage supply connected. Under certain conditions, dangerous potentials may exist when the power control is in the off position due to charges retained by capacitors. To avoid injuries, always remove power from, discharge, and ground a circuit before touching it.

Do Not Service or Adjust Alone

Do not attempt internal service or adjustment unless another person capable of rendering aid and resuscitation is present.

Resuscitation

Personnel working with or near dangerous voltages shall be familiar with modern methods of resuscitation. Such information may be obtained from your local American Medical Association.

Electro Static Discharge Sensitive Parts

⚠ Caution

Electrostatic discharge sensitive (ESDS) is applied to low power, solid-state parts which could be damaged or destroyed when exposed to discharges of static electricity. Maintenance personnel are often not aware that an ESDS part has been damaged or destroyed because electrostatic discharges at levels less than 4,000 volts cannot be seen, felt, or heard.

Compressed Gas

Use of compressed gas can create an environment of propelled foreign matter. Pressure system safety precautions apply to all ranges of pressure. Care must be taken during testing to ensure that all pneumatic connections are properly and tightly made prior to applying pressure. Personnel must wear eye protection to prevent injury.

Personal Protective Equipment

Wear eye protection approved for the materials and tools being used.

Inert Gases

Operation of pressure equipment may be accompanied by the discharge of inert gases to the atmosphere. The result is a reduction of oxygen concentration. Therefore, it is strongly suggested that exhaust gases not be trapped in the work area.

Symbols Used in this Manual

In this manual, a **Warning** identifies conditions and actions that pose a hazard to the user. A **Caution** identifies conditions and actions that may damage the Precision Pressure Indicator (PPI).

Symbols used on the Precision Pressure Indicator (PPI) and in this manual are explained in Table 1-1.

Table 1-1. Symbols

Symbol	Description
⏚	Earth Ground
⚠	Important Information: refer to manual
⚠	Shock Hazard
	Do not dispose of this product as unsorted municipal waste. Go to Fluke's website for recycling information.
CE	This equipment meets the requirements of all relevant European safety directives. The equipment carries the CE mark.

General Information

⚠ Warning

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

The AC main plug, switch and power cord shall remain readily accessible for the operation.

The RUSKA 7050 Precision Pressure Indicator uses force-balanced, fused-quartz Bourdon tube technology to provide the precise measurement of pressure.

In Measure mode, the PPI measures pressure. Typically, Measure mode applications are found in research laboratories, wind tunnel testing, power plant testing, and bubbler tank volume accountancy systems. It is also used to monitor barometric pressures, vacuum systems, and differential pressure devices.

Features

The following features are available on all RUSKA 7050 PPIs.

Fused-Quartz Bourdon Tube Technology

(5 - 2500 psi full scale ranges), RUSKA's force-balanced, fused-quartz Bourdon tube sensor makes use of the stability, high elasticity, low hysteresis, and excellent fatigue strength of fused quartz. This time-proven technology eliminates the need for gear trains, bearings, shafts, and other moving parts that can wear out or introduce hysteresis or deadband into the process.

Mercury-Free

All components in the PPI are mercury-free.

NIST Traceability

All PPIs are calibrated per ANSI/NCSL Z-540-1-1994 using RUSKA deadweight gauges that are directly traceable to the National Institute of Standards and Technology (NIST).

Universal Power Supply

The PPI's universal power supply accepts AC voltages between 100-120 VAC and 220-240 VAC. To "reconfigure" the PPI for use in another country, the user simply changes the power cord.

Friendly Display

The PPI's color active matrix TFT display combines a bright, low-glare readout with a wide viewing angle. During normal operation, the measured pressure is easily visible from a distance of 10 feet (3 meters).

Adjustable Pressure Display

The pressure display may be adjusted to show one decimal greater than or less than the default resolution.

Ease of Operation

An intuitive, menu-driven interface makes the PPI easy to use. Frequently used selections such as the units of measure are restored to memory each time the PPI powers up.

Modular Design

The sensing element, pneumatics, electronics, and user interface are separated into modules, making maintenance faster and easier.

Attractive Desktop Packaging

A sturdy aluminum case houses all of the PPI's pneumatics, electronics, and user controls. With the optional rack mount kit, this standard 19" EIA chassis fits easily into a rack mount system.

Power-On Self Test

Upon power-up, the PPI quickly tests its hardware and software. After the PPI completes this test, the user can select more extensive self-tests for the pneumatics and electronics.

Ease of Calibration

Calibration may be performed either remotely or entirely from the front panel. No disassembly is required, and there are no potentiometers to tune. On single sensor units, only a three-point calibration is required to fully characterize the instrument. On instruments that integrate multiple ranges such as the 7050i and 7050LP, additional calibration points are required.

Automatic Zero Adjust

At the user's request, the PPI's software automatically performs the zero adjustment, with no potentiometers to tune.

Automatic Head Correction

The PPI automatically corrects for head pressure between the PPI and the device under test (DUT), taking into account the density of the test gas; e.g., air or nitrogen.

Choice of Medium

Although the PPI is not sensitive to the type of gas used within the system, the user can select either instrumentation air or nitrogen, allowing the PPI to automatically make pressure head corrections.

Choice of Display Units

Standard units include inHg at 0 °C and 60 °F, kiloPascals, bars, psi, inH_2O at 4 °C, 20 °C, and 25 °C, kilograms per square centimeter, mmHg, cmHg at 0 °C, and cmH_2O at 4 °C. Altitude and airspeed units include feet, meters, knots, and kilometers per hour. In addition to these predefined units, four user-defined units are programmable.

Communications Interface

The PPI includes standard RS-232 serial and IEEE-488 interfaces. The user's computer communicates with the PPI through the Standard Commands for Programmable Instruments (SCPI) protocol. The 7050 shares the same protocol as the RUSKA 7010, 7215, 7215i and 7215xi, therefore, it can operate from software written for any of these products. *The PPI can also be configured to accept existing software written for the RUSKA Series 6000 Digital Pressure Gauge/Controller or the Druck model 510.*

NVLAP Accredited Calibrations

Fluke received formal accreditation from the National Voluntary Laboratory Accreditation Program (NVLAP) which is administrated by the National Institute of Standards and Technology (NIST). NVLAP has assigned Fluke laboratory code 200491-0 to indicate that our accredited calibration services are in compliance with all relevant requirements of ISO/IEC 17025:2005. Accredited calibration certifications are now provided standard by Fluke Calibration.

Standard Equipment and Options

A standard PPI includes this manual and a power cord. Although the standard PPI is fully functional with just these items and the appropriate pressure and vacuum supplies, the following options are also available.

Additional Power Cords: Additional power cords are available for most countries.

All options are summarized in 1-2. To order these items, please contact Fluke Calibration Sales in the U.S. at (713) 975-0547.

Table 1-2. RUSKA 7050 PPI - Options List

Option	Part Number
LabView Driver (National Instruments)	Downloadable from World Wide Web
Rack Mount Kit - Cabinets 18-24 inches deep	3879677
Vacuum Pump, 115/230 VAC 50/60 Hz	3917819
Power Cord, USA and Canada	284174
Power Cord, Central Europe	769422
Power Cord, India	782771
Power Cord, Japan	3898323
Power Cord, Australia/New Zealand	658641

Chapter 2
Theory of Operation

Introduction

The PPI's power supply, electronics, pneumatics, and sensor combine to form a complete, stand-alone, measure and control instrument. This section of the manual describes the PPI's component modules and provides a general discussion of each.

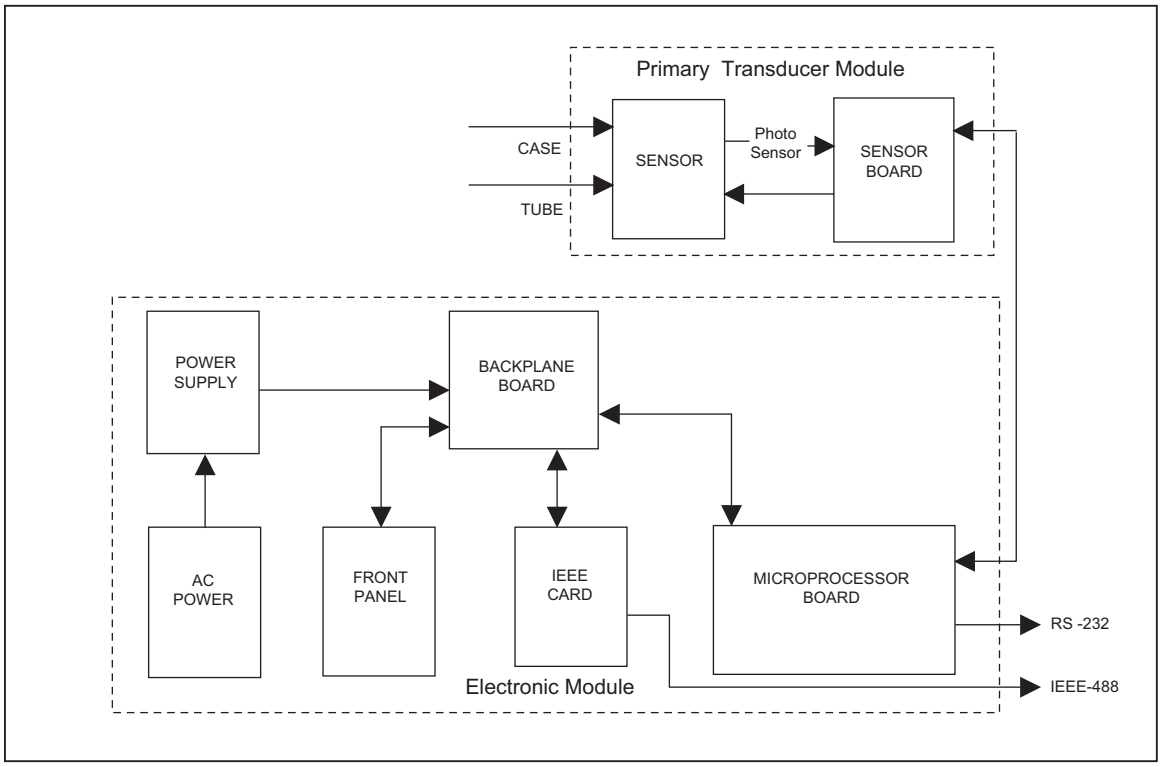


Figure 2-1. PPI Block Diagram

Power Supply

The PPI's universal power supply accepts AC voltages from 100-120 VAC and 220-240 VAC at 50/60Hz. This quad–output supply produces +5 VDC, +/-12 VDC, and 24 VDC which are distributed to the Control and Backplane Boards.

Electronics Module

Back-Plane Board

The Back-plane Board is used to interconnect all of the plug-in electronic boards and distribute power. The Microprocessor Board, the Digital Control Board, and the IEEE-488 Interface all plug into the Back-plane Board. The Front Panel communicates with the Microprocessor Board via cables. The Sensor Board communicates with the Microprocessor board through an internal RS-485 serial communication bus.

Microprocessor Board

All of the PPI's software resides in nonvolatile, programmable, read-only memory (Flash EPROM) on the Microprocessor Board, which plugs directly into the Back-plane Board. This software contains all of the instructions that operate the PPI, as well as the conversion factors that the PPI uses to translate the internal pressure unit-of-measure of kPa into the units selected by the user. These factors are given in Table 2-1.

Data that is subject to change after the PPI leaves the factory are held in electrically erasable, programmable, read-only memory (EEPROM). This includes the current units of measure, the coefficients from the zeroing process, the current pressure medium, calibration coefficients, and the conversion factors for the four user-defined units of measure.

When the PPI powers up, its software is loaded into random access memory (RAM), also on the Microprocessor Board. At the same time, the values stored in EEPROM Board are restored to memory.

Another important component on the Microprocessor Board is the lithium battery. The battery continuously updates the PPI's date and time, even when the unit is powered down. This battery has a varying life. If the instrument is left on 24 hours a day, it may last 5 to 10 years. If the instrument is stored, it may only last one year.

The Microprocessor Board also supports the RS-232 serial interface that allows the user's computer to communicate with the PPI.

Table 2-1. Conversion Factors

Symbol	Description	Conversion Factor
InHg	inches of mercury (0 °C)	= kPa x 0.2952998
InHg	inches of mercury (60 °F)	= kPa x 0.296134
KPa	KiloPascals	= kPa x 1.0
Bar	Bars	= kPa x 0.01
Psi	pounds per square inch	= kPa x 0.1450377
cmH_20	Centimeters of water (4 °C)	= kPa x 10.19744
inH_20	inches of water (4 °C)	= kPa x 4.014742
kg/cm^2	kilograms per square centimeter	= kPa x 0.0101972
mmHg	Millimeters of mercury (0 °C)	= kPa x 7.500605
cmHg	Centimeters of mercury (0 °C)	= kPa x 0.7500605
knots	indicated airspeed	per NASA TN D-822
km/hr	kilometers per hour	= knots x 1.852
Feet	feet of altitude	per MIL–STD–859A
meters	meters of altitude	per MIL–STD–859A
User1	user defined	= kPa x user defined
User2	user defined	= kPa x user defined
Pa	user defined (Pascals)	= kPa x 1000.0
hPa	user defined (hectoPascals)	= kPa x 10.0
%FS	percent of full scale	

IEEE-488 Interface

The PPI's IEEE-488 (GPIB) interface card, which plugs directly into the Back-plane Board, provides the PPI with an IEEE-488 interface. This interface allows the user to automate the measurement and control processes.

Front Panel

The Front Panel contains the active matrix TFT color display, rotary knob and rubberized keys used to operate the PPI.

Pneumatics Module

The PPI's Pneumatics Module varies depending on whether the PPI is a Gauge mode or Absolute mode instrument. Gauge mode PPI's reference their measurements to atmospheric pressure, whereas Absolute mode PPI measurements are made with respect to sealed vacuum.

A Simulated Absolute mode PPI has a barometric sensor in addition to a gauge Bourdon tube sensor. The PPI adds the barometric reading to the Bourdon tube reading to obtain a Simulated Absolute value. It can operate as a Gauge mode instrument if the user selects to not add the reference pressure.

The 7050 can also be supplied with an optional vacuum reference sensor. In this configuration, the 7050 can operate in the absolute mode by connecting a high capacity vacuum pump to the reference pump of the 7050 and evacuating the reference.

Therefore, both the barometric and the vacuum reference option allow the 7050 to operate in the absolute mode in addition to gauge mode. The difference between these two options is that the barometric option would not require an external vacuum pump to measure absolute pressures. The vacuum reference option would provide a more accurate absolute measurement, however, it would require and external vacuum pump evacuating the reference port to measure absolute pressures.

The valves, filters, and transducers that make up the pneumatics module of a Gauge mode (or Simulated Absolute) PPI are shown in Figure 2-2. The schematics for the Absolute mode PPI is shown in Figure 2-3.

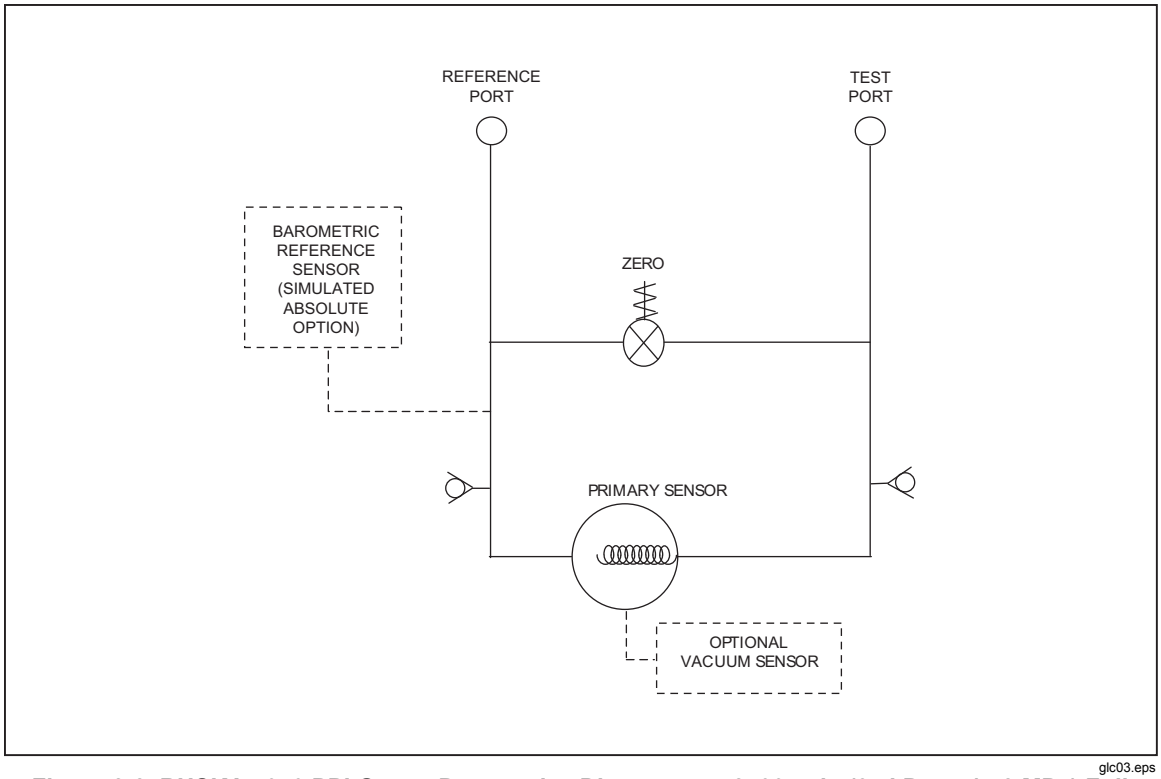


Figure 2-2. RUSKA 7050 PPI Gauge Pneumatics Diagram 5 to 2500 psig (34 kPa to 17.2 MPa) Full Scale Ranges

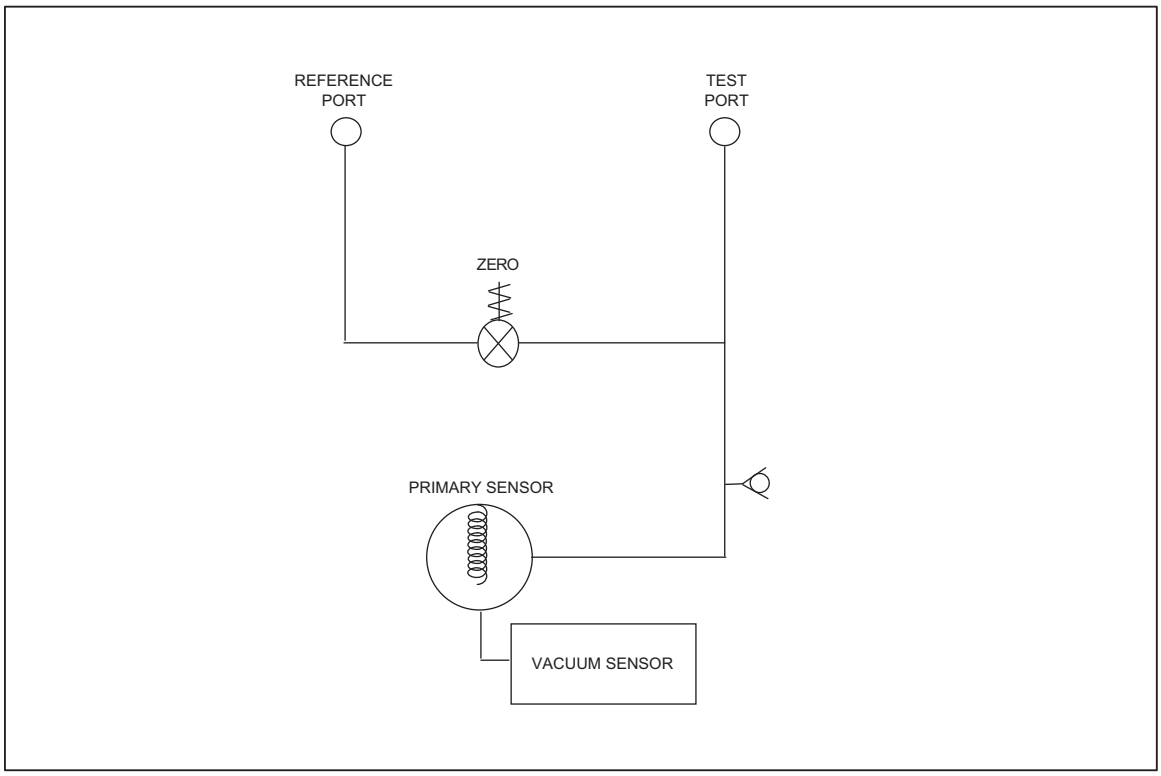


Figure 2-3. RUSKA 7050 PPI Absolute Pneumatics Diagram to 50 PSIA (340 kPa) FS

Measure Mode Pneumatics

Figures 2-2 and 2-3 summarize the Pneumatics of the PPI.

Reference Port

For gauge measurements, the Reference Port is left open to atmosphere.

The Reference Port is isolated from the Test Port by a solenoid valve that is closed during the PPI's Measure mode. When the user commands the PPI to perform the zeroing process, the solenoid automatically opens, and the pressures on the Reference Port and Test Port become equal.

The Reference Port is protected by a relief valve.

Barometric Sensor

For all Simulated Absolute instruments, the Reference Port is monitored by a precision barometric sensor (Figure 2-2). This sensor provides the barometric offset that allows the Gauge mode PPI to function in a simulated Absolute system.

Vacuum Reference Option

For instruments that have the vacuum reference option, a vacuum gauge is connected to the reference port. The operator can connect a vacuum pump to the reference port of the 7050 and evacuate its reference. The vacuum sensor is then used to zero the 7050 in the absolute mode and to track any vacuum changes that occur in the reference ports.

Test Port

The Test Port connects the DUT to the Pneumatics Module.

The Test Port is protected by a relief valve.

Transducer Module

Quartz Bourdon Tube Sensor

The quartz Bourdon tube sensor is mounted in a machined aluminum housing. The sensor consists of a helical quartz tube with a mirror affixed to one end, as shown in Figure 2-4.

A rigid beam is attached transverse to the axis of the helical tube. Attached to both ends of this beam are electromagnetic coils. Mounted beneath the coils are permanent magnets. A lamp assembly directs light through a quartz or sapphire window onto the mirror affixed to the helical tube, as shown in Figure 2-5. The mirror reflects the light back through the window and strikes two matching photodiodes. When there is zero pressure differential across the helical tube, the photodiode assembly is mechanically adjusted so that the light spot is centered between each photocell. In this "zero position," the outputs of the two photodiodes provide energy used to maintain the quartz assembly in its zero position; thus, a force balance is created.

As pressure is applied in the helical tube, the entire apparatus attempts to rotate. This causes the mirror to move the reflected light spot to shine more on one photodiode than the other. The Sensor Board (see next section, Chapter 2, Sensor Board) then responds by changing the current to the electromagnetic coils that, through interaction with the permanent magnets, force the helical tube to return to its zero position. The amount of current required to do this is proportional to the pressure applied across the helical tube. Thus, the pressure is determined by the amount of current required to return the helical tube to its zero position.



On Absolute Models, the process is similar, except that the Bourdon tube is permanently evacuated to less than 0.1 mtorr and sealed at the factory, and the test pressure is applied to the sensor case. With this configuration, all test pressures are measured with respect to vacuum.

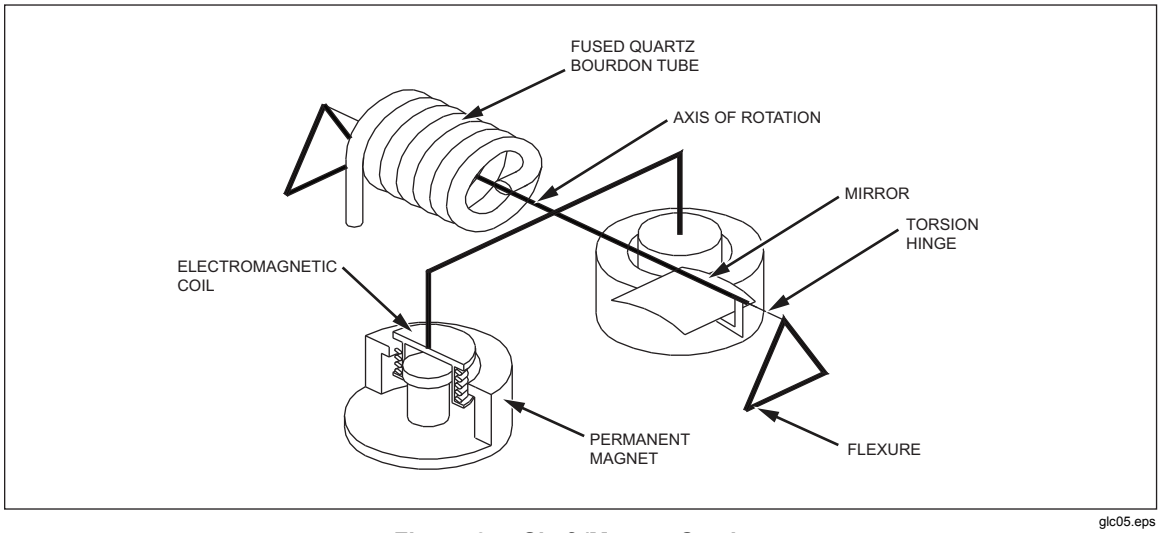


Figure 2-4. Shaft/Magnet Section

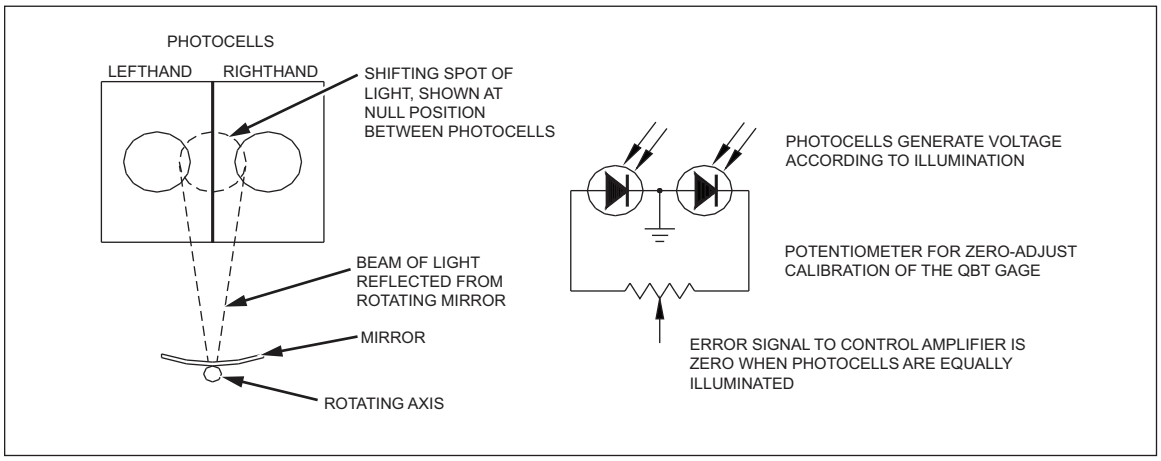


Figure 2-5. Photocell/Light Spot

Sensor Board

A temperature sensor, the quartz Bourdon tube pressure sensor and vacuum sensor are monitored by the Sensor Board. The Sensor board is also used to control and maintain the sensor housing at 50 °C.

Linearization Term

As described in the previous section, the relationship between the pressure being measured and the current required to keep the quartz Bourdon tube in its zero position is the main principle behind the operation of the PPI's sensing element.

Ideally this pressure-current relationship would be a linear equation of the form

$$l = KP_1,$$

where I is current, k is a constant of proportionality, and P is pressure. However, due to certain mechanical characteristics of the helical tube and its supporting structure, this pressure-current relationship is slightly nonlinear. The nonlinear portion of this pressure-current relationship closely follows the form of a second order polynomial, or

$$1 = aP^2 + bP + c_1$$

where again P is pressure and a, b, and c are coefficients generated during the calibration procedure as discussed below.

When the user performs a three-point calibration, the PPI's software creates the three coefficients based on the user's zero, mid-point, and full-scale adjustments. From then on, the nonlinear term given above is subtracted from the total pressure-current curve to achieve the desired linear pressure-current relationship.

On the 7050i and 7050LP, multiple quartz sensor ranges are used in order to provide the percent of reading specification. In these instruments, a total of three points per range with one point shared between two ranges is required. Therefore, for the 7050i, a 5 point calibration is performed and for the 7250LP, a 9 point calibration is performed to fully characterize the RUSKA quartz sensors.

Auxiliary Sensors

Auxiliary sensors are sensors such as the oven temperature sensor. These are reference sensors aligned at the factory and are utilized by the firmware.

Case Reference Vacuum Sensor

The case reference vacuum sensor is a user installed option. The user needs this sensor to zero an Absolute PPI. Please note that the uncertainty of the vacuum sensor used to zero the PPI must be considered in the overall uncertainty analysis of the PPI.

Software

The PPI is a digital, software-based instrument.

Software Safety Controls

Oven Control

The oven temperature is controlled via a pulse-width modulated signal. The time the heater is on can be varied from 0 to 100%. The pulse-width at startup is initialized to the previous value, which was stored in the battery-backed CMOS RAM.

The oven control is a PID controller updated approximately every 7 seconds. The sensor readings are accessed by pressing MENU | DISPLAY. With an exception of the 3000 psi (20.7 MPa) version 7050, the high accuracy quartz sensor is housed in a temperature controlled oven. There is a 3 hour warm-up time required prior to the PPI operating at its optimum precision. The user can verify when the instrument is thermally stable by viewing the MENU | DISPLAY screen and verifying that the temperature is at 50 ^{o}C. In addition to the temperature, this screen will show the duty cycle of the oven.

When operating the system in either a very cold or hot environment, if the oven in unable to maintain the temperature of the internal oven, the PPI will generate an Oven Control Failure error messages. The operator can review the temperature and duty cycle of the oven by pressing the MENU | DISPLAY keys. The unit must have been warmed up for a minimum of 3 hours prior to determining the condition of the oven temperature control. The temperature of the sensor should be controlled to 50 ^{o}C. The Duty Cycle indicates the amount of time (in units of percentage) that the oven control is turned on in order to maintain the oven at the proper set-point of 50 ^{o}C. A unit that is operating properly, after it has fully warmed up, should indicate a sensor temperature of 50 ^{o}C and a duty cycle between 10 to 90%.

If operating the instrument in a very cold environment and the oven duty cycle is at a high percentage (>90%) you will need to turn the fan off. If you are operating in a warm environment or when multiple systems are housed in consoles without adequate ventilation, the system may become too hot and generate the Oven Control Failure error message. If operating the instrument in a warm environment and the oven duty cycle is at a low percentage (>10%) you will need to turn the fan on. See Chapter 6, Fan Operation.

When the operator changes the status of the fan, it will remain in that condition until the operator changes the setting.



2-6.bmp

Figure 2-6. Menu | Display-Menu

Pressure Reading and Correction

The sensor's analog output is processed by an analog-to-digital circuit that results in an output referred to as counts. This output is corrected for the applied effects listed below.

The counts are linearized and the resulting pressure value is corrected for the variations in head pressure, vacuum, case effect, and oven temperature effects.

The following equations are used by the control algorithm to adjust and correct the pressure signal.

Zero Coefficients

CsH Zero correction for High FSR (Full-Scale Resistors) Value is in counts (7,381,975 = full scale of current sensor).

CsL Zero correction for Low FSR. Value is in counts (7,381,975 = full scale of low FSR)

HsZ Hardware zero correction. (0 to 4095, center is 2048).

SsZ Zero corrections scaling factor. Ratio of High FSR to Low FSR. Used only when Case Effect Coefficient or Oven Temperature Coefficient are non-zero.

s=0 for high range sensor, s=1 for low range sensor.

Range Coefficients

KnF 0=Range Unused
4=Valid High FSR Range
5=Valid Low FSR Range

Kn0, Kn1, Kn2 Calibration constants for range

$$B = \frac{K_{n2}}{2^{48}} * A^2 + \frac{K_{n1}}{2^{24}} * A + K_{n0}$$

Where A is the zero corrected counts (7,381,975 = full scale of current range) and B is the calibrated counts (7,381,975 = full scale of current sensor)

KnH Zero corrected counts for upper limit of range. When the zero corrected counts from the A/D exceed this value the next higher range will be used (if possible). (7,381,975 = full scale of current range)

KnL Zero corrected counts for lower limit of range. When the zero corrected counts from the A/D are below this value the next lower range will be used (if possible). (7,381,975 = full scale of current range)

n=Range number (1 - 4 for high range sensor, 5 - 8 for low range sensor)

Chapter 3
Installation

Introduction

This section of the manual discusses initial installation for the RUSKA 7050 PPI. Installing the PPI involves connecting the supply and test pressure tubing, powering up the unit, and configuring the system through the front panel.

Unpacking the PPI

Carefully unpack all components, checking for obvious signs of damage. The shipment contains the following items:

- RUSKA 7050 or 7050i PPI,
- power cord,
- user's manual,
- calibration report,
- user-specified instrument options.

If necessary, report any shipping damage to the freight agency. Remove all shipping and packing materials (including the shipping plugs) from all components. If possible, save the packing materials for future shipping needs.

Finally, install the PPI in a location that meets the requirements listed in Table 3-1.

Note

The PPI should be handled in such a way as to minimize mechanical shocks or vibration during installation or use. It should be mounted on a rigid bench or in a sturdy 19" rack. Although the zeroing process will compensate for a slightly unlevel mounting, the PPI should be mounted to within 5° of level.

Table 3-1. General Specifications and Parameters

Parameter	Value	Model
Operating Humidity	5–95%RH, noncondensing	all
Storage Humidity	none*	all
Operating Temperature	18 °C – 36 °C	all
Storage Temperature	-20 °C to 70 °C	all
Electrical Power	100 – 120 VAC and 220 – 240 VAC	all
Power Consumption	150 W	all
Warm-up Period	< 3 hrs	all

*If there is any condensation when storing the PPI, it must be thoroughly dried before power is applied. It is also recommended to connect the reference port to the test port and evacuating these simultaneously to remove any moisture from the sensor.

Cautions

The following cautions should be heeded at all times to ensure safe operation of the PPI.

⚠⚠ Warning

Never operate the PPI with the cover removed. The power supply has internal voltages near 400 volts.

Never apply more than 120% of the PPI's full scale as a pressure supply. Pressure supply must be regulated and meet all criteria as stated in Appendix A of this manual.

Never apply more than 110% of the PPI's full scale to the test port. Never try to control while a pressure source is connected to the test port.

⚠ Caution

Do not expose the instrument to thermal and mechanical shock, or vibration. This may affect performance and require re-zeroing.

See Chapter 1, Safety Information.

Powering Up the PPI

1. First, plug the power cord supplied with the PPI into the power connector on the PPI's back panel.

⚠ Caution

Grounding for the PPI is provided through the power cord.

2. Next, plug the power cord into a receptacle rated for any AC voltage between 90 and 260 volts. If a different power cord is necessary for your receptacle, consult Table 1-1 for available power cords.
3. Finally, turn on the PPI by toggling the power switch on the back panel. When the MEASURE screen appears on the display, the front panel will be fully operational.

Observing the PPI's Full Scale Rating

To observe the PPI's full scale rating,

1. Press PREVIOUS until the main menu appears.
2. Select MENU | CALIBRATE. The PPI's full scale pressure rating (FS) will appear on the screen (in the currently selected units of measure).
3. To return to the main menu, press PREVIOUS.

Pneumatic Connections

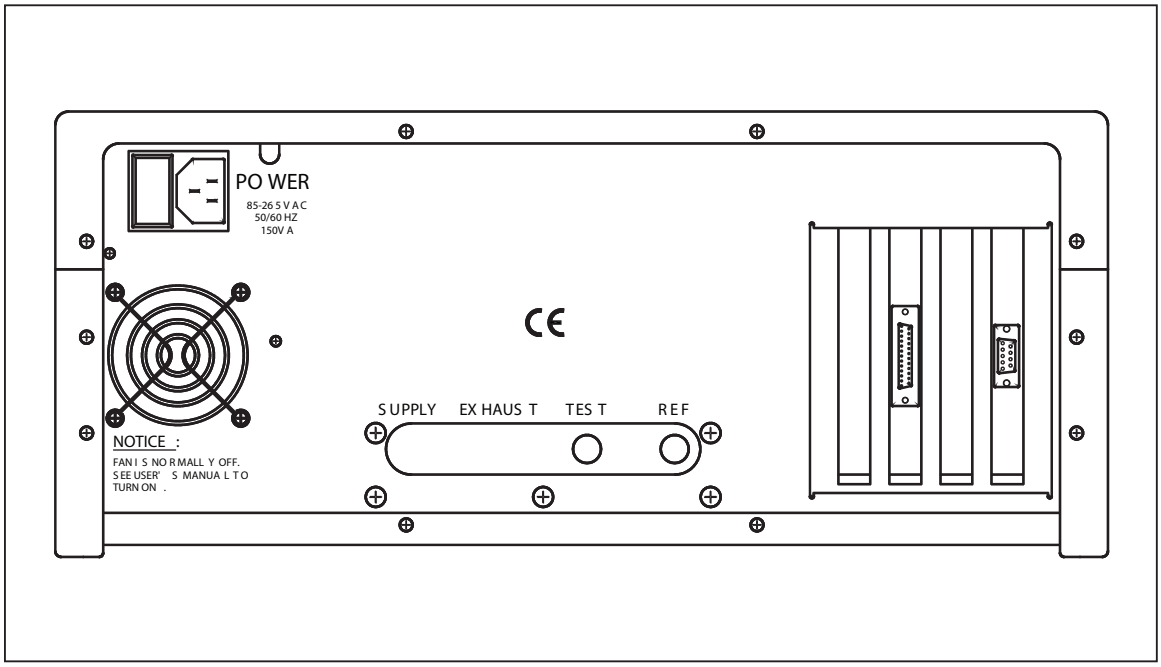
Pneumatic connection to the PPI is straightforward. The following sections discuss each port. All ports are ¼-inch NPT pipe fittings. See 3-1. Remove all plastic shipping plugs from the back panel pneumatic ports.

Test Port

The device(s) under test is connected to the test port. Excessive leaks in the test volume will cause measurement errors in the device under test. Tubing connected from the test port to the load volume should have an internal diameter greater than 1/8 inches (3 mm). Tubing should be shorter than 15 feet (5 meters) when minimum diameter tubing is used.

Reference Port

The reference port is open to atmosphere for gauge measurements or it can be connected to the Reference Port of the Device Under Test. For true absolute only systems or systems with the vacuum reference option, a vacuum pump capable of producing a vacuum level of 200 mTorr or less at the sensor reference port is required (used to zero the sensor).



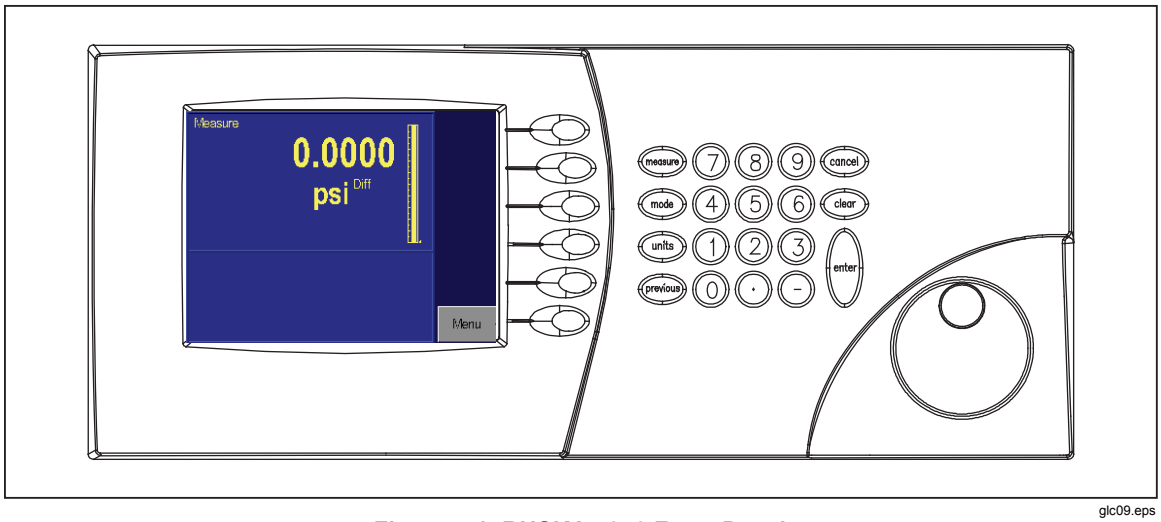
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Figure 3-1. RUSKA 7050 Back Panel

Chapter 4
Local Operation

Introduction

This section of the manual describes operation of the PPI using the front panel. The local interface (front panel) consists of a color TFT display, a rotary knob and a set of keys. The display shows the system status and menu options. The keys are grouped according to function.



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Figure 4-1. RUSKA 7050 Front Panel

Numeric Keypad

This includes the number keys, the decimal point [.], and the change sign key [-]. The UNITS key changes between units of measure, MODE changes between modes of operation such as gauge and absolute, MEASURE is used to place the unit into measure mode. CLEAR key will clear the numeric entry field. The ENTER key accepts the entered number or confirms a command.

Function Keys

These are the six keys that run vertically beside the display. The label shown in the display beside each key identifies their function. These functions will change based on which screen you are operating. For ease of communication, throughout the manual we refer to these keys as [F1] through [F6]. We consider the top key to be F1 and the bottom F6.

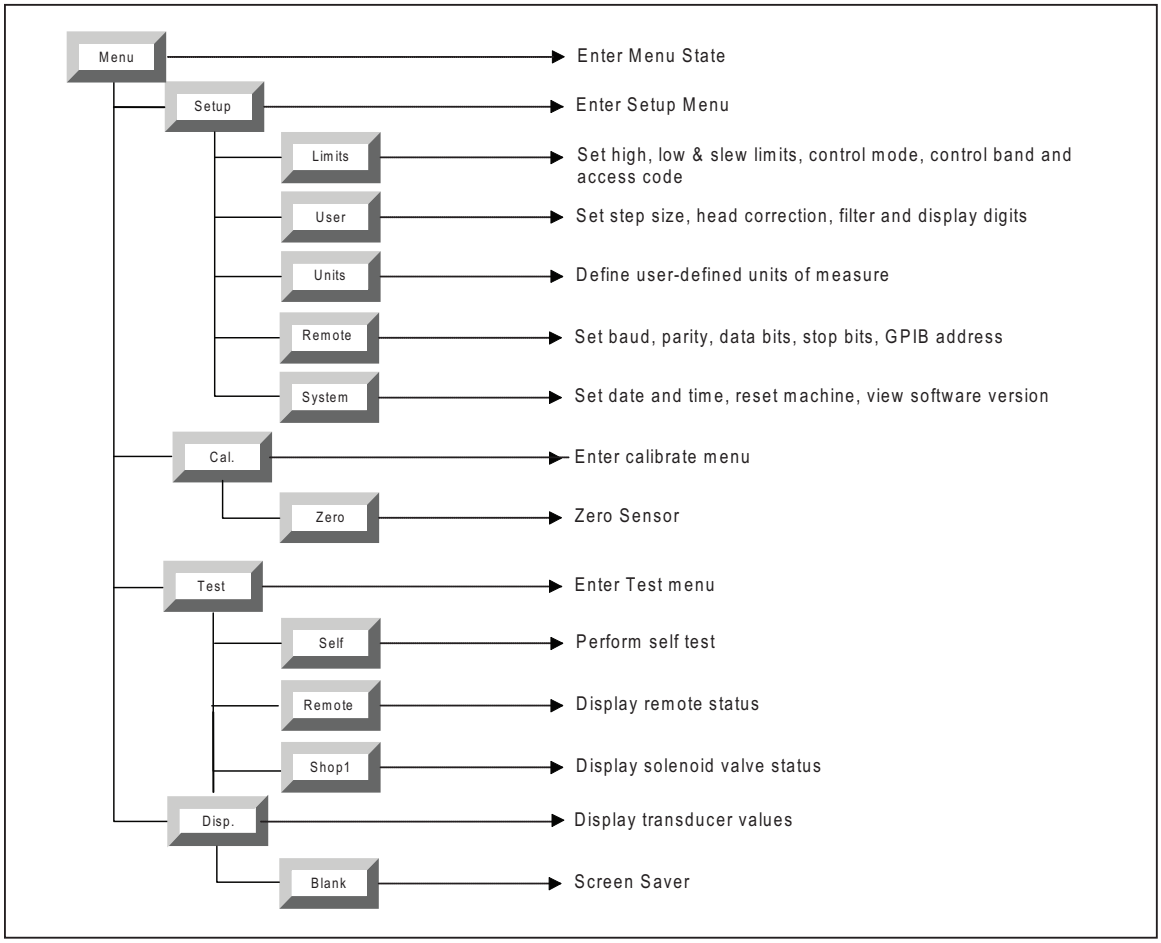
Rotary Knob

The rotary knob selects a field for editing.

Cancel, Previous

These keys are used to stop, undo, or exit the current operation. The CANCEL key returns all edited fields on the current entry screen to their original values. It also stops the current program sequence or calibration process. The PREVIOUS key exits the current menu and returns to the previous menu.

Figure 4-2 is a menu tree showing the relationship between all 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. To move towards the main menu, press the PREVIOUS key.

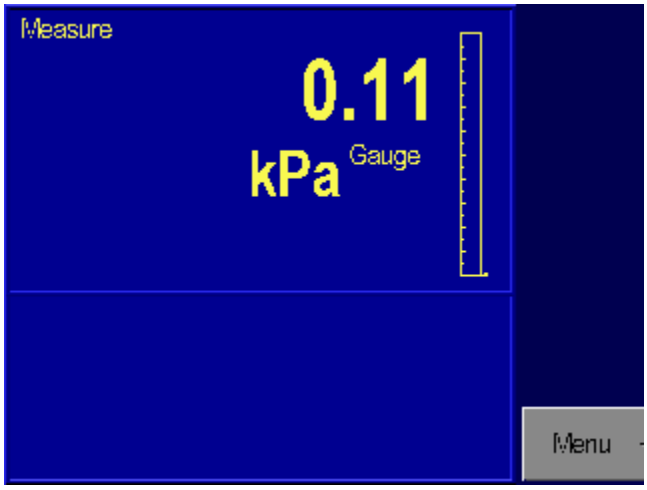


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Figure 4-2. Menu Tree

Tutorial

To begin the tutorial, first verify that the PPI is powered-up and that the pneumatic connections have been completed. The PPI should display a screen similar to the one shown below. (The right hand side of the display should show the options). At power up, there may be errors relating to the default settings. If an error message is displayed in red at the bottom of the screen, press [F6], then press PREVIOUS. If multiple errors exist, you will need to press the [F6] key multiple times to clear all of the errors.

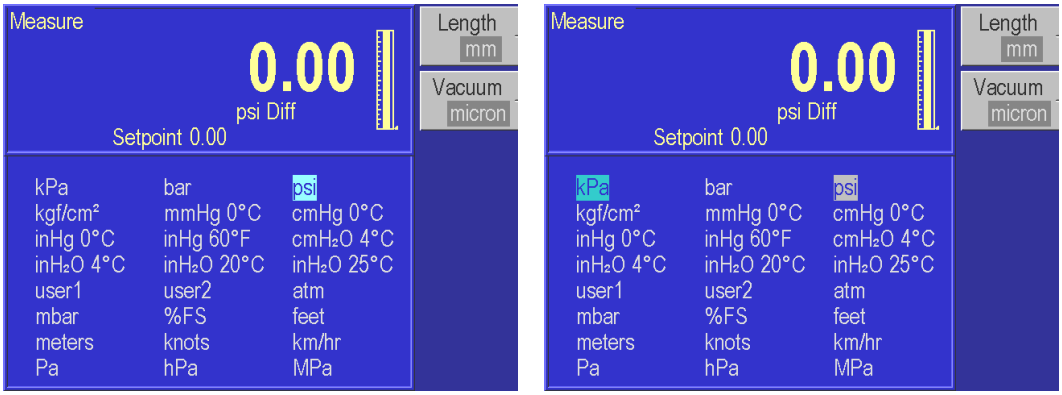


4-3.bmp

Figure 4-3. Main Menu

Figure 4-3 shows the Main Menu. It is at the top level of the menu tree (see Figure 4-2) and all descriptions in this manual start from this point. The double sized numbers in the top center of the display shows the current measured pressure. The upper left corner shows the current mode of the PPI. The right side of the screen shows a bar graph displaying the current pressure relative to a user-configurable full-scale value. The highlighted label on the right hand side of the screen displays the current assignments of the function keys [F1] through [F6] that are located beside the display.

1. Change the pressure units. The units are changed by selecting the UNITS key on the keypad.



glc11.bmp & glc12.bmp

Figure 4-4. Units Menu

2. Use the rotary knob located to the right of the display to move the highlight bar to the desired unit.

Note

The highlighted curser initially shows the current unit of measure. When the rotary knob is moved, the current unit remains highlighted in a gray color, and the new unit is highlighted in a light blue color.

3. When the unit desired is highlighted, press the ENTER key on the far right side of the front panel, under the numeric keypad. The display will return to the MAIN screen with the current units.

Selecting Language

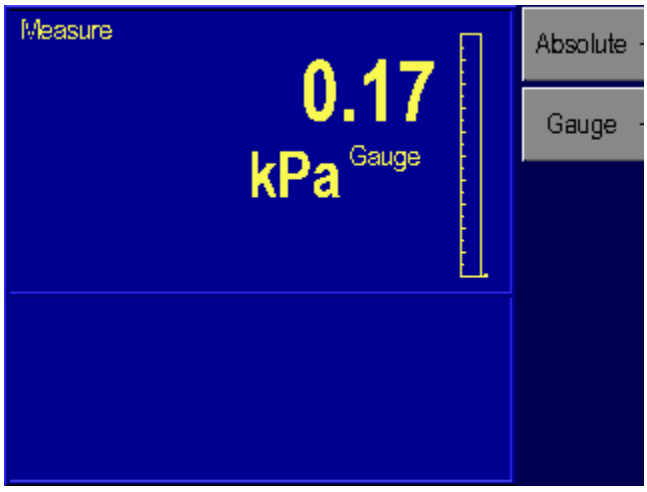
The 7050 PPI can operate in a variety of different languages. To select a different language, press the Mode key two times MODE, MODE. The current language will be highlighted. Use the rotary knob to highlight a new language and hit the ENTER key to select that language.

Selecting Mode of Operation

The 7050 PPI is offered in three different modes. These are gauge only, absolute only, and simulated absolute which operates in both gauge and absolute modes. Using a barometric reference, or true absolute, the vacuum reference option allows for both gauge and absolute modes.

Instruments with the Barometric Reference Option

This 7050 PPI is a Gauge and Vacuum (Negative Gauge) instrument with a barometric reference sensor. The summation of the pressure reading from the measurement sensor in the 7050 and the pressure reading from the barometric sensor provides for the "simulated absolute" pressure display. To change mode, from the keypad, press Mode, then select either Absolute [F1] or Gauge [F2] or Tare [F3]. Please note that the available selection may vary from unit to unit. For instance, on a permanent absolute instrument, the “Gauge” option would not be available but the simulated gauge is, via the Tare function.



4-5.bmp

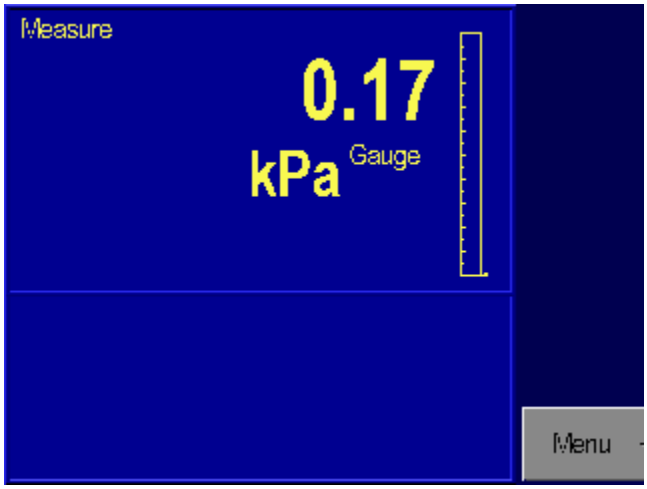
Figure 4-5. Mode Menu

True Absolute with Vacuum Reference Option

This 7050 PPI is a gauge (and optionally negative gauge) mode instrument which also has a vacuum reference sensor connected to internal reference of the primary sensor. An external vacuum pump can be used to evacuate the reference port of the 7050. The vacuum sensor is then used to zero the 7050 in the absolute mode and to track any variations that occur to the vacuum when operating in the absolute mode.

Main Menu

The Main Menu displays the measured pressure in double-sized numbers. Below the pressure reading is the current unit of measure and mode (Gauge, Differential or Absolute). The Main Menu can always be reached by repeatedly pressing PREVIOUS. The RUSKA 7050 is designed such that all of the commonly used functions are accessible by a direct key on the key pad or from a top level function key. Less commonly used set-up type functions are accessible through the menu function key.

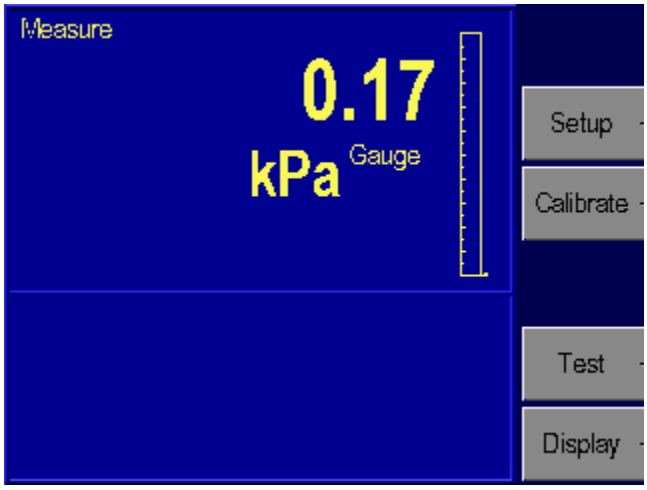


4-6.bmp

Figure 4-6. Main Menu Screen

Menu

The menu key is used to access the less commonly accessed configuration type functions. The menu key accesses the Setup, Calibration, Program, Test, and Display functions.

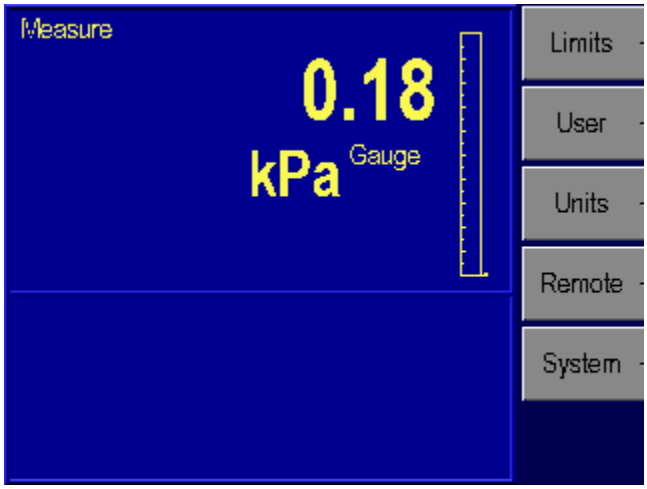


4-7.bmp

Figure 4-7. Menu Key - Functions

Menu | Setup

Setup is used to configure the system. This function includes setting all of the limits, user parameters, user-defined units of measure, remote interface and system setup.



4-8.bmp

Figure 4-8. Menu | Setup - Menu

Menu | Setup — Limits

The Menu | Setup | Limits menu is used to setup all of the limits in the system. The pressure limits can be used to protect the device-under-test (DUT) from overpressure.



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Figure 4-9. Menu | Setup | Limits - Menu

High Limit

The High Limit — User Defined Maximum Pressure Limit is often set just over the full-scale pressure of the device under test (DUT) in order to protect the DUT. The PPI will then prevent the pressure from exceeding the high limit. If the user enters a value greater than the user defined limit, the unit will not accept the value and it will generate an error code informing the user that they have entered a set-point that is greater than the high pressure limit. In control mode, if for any reason the pressure exceeds the user-defined limit, it will change into the measure mode and again display an error message to the operator informing them that the error occurred.

This value can be edited using the rotary knob to highlight the High Limit. Then enter the new value using the keypad. This will show up in the scratch pad on the lower portion of the screen. Press the Enter key and the value for the high limit will be updated to the value that was typed into the scratchpad.

Low Limit

The Low Limit — User Defined Minimum Pressure Limit is the same as the high limit except it is to protect the DUT from low pressure limits.

Slew Limit

The slew limit is used by the system to assure that the slew rate is not exceeded. If the slew rate is exceeded, the PPI will change from the control mode to the measure mode and it will generate an error message to the operator.

Access

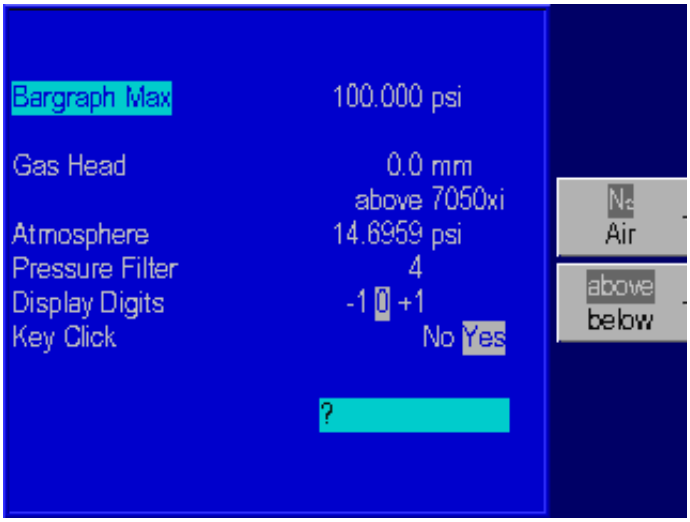
The test access password allows the user to protect access to PPI configuration and programs. If the test access password is set to any number other than zero (factory default), it is *required* before the user is allowed to change the limits, control parameters or programs.

Note

It is recommended that the access password be recorded and filed in a secure location.

Menu | Setup — User

The Menu | Setup | User menu is used to setup all of the user specific configurations. This includes setting the control step size, range of bar-graph, pressure gas head, display pressure filter, display resolution digits, and audible key click.



glc18.bmp

Figure 4-10. Menu | Setup | User - Menu

Gas Head Pressure Correction

The term “head height” refers to the vertical distance between the sensing element in the device under test and the PPI’s pressure reference plane. Once the user inputs the head height and selects air or nitrogen, the PPI automatically corrects for head pressure.

1. The Pressure Reference Line on the PPI is defined as the bottom of the color display where the display and the front panel join. This provides the *reference plane* against which the device under test (DUT) pressure is measured.

2. Determine the vertical distance between the PPI Pressure Reference Line and the reference plane of the device under test.
3. Press the Unit key found in the keypad and press in/mm [F1] to select either inches (in) or millimeters (mm) for the head height entry.
4. The head height is set from the Setup | User | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Setup [F2] | User [F2].
5. Press Medium [F3] to select either “Air” or “Nitrogen”. The selected units will be highlighted.
6. Press Position [F4] to select if the position of the Device Under Test is either “Above” or “Below” the 7050. The selected units will be highlighted and appear in the Gas Head description.
7. Use the rotary knob to highlight the label “Gas Head”.
8. Use the numeric keypad to enter the height in the selected unit.
9. Press ENTER to accept the entry.

Atmosphere

The nominal barometric pressure value for the location that the PPI is utilized should be entered for atmosphere. On gauge mode instruments, this number is used to calculate the density of the test port pressure medium and to correct for head pressure variances between the reference port of the PPI and the DUT.

Pressure Filter

Pressure filter is used to adjust the degree to which the front display pressure value is filtered. A value of four (4), is the default value. As the value increases, the filtering level increases, however, the display update rate reduces. Typical filter values would range from 1 to 10.

Changing the Number of Decimals

Each unit has a default number of decimal places used for pressure display. This may be adjusted up or down by one decimal place.

1. The decimal digits are set from the Setup | User | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Setup [F2] | User [F2].
2. Turn the rotary knob until the label “Display digits” is highlighted.
3. Turn the rotary knob further until the desired number of digits from the default resolution is highlighted (-1, 0, +1), and then press the ENTER key to select.

Key Click

The PPI can be configured to emit a “clicking” sound each time a key is pressed.

1. The key “click” is set from the Setup | User | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Setup [F2] | User [F2].
2. Turn the rotary knob to highlight “Key click” and then highlight either on or off.
3. Press the ENTER key to select.

Menu | Setup — Units

In addition to the standard units of measure provided by the PPI, four user-defined units are available. To create a user-defined unit, the user enters a *name* that is one to ten characters long and a *conversion factor* that is a multiple of kiloPascals (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.

$$mTorr = kPa\ x\ \frac{1000\ mTorr}{1\ Torr}\ x\ \frac{1\ Torr}{1\ mmHg\ \ 0\ °C}\ x\ \frac{1\ mmHg\ \ 0\ °C}{0.0193377\ \ psi}\ x\ \frac{0.1450377\ \ psi}{1\ kPa}$$

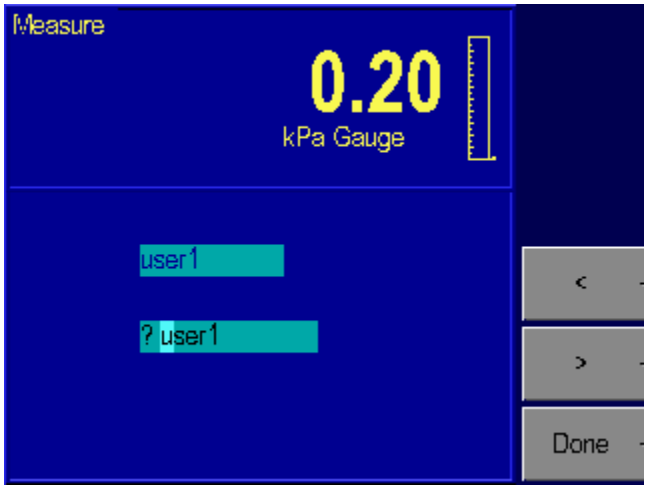
thus the conversion factor simplifies to $mTorr = kPa\ x\ 7500.6180$



4-11.bmp

Figure 4-11. Menu | Setup | Units - Menu

1. The pressure units are defined from the Units | Define | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears) press Menu [F6] | Setup [F2] | Units [F3].
2. Use the rotary knob to highlight the desired user-defined unit, and then select the Edit Name [F1] function key.
3. The following sequence is used to change the name of the selected unit.



4-12.bmp

Figure 4-12. Menu | Setup | Units | Edit Name - Menu

a. Use the < [F4] or > [F5] key to highlight the desired character in the matrix.

b. Use the rotary knob to change the character.

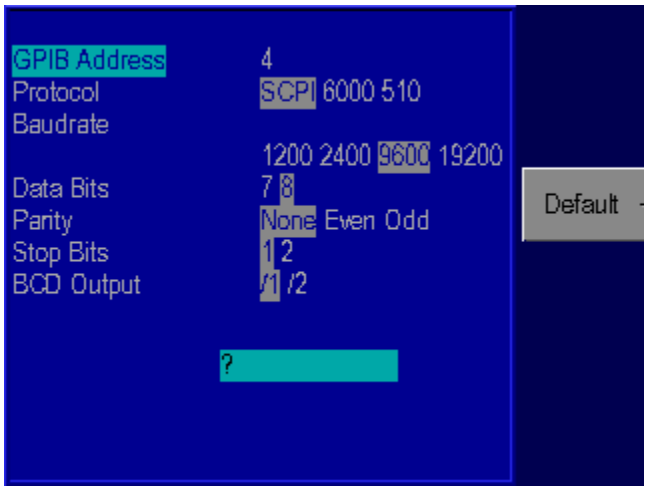
c. Repeat steps a and b until the desired name is entered. Press the Clear key to start over.

d. Press the Done [F6] key when the name change is completed.

4. Use the rotary knob to highlight the desired user-defined unit that has just been renamed.
5. Use the numeric keypad to enter the conversion factor and press ENTER to accept.
6. Press PREVIOUS three times to return to the Main Menu. The new unit definition may now be selected using the Units key.

Menu | Setup — Remote

The Menu | Setup | Remote screen is where the remote communication interface is set-up.



4-13.bmp

Figure 4-13. Menu | Setup | Remote - Menu

GPIB Address

Sets the IEEE-488 interface address.

Protocol

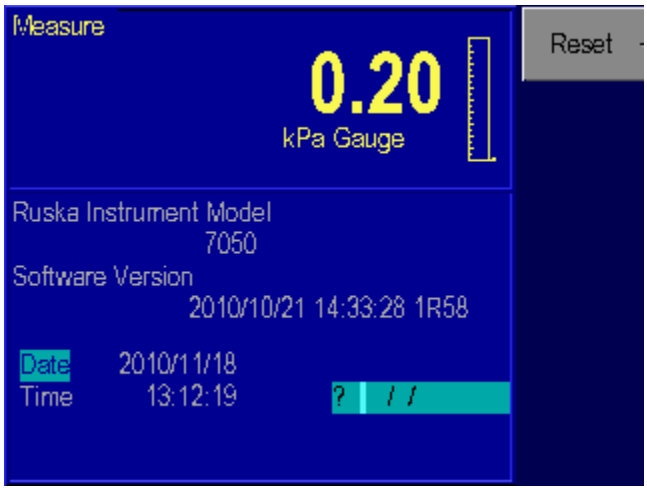
The Protocol defines which protocol should be used by the remote interface. The options are Standard Communication for Programmable Instruments (SCPI) which is the standard interface, 6000 to emulate the RUSKA Series 6000 Pressure Controller, and 510 to emulate the Druck 510 Pressure Controller. When using the SCPI interface, the RUSKA 7050 will emulate the RUSKA 7010 and 7215 Series Controllers.

Serial Interface Set-Up

The operator can set-up the Baud Rate, Data Bits, Parity, and Stop Bits for the Serial Interface.

Menu | Setup — System

The System Menu identifies the Software release version that is being operated in the PPI. It also stores and allows the operator to edit the Date and Time.



4-14.bmp

Figure 4-14. Menu | Setup | System - Menu

Date/Time

The PPI's system clock is continuously updated. If the date or time requires editing, the following applies;

1. The date and time are set from the Setup | System | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Setup [F2] | System [F5].
2. To set the system date, turn the rotary knob until Date is highlighted. Use the numeric keypad to enter the current four-digit year, month, and day (yyyymmdd). All digits must be entered. Press ENTER to accept.
3. To set the system time, turn the rotary knob until Time is highlighted. Use the numeric keypad to enter the current hour, minute, and second (hhmmss). All digits must be entered. Press ENTER to accept.

Reset

The Reset [F1] command is used to re-boot the PPI.

To reset the system, from the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Setup [F2] | System [F5] | Reset [F1].

Menu | Calibrate

The Menu | Calibrate command is used to perform the calibrations on all of the sensors utilized by the PPI. The 7050 can be completely calibrated using the front panel interface. It does not require any external computer or software in order to perform a successful calibration. It also has the capability of being calibrated remotely through either the RS232 or IEEE-488 interface. The 7050 will guide the operator through a menu driven calibration procedure identifying the pressures that should be supplied by a standard. Following the calibration procedure, the 7050 calculates and saves the coefficients. The calibration coefficients are date stamped so the user can easily identify the last time the instrument went through a full calibration, when the coefficients were last edited or when the PPI was re-zeroed.

The calibration section in the PPI can be password protected to prevent any unauthorized entry into the calibration section of the system. Refer to Chapter 6, Maintenance, for more detailed information regarding the calibration of the PPI.

Calibration Password

The calibration password allows the user to protect access to PPI 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

It is recommended that the access password be recorded and filed in a secure location.

1. The calibration password is set from the Calibration Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Calibrate [F3].
2. Press the Access [F4] key. If there is a password in the system other than 0, then you must enter the current valid password into the 7050 before it will allow you to modify the password.
3. Use the numeric keypad to enter the new calibration password. Setting the calibration password to zero allows free access to PPI calibration and constants. Press ENTER.
4. Press Yes [F4] to acknowledge changing the calibration password. Press No [F5] to reject changing the calibration password.

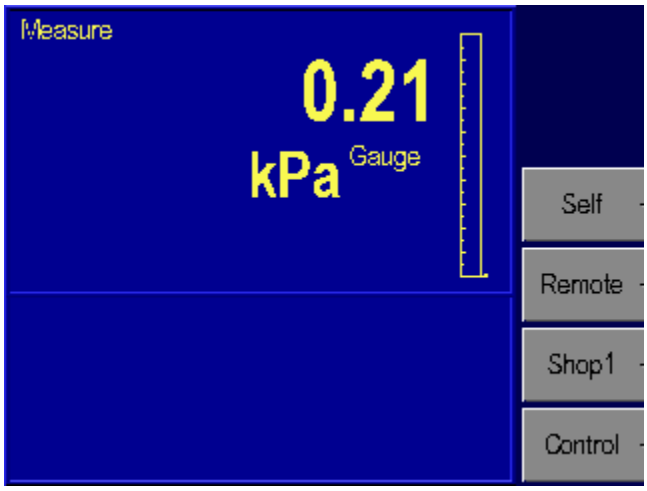
Zeroing

Fluke recommends that the PPI be zeroed once a day to maintain optimal performance. The zero drift specification is defined in Appendix A under General Specifications. Refer to Chapter 6, Zeroing, for the zeroing procedure. On gauge mode instruments, the zeroing procedure automatically ties both test and reference ports of the RUSKA quartz sensor together and performs the zeroing routine.

On permanent absolute instruments, a vacuum pump and vacuum gauge is required to zero the instrument. The optional vacuum gauge sensor should be installed in a port that is located internally to the PPI very near to the RUSKA quartz sensor. When initiating the zeroing command in the PPI, it will cycle the internal valves allowing the external vacuum pump to pull a hard vacuum on the RUSKA sensor. It is recommended that the sensor be pulled down to a vacuum of less than 200 mTorr (preferably less than 100 mTorr) in order to obtain a proper zero. The PPI can be zeroed at higher vacuum levels; however, the uncertainty of vacuum sensors tend to increase at higher vacuum levels, therefore, the uncertainty in the PPI would also increase if zeroed at higher vacuum levels. Once the vacuum level is stable, the user enters the vacuum level as indicated by the vacuum gauge and then the zeroing procedure completes. Refer to Chapter 6, Maintenance, of the manual for more detailed information regarding the zeroing procedure of the PPI.

Menu | Test

The Menu | Test section of the system is used to perform a number of the diagnostic and tuning functions that are available with the RUSKA 7050.



4-15.bmp

Figure 4-15. Menu | Test - Menu

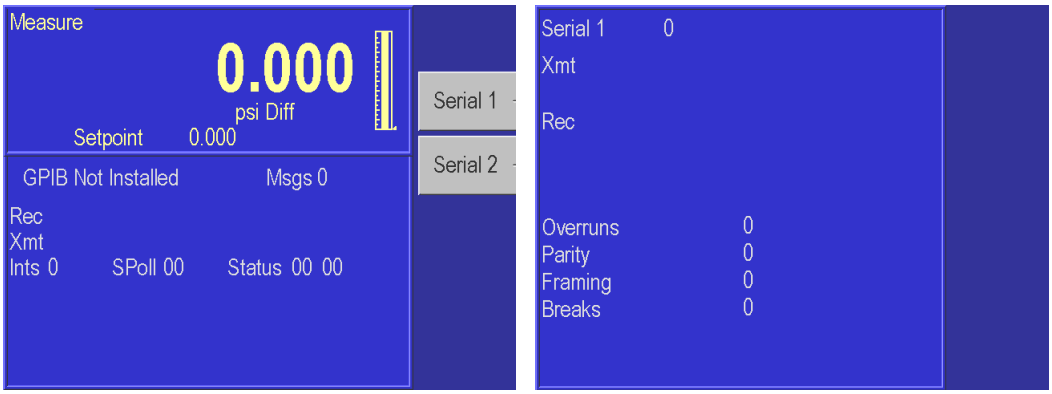
Menu | Test — Self Test

The PPI can perform an electrical self test to assist in trouble shooting potential problems. Refer to Chapter 6, Maintenance, for more details.

Menu | Test — Remote Test

The Menu | Test | Remote section of the system is used to perform a number of the diagnostic functions on the remote interface. It can be used to display the transmitted and received messages that are sent across the interface. This can be a powerful tool to assist in identifying the source of communication problems.

The Menu | Test | Remote menu displays information from the IEEE-488 interface. Pressing the Serial 1 [F2] or Serial 2 [F3] keys will display information from the serial ports.



Glc24.bmp & glc25.bmp

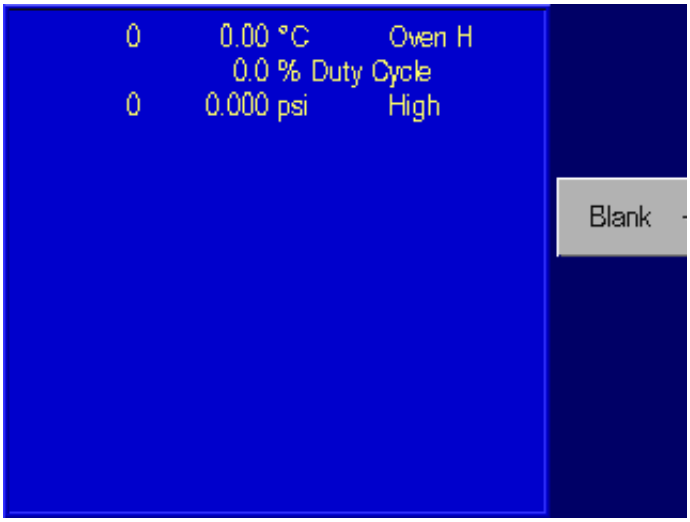
Figure 4-16. Menu | Test | Remote - GPIB Menu & Serial1 Menu

Menu | Test — Shop1

The Menu | Test | Shop1 menu of the system is used to display the current status of the various valve positions in the system. This menu is primarily used for diagnostics and will be discussed further in Chapter 6, Maintenance.

Menu | Display

The Menu | Display is used to conveniently monitor most of the sensor output parameters. It is primarily used for troubleshooting.



glc26.bmp

Figure 4-17. Menu I Display - Menu

Menu | Display — Blank

Menu | Display — Blank is used as a screen saver in the 7050.

Chapter 5
Remote Operation

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). The IEEE-488 interface additionally supports emulation of a RUSKA Single Channel Interface Panel (Models 6005-701 and 6005-761). 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 CommonCommands
SCPI 1991.0	Standard Commands for Programmable Instruments

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 /Setup/Remote screen.

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. It is located on the processor board. 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

Remote/Local Operation

In Local mode, the PPI is operated manually through the front panel. Chapter 4 covers local 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.

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	Baud Rate, Data Bits, Parity, Stop Bits

To configure the remote interface:

1. The remote interface is configured from the Setup | Remote | Menu. From the Main Menu (press PREVIOUS until the Main Menu appears), press Menu [F6] | Setup [F2] | Remote [F4].
2. Use the rotary knob to highlight the desired parameter.
3. Use the numeric keypad to enter the address; use the rotary knob to change the other parameters. The ENTER key must be pressed after entering the address.
4. Repeat steps 2 and 3 to set all parameters needed.

Device Messages

SCPI Command Format

SCPI mnemonics have two forms: long and short. The short form 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. SCPI ignores case: uppercase and lowercase are equivalent.

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.

SCPI Response Format

Most values can be queried by appending a question mark (?) to a command and not specifying any parameters. Commands ending with a question mark (?) in the command summary cannot be set only queried. 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.”

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)

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]?                Returns Current Pressure Reading
        :TEMPerature2?              Returns Oven Temperature
        :TEMPerature3?              Returns Oven 2 Temperature (7050xi only)
        :PRESsure2?                 Return Case Pressure
        :PRESsure3?                 Return Barometric Reference Pressure
        :SLEW?                      Returns Pressure Slew Rate (units/sec)
     CALCulate
        :LIMit
          :LOWer <number>           Get/Set Low Pressure Limit
          :SLEW  <number>           Get/Set Slew Rate Limit
          :UPPer <number>           Get/Set High Pressure Limit
        :TARE
          :VALUE <number>           Get/Set Tare Value
          :STATe ON/OFF             Set Tare state using current pressure
     CALibration
        [:PRESsure]
        :VALue<n> <number>          Perform calibration point
        :DATA
             :POINts?               Number of calibration constants
             :VALue<n>?             returns cal. constant label, value
             :VALue<n> <number>     Set calibration constant
     :CALibration
        :POINts?                    Number of calibration points
        :VALue?                     Nominal calibration point
     :DATE?                         Last calibration date
     :TIME?                         Last calibration time
:ZERO                               Performs Zero Calibration
     :VALUE<number>                 Sets Vacuum Value
     :INITiate                      Enter Zero Calibration Mode
     :INITiate?                     Status for Cal, Pressure, Temp., Reference
                                    Cal:    0=Not Zeroing,
                                            1=Local Zero,
                                            2=Remote Zero
                                    Pressure, Temperature, Reference:
                                            -1=Out of Range
                                            0=Stable
                                            >0=Time until stable
     :RUN                           Start Zero Calibration
        :DATE?                      Last zero date
        :TIME?                      Last zero time
     :PRESsure2                     Case reference sensor
        :VALue<n> <number>          Perform calibration point
        :DATA
             :POINts?               Number of calibration constants
             :VALue<n>?             returns cal. constant label, value
             :VALue<n> <number>     Set calibration constant
```

```
   :CALibration
        :POINts?                  Number of calibration points
        :VALue?                   Nominal calibration point
   :ZERO <number>                 Zero sensor to value
:PRESsure3                        Reference sensor
   Same as PRESsure2 above
:PRESsure4PDCR                    sensor
   Same as PRESsure2 above
:VACuum
   Same as PRESsure2 above
:TEMPerature                      Gas Temperature
   Same as PRESsure2 above
:TEMPerature2                     High Sensor Temperature
   Same as PRESsure2 above
:TEMPerature3                     Low Sensor Temperature
   Same as PRESsure2 above
:MODE?                            return 1 if calibration edit enabled
:MODE <access code>               Request calibration edit
DISP
   :ENABle ON|OFF|1|0             Turns Front Panel Display On/Off
   TEXT <string>                  Displays Message on Front Panel
   :BGRaph<number>                Sets Bar Graph Maximum
SENSE
       [:PRESSure]
       [:RESolution] <number>     Set Pressure Display Resolution
            :AUTO<boolean>|ONCE   Return to Default Resolution
       :MODE?                     Returns ABSOLUTE or GAUGE
       :MODE ABSolute|GAUGe       Turns On or Off Simulated Absolute
       :RANGE
           [:UPPer]?              Returns PPI Full Scale Value in Units
           :LOWer?                Returns Lowest Calibrated Value
       :REFerence
           [:HEIGht] <number>     Set Gas Head Height
           :MEDium N2|AIR         Set Gas Medium
STATus
   :OPERation
   [:EVENT]?                      Read/Clear Operation Event Register
   :CONDition?                    Read Operation Condition Register
   :ENABle<number>                Set Operation Enable Mask
   :QUEStionable
      [:EVENT]?                   Read/Clear Questionable Event Register
      :CONDition?                 Read Questionable Condition Register
      :ENABle <number>            Set Questionable Enable Mask
   :PRESet                        Reset Condition Flags
SYSTem
   :DATE <year>,<month>,<day>     Set System Date
   :ERRor?                        Returns <error#,"descr;info">
                                  Or 0,"No Error"
   :KLOCk ON|OFF|1|0              Lock Keyboard
   :TIME <hour>,<minute>,<second>Set System Time
   :VERSion?                      Returns 1991.0
   :LANGuage "6000"|"SCPI"|"500" Set Interface Protocol to 6000 or SCPI, or
                                  Druck DPI-500
   :PRESet                        Reset System
TEST
   :ELECtronic?                   Perform Electronic Self-Test
   STOP                           Abort Pneumatic Self-Test
UNIT
   :DEFine<n> <name>,<number>     Define a Unit
   :LENGth MM|IN                  Set Length Units for Head Height
   [:PRESsure] <unit name>        Set Pressure Units.  Valid unit names are
                                  KPA, BAR, PSI, KG/CM2, MMHG0C,
                                  CMHG0C, INHG0C, INHG60F
                                  CMH204C, INH2020C, INH2025C, %FS
                                  FT, M, KNOT, KM/HR, MPA, PA
```

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?

To zero the unit via the remote interface use the following sequence:

CAL:ZERO:INIT	Enter Zero Mode
CAL:ZERO:INIT?	Read Status (Mode, Pressure, Temperature, Reference) and Wait Until Stable.
CAL:ZERO:RUN	Start Zero Adjust Sequence
STAT:OPER:COND**?**	Wait Until Complete (Bit 0 = 0)

SCPI Status Registers

Three types of status registers are available: Condition, Event, and Enable.

Condition registers always show the current status of the instrument. Bits may turn on and back off between reads. The status read is the status of instrument at the moment of the read. Condition registers include:

*STB?	Status Byte Register
*ESR?	Standard Event Status Register
STAT:OPER:COND?	Operation Status Condition Register
STAT:QUES:COND?	Questionable Status Condition Register

Event registers do not show the current state but flag the bits in the condition registers that have changed since the last time the event register was read. When an event register is read it is reset to zero.

STAT:OPER:EVENT?	Operation Status Event Register
STAT:QUES:EVENT?	Questionable Status Event Register

Enable registers are set by the user to create summary bits. If the user sets a bit in the enable register, when the instrument sets the corresponding bit in the event register a summary bit in the Status Byte Register is set.

*ESE
STAT:OPER:ENAB
STAT:QUES:ENAB

The Service Request Enable Register (*SRE) is used to generate service requests on the IEEE-488 bus. If a user sets a bit in this register, when the instruments sets the corresponding bit in the Status Byte Register (*STB) a service request is generated.

*SRE

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. 0.
Bit 0 Reserved. 0.

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

Bit 7 Power-on. Set at power-up.
Bit 6 Reserved 0.
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 Query error. Output queue empty when request received.
Bit 1 Reserved. 0.
Bit 0 Operation complete. Set for *OPC command.

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

Bit 0 Calibrating. Currently performing a calibration.
Bit 1 Settling. Control setpoint has not been reached. Pressure tolerance set by SOUR:PRES:TOL
Bit 2 Reserved. 0.
Bit 3 Reserved. 0.
Bit 4 Measuring. The instrument is actively measuring.
Bit 5 Reserved. 0.
Bit 7 Reserved. 0.
Bit 8 Self-test in progress.
Bit 9 Reserved.
Bit 10 Reserved. 0.
Bit 11 Reserved. 0.
Bit 12 Reserved. 0.
Bit 13 Reserved. 0.
Bit 14 Program running.
Bit 15 Reserved. 0.

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

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

6005 Interface Panel Emulation

The PPI may be configured to emulate the IEEE-488 command set of the RUSKA Single Channel Interface Panel (Models 6005-701 and 6005-761). See the Interface Panel User's Manual for a description of the protocol. The PPI emulation has the following differences:

1. The PPI is always in Remote mode (Byte 1, Bit 1).
2. All TI strip outputs must be written as OFF.
3. No special functions are implemented.
4. Any message written to the PPI that starts with a colon as the first character is interpreted as a SCPI command.

To change from SCPI to Interface Panel Emulation via the remote interface, send the following message:
:SYSTem:LANGuage "6000".

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

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.

Druck DPI-510 Emulation Command Summary

Supported Commands

B <value>	Set Tare amount
C0	Go to MEASURE mode.
C1	Go to CONTROL mode.
D0, D2	Transmit Pressure Reading
D1	Transmit Set-point
Fxx	*(Ignored)*
I0	Disable SRQ
I1	SRQ on In Limit
I2	SRQ on Error
I3	SRQ on In Limit and Error
I4	SRQ on End of Conversion
I5	SRQ on Error and End of Conversion
I6	SRQ on In Limit and End of Conversion
I7	SRQ on In Limit, Error and End of Conversion
J0,J1,J2	Set Pre-programmed rate.
M	Unlock keyboard
N0,N1,N2,N3,N4	Set talk mode notation
O1	Zero
P<value>	Set pressure Set-point
R0	Unlock keyboard

R1,R2	Lock keyboard
S0,S1,S2,S3	Set pre-programmed units
T0	Turn off Tare mode
T1	Turn on tare mode to value set to B (B must be set first)
U1 to U23	Set S4 units (if S4 is selected this will change current units immediately)
V<value>	Set slew rate (sets low overshoot mode)
W<value>	Set In Limit wait time
/0 to /11	Set set-point as fraction of P value
*0 to *11	Set pre-programmed set-point
@0	Disable error reporting
@1	Enable error reporting

Response Formats

N0 <Pressure or Setpoint><REM|LOC>RnSnDn[@nn]

N1 <Pressure or Setpoint>[@nn]

N2 <REM|LOC>RnSnDnCnInFn

N3 <In Limit Status>[@nn]

N4 @nEnJnVnnnnUaaaa

Note

Secondary addressing is not supported.

Reset Conditions

N0 D0 F0 I0 @1 R0 S0 W002

Keyboard Entry

MENU/SETUP/REMOTE/510EMUL

Termination: CR/LF/EOI, CR/EIO, LF/EOI, or EOI

Zero Delay: Delay for zero stabilization.

F1,F2,F3 Rates Specify rates used by J0, J1, J2

MENU/SETUP/REMOTE/510EMUL/F1UNIT

MENU/SETUP/REMOTE/510EMUL/F2UNIT

MENU/SETUP/REMOTE/510EMUL/F3UNIT

Select units for S0, S1, S2

MENU/SETUP/REMOTE/510EMUL/RATIOS

Specify ratios used by /0 to /11

MENU/SETUP/REMOTE/510EMUL/PRESETS

Specify presets used by *0 to *11

Notes

Format

Upper and lower case are equivalent. Spaces and equal signs are ignored before numeric values. Spaces, commas, semi-colons, and colons are ignored before and after commands.

Zeroing

The RUSKA sensor takes longer to zero. This time can be set from the front panel. The default is 5 seconds but this may need to be increased especially for absolute units. When the zero command is received the zeroing valve is opened, the system waits the zero delay time and then the sensor is zeroed.

Rate

If the rate is positive it will be used at the maximum rate with the overshoot set to low. If the rate is zero then the maximum rate will be used with the overshoot set to low. If the rate is negative the maximum rate will be used with the overshoot set to normal.

Units

Unit Number	Unit Name	RUSKA display units
1	Pa	kPa
2	kPa	kPa
3	Mpa	kPa
4	mbar	bar
5	bar	bar
6	kg/cm2	kg/cm^2
7	kg/m2	kg/cm^2
8	mmHg	mmHg 0^oC
9	cmHg	cmHg 0^oC
10	mHg	cmHg 0^oC
11	mmH2O	cmH_2O 4^oC
12	cmH2O	cmH_2O 4^oC
13	mH2O	cmH_2O 4^oC
14	torr	mmHg 0^oC
15	atm	bar
16	psi	psi
17	lb/ft2	psi
18	inHg	inHg 0^oC
19	"H2O04	inH_2O 4^oC
20	'H2O04	InH_2O 4^oC
21	SPEC'L	User Defined 1
22	"H2O20	inH_2O 20^oC
23	'H2O20	inH_2O 20^oC

Sample Program

Sample Program - 7050 GPIB (IEEE-488) - Zero Sequence

```
/*-------------------------------------------------------------*/
/*      Sample Program 2 - 7050 GPIB (IEEE-488)                */
/*                                                             */
/*      Zero Sequence                                          */
/*-------------------------------------------------------------*/
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <conio.h>

#include "decl.h"

/*-------------------------------------------------------------*/

int    device;                  /* GPIB Device descriptor */
char   buffer[256];         /* buffer for input/output strings */
double pressure;                /* Pressure read from unit */
int    status;                  /* Status register from unit */

int    check_errors (void);
int    zero (void);
void   write_7000 (char *s);
void   request_7000 (char *s);
/*-------------------------------------------------------------*/

void main (void)
{
   char *p;

   /*---------------------------*/
   /* Initialize GPIB Interface */
   /*---------------------------*/
   device = ibdev (0,                /* First GPIB Board */
                   4,                /* GPIB Address of 7250 */
                  NO_SAD,          /* No secondary addressing */
                   T1s,              /* 1 Second Timeout */
                  0,              /* No automatic EOI for transmit */
                   REOS+LF);         /* Terminate read on Line Feed */
    if (ibsta & ERR)
      { cprintf ("GPIB Driver not installed.\n");
        return;
      }

   /*-----------*/
   /* Zero 7010 */
   /*-----------*/
   if (!zero ( ))
      { ibonl (device, 0);
        return;
      }
   /*----------------------*/
   /* Reset GPIB Interface */
   /*----------------------*/
   ibonl (device, 0);
}

/*-------------------------------------------------------------*/
/* Zero : perform zero adjust of 7250                          */
/*-------------------------------------------------------------*/
int zero (void)
{
   int cstat, pstat, tstat, rstat;

   clrscr ( );
   cprintf ("Zeroing");

   gotoxy (1, 5); cprintf ("Pressure Reading");
   gotoxy (1, 6); cprintf ("Sensor Temperature");
   gotoxy (1, 7); cprintf ("Reference Pressure");
```

```
   /*-------------------*/
   /* Enter Zero Mode   */
   /*     CAL:ZERO:INIT */
   /*-------------------*/
   write_7000 ("CAL:ZERO:INIT\n");

   /*-------------------------------------------------*/
   /* Wait for calibration values to be within limits */
   /*     CAL:ZERO:INIT?                              */
   /*-------------------------------------------------*/
   do
      { if (kbhit ( ))
           { getch ( );
             break;
           }

        request_7000 ("CAL:ZERO:INIT?\n");
        sscanf (buffer, "%d,%d,%d,%d", &cstat, &pstat, &tstat, &rstat);

        if (check_errors ( ))
           return 0;

        gotoxy (20, 5);
        if (pstat == 0)     cprintf ("Stable                ");
        else if (pstat < 0) cprintf ("Out of Range          ");
        else if (pstat > 0) cprintf ("Unstable (%2d seconds)", pstat);

        gotoxy (20, 6);
        if (tstat == 0)     cprintf ("Stable");
        else if (tstat < 0) cprintf ("Out of Range");
        else if (tstat > 0) cprintf ("Unstable (%2d minutes)", tstat);

        gotoxy (20, 7);
        if (rstat == 0)     cprintf ("Stable");
        else if (rstat < 0) cprintf ("Out of Range");
        else if (rstat > 0) cprintf ("Unstable (%2d seconds)", rstat);

      }
   while (pstat != 0 || tstat != 0 || rstat != 0);

   /*-------------------*/
   /* Start Zero Adjust */
   /*     CAL:ZERO:RUN  */
   /*-------------------*/
   write_7000 ("CAL:ZERO:RUN\n");

   /*---------------------------*/
   /* Wait for zero to complete */
   /*     STAT:OPER:COND?       */
   /*---------------------------*/
   do
      { request_7000 ("STAT:OPER:COND?\n");
        sscanf (buffer, "%d", &status);

        if (check_errors ( ))
           return 0;

        gotoxy (1, 9);
        cprintf ("Zeroing");
      }
   while ((status & 1) != 0);

   gotoxy (1, 9);
   cprintf ("Zero Complete");
   return 1;
}

/*-------------------------------------------------------------*/
/* check_errors : display all GPIB and 7250 error messages     */
/*                return TRUE if any errors were found         */
/*-------------------------------------------------------------*/

int check_errors (void)
```

```
{
   unsigned char status7;
   int retval;

   /*---------------------------------*/
   /* Check for GPIB Interface Errors */
   /*---------------------------------*/
   if (ibsta & ERR)
      { cprintf ("GPIB Status=%4X Error=%d\r\n", ibsta, iberr);
        return 1;
      }

   /*------------------------*/
   /* Check for 7250 Errors */
   /*------------------------*/
   retval = 0;
   while (!kbhit ( ))
      { ibrsp (device, &status7);              /* Serial poll */
        if ((status7 & 4) == 0)            /* Check error bit */
           break;
        retval = 1;
        request_7000 ("SYST:ERR?\n");    /* Get error message */
        cprintf (buffer);
      }
   return retval;
}

/*-------------------------------------------------------------*/
/* write_7000 : write a command to the 7250                    */
/*-------------------------------------------------------------*/
void write_7000 (char *s)
{
   ibwrt (device, s, strlen (s));
}
/*-------------------------------------------------------------*/
/* request_7000 : write a query command and read the response */
/*-------------------------------------------------------------*/
void request_7000 (char *s)
{
   ibwrt (device, s, strlen (s));
   ibrd (device, buffer, sizeof (buffer));
}
/*-------------------------------------------------------------*/
```

Chapter 6
Maintenance

Introduction

Very little maintenance is required for the PPI. This section of the manual discusses suggested maintenance procedures.

Observing the Software Version Number

Follow the steps below to observe the PPI's software version number.

1. If necessary, press PREVIOUS] several times to return the display to the Main Menu.
2. Select MENU | SETUP | SYSTEM. The software version number will appear on the screen.
3. Press PREVIOUS to return to the previous screen.

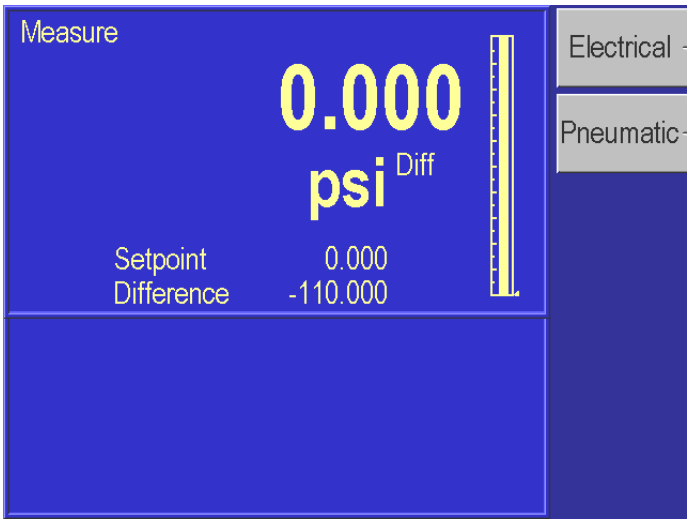
Preventive Maintenance

Although the PPI is designed to be nearly maintenance free, occasional preventive maintenance is required to keep the PPI's performance optimal.

Initiating the PPI's Self Test

To test the PPI's hardware, software, and pneumatics, follow the steps below.

1. If necessary, press PREVIOUS several times to return the display to the Main Menu.
2. Select MENU | TEST | SELF



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Figure 6-1. Menu | Test | Self - Menu

3. Press ELECTRICAL [F1]. The electronics self test will run and display the results.
4. Press PREVIOUS to return to the previous screen.

The electronics test runs eight sets of tests on various parts of the electronic modules. Table 6-1 describes these tests and the possible actions needed if a test fails.

Table 6-1. Electronics Self Test

Test	Description	Action on failure
Processor	Tests the processor chip	Replace processor board.
Clock	Tests the real time clock	Replace processor board.
Timer	Tests 10 ms interval timer	Replace processor board
EEPROM	Tests the nonvolatile memory	Replace processor board
Oven	Tests operation of the sensor oven	Replace sensor assy. Allow oven to warm up.

Removing the PPI's Cover

⚠⚠ Warning

The PPI should only be opened by qualified electrical/mechanical service technicians. Lethal voltages are present and exposed in the power supply and display.

1. Turn off the PPI and disconnect the power cord from the PPI.
2. Locate and unscrew the four screws that secure the cover to the back panel.
3. Place your hands near the middle of the cover and slide the cover towards the PPI's back panel.
4. Lift up on the cover. With the cover removed, use typical electronic cleaning tools to remove any accumulated dust from inside the instrument.
5. Replace the cover before resuming operation.

Moisture Filter

The Bourdon tube sensor is hydroscopic. An external desiccant filter prevents introduction of moisture and is strongly recommended for high humidity areas. The filter should be replaced annually. The moisture filter is used with the reference port only (absolute only instruments do not need a moisture filter).

Particle Filters

Refer to Appendix A for air supply quality requirements. During normal operation, the PPI transfers gas both into and out of the device under test (DUT). When necessary, the user is expected to use and maintain an in-line disposable particle filter to protect the PPI's pneumatics from any contamination that may exist in the DUT.

Vacuum Pumps

Periodic checks of the user's vacuum pumps for oil levels. It is very highly recommended that a power-down vacuum venting valve is installed onto the vacuum pumps to ensure minimal chances of oil contamination from the vacuum sources. These are normally open solenoid valves that are powered through the vacuum pump power switch. When the vacuum pump is turned on, the solenoid valve is energized and closes allowing the pump to operate normally. When the pump is turned off, power is removed from the solenoid and the vacuum is vented to atmosphere. Periodic changing of vacuum pump oil should also be done as recommended by the vacuum pump manufacturer.

Processor Battery

The processor board uses a lithium battery to maintain time and date information. This battery has a varying life. If the instrument is left on 24 hours a day, it may last 5 to 10 years. If the instrument is stored, it may only last one year. Annual replacement is recommended. To replace the battery:

1. Turn off power and remove the instrument cover.
2. Remove the processor card by removing the screw and the bracket that locks the display cable in place and gently rock the card upward.
3. Holding the processor card, remove the battery (the round silver object), by carefully pulling on the battery.
4. Plug in a new battery (part number 4-725).
5. Reinstall the processor card, the bracket that locks the display cable in place and the screw. Replace the instrument cover.
6. The time and date may have to be re-entered. See Chapter 4, Menu; Menu | Setup; Menu | Setup – System; Date/Time.

Calibration

To keep the PPI operating within its specified precision, the calibration procedure described below should be performed once every year. If a higher level of overall performance is desired, the user can calibrate more frequently.

Note

The calibration procedure automatically generates coefficients that are stored in memory on the PPI. 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 Chapter 6, Barometric Reference Calibration — Simulated Absolute.)

Calibration Instructions

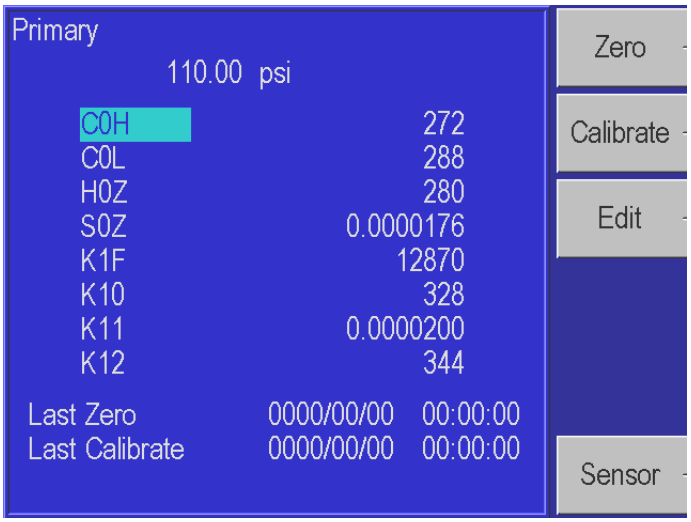
To calibrate the PPI, the user connects a calibration standard such as the RUSKA Instrument Model 2465 (or 2470 for high pressure ranges) Gas Piston Gauge to the PPI's test port, then follow the multi-step calibration procedure on the PPI's display. The standard PPI requires a positive pressure calibration. A vacuum (negative gauge) option is available and requires special calibration; see Chapter 6, Vacuum (Negative Gauge) Calibrations. No disassembly is required and there are no potentiometers to tune.

Note

The uncertainty of the final calibration must include the uncertainty of the pressure standard being used.

Preparation

1. Verify that the PPI's Reference Port is open to atmosphere for gauge calibrations and that the calibration standard is connected to the Test Port.
2. Verify that the PPI has been at stable environmental temperature and that the oven temperature (MENU | DISPLAY) has been stable for at least three hours.
3. Verify that the PPI is in Measure mode (Chapter 4).
4. If desired, change the PPI's units of measure (Chapter 4) to match those of the calibration standard.
5. Set the gas head to 0. Select MENU | SETUP | USER.
6. To access the calibration screen, select MENU | CALIBRATION.



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Figure 6-2. Menu | Calibration

7. When you first enter the Calibration menu, the top left hand side of the display will indicate which sensor is being the viewed. The sensors coefficients are then shown below the sensor label. The first sensor that is shown is the primary measuring sensor. This is indicated by the word Primary displayed in the top of the display. To cycle through the various sensors that exist in the system, you would press the Sensor [F6] function key. Assure that you are in the screen that is labeled as Primary.
8. To begin the calibration process, press the Calibrate [F2] button. If the calibration access code is enabled, enter it at the prompt. The first calibration screen will appear.

Note

To exit the calibration procedure before the calibration coefficients have been changed, press [CANCEL] any time during the procedure. Canceling restores all previous calibration values.

Step 1

1. To begin Step 1 of the calibration process, select the Zeroset [F1] button. The zero procedure will start when the reading is in-range and stable or when OK [F6] is pressed. Press OK [F6] only if the zeroing conditions are stable. The zero calibration will not be accurate if OK [F6] is pressed when conditions are unstable.
2. Wait until the zero procedure finishes. This may take several minutes. When the PPI completes Step 1, the calibration screen will appear.



On High Pressure Models, pressure must be removed from the test port. If zeroing an Absolute unit then the Test Port must be isolated.

Step 2

1. To begin step 2, use the calibration standard to apply the various pressures that will be requested by the 7050. The number of pressure points required to calibrate the PPI will vary based on whether the PPI is a 7050, 7050i or 7050LP and if it has a vacuum (negative gauge) option. The screen will display a table noting the following information;

Step	The pressure step in the calibration sequence
Apply	The pressure that the standard is to generate to the PPI.
Tolerance	The tolerance about the apply value that can be generated by the standard and still accepted by the PPI.
Actual	The actual pressure value that was generated by the standard when the point was accepted.
Adj. %FS	Depicts the amount that the PPI corrected its output to align to the standard. This is used as a trouble-shooting tool. If one point has a significantly higher adjustment required than other points in the calibration, this may indicate that there was an error in that specific calibration point. The operator can re-check this pressure point prior to completing and accepting the full calibration.

2. The Step 1, actual value will be highlight. This is your first pressure point in the calibration procedure.

Note

If the PPI has the Vacuum (Negative Gauge Option) or the Barometric reference, the first two points in the procedure will show the negative pressures that should be generated to calibrate the sensor in the negative gauge direction. You are not required to perform both the negative and the positive gauge calibrations every time the unit is calibrated. If you want to calibrate only the positive pressures, using the rotary knob move the highlighted curser down to the first positive pressure step and generate all of the positive pressures in the procedure. When you are complete with the positive points, hit the Done key, the unit will maintain the older coefficients for the negative gauge portion of the sensor and calculate new coefficients for the positive gauge ranges. Conversely, you can calibrate just the negative gauge section if desired. However, you must complete all of the positive or negative gauge steps in the procedure to complete a valid calibration.

3. Using your calibration standard, generate the pressure shown in the Apply column. When the measured pressure stabilizes, use the PPI's numeric keypad to enter the actual pressure applied by the calibration standard and then press ENTER. Do not enter the measured pressure reported by the PPI. If necessary, use the CLEAR key to correct a mistake in the edit field. If the actual pressure applied is within the indicated tolerance, the unit will accept that point and the highlighted curser will automatically scroll down to the next calibration step.

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 [F6], then re-enter the actual pressure, repeating Step 2, number 1, if necessary.

Step 3

1. Generate the next pressure calibration point requested by the PPI. Apply this pressure using calibration standard and follow the instructions in Step 2, number 3, entering the actual pressure applied.
2. Repeat this procedure until all of the calibration steps are complete. Review the Adj. %FS field to see if one point has a significantly higher adjustment required than other points in the calibration. This may indicate that there was an error in that specific calibration point. The operator can re-check this pressure point prior to completing and accepting the full calibration. To re-enter a point, use the rotary knob and move the highlighted curser to the actual pressure values in the step in question. Generate the requested apply pressure using the standard and enter then new actual value when stabilized.

Storing the Coefficients

Step 4

Calibration is complete. To exit the calibration procedure without storing the calibration coefficients in memory, press CANCEL. To store the calibration coefficients in memory, select the Done [F6] key and the PPI will calculate all of its new coefficients.

Note

In additional 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.

Step 5

1. Press PREVIOUS to return to the Main Menu.
2. Once the calibration procedure is complete, the user should verify several pressure readings against the pressure standard. If there are variances beyond the stated precision, then an error was probably made in generating one of the calibration pressures, and the calibration procedure should be repeated.

Vacuum (Negative Gauge) Calibrations

Vacuum mode is an available option. The following configuration should be used when calibrating in the Vacuum mode.

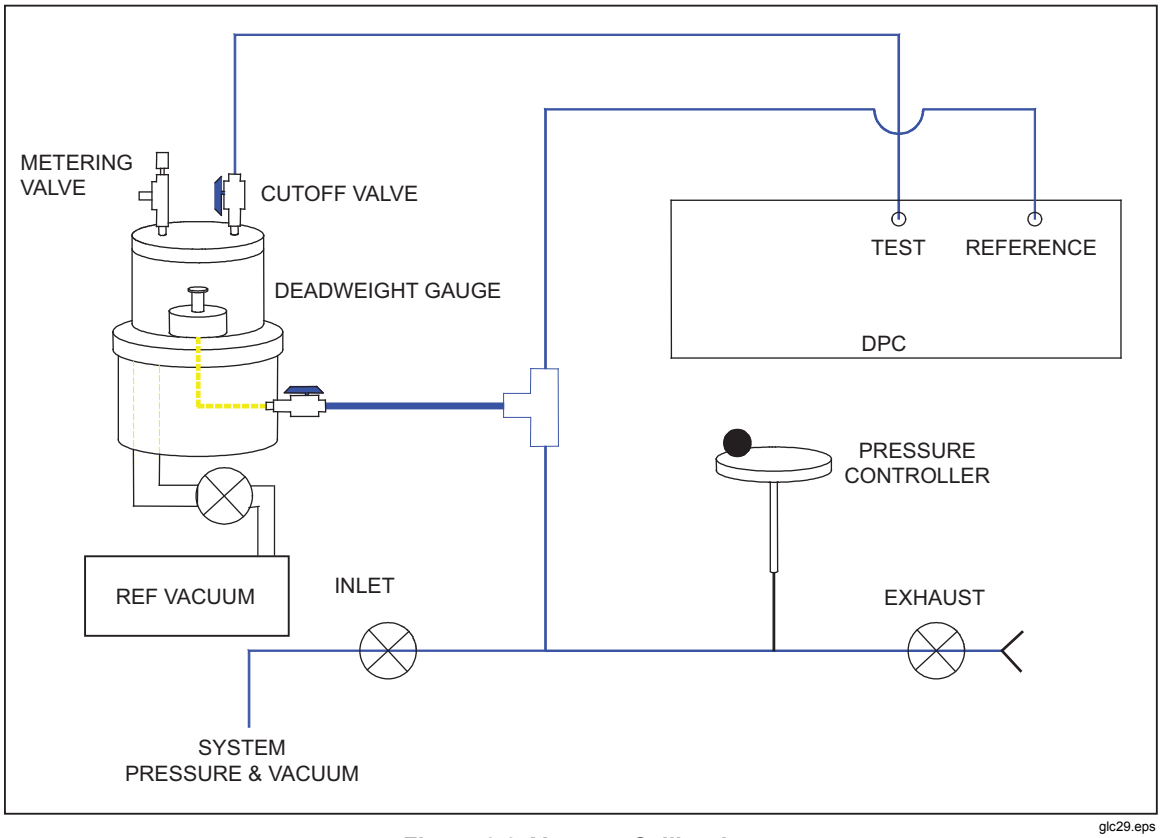


Figure 6-3. Vacuum Calibration

To calibrate in Vacuum mode with the configuration shown in Figure 6-3, the following actions should be taken. The system pressure and vacuum inlet valve should remain closed. The bottom side of the piston must be open (vented) to atmosphere and connected to the reference port of the DUT. The test port of the DUT must be connected to the bell jar with a cutoff valve to isolate it from the DUT. Additionally, there must be a cutoff valve located between the Vacuum pump and the bell jar.

Close the Cut-off valve to isolate the DUT test port from the bell jar. Open the Vacuum Pump Valve to pull a hard vacuum on the bell jar to seal the bell jar and to float the masses. Once the masses have risen in response to evacuation of the bell jar, close the reference vacuum pump cutoff valve. Use the metering valve on the bell jar to adjust (vent) the bell jar vacuum towards atmosphere until the masses begin to float. Close the metering valve as soon as the masses begin to float. Open the bell jar cutoff valve to the test port of the DUT, close the exhaust (Vent) valve, and use the pressure adjuster handwheel to adjust float position of the deadweight gauge to float the piston at mid-float position.

RPT Calibration — Simulated Absolute

A span correction can be applied to the RPT (barometric) sensor. This correction is done using the PPI software and can be performed without removing the RPT from the PPI chassis.

1. Place the PPI in Measure mode. Remove all pressure sources from the system.
2. Connect a pressure standard to the Reference Port of the PPI.
3. If desired, change the PPI's units of measure (see Chapter 4) to match those of the calibration standard.
4. To access the Calibration screen, from the Main Menu, select MENU | CALIBRATE.
5. Select the atmospheric sensor by pressing the Sensor [F6] key until the words Atmospheric Sensor are displayed above the calibration coefficients.
6. To begin the calibration process, press CALIBRATE. If the calibration access code is enabled, enter it at the prompt. The first Calibration screen will appear.
7. You will use the calibration standard to apply the various pressures that will be requested by the 7050. The screen will display a table noting the following information;

Step	The pressure step in the calibration sequence.
Apply	The pressure that the standard is to generate to the PPI.
Actual	The actual pressure value that was generated by the standard when the point was accepted.

8. The Actual value will be highlighted. This is your first pressure point in the calibration procedure. This calibration requires the generation of two pressures within the range of 700 to 1100 mbar absolute. The selected pressures should be spaced as far apart as possible within the allowable range.
9. Generate the first pressure. Enter the actual value of the applied pressure generated by the standard and press ENTER.
10. Generate the second pressure. Enter the actual value of the applied pressure generated by the standard and press ENTER.

11. The RPT sensor is now linearly compensated. Once the calibration procedure is complete, the user should verify several pressure readings against the pressure standard. If there are variances beyond the stated precision, then an error was probably made in generating one of the calibration pressures, and the calibration procedure should be repeated.
12. Remove the pressure source from the Reference Port.

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.

1. Verify that the PPI is in Measure mode (Chapter 4).
2. Enter the Calibration screen by selecting MENU | CALIBRATE.
3. When you first enter the Calibration menu, the top line of the display will indicate which sensor is being the viewed. The sensors coefficients are then shown below the sensor label. The first sensor that is shown is the primary measuring sensor. This is indicated by the word Primary displayed in the top of the display. To cycle through the various sensors that exist in the system, you would press the Sensor [F6] function key. The two common sensors that would be calibrated would be the RUSKA sensor which would be labeled as Primary and if the unit has the optional Barometric Reference sensor, this would be labeled as Atmospheric Sensor.
4. To edit the calibration coefficients, press the EDIT button. If the calibration access code is enabled, enter it at the prompt. The first calibration screen will appear.

Note

To exit the calibration procedure before the calibration coefficients have been changed, press CANCEL any time during the procedure. Canceling restores all previous calibration values.

5. Use the rotary knob to highlight the coefficient to be edited. The terms are coefficients of a linear regression analysis.
6. Use the numeric keypad and the ENTER key to enter a new value. To correct a mistake in the edit field, use the CLEAR key.
7. Repeat steps 4 and 5 until all coefficients are correct.

Note

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

8. To exit the editing procedure without storing the calibration coefficients in memory, press CANCEL. To store the calibration coefficients in memory, select DONE [F6].
9. Press PREVIOUS to return to the Main Menu.

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

Zeroing

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 guarantee that there is not a pressure differential between the sensor's test port and case reference.

If during the zeroing procedure, the message "Mechanical Zeroing Needed" appears, the sensor photocell may need to be zeroed. See Chapter 6, Sensor Photocell Zeroing, for more information.

The zeroing screen presents several pieces of information.

The screen will display the current status of the pressure sensor Stability and Temperature. If any of the above are unstable, then the system will delay until stability is achieved. Pressing OK [F6] will bypass this wait period.

Note

By-passing this wait period can have a negative effect on the zeroing procedure.

Gauge and Vacuum (Negative Gauge) Instruments

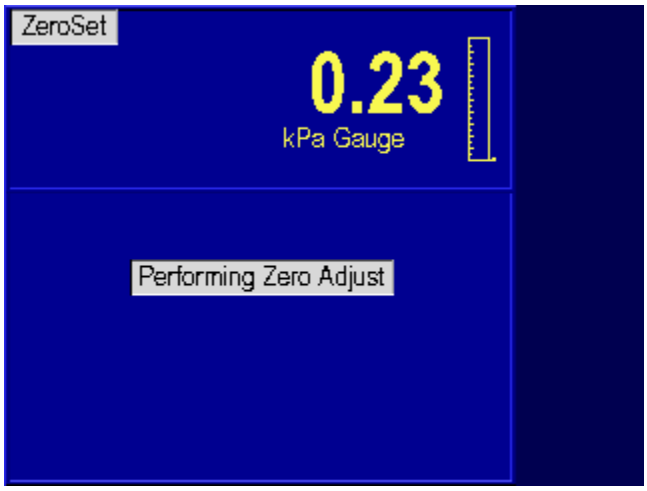
1. Verify that the Reference Port is open to atmosphere.
2. Enter the Calibration screen by selecting MENU | CALIBRATION.
3. Select Zero [F1]. Do NOT press the Calibrate button.



6-4.bmp

Figure 6-4. Zeroing Menu

4. Do not disturb the instrument while zeroing is in process.
5. Wait for the zeroing procedure to finish.
6. Press PREVIOUS to return to the Main Menu.



6-5.bmp

Figure 6-5. Zero Set

Absolute Instruments

A vacuum pump must be connected to the reference port.

A vacuum gauge should be installed for measuring the case reference pressure. This gauge should be installed as close to the sensor as possible. There is an 1/8-inch NPT fitting available for this installation inside the PPI near the sensor

1. Select the desired pressure units using the UNITS key. You can change both the unit of measure that the PPI is displaying, Pressure, and the unit of measure, for the vacuum sensor. It is not required to have the PPI displaying pressure in the same unit of measure as the vacuum sensor. To change the unit of measure for the Vacuum sensor, press the UNIT key and then the Vacuum [F2] key.
2. Enter the Calibration screen by selecting MENU | CALIBRATE.
3. Select Zero [F1]. Do NOT press the Calibrate button. When initiating the zeroing command in the PPI, it will cycle the internal valves allowing the external vacuum pump to pull a hard vacuum on the RUSKA sensor. It is recommended that the sensor be pulled down to a vacuum of less than 200 mTorr (preferably less than 100 mTorr) in order to obtain a proper zero. The PPI can be zeroed at higher vacuum levels; however, the uncertainty of vacuum sensors tend to increase at higher vacuum levels, therefore, the uncertainty in the PPI would also increase if zeroed at higher vacuum levels.
4. Wait for the vacuum level on the test port to stabilize.
5. Press OK [F6].
6. Do not disturb the instrument while zeroing is in process.
7. Wait for the zeroing procedure to finish.
8. Press PREVIOUS to return to the Main Menu.

RPT — Simulated Absolute Instruments

Simulated absolute PPI's contain two sensors that require periodic zeroing. The primary sensor is zeroed according to the instructions in Chapter 6, Gauge and Vacuum (Negative Gauge) Instruments, or Chapter 6, Absolute Instruments. The barometric sensor is zeroed according to the following instructions.

1. Verify that the Reference Port is open to atmosphere.
2. Enter the Calibration screen by selecting MENU | CALIBRATE.
3. Select the Atmospheric Sensor by pressing the Sensor [F6] key until the words Atmospheric Sensor are displayed above the calibration coefficients.
4. To begin the zeroing process, press ZERO. If the calibration access code is enabled, enter it at the prompt. The zeroing screen will appear.

Note

The next step requires the use of a properly calibrated standard. This zeroing process does contribute directly to the overall accuracy of the system, since the pressure applied to the sensor is a non-zero differential pressure.

5. Enter the current barometric pressure. Press ENTER.

Sensor Photocell Zeroing

If the error message "Mechanical Zeroing Needed" is displayed, the sensor photocell must be zeroed. The following steps describe this process.

⚠⚠ Warning

The PPI should only be opened by qualified electrical/mechanical service technicians. Lethal voltages are present and exposed in the power supply and display.

Note

The sensor MUST have zero differential between the Test port and Reference port. For Gauge PPIs, apply atmospheric pressure to the Reference port. For Absolute PPIs, apply a vacuum to the Reference port (<200 µHg.)

1. Remove the PPI's top cover.
2. Locate and remove the plastic zeroing plug located on the side of the sensor oven assembly.
3. Enter the Zeroing screen by selecting MENU | CALIBRATE.
4. Select the Primary sensor by pressing the Sensor [F6] key until the word Primary is displayed above the calibration coefficients.
5. Select Zero [F1]. Do NOT press the Calibrate button.
6. Select the Mechanical Zero [F1] key.



6-6.bmp

Figure 6-6. Photocell Zeroing Menu

7. Referring to Figure 6-6, slightly loosen the Allen screw on the back of the sensor bracket, making sure to maintain a snug fit on the screw. Using the T-shaped Photocell Centering Tool (part # 7250-111), adjust the photocells by placing the tool in the hole in the back of the sensor and turning the tool slightly. The screen will show a number of horizontal lines. The top yellow bar represents the current zero setting. The bottom portion of the bar has a green bar in the center and two red bars on either end. If the top yellow bar is over the red bar, then mechanical zeroing is required. If the yellow bar is over the green bar, then no adjustment is required.



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Figure 6-7. Centering the Photocell

8. Adjusting the photocell will cause the yellow bar to reduce in width. You want to adjust the photocell until the yellow line is as thin as possible over the green bar.



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Figure 6-8. Correct Adjustment of Photocell Centering Bar

9. Tighten the Allen screw.
10. Often, when the Allen screw is tightened, the zero will move. Review the width of the yellow line, again loosen the Allen screw, and now offset the yellow bar the same width that you observed it moving from tightening the Allen screw, and now offset it in the opposite direction by this same width.
11. Again, tighten the Allen screw. Now the width of the yellow line should be minimized.
12. Tap on the bracket with a screwdriver handle to relieve mechanical stress. Continue to tap on the bracket until the counts stop changing.
13. If the zero moved significantly as a result from tapping the bracket, repeat this procedure as necessary.
14. Reinstall plastic zeroing plug.
15. After the unit has become thermally stabilized, perform a normal instrument zeroing procedure. See Chapter 6, Editing The Calibration Coefficients.

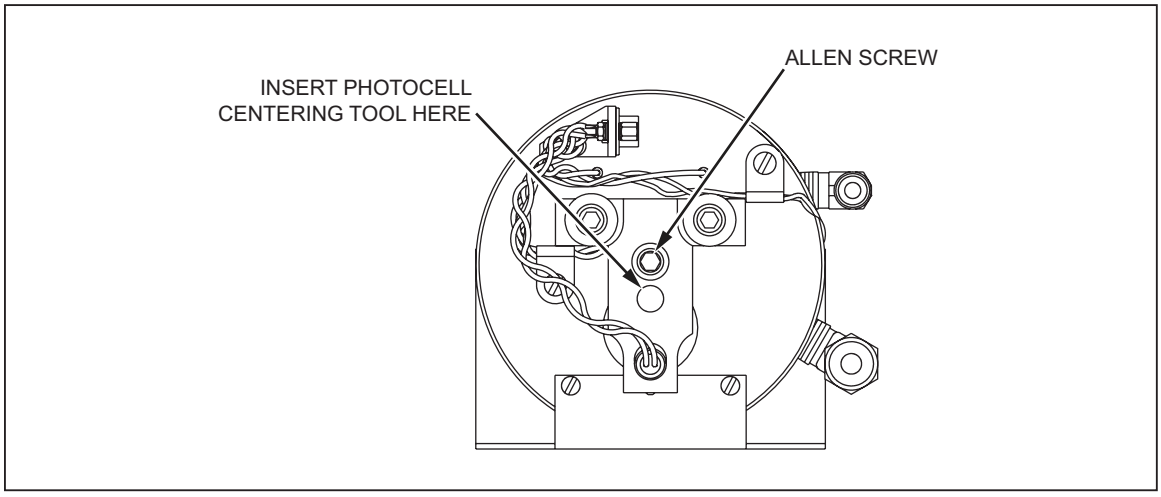


Figure 6-9. Photocell Location

Fan Operation

The fan in the 7050 can be turned on or off. It is recommended to keep the fan ON since this will extend the life of the power supply.

When operating the system in either a very cold or hot environment, if the oven is unable to maintain the temperature of the internal oven, it will generate error Oven Control Failure Error messages. The operator can review the temperature and duty cycle of the oven by pressing the MENU | DISPLAY keys. The unit must have been warmed up for a minimum of 2 hours prior to determining the condition of the oven temperature control. The temperature of the sensor should be controlled to 50 °C. The Duty cycle indicates the percentage of time that the oven control is turned on in order to maintain the oven at the proper set-point of 50 °C. A unit that is operating properly, after it has fully warmed up, should indicate a sensor temperature of 50 °C and a duty cycle between 10 to 90%.

If operating the instrument in a very cold environment and the oven duty cycle is at a high percentage (>90%) you will need to turn the fan off. If you are operating in a warm environment or when multiple systems are housed in consoles without adequate ventilation, the system may become too hot and generate the oven control failure error message. If operating the instrument in a warm environment and the oven duty cycle is at a low percentage (>10%) you will need to turn the fan on.

When the operator changes the status of the fan, it will default to that condition until it is changed by the operator.



6-10.bmp

Figure 6-10. Menu | Test | Shop 1 - Menu

To turn the fan on or off, press Menu [F6] from Main Menu, then Test [F5] | Shop1 [F5].

Use the rotary knob to highlight either fan Off or On. Press ENTER to select.

System Software Update Procedure

Note

Calibration and other stored constants are not affected by program updates.

The update procedure requires a PC connected to the RS-232 port on the 7XXX. (9-pin to 9-pin, null modem cable minimum pinout 2-3, 3-2, 5-5).

1. When appropriate, RUSKA can e-mail the latest version of the software for upgrading instruments. The e-mail will have a zip file attached contains two files UPDATE7.EXE and <version>.IMG. Unzip these files into a directory on the PC.
2. Set the 7XXX to 9600 baud, 8 databits, no parity, 1 stopbit.

3. Run the program Update7.
4. Follow the prompts to select the communications port and the image file.
5. When the upgrade is finished, Update7 running on the PC and the 7XXX should both display Complete.

Replacement Parts

The following is a list of the common replacement parts used in the RUSKA 7050 PPI.

Table 6-2. RUSKA 7050 PPI - Parts List

Part Number	Description
3915651	Zeroing Valve
3879016	TFT Display & Inverter
3876760	Sensor LED Lamp Assembly
3908093	Sensor Photocell
3878975	Photocell Adjustment Tool
3962098	Fan Assembly
3878927	Rotary Encoder
3878543	Front Panel Keyboard Electronic Card

Chapter 7
Preparation for Storage & Shipment

Introduction

⚠ Caution

The procedures given in this Chapter must be strictly adhered to in order to prevent damage to the instrument. Failure to follow these procedures will likely result in damage to the PPI during shipment. This damage is not covered by the carrier's insurance.

Disconnecting the PPI

1. Relieve all pneumatic pressure from the PPI.
2. Turn the PPI power switch to the off position.
3. Disconnect the power cable from the PPI power receptacle.
4. Disconnect all pneumatic lines and fittings from the PPI's back panel.
5. Plug all ports.

Packing Instructions

To prevent shipping and handling damage to the instrument, adhere to and strictly follow the instructions below.

The governing discipline in ensuring a damage-free shipment is to ensure that the possibility of handling shocks to the PPI is minimized and/or prevented during transit. Fluke accomplishes this task by cradling the PPI within two foam cradles that are encapsulated within a double-walled, corrugated box. The PPI is restrained and supported, but still has resilience. The materials used in the packaging operation are foams that have a minimum impact rating of not less than N-95.

⚠ Caution

Styrofoam, poured "foam in place" mixtures, and other rigid foams are not recommended.

If polyfoam or rubber foam other than that used in the original packaging is to be used, cut it into strips so that it will not present a large rigid surface to the PPI.

Fluke has found that corrugated cardboard boxes provide the best packaging exterior. The box must have an impact rating of 275 lb and be of double-walled construction. This type of box will sustain most types of damages incurred during the shipping and handling process, but ensures that the contents remain intact and damage-free. The foam cradle ensures that a minimum of 3 inches of foam separates the inner surface of the box and any portion of the PPI.

⚠ Caution

Wood or metal boxes do not absorb shock when dropped and; therefore, are not recommended.

If the original packaging and shipping materials have been 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 inside the box.

The PPI must be prepared for shipment in the following manner:

1. Fluke Calibration has an RMA procedure in place. Please contact the Customer Service Center to obtain an RMA number prior to returning any equipment to Fluke. Have the following information available when contacting Fluke:

   - the part number,
   - the serial number,
   - the purchase order number,
   - the billing and ship to address, and
   - the buyer's name and telephone number.

This information plus the RMA number must be attached to the unit when it is shipped to Fluke Calibration. There will be a minimal charge for inspection and/or evaluation of returned goods.

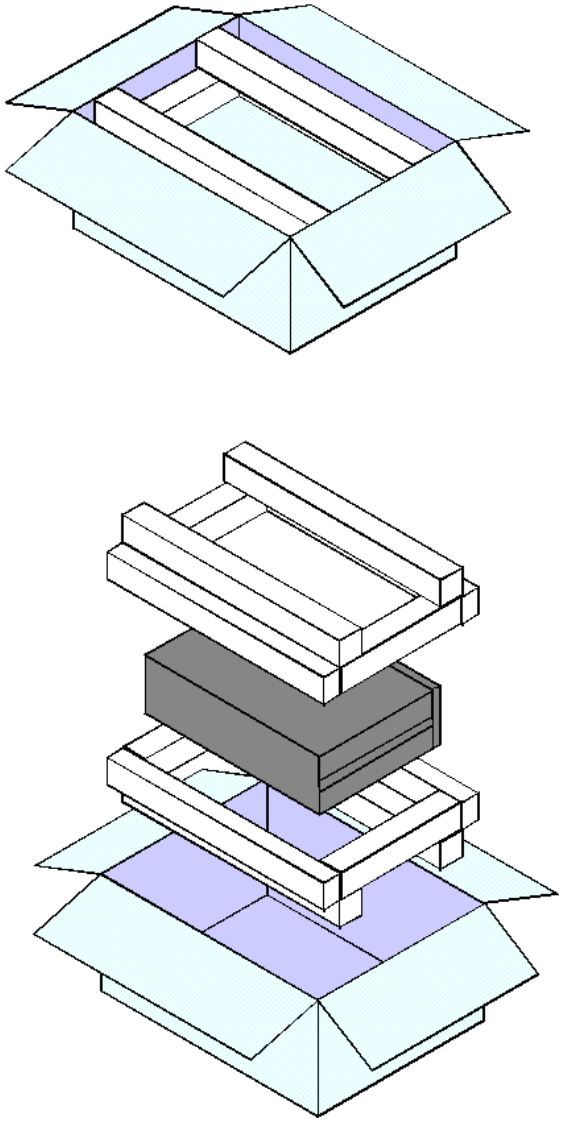
2. Enclose the PPI in plastic or any good water barrier material. Antistatic material is recommended.
3. If the original shipping carton is not usable or available, use a double-walled corrugated carton with a 275-lb rating. The recommended carton size is 25 1/2 x 19 1/2 x 12 3/8 inches.
4. Insert one foam cradle from the original shipment onto the floor of the box. (The original foam cradles are of the same type of construction and are completely interchangeable.) If the foam cradles are not available, cover the bottom and sides with no less than 3 inches of N–95 foam strips. Arrange the strips in the configuration illustrated in 7-1.
5. Before sealing the carton, include the following:

   - Statement of the problem or service needed. Be specific. Include the name and telephone number of a knowledgeable technician for consultation.
   - The part number, serial number, return address, and purchase order number.

6. Seal the carton using gummed tape.
7. Address the carton to:

FLUKE CALIBRATION
10311 WESTPARK DRIVE
HOUSTON, TX 77042
USA

8. Label the carton with the following labels: **THIS SIDE UP, HANDLE WITH CARE, DO NOT DROP,** and **FRAGILE.** (If the original Fluke shipping carton is utilized for this shipment, the above markings are preprinted on the carton.)



glc37.bmp

Figure 7-1. Packing the PPI

Shipping Instructions

Fluke recommends using air freight for transportation. Surface transportation subjects the shipment to more frequent handling and much more intense shock. In most cases, if surface transportation is the mode of transport employed, handling damage is likely.

Again, it is essential that the procedures mentioned in this Chapter be strictly adhered to in order to prevent any shipping and handling damage to the instrument.

Appendix A
Summary of Specifications

Uncertainty Analysis

To perform an Uncertainty Analysis on a measurement device, you must be able to identify all of the parameters that influence the measurement. You must be able to quantify the magnitude of the potential error source and combine these into an overall uncertainty statement.

To determine the expanded uncertainty on any manufacturers pressure Transfer Standard (TS), you must identify the following four primary influences;

1. Performance specifications of the TS
2. Long term Stability of TS
3. Uncertainty of the standard used to calibrate the TS
4. Environmental or installation influences that could cause errors in the TS

Performance Specifications

Performance specifications are the short-term measurement properties of the device. These traditionally include linearity, hysteresis, and repeatability properties of the transfer standard. There often is considerable confusion with the performance specification because different manufacturers use different terms to describe the performance characteristics of their instruments. The two most common terms used are “Accuracy” and “Precision”. In both cases, as a minimum the manufacturers define these terms to be the combined effects of linearity, hysteresis and repeatability. Since the manufacturer defined the terms they used, this should not be a problem. However, it is common that the users definition of these terms differ from the manufacturers and therefore cause considerable confusion. For instance, the user may believe that the term “Accuracy” includes all sources of uncertainty. This would include items 1 through 4 listed above which would be an all encompassing specification. The manufacturer may define “Accuracy” as the performance specification which consists only of item 1 above. The result would be that the instrument would not be capable of meeting the user’s application because it would not meet the users definition of “Accuracy”.

Long Term Stability

Long term stability defines how the instrument drifts with time. This specification can be utilized to define the calibration interval for the standard. Some manufacturers will provide more than one stability specification for their instrument based on different calibration time intervals. It is important to understand that you should not arbitrarily vary the manufacturers stability specification based on time without knowing the

characteristics of their device. Some manufacturers identify that their stability specification is proportional with time. Therefore, if the calibration interval were reduced in half, the magnitude of the stability specification would also be halved. This can be a powerful tool when you are trying to improve the measurement performance of a standard. By reducing the calibration interval, the expanded uncertainty would also reduce. On the other hand, some manufacturers do not claim that their stability specification is proportional with time. This would be the case for instance if the instrument naturally drifted in a sinusoidal fashion. This would suggest that the sensor could drift to its maximum stability limit at any time and therefore, reducing the calibration interval would not improve the expanded uncertainty of the device.

Uncertainty of the Standard

Uncertainty of the Standard used to calibrate the transfer standard. This is the expanded uncertainty of the calibration standard that was used by the manufacturer to calibrate the digital transfer standard. This should be the expanded uncertainty of the calibration standard and include all sources of uncertainty that would influence the calibration standard including the uncertainty from the National Standards Laboratory that the standard is traceable.

It should also be noted that when the instrument is re-calibrated, the uncertainty of the device is influenced by the uncertainty of the calibration standard that will be used to perform the re-calibration. Therefore, the uncertainty analysis should be evaluated following each re-calibration. If the instrument is re-calibrated using a different calibration service provider than the manufacturer, the uncertainty of the standard that the calibration service provider used to perform the calibration would need to be substituted for the manufacturer's calibration uncertainty that was used in the original uncertainty analysis.

Environmental or Installation Influences

Environmental or Installation Influences that could cause errors in the transfer standard includes influences such as ambient temperature, line pressure, head pressure, time response, and controller effects. (It may include other influences that are very specific to one manufacturer's instrument.) It is recommended that the intended application is reviewed to assure that the environmental does not impact the instruments performance, or that the impact from the environment is accounted for in the uncertainty analysis. For instance, if an instrument has a 0.001%FS per degree Celsius temperature effect from a calibrated temperature of 20 degrees Celsius, and the instrument is to be used in an environment where the temperature will vary from 15 to 25 degree Celsius, then a +/- 0.005% of full scale uncertainty should be included in the uncertainty analysis for ambient temperature effects.

Combining the Uncertainty Components

Combining the Uncertainty Components into an Expanded Uncertainty Statement means that once all of the uncertainty components are identified, they can be combined into an overall Expanded Uncertainty Statement for the instrument. The vast majority of the measurement community has adopted a statistical approach to uncertainty analysis such as the International Organization for Standards (ISO) Guild to the Expression of Uncertainty in Measurement. This statistical approach combines all of the uncertainty components in quadrature (RSS).

In this approach, it is important to define the level of confidence that all of the uncertainty components are defined. For instance, all of the uncertainty specifications that Fluke Calibration publishes are at the 2 sigma level which would be at a 95% confidence level. Some manufacturers may state their uncertainty at different confidence level and therefore, you would need to be able to convert from one to the other in order to compare the two devices. For instance, if a manufacturer states that they have an uncertainty of 0.005% FS and that the uncertainty is expressed at the 1 sigma level, then it would be doubled to express it at the 2 sigma level (i.e. it would be an 0.01% FS device at a 2 sigma or 95% confidence level.)

The following two tables are uncertainty analysis examples for a 7050i based on a three month and a yearly calibration.

Table A-1. Uncertainty Analysis for 7050i—Three Month Analysis

Uncertainty Analysis – 3 Month Calibration Interval RUSKA 7050i from 25 to 100% of Range	**Uncertainty (2 sigma)**
A. Performance – (Linearity, Hysteresis, Repeatability and Temperature)	0.005% of Reading
B. Stability – (3 months)	0.0019% of Reading per 90 days
C. Calibration Standard – (RUSKA 2465 DWG)	0.0010% of Reading
D. Environmental –	
Temperature (Included in A. above)	0.000% of Reading
Head Pressure	0.001% of Reading
2 sigma Expanded Uncertainty (RSS)	**0.0055% of Reading per 90 days**

Table A-2. Uncertainty Analysis for 7050i—One Year Analysis

Uncertainty Analysis – One Year Calibration Interval RUSKA 7050i from 5 to 100% of Range	**Uncertainty (2 sigma)**
A. Performance – (Linearity, Hysteresis, Repeatability and Temperature)	0.005% of Reading
B. Stability – (1 year)	0.0075% of Reading / year
C. Calibration Standard – (RUSKA 2465 DWG)	0.0010% of Reading
D. Environmental –	
Temperature (Included in A. above)	0.000% of Reading
Head Pressure	0.001% of Reading
2 sigma Expanded Uncertainty (RSS)	**0.009% of Reading per year**

The following two tables are uncertainty analysis examples for a single range 7050 based on a three month and a yearly calibration.

Table A-3. Uncertainty Analysis for 7050—Three Month Analysis

Uncertainty Analysis – 3 Month Calibration Interval RUSKA 7050	**Uncertainty (2 sigma)**
A. Performance – (Linearity, Hysteresis, Repeatability and Temperature)	0.003% of Full Scale
B. Stability – (3 months)	0.0019% of Reading per 90 days
C. Calibration Standard – (RUSKA 2465 DWG)	0.0010% of Reading
D. Environmental –	
Temperature (Included in A. above)	0.000% of Reading
Head Pressure	0.001% of Reading
2 sigma Expanded Uncertainty (RSS)	**0.003% of Full Scale RSS with 0.0024% of Reading per 3 months**

Table A-4. Uncertainty Analysis for 7050—One Year Analysis

Uncertainty Analysis – One Year Calibration Interval RUSKA 7050	**Uncertainty (2 sigma)**
A. Performance – (Linearity, Hysteresis, Repeatability and Temperature)	0.003% of Full Scale
B. Stability – (1 year)	0.0075% of Reading / year
C. Calibration Standard – (RUSKA 2465 DWG)	0.0010% of Reading
D. Environmental –	
Temperature (Included in A. above)	0.000% of Reading
Head Pressure	0.001% of Reading
2 sigma Expanded Uncertainty (RSS)	**0.003% of Full Scale RSS with 0.0076% of Reading per year**

Specifications

General Specifications

Pressure Range:	Minimum: 0 to 5 (0 to 700 mbar) Maximum: 0 to 3000 psi (0 to 200 bar)
Display	6.4 inch, TFT Active Matrix Color
Display Resolution	User-selectable up to 1:1,000,000
Electrical Power	100–120/220–240 VAC 50/60 Hz Single Phase, 150 W
Operating Temperature	18 °C – 36 °C
Storage Temperature	–20 °C – 70 °C
Humidity	5% – 95% relative humidity, non-condensing
Dimensions:	7**"** H x 16.5**"** W x 19**"** D (17.8 cm x 41.9 cm x 48.3 cm)
Weight	7250i 16 lb (7.25 kg)
Standard Pressure Units	inHg at 0 °C and 60 °F, kPa, bar, psi, inH_2O at 4 ^{o}C, 20, and 25 °C, kg/cm^2, mmHg at 0 °C, cmHg at 0 °C, and cmH_2O at 4 °C
Pneumatic Ports	$^1/_4$-inch NPT female
Relief Valves	Test Port: 120% of Maximum Scaled Quartz Sensor Range Reference: 10 Psig (where applicable)
Ingress Protection:	IP-20, Indoor use, Altitude <2000 in
EMC:	EN 61326
Electrical Safety:	EN 61010
Pressure Safety:	Pressure Equipment Directive 97/23/EC-class, Sound Engineering Practice (SEP)
Interface:	IEEE 488 and RS232

Performance

Table A-5. Performance Specifications

	7050	7050i	7050LP
Precision[1]	0.003% FS	From 25% to 100% FS: 0.005% RDG Below 25%FS: 0.005% of 25%FS	0.005% of each Range
Stability	0.0019% RDG/ 3 months or 0.0075% RDG/year		
Zero Drift[2]	<0.004%FS / 24hrs	<0.002%FS / 24hrs	<0.004%FS / 24hrs
Options			
Neg. Gauge Precison[1]	0.003% of max positive FS	Greater of 0.005% of 25%FS or 0.0005 psi (3.5 Pa)	0.005% of max FS (Optional 0.005% of each range)
Barometric Reference[3]	0.002 psi / year (14 Pa / year)	0.002 psi / year (14 Pa / year)	N/A
Vacuum Reference[3]	0.002 psi / year (1.33 Pa / year)	0.002 psi / year (1.33 Pa / year)	N/A

[1] Precision is defined as the combined effect of linearity, repeatability, and hysteresis throughout the operating temperature range. Some manufacturers use the word “Accuracy” in place of “Precision”, however the meaning is identical.

[2] Zero drift typically improves with sensor age.

[3] Requires Additional Uncertainty when operating in gauge mode 7050 or 7050i in the absolute mode. This uncertainty component would be combined RSS with the gauge mode uncertainty of the instrument.

Appendix B
Summary of Error Messages

Summary of Error Messages

Negative error numbers are from the Standard Commands for Programmable Instruments (Version 1991.0).

Table B-1. Summary of Error Messages

Value	Description and Corrective Action
0	No Error.
-103	Invalid Separator. Check punctuation in the SCPI command.
-104	Data Type. The type of parameter data is incorrect.
-109	Missing Parameter. No valid parameter was found for the SCPI command.
-110	Command Header. The command name is not valid.
-113	Command Unknown. The command specified does not exist.
-114	Header Suffix. The numeric suffix for the command name is out of range.
-221	Settings Conflict. The command could not be executed due to the current state of the DPC. Some commands cannot be executed while a program, self-test, or calibration is in progress.
-222	Out of Range. The value is not within the valid range. For pressures check high and low limits.
-281	Cannot create program. Program memory is full.
-282	Illegal Program Name. The name specified is not valid or does not exist.
-284	Program Currently Running. The command cannot be executed while a program is running.
-285	Program Syntax Error. The syntax of the program definition is not correct.
-286	Program Runtime Error. An error occurred while running the program. Usually the set-point is out of range.
-313	Calibration Data Lost. The calibration data has been lost and the unit must be recalibrated.

Summary of Error Messages, cont.

Value	Description and Corrective Action
-315	Configuration Data Lost. The configuration data has been lost. Check all parameters to be sure they are correct.
-330	Self-Test Failed. Check the display for the test that failed.
-350	Queue Overflow. The error queue was full and messages were lost.
-400	Query Error. A read request was received when there was nothing to read.
500	Controller Malfunction. Internal control failure.
501	High Limit Exceeded. The pressure was greater than the high limit.
502	Low Limit Exceeded. The pressure was less that the low limit.
503	Slew limit Exceeded. The pressure changed faster than the slew limit allowed.
521	Pressure Overrange. The pressure reading is outside the range of the PPI.
531	Oven Temp Overrange. Either the transistor that drives the heater for the quartz Bourdon tube sensor (Chapter 2) or the oven temperature sensor itself is malfunctioning. To observe the oven temperature, select OK then select MENU/DISP. Check the transistor and sensor for malfunction, requesting service (Chapter 7) if necessary.
533	Case Pressure Overrange. Select OK, then reduce the pressure at the case reference port to 30 psia or lower.
540	Mechanical Zeroing Needed. The zero point of the quartz Bourdon sensor is beyond the range of the compensation circuit. The zero is adjusted by the software but should be manually adjusted for complete accuracy.
542	Oven Control Failure. The temperature controller is unable to keep the sensor at the proper temperature.
545	Sensor Communication Error. Unable to Communicate with 7215xi Sensor
546	Sensor Calibration Lost. The 7215xi sensor has lost its calibration and must be recalibrated.
600	Factory Data Lost. Internal factory constants have been lost. Contact Fluke for more information.
601	Calibration Mode. The Calibrate button must be pressed before SCPI calibration commands can be executed.
800	Solenoid Over-Temperature. The control solenoids have over-heated. Wait until they have cooled before entering Control mode.
801	Error reading Barometric RPT Pressure Sensor
802	Control Sensor out of range
803	Controller Communication Error
804	Autotune Failed