HIGH PRESSURE PNEUMATIC CONTROLLER

MODEL 7310

USER'S MANUAL

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RELEASE NUMBER	REV	DATE OF RELEASE	DESCRIPTION
7310-1D01	A	12/1/96	Original release
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REVISION HISTORY

RELEASE 7310-1D01 **Revison A (12/1/96)**
Original release

RELEASE 7210-1D01 **Revison B (10/16/00)**
Changes made per DC/RO-22716.

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.

ELECTROSTATIC 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.

When the ESDS symbol appears between a paragraph number and paragraph title, the entire paragraph and all subparagraphs shall be considered ESD sensitive. When the ESDS symbol appears between a step number and the step test, the step shall be considered ESD sensitive.

COMPRESSED AIR

Use of compressed air 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 mandatory that all exhaust gases be vented outside the work area.

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SECTION 1.0
GENERAL INFORMATION

1.1 INTRODUCTION

This manual contains operation and routine and preventive maintenance instructions for the Model 7310 High Pressure Pneumatic Controller manufactured by Ruska Instrument Corporation, Houston, Texas. This portion of the manual provides general information about the 7310 and presents its features and options.

1.2 GENERAL INFORMATION

The Ruska Model 7310 uses transducers to provide the precise measurement of pressure. During normal operation, the 7310 performs in either measure mode or control mode.

In control mode, the 7310 simultaneously measures and controls pressure. Control mode is commonly used in the calibration and testing of pressure gauges, transducers, pressure switches, and production pressure instruments.

In Measure mode, the 7310 measures pressure. Typically, measure mode finds applications in research laboratories, testing of gauges and transducers.

1.3 FEATURES

The following features are standard on all Model 7310s.

Mercury-free: All components in the 7310 are mercury-free.

NIST Traceability: All 7310's are calibrated per ANSI/NCSL Z540-1-1994 using Ruska deadweight gauges, which are directly traceable to the National Institute of Standards and Technology (NIST).

Power Supply: The 7310s are either 115VAC, 1PH, 50/50HZ or 230VAC, 1PH, 50/60HZ.

Measurement While Control: The 7310 simultaneously displays the commanded pressure, the actual pressure, and the difference between the two. A bar graph shows the user how close the actual pressure is to the commanded pressure, as well as how close the commanded pressure is to the 7310's full scale pressure.

Friendly Display: The 7310's vacuum fluorescent 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 can be adjusted to show one decimal greater than or less than the default resolution.

Ease of Operation: An intuitive, menu-driven interface makes the 7310 easy to use. Frequently used selections such as the units of measure are restored to memory each time the 7310 powers up.

Easily Programmable: The 7310's powerful microprocessor provides the basis for smart electronics. With a few simple keystrokes, the user can set limits on the system pressure, create unique units of measure, program a test sequence, and more.

Modular Design: The pneumatic and user interface controller are separated into modules, making maintenance faster and easier.

Attractive Desktop Packaging: A sturdy aluminum case houses all of the 7310's pneumatics, electronics, and user controls. Pneumatic and electronics modules are standard 19-inch EIA chassis and can easily fit into a rack mount system.

Power On Self Test: Upon power-up, the 7310 quickly tests its hardware and software. After the 7310 completes this test, the user can select more extensive self-tests for the pneumatics and electronics.

Ease of Calibration: A three-point calibration can be performed either remotely or entirely from the front panel. No disassembly is required, and there are no potentiometers to tune.

Automatic Zero Adjust: At the user's request, the 7310's software automatically performs the zero adjustment, with no potentiometers to tune.

Automatic Head Correction: The 7310 automatically corrects for head pressure between the 7310 and the DUT, (Device Under Test) taking into account the density of the test gas.

Choice of Medium: The pneumatic 7310 can be used with dry, clean nitrogen as the pressure medium.

Choice of Display Units: Standard units include inches of mercury at 0 °C and 60 °C, kiloPascals, bars, pounds per square inch, inches of water at 4 °C, 20 °C, and 25 °C, kilograms per square centimeter, millimeters of mercury, centimeters of mercury at 0 °C, and centimeters of water at 4 °C. Altitude and airspeed units include feet, meters, knots, and kilometers/hour. In addition to these predefined units, four user-defined units are programmable.

Communications Interface: In addition to the standard RS-232 serial interface, RS-485 and IEEE-488 interfaces are available. The user's computer communicates with the 7310 through the Standard Commands for Programmable Instruments (SCPI) protocol. *The 7310 can also be configured to accept existing software written for the Ruska Series 6000 DPG.*

1.4 STANDARD EQUIPMENT & OPTIONS

A standard pneumatic 7310 comes with this manual, and a power cord. The standard pneumatic 7310 is fully functional, but the following options are also available.

IEEE-488 Interface: All models of the 7310 have an IEEE-488 (GPIB) card. The user's computer communicates with the 7310 through the Standard Commands for Programmable Instruments (SCPI) protocol. In addition, software written for the Ruska Series 7000 DPC and Series 6000 DPG is fully compatible with the 7310.

RS-485 Interface: With the optional RS-485 serial interface port, the 7310 can communicate with multi-dropped instruments up to 2,000 feet away.

Memory Card: The 7310 accepts a credit-card sized memory card through the front panel. This allows the user to move test sequences from machine to machine and to easily upgrade software.

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

Table 1-1
Options List for the Model 7310

Option	Ruska Part Number
Opto 22 Kit	Based on application
RS-485 Interface	N/A
Communication Software	contact Ruska
Memory Card	35-403
User's Manual	7310-1D01
Service Manual	contact Ruska
Power Cord, USA and Canada; Central Europe	16-81; 16-86
Power Cord, India; Japan; Israel	16-96; 16-93; 16-97
Power Cord, Australia/New Zealand	16-95
Battery, Spare	4-720

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SECTION 2.0
THEORY OF OPERATION

2.1 INTRODUCTION

The 7310's power supply, electronics, pneumatics, and sensor combine to form a complete, stand-alone, measure and control instrument. This portion of the manual breaks the 7310 down into its component modules (figure 2-1) and provides a general discussion of each.

2.2 THE POWER SUPPLY

The 7310's universal power supply accepts AC voltages from 90 to 260 volts and DC voltages from 100 to 370 volts. This triple-output supply produces +5 VDC, +12 VDC, and -12 VDC, which are distributed to the Control Board.

2.3 THE ELECTRONICS MODULE

The 7310's electronics module consists of the Control Board, the Microprocessor Board, the Option Board, the IEEE interface, and the Front Panel.

2.3.1 THE CONTROL BOARD

The Control Board monitors every major component of the Electronics Module. The Microprocessor Board, the Option Board, and the optional IEEE and memory cards all plug into the Control Board. The Sensor Board and Front Panel both communicate with the Control Board through ribbon cables.

The three voltages produced by the Power Supply are distributed to the Control Board, where they are conditioned to produce four additional voltages of +5 VDC, -5 VDC, +15 VDC, and -15 VDC for analog use. The resulting seven DC voltages are then used either directly or indirectly throughout the entire 7310.

Data that is subject to change after the 7310 leaves the factory is held in electrically erasable, programmable, read-only memory (EEPROM) on the Control Board. This includes the current units of measure, the coefficients from the zeroing process, the current pressure medium, and the conversion factors for the four user-defined units of measure. These values are used by the Microprocessor Board as described below.

The Control Board also holds the OPTO 22 connector, which communicates with the user's OPTO 22 modules through a cable that connects to the rear panel.

2.3.2 THE MICROPROCESSOR BOARD

All of the 7310's software resides in nonvolatile, programmable, read-only memory (Flash EPROM) on the Microprocessor Board, which plugs directly into the Control Board. This software contains all of the instructions that operate the 7310, as well as the conversion factors that the 7310 uses to translate the detected pressure into the units selected by the user. These factors are given in table 2-1.

When the 7310 powers up, its software is loaded into random access memory (RAM), which is also on the Microprocessor Board. At the same time, the values stored in EEPROM on the Control Board are restored to memory.

Another important component on the Microprocessor Board is the lithium battery, which continuously updates the 7310's date and time, even when the unit is powered down.

The Microprocessor Board also supports the RS-232 or optional RS-485 serial interfaces, which allow the user's computer to communicate with the 7310.

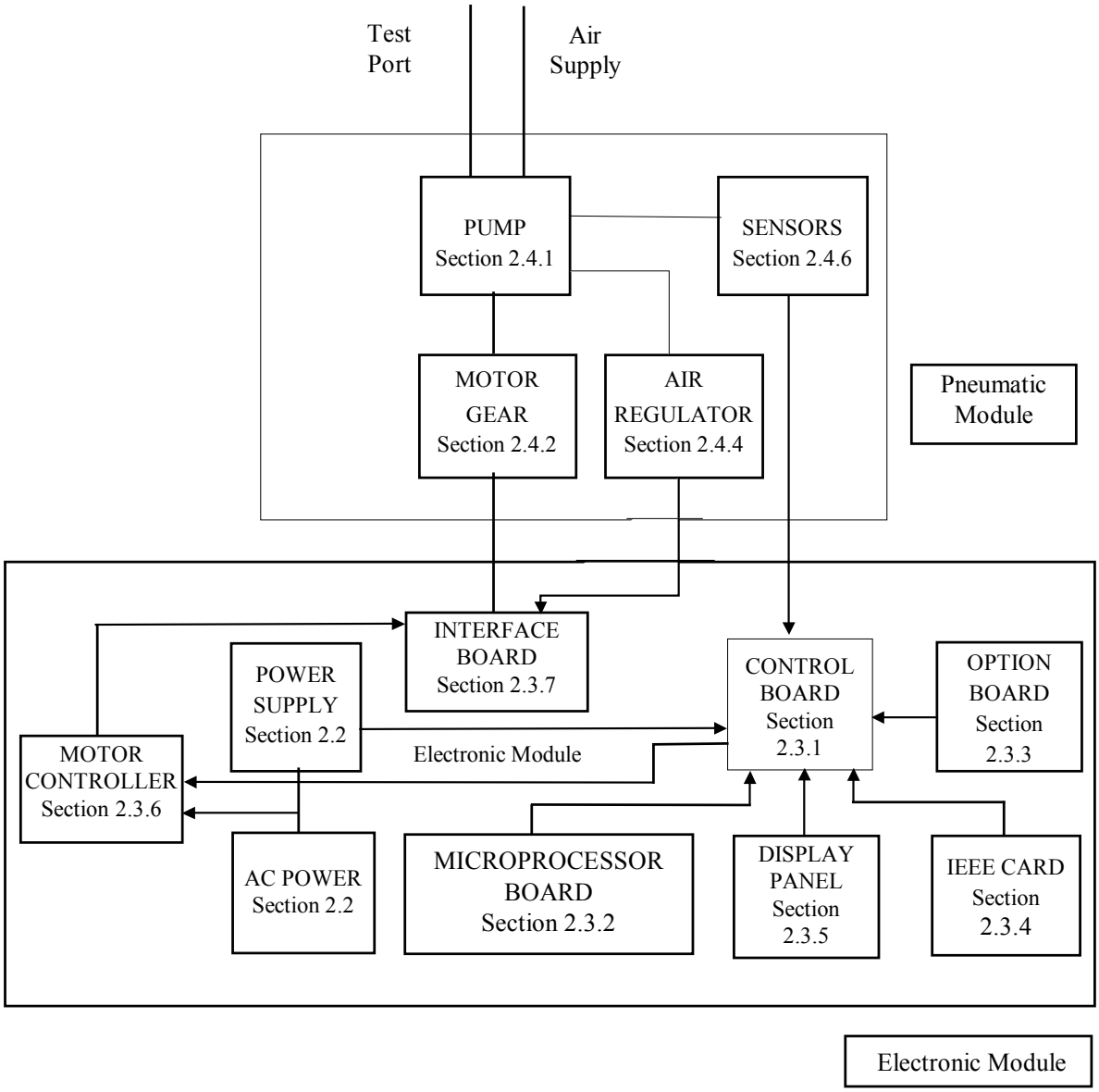

Figure 2-1
7310 Block Diagram

2.3.3 THE OPTION BOARD

Future models of the 7310 may include an Option Board that plugs directly into the Control Board. In the future, this board could be used to provide nonstandard options.

Table 2-1
Conversion Factors

Symbol	Description	Conversion Factor
inHg	inches of mercury (0°C)	= kPa x 0.2952998
inHg	inches of mercury (60°C)	= kPa x 0.296134
kPa	kiloPascals	= kPa x 1.0
bar	bars	= kPa x 0.01
psi	pounds per inch^2	= kPa x 0.1450377
cmH2O	centimeters of water (4°C)	= kPa x 10.19744
inH2O	inches of water (4°C)	= kPa x 4.014742
inH2O	inches of water (20°C)	= kPa x 4.021898
inH2O	inches of water (25°C)	= kPa x 4.024108
kg/cm2	kilograms per cm^2	= 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	airspeed knots	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
%FS	user defined (percent of full scale)	

2.3.4 THE IEEE-488 INTERFACE

The 7310's IEEE-488 (GPIB) Interface Card, which plugs directly into the Control Board, provides the 7310 with an IEEE-488 Interface. This interface allows the user to automate the measurement and control processes.

2.3.5 THE FRONT PANEL

The Microprocessor Board and Control Board work together to interpret all input from the Front Panel. The Front Panel contains the vacuum fluorescent display and rubberized keys used to operate the 7310.

The 7310 also accepts an optional memory card, which slides through a slot in the Front Panel and plugs directly into the Control Board.

2.3.6 MOTOR CONTROLLER

This motor controller controls the speed of the motor driving the pump in the pneumatic section of the 7310. The motor controller receives its analog signal (+/-10VDC) from the Control Board and in turn runs the motor at variable speed. The controller can be configured with jumpers for either 115VAC or 230 VAC power supply.

2.3.7 INTERFACE BOARD

This board interfaces and conditions the pump position pot, pump compression limit switch, and pump expansion limit switch signals. The board interfaces these signals between the electronic and pneumatic module. The position pot signal is conditioned to 0-2VDC on this board. This board also provides a 0-10VDC signal to 0-100 psi electronic pneumatic regulators.

2.4 THE PNEUMATIC MODULE

The pneumatic module shown in figure 2-2 houses components that control and accurately measure pneumatic pressure.

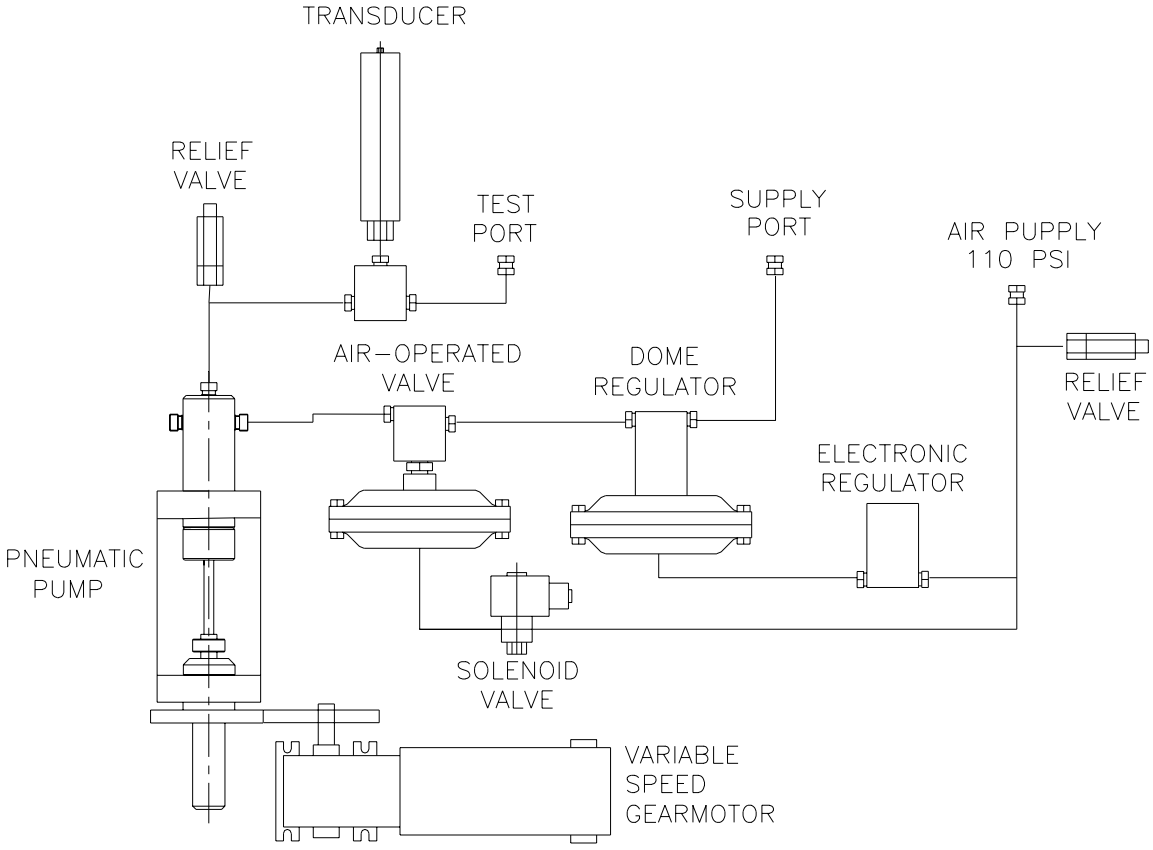

Figure 2-2
Model 7310 Pneumatic Diagram

2.4.1 PNEUMATIC PUMP

The pneumatic pump is a Ruska positive displacement pump that precisely varies the system pressure by compressing and expanding system gas. The pump is driven by a variable speed gearmotor. The pump has a position sensor that tracks the position of the pump plunger. It has two travel limit switches at each end of its stroke. The pump and the system are protected from overpressure by a relief valve. The pump pressure is monitored by a pressure transducer.

2.4.2 GEARMOTOR

The variable speed gearmotor drives the pneumatic pump. The gear box on the motor reduces the motor speed.

2.4.3 SYSTEM VALVE

The system valve isolates the pump and system from the gas supply regulators. It is a high pressure air-operated valve. This valve has a diaphragm operator that requires a minimum of 60 psi of air pressure to close the valve. The air is supplied to this valve through a three-way normally-open solenoid valve.

2.4.4 ELECTRONICS REGULATOR

The electronics regulator supplies a 0-100 psi air signal for the dome regulator. The electronics regulator is driven by a 0-10VDC signal from the interface board.

2.4.5 DOME REGULATOR

The dome regulators, which are self-relieving, "rough" in the commanded pressure. The precise pressure is then achieved by the pump after closing the system valve.

2.4.6 SYSTEM TRANSDUCER

The system transducer accurately measures (accuracy is specified as purchased, 0.01% minimum) the controlled pressure. This pressure is communicated through an RS-232 port to the control board. This transducer should be calibrated at a regular interval to maintain its stated accuracy.

2.4.7 TEST PORT

The device under test is connected to this port. This port is a $^{1}/_{8}$ NPT female connection.

2.4.8 AIR-SUPPLY PORT

The supply air is connected to the supply port. The supply air should not exceed 110 psi. The pneumatic side is protected by a relief valve set at 120 psi. This port is a 1/4 Swagelok tube connection.

2.4.9 NITROGEN SUPPLY PORT

The clean, dry nitrogen supply is connected to this port. The nitrogen pressure should be above the full scale pressure of the controller. This port is a $^{1}/_{8}$ NPT female connection.

2.5 USING OPTO 22 MODULES

Opto 22 I/O modules may be used to turn external devices like vacuum pumps on and off. Valid Opto 22 mounting racks include the PB8, PB16A, PB16C, PB16H, PB16HC, PB16HQ, PB24, and PB24Q. For use, the Opto 22 modules should be configured according to table 2-2.

Table 2-2
OPTO 22 MODULES

Number & Type	Device/Function
0 -3 (reserved)	
15 (reserved)	Remote-operation **continue**. When remote operation (Section 5) is being used to run a programmed test sequence (Section 3), input from this module causes the next instruction in the test fequency to be executed.
16	Pressure supply okay. When this input turns off, a pressure supply alarm is generated.
17-18 (user-defined)	Intended for input. Responses may be observed through the 7310's front panel.
4-14, 19-23 (user-defined)	Intended for output. Responses may be controlled through the 7310's front panel.

The user's Opto 22 mounting rack connects to a 50-pin connector on the 7310's back panel. The 7310's Input/Output (I/O) screen then allows the user to observe the various modules and turn them on or off.

1. Connect the desired Opto 22 mounting rack to the 50 pin connector on the 7310's back panel. Connect the desired external devices to the modules according to table 2-2, and provide power to the mounting rack.
2. To control the board from the 7310's front panel, select **MENU/SETUP/SYSTEM/I/O.** The I/O screen will appear.
3. To turn the desired module on or off, use the arrow keys to move the cursor bar to the module, then select **on** or **off**.
4. To exit the I/O and calibration screens, press **PREV.** twice.

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SECTION 3.0
INSTALLATION

3.1 INTRODUCTION

This portion of the manual discusses initial installation for the Model 7310. Installing the 7310 is a relatively simple process of unpacking the 7310, powering it up, and then using the front panel to configure the system.

3.2 UNPACKING THE 7310

Carefully unpack all components, checking for obvious signs of damage. In addition to any nonstandard items ordered with the 7310, the shipment should contain at least the following items:

- a Model 7310,
- a power cord, and this user's manual,

If necessary, report any shipping damage to the freight agency. Remove masking tape, strings, and packing materials from all components. If possible, save the packing materials for future use.

Finally, install the DPC in a location that meets the requirements listed in table 3-1.

NOTE: The 7310 should not be subjected to mechanical shocks during installation or use. It should be mounted on a rigid bench or in a sturdy 19 inch rack. Although the zeroing process will compensate for a slightly unlevel mounting, the 7310 should be mounted to within 5° of level.

Table 3-1
General Specifications: General Parameters

Parameter	Value	Model
Operating Humidity Range	5% to 95% RH	all
Operating Temperature Range	5 to 50°C	all
Storage Humidity Range	None[1]	all
Storage Temperature	-20 to 70°C	all
Power Requirements	115 VAC or 230 VAC	all
Warm Up Period	≤3 hrs.	all

[1] NOTE: If there is any condensation, the 7310 must be thoroughly dried before power is applied.

3.3 CAUTIONS

The following cautions should be heeded at all times to insure safe operation of the 7310.

- Never operate the unit with the cover removed. The power supply has internal voltages near 400 volts.
- Never apply more than 110% of the unit's full scale pressure range to the test port. Never try to control while a pressure source is connected to the test port.
- Avoid thermal and mechanical shock to the instrument. This will affect performance and require rezeroing.

3.4 POWERING UP THE 7310

First, plug the power cord supplied with the 7310 into the power connector on the 7310's back panel.

NOTE: Grounding for the 7310 is provided through the power cord.

Next, plug the power cord into a receptacle rated for either 115 VAC or 230 VAC (check name plate). If a different power cord is necessary for your receptacle, consult table 1-1 for available power cords. Finally, turn on the 7310 by flipping the POWER switch on the back panel. The MEASURE screen will appear on the vacuum fluorescent display, and the front panel will be fully operational.

3.5 PNEUMATIC CONNECTIONS

Pneumatic connection to the 7310 is straightforward. The following sections discuss each port.

3.5.1 AIR SUPPLY PORT

The air supply port must be connected to a well regulated source of shop air. Air supply should be at least 110 psi. Supply port is a 1/4 Swagelok tube connection.

3.5.2 TEST PORT

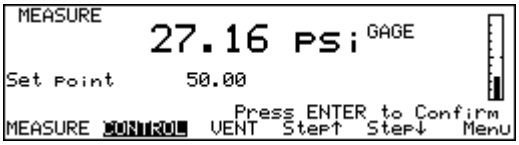
The test port is designed to control a wide range of volumes. Any leaks on the test port will cause measurement errors. For best results, a minimum volume of approximately 3 in^3 (50 cc) is recommended. The test port is $^1/_8$ NPT female.

3.5.3 NITROGEN SUPPLY PORT

The nitrogen supply port should be connected to a clean, dry nitrogen supply with a pressure of above the full scale pressure but below 11,000 psi. The port is $^1/_8$ NPT female.

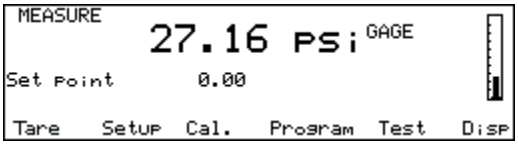
3.6 TUTORIAL

At this point, the 7310 should be in the power-up state and the pneumatic connections made. The 7310 should display a screen similar to the one shown below. (If the bottom line of the display is not showing these options, press **F6** if an error message is displayed, then press **PREV.)**

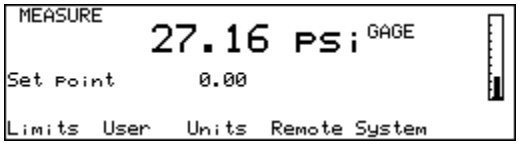


This is called the Main Menu. It is at the top level of the menu tree and all descriptions in this manual start from this point. The top center of the display shows the current pressure (27.16 psi gauge). The upper left corner shows the current mode of the 7310 ("MEASURE" or "CONTROL"). The right side of the screen shows a bar graph displaying the current pressure relative to a user-configurable full-scale value. Below the pressure is the pressure control setpoint with a numeric scratchpad for entering a new setpoint value. The bottom line of the screen displays the current assignments of the function keys **F1** through **F6** that are located below the display.

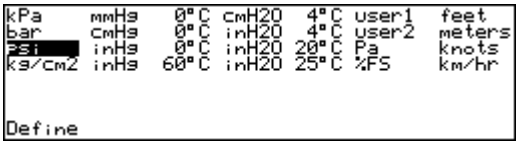
Step 1 The first thing we will do is change the pressure units. The units are changed from the screen **MENU/SETUP/UNITS**. This means from the Main Menu press Menu (the **F6** key). This will display the **MENU** screen:



Step 2 Now press **Setup** (the **F2** key). This will display the **MENU/SETUP** screen.



Step 3 Now press **Units** (the **F3** key). This will display the **MENU/SETUP/UNITS** screen. The list of available units will be displayed with the current units highlighted.



Step 4 Use the arrow keys located on the right of the display to move the highlight bar.

Step 5 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 **MENU/SETUP** screen with the current units.

Step 6 Press **PREV.** to return to the **MENU** screen.

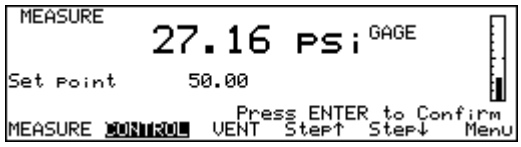
Step 7 Press **PREV.** again to return to the Main Menu.

The second part of this tutorial illustrates the use of the 7310 to generate pressure. This requires the system to be connected to the air supply and nitrogen supply, and the test port connected to a closed volume.

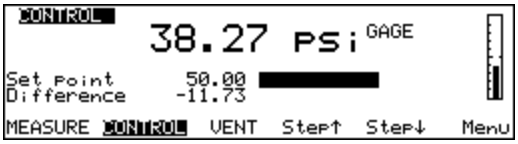
Step 8 From the Main Menu use the numeric keypad to enter the setpoint pressure. The pressure is entered in the units set in the previous illustration. As you enter the pressure, each digit will be displayed in the numeric scratchpad (the highlighted box in the middle of the display). If you make a mistake, press the **CLEAR** key (under the numeric keypad) and the numeric scratchpad will be cleared.

Step 9 When the entry is correct, press the **ENTER** key. The scratchpad will be cleared and the value will appear to the left of the scratchpad.

Step 10 Now that the starting pressure is entered, we can now enter control mode. Press **CONTROL** (the **F2** key). The highlight will move from MEASURE to CONTROL and the message "Press Enter to Confirm" will appear above the function key definitions. Notice that the upper left corner still shows MEASURE. The 7310 stays in measure mode until the change is confirmed.



Step 12 Press **ENTER** to confirm the mode change. The upper left corner will change to PUMPING and the pressure will start moving towards the setpoint. When the commanded pressure is close, the system closes the system valve. The finer pressure control is done by the pump. When the pressure is within the control band, the upper left corner changes to **CONTROL**.



Step 13 After the pressure is stabilized, press the Step↑ or Step↓ key. The scratchpad be will updated with a new setpoint. The step size defaults to 10% of full scale. (The step size is set to other values in the MENU/SETUP/LIMITS screen.)

Step 14 Press **ENTER** to accept the new setpoint. The controller will move to the new setpoint.

Step 15 Press **MEASURE** (the **F1** key). The 7310 will change to measure mode. No confirmation is necessary to leave control mode.

NOTES

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SECTION 4.0
LOCAL OPERATIONS

The local interface consists of a vacuum fluorescent display and a set of keys. The display shows the system status and menu options. The keys are separated according to their function.

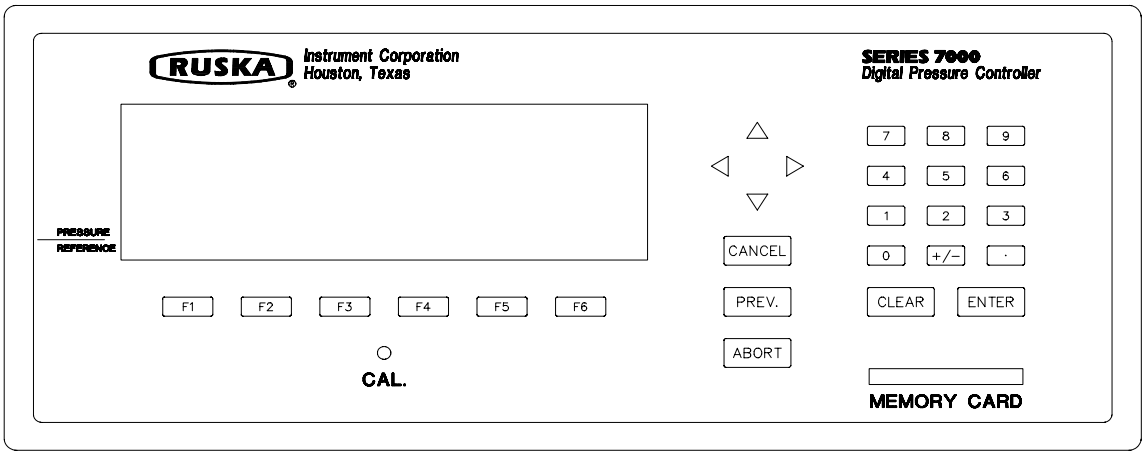


Figure 4-1
Model 7310 Front Panel

Numeric Keypad: This includes the numeric digits, the decimal point, and the change sign key. The **CLEAR** key will clear the numeric entry field. The **ENTER** key accepts the entered number or confirms a command.

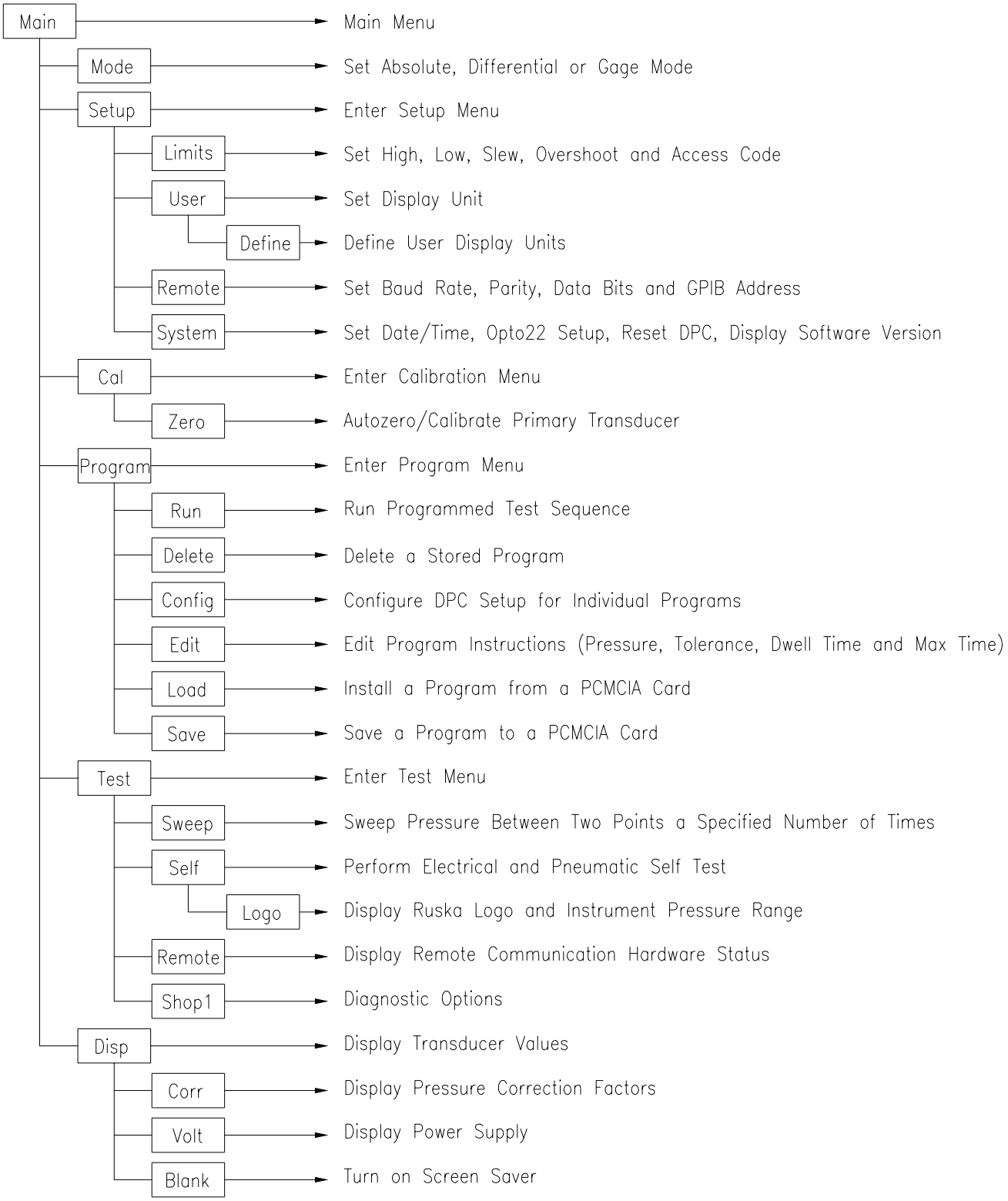
Function Keys: The **F1** through **F6** keys are used to navigate the menus and perform predefined functions. The name of the function is displayed above the key on the bottom line of the display.

Arrow Keys: The up and down arrows select a field for editing. The left and right arrows choose between multiple choice options for the selected field. The up and down arrows are also used for small pressure changes (pressure jog) at the main menu.

CANCEL, PREV., ABORT: These keys are used to stop, undo, or exit the current operation. The **CANCEL** key will return all edited fields on the current entry screen to their original values. It will also stop the current program sequence or calibration process. The **PREV.** key will exit the current menu to the previous menu. The **ABORT** key will cause an immediate shutdown of the system.

Table 4-1 is a menu tree showing the relationship between all the menus in the system. To move to a lower menu, press the function key with the correct label. To move towards the main menu, press the **PREV.** key. To go to one of the menus from the main menu, press the **F6** key. The **F1** key places the unit in measure mode. The **F2** key places the unit in control mode. **ENTER** must be pressed to actually enter the control mode. The **F3** key places the unit in vent mode. This opens the test port to atmosphere and rapidly reduces the pressure. **ENTER** is required to confirm the operation. The **F4** and **F5** keys step the control setpoint by the correct step amount.

TABLE 4-1
MENU TREE



4.1 MEASURING PRESSURE

The Main Menu displays the measured pressure in double-sized numbers. To the right of the pressure is the current unit and type (Gauge or Absolute). The Main Menu can always be reached by repeatedly pressing **PREV**.

4.1.1 SELECTING PRESSURE UNITS

The 7310 uses the conversion factors listed in table 2-1 to translate the pressure from kiloPascals to one of the 7310's units of measure. These include inches of mercury, kilopascals, bars, pounds per square inch, feet, meters, knots, and kilometers per hour. In addition to these predefined units, four user-defined units are available.

1. The pressure units are selected from the Units Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2**), and then **Units (F3).** The current units will be highlighted.
2. Use the Arrow Keys to highlight the desired pressure unit.
3. Press **ENTER** to accept the change. Press **PREV.** to exit without changing the units.

4.1.2 DEFINING A NEW PRESSURE UNIT

In addition to the standard units of measure provided by the 7310, four user-defined units are available. To create one of these units, the user enters a *name* that is one to six characters long and a *conversion factor* that is a multiple of kiloPascals (kPa).

For example, a millitorr, which equals one micron of mercury at 0 °C, is related to a millimeter of mercury by a factor of 1,000. Thus, based on the conversion factors listed in table 2-1, a millitorr would have a user-defined conversion factor of 7.500605 times 1,000, or 7,500.605. The user-defined name for this unit could be **mtorr**.

1. The pressure units are defined from the Units Define Menu. From the Main Menu (press **PREV**. until the Main Menu appears) press **Menu (F6)**, then **Setup (F2),** then **Units (F3),** and then **Define (F1).**
2. Press **Next ↓ (F2)** until the desired user-defined unit is highlighted.
3. The following sequence is used to change the name of the selected unit.

a. Use the arrow keys to highlight the desired character in the matrix.
b. Press **Add (F3)** to add the character to the name entry box.
c. Repeat steps a and b until the desired name is entered. Press **Clear (F4)** to start over.
d. Press **Enter (F5)** to accept the name.

4. Use the numeric keypad to enter the conversion factor and press **ENTER** to accept.
5. Press **PREV.** to return to the Units Menu. The new unit definition may be selected.

4.1.3 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 **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **User (F2).**
2. Press the down arrow key until the label Display digits is highlighted.
3. Use the left and right arrow keys to change the number of decimal digits.
4. Press **PREV.** to exit the menu. Press **CANCEL** to return all edited fields to their original values.

4.1.4 SETTING THE ALARM LIMITS

The 7310 continually checks the measured pressure against high, low, and slew rate limits. If the measured pressure exceeds the high limit, falls below the low limit, or changes faster than the slew rate limit, an alarm is generated.

1. The alarm limits are set from the Setup Limits Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **Limits (F1).**
2. Press the up and down arrow keys to highlight the desired limit.
3. Use the numeric keypad to enter the new value.
4. Press **ENTER** to accept the new value.
5. **Default (F1), Max (F2),** and **Min (F3)** put standard values for the field into the numeric scratchpad.
6. Press **PREV.** to exit the menu. Press **CANCEL** to return all edited fields to their original values.

4.1.5 USING HEAD PRESSURE CORRECTION

The term *head height* refers to the vertical distance between the sensing element in the device under test and the 7310's sensor. Once the user inputs the head height and specific gravity of fluid used, the 7310 automatically corrects for head pressure.

1. Determine the **PRESSURE REFERENCE** line on the 7310's front panel. This line indicates the vertical location of the 7310's sensor.
2. Determine the vertical distance between the **PRESSURE REFERENCE** line and the sensing element in the device under test.
3. The head height is set from the Setup User Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **User (F2).**
4. Press **Length (F1)** to select either inches (**in**) or millimeters (**mm**) for the head height entry. The select units will appear on the **Gas Head** line to the right of the number.
5. Highlight "specific gravity" and enter the specific gravity of the fluid used in the system.
6. Press the up or down arrows to highlight the label Head Height.

7. Use the numeric keypad to enter the height. Use a negative value if the DUT is below the 7310.
8. Press **ENTER** to accept the entry.
9. Press **PREV.** to exit the menu. Press **CANCEL** to return all edited fields to their original values.

4.1.6 SETTING TARE MODE

The tare mode provides instant zeroing at the push of a button. The tare mode also allows switching from absolute to gauge pressure for a short term test.

1. The tare mode is set from the **TARE** Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **TARE (F1).**
2. In this menu, press **TARE (F4)** to toggle between tare mode and absolute mode. Tare value is displayed in the highlighted area.

4.2 CONTROLLING PRESSURE

4.2.1 SETTING THE PRESSURE SETPOINT

The pressure setpoint is the destination of the pressure control algorithm. It should be set before entering control mode. The pressure setpoint is set to zero at power-up and whenever a pressure error occurs.

1. The pressure setpoint is set from the Main Menu (press **PREV.** until the Main Menu appears).
2. Use the numeric keypad to enter the new pressure setpoint in the current pressure units.
3. Press **ENTER** to accept the entry or press **CLEAR** to clear the numeric scratchpad.

4.2.2 ENTERING/EXITING CONTROL MODE

1. The control mode is set from the Main Menu (press **PREV.** until the Main Menu appears).
2. Press **CONTROL (F2)** to enter control mode. **ENTER** must be pressed to confirm entry into control mode. Note that any entry in the numeric scratchpad will also be taken as the new pressure setpoint.
3. Press **MEASURE (F1)** to exit control mode. No confirmation is necessary.

4.2.3 SETTING SLEW RATE

Slew rate is the maximum rate of pressure change for the control algorithm.

1. The slew rate is set from the Setup Limits Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **Limits (F1).**
2. Press the down arrow key until the label Slew Rate is highlighted.
3. Use the numeric keypad to enter a new value for slew rate. Press **ENTER** to confirm.
4. Press **PREV.** to exit the menu. Press **CANCEL** to return all edited fields to their original values.

4.2.4 STEPPING AND JOGGING

In addition to entering a new value, the pressure setpoint may also be changed by user-definable steps and by jogging small amounts. From the Main Menu (press **PREV.** until the Main Menu appears) press Step↑**(F4)** to add the step amount to the current setpoint. Press **ENTER** to confirm the setpoint change. In the same way use Step↓ to subtract the step amount from the current setpoint. The up and down arrows may be used to jog the pressure. Each press increments or decrements the pressure in the least significant digit. If the up or down arrow key is held down, the pressure will continue to change until the key is released. The jog increment is fixed but the step amount may be changed.

1. The step amount is set from the Setup User Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2**), and then **User (F1).**
2. Press the up or down arrows to highlight the step size parameter.
3. Use the numeric keypad to enter a new value. Press **ENTER** to confirm.
4. Press **PREV.** to exit the menu. Press **CANCEL** to return all edited fields to their original values.

4.3 PROGRAMMING SEQUENCES

4.3.1 STORING A SEQUENCE IN MEMORY

Consider an exercise that requires the 7310 to start at 300 psi, go up to 500 psi, then come back down to 200 psi. Test sequences like this may be stored in the 7310's memory as a *program*.

One benefit of storing a sequence in memory is that the operator does not have to command each pressure separately every time the exercise is performed. Another benefit is that the user can specify a tolerance for each setpoint pressure. Once a tolerance is set, instead of controlling the pressure to the exact setpoint, the 7310 will continue on to the next step once the pressure gets within the specified tolerance for that setpoint. This gives the user a time advantage over controlling pressures manually.

The 7310 can store up to 1,000 program steps, which may be unevenly divided among a maximum of 20 named programs. Additional programs can be stored on memory cards (see Section 4.5 Memory Card).

4.3.2 PREPARING TO PROGRAM

Before entering a test sequence, the user is encouraged to consider the items discussed below.

Program Name - Valid program names range from one to eight characters in length and can include numbers, upper case letters, and the **/, %,** and **#** symbols. For example, **Exer#14** and **%FStest** are both valid names.

Configuration - Since a program may depend upon the current setup of the 7310, the current configuration is stored with the program. The user should set the units, limits, control parameters, etc., to the desired values before creating a program.

Number of Setpoints - Before entering the sequence, the user should determine the number of upscale *and* downscale setpoints required to complete the exercise.

Setpoint Pressure and Tolerance - Each setpoint in the program requires both a *pressure* and a *tolerance*, in the current units of measure. For example, one setpoint might require a tolerance as low as 0.5 (min control) psi, whereas another setpoint in the same program could be satisfied with a tolerance as high as 5 psi.

Dwell Time - Once the pressure gets within the specified tolerance, the 7310 starts a timer that runs for a certain number of seconds. As long as this timer is running, the 7310 will not continue to the next setpoint unless the *max time* (see below) elapses.

Usually *dwell time* has a value of a few seconds, but a value of 0 can be used to create a **pause** in the program. When the dwell time is set to 0, the 7310 switches to manual control once it gets within the tolerance value of the setpoint pressure. The operator must then press a key on the front panel to continue the exercise.

Max Time - The max time is the maximum time in seconds, including the dwell time, that the 7310 can spend on one step of the program. After the max time elapses, the 7310 will automatically proceed to the next set point in the program, even if the current setpoint has not been achieved. Thus, the max time selection limits the amount of time that the 7310 can spend on any one setpoint.

Mode of Entry - If the upscale portion of the sequence *and* the downscale portion of the sequence both have the same highest and lowest setpoints *and* consist of evenly spaced steps, the <Auto> option can be used to automatically generate the program.

However, if any part of sequence includes unevenly spaced steps or the starting and ending setpoints are not the same, each step must be programmed individually. In the example given at the beginning of Section 4.3.1, each step must be programmed individually since the starting setpoint is 30 psi and the ending setpoint is 20 psi.

Detailed instructions for entering these items are given in the sections that follow.

4.3.3 ENTERING A NEW PROGRAM

To "program" the 7310, the operator simply uses the keys on the front panel to change values on the 7310's program editing screen. Instructions for entering each step of a new program are included below.

1. Ensure that the units, limits, and control parameters are at their desired values.
2. The program is entered from the Program Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Program (F4).**
3. Use the arrow keys to highlight **new**.
4. Press **Edit (F4).** Since **new** was highlighted, the 7310 will create a new program and give a default name of NAMEnn, where nn is a two digit number. The program editing screen will appear, displaying the first step.
5. Using the numeric keypad, enter the values for **Pressure, Tolerance, Dwell time**, and **Max time,** pressing **ENTER** after each value. The up and down arrow keys may be used to skip fields.
6. Press **Next (F1)** to move to the next step.
7. Repeat steps 5 and 6 until the test sequence is complete.

8. When all steps have been entered, press **PREV.** to return to the **Named programs** screen.

4.3.4 AUTOMATICALLY GENERATING A PROGRAM

In order for the 7310 to automatically generate a program the user must input the first setpoint pressure, the last setpoint pressure, and the number of steps in between, as well as the dwell time, max time and tolerance common to all setpoints.

1. Insure that the units, limits, and control parameters are their desired values.
2. The program is entered from the Program Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press Menu (F6), then **Program (F4).**
3. Use the arrow keys to highlight **new**. If these steps are used on an existing program, all program steps will be deleted and replaced with the automatically generated program.
4. Press **Edit (F4).** Since **new** was highlighted, the 7310 will create a new program and give a default name of NAMEnn where nn is a two digit number. The program editing screen will appear, displaying the first step.
5. Press **Auto (F3).**
6. Using the numeric keypad enter the values for **Start, Stop, Tolerance, Dwell time**, **Max time, Points up**, and **Points down** pressing **ENTER** after each value. The up and down arrow keys may be used to skip fields.
7. Press Program (F1). The program will be generated and the display will show the first step.
8. Press **PREV.** to return to the **Named programs** screen.

4.3.5 CHANGING THE NAME OF A PROGRAM

1. The name is changed from the Program Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Program (F4).**
2. Use the arrow keys to highlight the current name.
3. Press **Edit (F4).** The program editing screen will appear, displaying the first step.
4. Press **Name (F6).**
5. Use the arrow keys to highlight a character from the character set.
6. Press **Add (F3)** to add the character to the scratchpad.
7. To correct a mistake press **Clear (F4)** and return to step 5.
8. Repeat steps 5 and 6 until the name is complete.
9. Press **Enter (F5)** to store the contents of the scratchpad as the new name of the program.
10. Press **PREV.** twice to return to the **Named programs** screen.

4.3.6 CHANGING AN EXISTING PROGRAM

Instructions for changing an existing sequence are given below. Both manually and automatically generated programs may be edited.

1. Programs are changed from the Program Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Program (F4).**
2. Use the arrow keys to highlight the name of the program.
3. Press **Edit (F4).** The program editing screen will appear, displaying the first step.
4. The **Next (F1)** and **Prev. (F2)** keys may be used to move through the program. To go directly to a specific step use the arrow keys to highlight **go to step**, use the numeric keypad to enter the step number and press **ENTER**.

NOTE: **Next (F1)** will actually display one step past the end of the program (Step 6 of 5). This is to allow adding a step to the end of a program. The step does not actually exist until **ENTER** is pressed.

5. To add a step to the program, first move to the step *after* the new step. For example, to insert a step between steps 3 and 4, move to step 4. Press **Insert (F4).**
6. To delete a step in the program, first move to the step to be deleted, then press **Delete (F5).**
7. To change a step in the program, move to the desired step. Use the up and down arrow keys to highlight the field to be changed. Use the numeric keypad to enter the new value. Press **ENTER** to save the value.
8. When all changes have been made, press **PREV.** to return to the **Named programs** screen.

4.3.7 CHANGING THE CONFIGURATION STORED WITH A PROGRAM

1. Programs are configured from the Program Menu. From the Main Menu (press **PREV**. until the Main Menu appears) press **Menu (F6),** then **Program (F4).**
2. Use the arrow keys to highlight the name of the program.
3. Press **Config (F3).** The configuration screen will appear.
4. Press **Recall (F2).** The 7310 will be set to the configuration stored with the program.
5. Press **PREV.** until the Main Menu appears.
6. Change the desired parameters using the normal procedures.
7. Return to the Main Menu by pressing **PREV.** until it appears.
8. Press **Menu (F6),** then **Program (F4).**
9. Use the arrow keys to highlight the name of the program.
10. Press **Config (F3),** then **Save (F1).** The changed configuration of the 7310 is stored in the program's configuration.

4.3.8 RUNNING A PROGRAM

1. Programs are run from the Program Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Program (F4).**
2. Use the arrow keys to highlight the name of the program.
3. Press **Run (F1).** The program run screen will appear. **Stop** will be highlighted, showing that the program is not currently running.

4. Press Run (F2). The configuration of the 7310 stored with the program is restored, the pressure setpoint is set to the pressure value in the first step, and the 7310 is placed in control mode. Run will now be highlighted and the program will proceed through its steps.
5. To pause the program press Pause (F3). Pause will now be highlighted and the 7310 will continue controlling to the current setpoint. Press Cont (F4) to resume the program.
6. To stop the program press Stop (F5). The program will stop running but the 7310 will continue controlling to the current setpoint.

4.4 CONFIGURATION

4.4.1 TEST ACCESS CODE

The test access code allows the user to protect access to 7310 configuration and programs. Once set, the test access code is required before the user is allowed to change the limits, control parameters, or programs. Setting the test access code to zero disables the limited access.

1. The test access code is set from the Limits Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **Limits (F1).**
2. Use the up and down arrow keys to highlight **Access.**
3. Use the numeric keypad to enter the new access code. Press **ENTER.**
4. Press **Yes (F4)** to acknowledge changing the access code.

4.4.2 BARGRAPH MAXIMUM

The bargraph on the Main Menu screen can be scaled to match the device under test by setting the full scale value of the bargraph.

1. The bargraph maximum is set from the Setup User Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **User (F2).**
2. Use the up and down arrow keys to highlight **Bargraph Max.**
3. Use the numeric keypad to enter the bargraph maximum value in the current pressure units.
4. Press **ENTER.**

4.4.3 KEY CLICK

The 7310 can be configured to click each time a key is pressed.

1. The Key Click is set from the Setup User Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then Setup (F2), and then **User (F2).**
2. Use the up and down arrow keys to highlight Key click.
3. Use the left and right arrow keys to select **on** or **off.**

4.4.4 ENABLE ERROR

The Enable Error selection enables the out of range errors on the secondary transducers. Normally the only secondary transducer installed is the position and pump pressure transducers.

1. The Enable Error is set from the Setup User Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **User (F2).**
2. Use the up and down arrow keys to highlight **Enable Err.**
3. Use the left and right arrow keys to select **on** or **off**.

4.4.5 DATE/TIME

The 7310's system clock is continuously updated, even through power off and on.

1. The date and dime are set from the Setup System Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **System (F5).**
2. To set the system date, press **Date (F1).** Use the numeric keypad to enter the current month, date, and four-digit year. All digits must be entered. Press **ENTER** to accept.
3. To set the system time, press **Time (F2).** Use the numeric keypad to enter the current hour, minute, and second. All digits must be entered. Press **ENTER** to accept.

4.5 MEMORY CARD

The 7310 supports use of a PCMCIA memory card to store setup, calibration, and program information. This provides the ability to save the current setup of the system for later restoration or loading into another 7310. The calibration information is specific to the device and can only be loaded into the 7310 it was saved from. The 7310 supports static RAM cards conforming to the PCMCIA Type I specification.

4.5.1 SETUP INFORMATION

The setup information is stored to the memory card by using **SAVE (F6)** under **MENU/SETUP/SYSTEM**. The saved information includes the parameter entries from **MENU/SETUP/LIMITS, MENU/SETUP/USER, MENU/SETUP/UNITS**, and **MENU/ SETUP/REMOTE.** The information on the memory card is restored by **MENU/SETUP/ SYSTEM/LOAD.**

4.5.2 CALIBRATION INFORMATION

Saving and restoring calibration information requires entry into calibration mode. First the **MENU/CAL** menu must be entered. Then the **CAL.** button on the front panel must be pressed. This will enable the additional keys. Then Save (F6) may be pressed to save the calibration data or **Load (F5)** to restore the calibration data. Calibration data may only be restored to the same 7310 that saved it.

4.5.3 PROGRAMS

Programs are saved and restored individually by name. Programs are saved from the **MENU/PROGRAM** screen. Use the arrow keys to highlight the program to be saved.

Press **Save (F6).** The program is written to the memory card. Repeat for all programs desired. If a program with the same name already exists on the memory card, it is overwritten.

Programs from the memory card are loaded from the **MENU/PROGRAM/LOAD** screen. The screen will display all programs on the memory card. Use the arrow keys to highlight the program to be loaded. Press **B.** The program will be copied from the memory card into the 7310. If a program with the same name already exists in the 7310, it is overwritten. **Delete (F2)** can be used to erase the highlighted program from the card.

SECTION 5.0
REMOTE OPERATION

The 7310 can be operated remotely by a computer. Three interfaces are supported; IEEE-488, RS-232, and RS-485. All three interfaces support Standard Commands for Programmable Instruments (SCPI).

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 Common Commands
SCPI 1991.0	Standard Commands for Programmable Instruments

5.1 CAPABILITIES

5.1.1 IEEE-488

The following identification codes define the interface capabilities of the 7310. Their meaning is 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 optional 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.

5.1.2 RS-232

The RS-232 interface supports standard serial operation from a computer to a single 7310. RS-232 supports the IEEE-488.2 and SCPI commands. The 7310 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 7310. It is located on the processor board directly above the DB-25S connector. The following pins are used; all other pins are reserved.

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

5.1.3 RS-485

The optional RS-485 interface supports two-wire serial differential communication. A single computer may be connected to multiple 7310s. The IEEE-488.2 and SCPI commands are supported. The 7310 allows the following port setups.

Address:	0 to 31
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 optional RS-485 connection is a DB-9P connector. It is located beside the processor board on the back panel of the 7310. The following pins are used, all other pins are reserved.

Pin #	Direction	Signal	
3	In/Out	DATA-	Receive/Transmit Data
4	In/Out	DATA+	Receive/Transmit Data
9	—	GND	Ground

The RS-485 bus requires termination at both ends. A 120 Ohm resistor should be connected from the DATA- to the DATA+ terminals on the units at each end of the bus. Additionally the common mode voltage must be kept within the range -7 volts to +12 volts. For more information see the specification EIA-485 available from Global Engineering Documents, 1990 M Street NW, Washington DC 20036, Phone (202) 429-2860, FAX (202) 331-0960.

5.2 REMOTE/LOCAL OPERATION

In local mode, the 7310 is operated manually through the front panel. Section 4, Local Operation, covers local operation. The 7310 always powers up in the local mode. In remote mode, the 7310 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 7310 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 interfaces.
2. Issue the SCPI command "SYSTEM:KLOCK ON" to lock the local keyboard. The 7310 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 powering the 7310 off and back on.

5.3 CONFIGURATION

The remote interface is configured using the local interface before the remote is connected. The parameters needed varies with the interface used.

IEEE-488	Address, Protocol
RS-232	Baud Rate, Data Bits, Parity, Stop Bits
RS-485	Address, Baud Rate, Data Bits, Parity, Stop Bits

To configure the remote interface follow these steps:

1. The remote interface is configured from the Setup Remote Menu. From the Main Menu (press **PREV.** until the Main Menu appears) press **Menu (F6),** then **Setup (F2),** and then **Remote (F4).**
2. Use the up and down arrows to highlight the desired parameter.
3. Use the numeric keypad to enter the address, use the left and right arrows 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.

5.4 DEVICE MESSAGES

5.4.1 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 of the root of the command tree. IEEE 488.2 commands may occur between SCPI commands without affecting the tree level.

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

A message is terminated by a Line Feed (hexadecimal 0A). Carriage Returns, Tabs, and other control characters are ignored.

5.4.2 SCPI RESPONSE FORMAT

Only commands ending in a question mark have responses. Multiple values from a single command are separated by commas. Responses from different commands in the same message are separated by semi-colons. The response message is terminated by a Line Feed (hexadecimal 0A).

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

5.4.3 ANSI/IEEE 488.2-1987 COMMAND SUMMARY

*CLS	Clear Status
*ESE?	Event Status Enable Query
*ESE <number>	Event Status Enable
*ESR?	Event Status Register
*IDN?	Identification
*OPC?	Operation Complete Query (Returns 1)
*OPC	Operation Complete
*RST	Reset
*SRE?	Service Request Enable Query
*SRE <number>	Service Request Enable
*STB?	Status Byte Query
*TST?	Self-Test Query
*WAI	Wait (No operation)

5.4.4 SCPI COMMAND SUMMARY

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

MEASure	
[:PRESsure]?	returns current pressure reading
:PRESsure2?	return pump pressure
:VOLTage?	returns -15V (volts)
:VOLTage2?	returns +15V (volts)
:VOLTage3?	returns +5V (volts)

:POSITION	returns pump position (%)
POSITION	returns pump position (%)
CALCulate	
:LIMit	
:LOWer <number>	get/set low pressure limit
:SLEW <number>	get/set slew rate limit
:UPPer <number>	get/set high pressure limit
:VENT <number>	get/set auto-vent limit
:TARE	
:VALue <number>	get/set tare value
:STATe ON/OFF	set tare using current pressure
CALibration	
[:PRESsure]	
:DATA <n,n,n,n>	sets C0, C1, C2, C3 for pressure
:DATA?	reads coefficients
:VALue1 <number>	perform mid-point calibration
:VALue2 <number>	perform full scale calibration
:ZERO	performs zero calibration
:VALUE <number>	sets vacuum value
:INITiate	enter zero calibration mode
:INITiate?	returns status for cal, press, temp, ref
:RUN	start zero calibration
:STOP	abort zero calibration
:PRESsure2	
:DATA <number>,<number>	sets C0, C1 for pump pressure
:VALue <number>	sets first calibration point
:VALue2 <number>	sets second calibration point
:POSition	
:DATA <number>, <number>	sets C0, C1 position
:DATA?	reads C0, C1
:VALue <number>	sets first calibration point
:VALue 2 <number>	sets second calibration point
:MODE?	calibration edit enabled?
:MODE ON¦OFF¦1¦0	enable calibration edit
	(Cal. button required)
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
OUTPut	
:STATe ON¦OFF¦1¦0	off=MEASure, on=CONTrol
:STATe?	returns 0=Measure or 1=Control
:MODE MEASure¦CONTrol¦VENT	sets mode
:MODE?	returns mode string
:SSTate<n> ON¦OFF¦1¦0	set Opto-22 Module
PROGram	
:CATalog?	returns list of defined programs
[SELected]	
:DEFine <program block>	Define program

```
                                        press1, toler1, dwell1, max1, press2,
                                        toler2, ...
    :DEFine?                                read program definition
    :DELete
        [:SELected]                     deletes current program
        :ALL                                deletes all programs
    :NAME <program name>                select current program
    :STATe RUN|PAUSe|STOP|CONTinue      set program state
    :STATe?                             read program state
    :CONFigure
        :RECall                         restore saved configuration
        :SAVE                           save current configuration
SENSE
  [:PRESSure]
    [:RESolution] <number>              set pressure display resolution
        :AUTO <boolean>|ONCE            return to default resolution
    :MODE?                                  returns ABSOLUTE or TARE
    :RANGE
        [:UPPer]                            returns 7310 full scale value in
  units
        :LOWer                          returns 0
    :REFerence
        [:HEIGht] <number>              set head height
        :SGRavity <numbers>             set specific gravity
[SOURCE]
  [:PRESsure]
    [:LEVel]
        [:IMMediate]
            [:AMPLitude] <number>       sets pressure setpoint
            [:AMPLitude]?               read pressure setpoint
    :MODE FIXed|LIST                    set source parameter set
    :TOLerance <number>                 specifies output tolerance
    :SLEW <number>                          set slew rate
    :CONTrol <number>                   set control band
  :LIST
    :PRESsure <number> [,<number>]      set list of pressure values
        :POINts?                            returns number of points defined
    :DWELl <number> [,<number>]         specifies dwell times
        :POINts?                            returns number of dwell times
    :TOLerance <number> [,<number>]     specifies tolerances
        :POINts?                            returns number of tolerances
    :DIRection UP|DOWN                  direction to go through list
    :COUNt <number>                         number of times to go through list
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"              set interface protocol to 6000 or SCPI
  :PRESet                              reset system
TEST
  :ELECtronic?                         perform electronic 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
```

5.4.5 EXAMPLE SCPI COMMANDS

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

```
:MEASURE:PRESSURE?

:measure:pressure?
:MeAsUrE:pReSsUrE?
:meas:pres?
:measure?
:meas?
MEAS?
```

To set the control pressure setpoint to 50, all of the following commands are equivalent:

```
SOURCE:PRESSURE:LEVEL:IMMEDIATE:AMPLITUDE 50
SOUR:PRES:LEV:IMM:AMPL 50.0
PRESSURE +50
PRES 50
```

5.4.6 SCPI STATIS REGISTERS

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

Bit 7 Operation Stus Summary. Set when an event enabled in OPER:ENABLE occurs.

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 Always 0.

Bit 0 Always 0.

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

Bit 7 Power-on. set at power-up.

Bit 6 User request. Always 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 Request Control. Always 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. Waiting for control to stabilize.

Bit 2 Ranging. Always 0.

Bit 3 Sweeping. Always 0.

Bit 4 Measuring. The instument is actively measuring. Always 1.

Bit 5 Waiting for Trigger. Always 0.

Bit 7 Correcting. Currently performing a correction. Always 0.

Bit 8 Self-test in progress.

Bit 9 Always 0.

Bit 10 Always 0.

Bit 11 Always 0.

Bit 12 Always 0.

Bit 13 Instrument Summary bit. Always 0.

Bit 14 Program Running.

Bit 15 0.

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

Bit 0 Voltage is questionable. Set when supply voltages are not within 5%.

Bit 1 Current is questionable. Always 0.

Bit 2 Time is questionable. Set when the clock has not been set.

Bit 3. Temperature is questionable. Set when the oven temperature is not within range.

Bit 5. Phase is questionable. Always 0.

Bit 6 Modulation is questionable. Always 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 Always 0.

Bit 10 Always 0.

Bit 11 Always 0.

Bit 12 Always 0.

Bit 13 Instument Summary bit. Always 0.

Bit 14 Command Warning. Set whenever a command ignores a parameter.

Bit 15. 0.

5.5 6005 INTERFACE PANEL EMULATION

The 7310 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 manual for a description of the protocol. The 7310 emulation has the following differences:

1. The 7310 is always in remote mode (Byte 0, Bit 2)
2. All TI strip outputs read as OFF (zero) and must be written as OFF.
3. No special functions are implemented.
4. Any message written to the 7310 which 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"

5.6 Serial Operation

The RS-232 and RS-485 ports accept 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 ports also support XON/XOFF. When the XOFF (hexadecimal 13) command is received, the 7310 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.

When more than one unit is attached via the RS-485 multi-drop interface, an address sequence must be sent. The Data Link Escape (hexadecimal 10) command is sent followed by the address byte (hexadecimal 20 + unit address). This sequence will enable the address unit and disable all others. The Clear (hexadecimal 14) command may be used to clear the transmit and receive buffers without disabling addressing.

NOTES

SECTION 6.0
MAINTENANCE

6.1 INTRODUCTION

Very little maintenance is normally required for the 7310. The following sections discuss some of the suggested procedures.

6.2 OBSERVING THE 7310'S FULL SCALE RATING

Instructions for observing the 7310's full scale rating are given below.

1. If necessary, press **PREV.** several times to return the display to the main screen.
2. Select **MENU/CAL**. The 7310's full scale pressure rating **(FS:)** will appear on the screen, in the current units of measure.
3. Press **PREV.** to return to the previous screen.

6.3 OBSERVING THE SOFTWARE VERSION NUMBER

Follow the steps below to observe the 7310's software version number.

1. If necessary, press **PREV** several times to return the display to the main screen.
2. Select **MENU/SETUP/SYSTEM**. The software version number will appear on the screen.
3. Press **PREV.** to return to the previous screen.

6.4 PREVENTIVE MAINTENANCE

Although the 7310 is designed to be nearly maintenance free, occasional preventive maintenance is required to keep the 7310's performance optimal.

6.4.1 INITIATING THE 7310'S SELF TEST

To test the 7310's hardware, software, and pneumatics, follow the steps below.

1. If necessary, press **PREV.** several times to return the display to the main screen.
2. Select **MENU/TEST/SELF**. The electronics self test will run and display the results.
3. Press **Pneu** to run the pneumatic test.
4. Press **PREV.** to return to the previous screen.

6.4.2 REMOVING THE 7310'S COVER

The 7310 should be kept clean and completely assembled at all times. Operating the 7310 without its cover affects the 7310's thermal gradients and therefore reduces accuracy. If it becomes necessary to remove the 7310's cover, follow the instructions below.

CAUTION: The 7310 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 7310 and disconnect the power cord from the power supply.
2. Locate the two screws that secure the cover to the back panel.
3. Unscrew these two screws.

4. To remove the cover, place hands near the middle of the cover, and slide the cover towards the 7310's back panel.
5. Lift up.
6. Replace the cover before resuming operation.

6.5 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 will last 5-10 years. If the instrument is stored, it will last one year. It is recommended to replace it every year. To do this follow the instructions below:

1. Remove cover - see section 6.4.2.
2. Remove processor card by removing one screw and rocking upward.
3. Remove battery, a round silver object, by carefully pulling on battery while holding card.
4. Plug in new battery (part no. 4-720).
5. Reassemble in reverse order.
6. The time and date may have to be re-entered. See section 4.4.5.

6.6 CALIBRATION

To keep the 7310 operating within its specified accuracy (Appendix A), the calibration procedure described below must be performed every year. Use appropriate DWG, such as Ruska Model 2475.

NOTE: The calibration procedure automatically generates coefficients which are stored in memory on the 7310's Control Board (Section 2). If these constants are "lost" for any reason, the calibration procedure must be performed, regardless of the last calibration date. If the calibration coefficients are known, they may be restored to the 7310 at any time by "editing the coefficients" (Section 6.5.2).

6.6.1 CALIBRATION INSTRUCTIONS

To calibrate the 7310, the user simply connects a calibration standard to the 7310's Test Port then follows the 3-step calibration procedure on the 7310's display. This procedure requires the user to control the calibration standard to 50% and 100% of the 7310's full scale rating (Section 6.2). No disassembly is required and there are no potentiometers to tune.

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

PREPARATION

- Verify that the calibration standard is connected to the TEST PORT.
- Verify that the 7310 has been at stable operating temperature for *at least* two hours
- Verify that the 7310 is in Measure mode (Section 4).

- If desired, change the 7310's units of measure (Section 4) to match those of the calibration standard.
- To go to the calibration screen, select **MENU/CAL**.

To begin the calibration process, press the recessed **CAL.** button beneath the vacuum fluorescent display. If the calibration access code is enabled, enter it at the prompt. The **Calibration step 1** screen will appear.

NOTE: To exit the calibration procedure before the calibration coefficients have been changed, press **CANCEL** any time during the procedure.

Step 1

1.1 To begin Step 1 of the calibration process, select **ZERO.** Enter the actual pressure applied and press ok.

1.2 Wait until the zero procedure completes. This may take several minutes. When the 7310 completes Step 1, the Calibration step 2 screen will appear.

Step 2

2.1 To begin Step 2, use the calibration standard to **Apply** the mid-point pressure requested by the 7310. As pressure is admitted into the Test Port, the **Measured pressure** on the 7310's screen will change accordingly.

2.2 When the Measured pressure stabilizes, use the 7310's numeric keypad and OK to enter the actual pressure applied by the calibration standard. *Do not enter the* **Measured pressure** *reported by the 7310*. If necessary, use the **CLEAR** key to correct a mistake in the edit field. If the **actual pressure applied** is acceptable, the Calibration step 3 screen will appear.

NOTE: If the actual pressure is outside of the tolerance for the requested mid-point pressure, *Error —222 Data out of range* will occur. Acknowledge this error by selecting **OK**, then re-enter the **actual pressure**, repeating step 2.1 if necessary.

Step 3

3.1 To begin Step 3, use the calibration standard to **Apply** the high-point pressure requested by the 7310. As pressure is admitted into the Test Port, the **Measured pressure** on the 7310's screen will change accordingly.

3.2 When the Measured pressure stabilize, use the 7310's numeric keypad and **OK** to enter the **actual pressure** reported by the calibration standard. *Do not enter the* **Measured pressure** *reported by the 7310*. If necessary, use the **CLEAR** key to correct a mistake in the edit field. If the **actual pressure applied** is acceptable, the **Calibration complete** screen will appear.

NOTE: If the actual pressure applied is outside of the tolerance for the requested high-point pressure, *Error —222 Data out of range* will occur. Acknowledge this error by selecting OK, then re-enter the actual pressure, repeating step 3.1 if necessary.

STORING THE COEFFICIENTS

NOTE: In addition to saving the calibration coefficients to the 7310's memory, the user is advised to separately record the calibration coefficients and store this "backup" in a safe place.

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 **OK**.

Step 5

Press **PREV.** to return to the main screen.

Once the calibration procedure is complete, the user is advised to record several pressure readings. If there are any significant errors at these points, then an error was probably made in generating one of the calibration pressures, and the calibration procedure should be repeated.

6.6.2 EDITING THE CALIBRATION COEFFICIENTS

If the 7310's memory is erased but the calibration coefficients are known, the user can restore the coefficients to the 7310 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 7310 is in Measure mode (Section 4).
2. To go to the calibration screen, select **MENU/CAL**.
3. To edit the calibration coefficients, press the recessed **CAL.** button beneath the vacuum fluorescent display. If the calibration access code is enabled, enter it at the prompt. The **Calibration step** 1 screen will appear.

NOTE: To exit the calibration procedure before the calibration coefficients have been changed, press **CANCEL** any time during the procedure.

4. Use the arrow keys to highlight **C0:, C1:, C2:,** or **C3:**.
5. Use the numeric keypad and **ENTER** key to enter a new value. To correct a mistake in the edit field, use the **CLEAR** key.
6. Repeat steps 4 and 5 until all four coefficients are correct.

NOTE: In addition to saving the calibration coefficients to the 7310's memory, the user is advised to separately record the calibration coefficients and store this "backup" in a safe place.

7. To exit the editing procedure without storing the calibration coefficients in memory, press **CANCEL.** To store the calibration coefficients in memory, select **OK.**

8. Press **PREV.** to return to the main screen.

Once the calibration coefficients are input, the user is advised to record several pressure readings. If there are any significant errors at these points, then the calibration procedure should be performed.

6.6.3 ZEROING

The zero procedure may be performed by itself without requiring a full calibration.

- Verify that the 7310's test port is open to atmosphere.
- Verify that the 7310 has been at stable operating temperature for at least two hours.
- Verify that the 7310 is in Measure mode.

Step 1

Enter the calibration screen by selecting **MENU/CAL**.

Step 2

Select ZERO. The recessed **CAL** button should *not* be pressed. If the **CAL.** button is pressed, a full calibration will be selected.

Step 3

Use the numeric keypad to enter the pressure at the test point. Press **OK** when the measured pressure is stable.

Step 4

Wait until the zero procedure completes. This may take several minutes. When the 7310 completes the procedure, it will return to the **CAL.** screen.

NOTES

SECTION 7.0
PREPARATION FOR STORAGE & SHIPMENT

7.1 DISCONNECTION INSTRUCTIONS

NOTE: It is essential that the procedures given in Sections 7.1 through 7.3 be strictly adhered to in order to prevent damage to the instrument. Failure to follow these procedures may result in damage during shipment that will not be covered by the carrier's insurance.

1. Relieve all pneumatic pressure from the 7310.
2. Turn the 7310 power switch off.
3. Disconnect the power cable from the 7310 power receptacle.
4. Disconnect all pneumatic lines from the 7310's back panel.
5. Plug all ports.

7.2 PACKING INSTRUCTIONS

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

The main principle behind a successful shipment is that of minimizing shocks. This is accomplished by cradling the device within two boxes such that the 7310 is restrained but still has resilience. The two most successful materials for this purpose are rubber foam and flexible polyurethane foams. Styrofoam, poured "foam in place" mixtures, and other rigid foams are *not* suitable. Even polyfoam or rubber foam should be cut into strips so that it will not present a large rigid surface to the 7310.

Ruska has found that corrugated cardboard boxes provide the best packing. The boxes sometimes arrive damaged, but the contents are usually intact. A minimum of 3 inches of foam with at least an N95 impact rating should separate the inner surface of the inner box and any portion of the 7310. The same is true for the inner and outer box. *Wood or metal boxes do not absorb shock when dropped and therefore are not recommended.*

If the original packing and shipping materials were retained, use them for packing the 7310. If the 7310 is being packed for long-term storage (more than 30 days), place a desiccant bag inside the unit. In general, prepare the 7310 for shipment as follows.

1. Ruska Instrument has an RMA procedure in place. Please contact the Customer Service Center to obtain an RMA number prior to returning any equipment to Ruska. Have the following information available when contacting Ruska:
   a. the part number,
   b. the serial number,
   c. the purchase order number,
   d. the billing and ship to address, and
   e. the buyer's name and telephone number.

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

2. Enclose the 7310 in plastic or any good water barrier material. Anti-static material is advisable.
3. Interior Carton (size 30 x 30 x 30 inches): Cover bottom and sides with no less than 3 inches of polyfoam. Use four strips 4" to 6" wide and 50" to 60" long. Arrange strips to cross each other inside carton. Cover sides and top, completely filling entire carton. Tape carton closed.
4. The Exterior Carton must be a double wall of corrugated or fiberboard box. Use four 3 x 3 x 84 inch strips of polyfoam crossing each other inside the carton. Place interior carton inside, making sure exterior carton is completely filled. Do not close the carton yet.
5. Inside the exterior carton, include the following:
   a. Statement of the problem or service needed. Be specific. Include the name and telephone number of a knowledgeable technician for consultation.
   b. The part number, serial number, return address, and purchase order number.
6. Seal the carton, using gummed tape.
7. Address the carton to:

RUSKA INSTRUMENT CORPORATION
10311 Westpark Drive
Houston, TX 77042

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

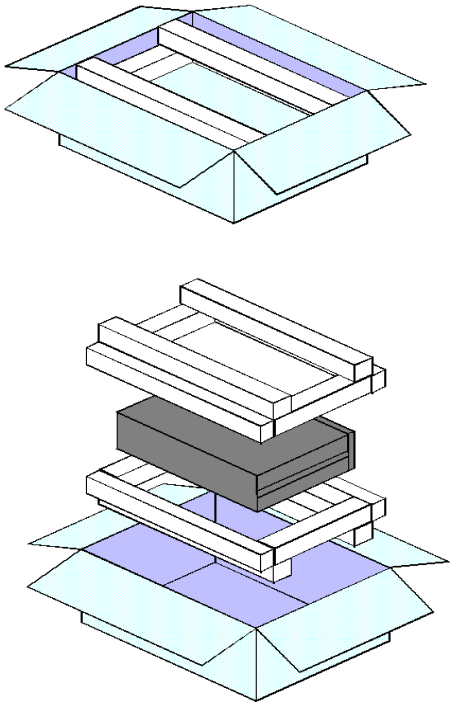


Figure 7-1
Packing the DPC

7.3 SHIPPING INSTRUCTIONS

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

Again, it is essential that the procedures mentioned in Sections 7.1 through 7.3 be strictly adhered to in order to prevent damage to the instrument.

NOTES

APPENDIX A
SUMMARY OF SPECIFICATIONS

A.1 ACCURACY

Specifications of pressure transducer instrumentation can be divided into three categories: Input Specifications, General Specifications, and Performance Specifications. Each of these categories in turn consists of parameters which are usually specified by minimum and/or maximum numeric limits. Almost all of these parameters can have an effect on what is generally referred to as the instrument's "accuracy." Therefore, the accuracy of pressure instrumentation can be varied either beneficially or detrimentally by controlling the Input Specifications, operating within the General Specifications, or knowing the actual Performance Specifications.

For example, if Input Specifications have not been met for the line voltage, the unit may not have a catastrophic failure, but errors may be present in the transducer measurement. As another example, if the requirement for the Pressure Source Flow Capacity has not been met, the 7310 may not be able to achieve a final steady state controlled pressure within the settling time specification. Finally, if the 7310 is commanded to a pressure outside of the Applicable Control Pressure Range, the nonlinearity in the pressure output may be greater than that specified.

Performance Specifications give the user the most flexibility and control over his "accuracy claims." The term accuracy is defined by ISA-S37.1 as either the ratio of the error to the full-scale output (%FS) or the ratio of the error to the reading (%RDG). Note that the definition of accuracy is not the summation of some or even all of the possible error source maximum limits.

The true accuracy of an instrument is relative to the actual error introduced by the calibration transfer standard plus the actual error not eliminated from the instrument's indicated output. Therefore, an instrument's accuracy can be manipulated by introducing more or less actual error through the choice of a calibration standard; or its accuracy can be varied by the elimination of actual errors inherent in the instrument. For example, if an instrument has a known error due to being used in an attitude, or tilt, the %FS zero shift error can be eliminated by rezeroing the instrument in the tilted position. Even %RDG sensitivity shifts can be eliminated mathematically or by controlling the attitude of the instrument during its calibration.

The key to eliminating an error is knowing its source and type along with its polarity and magnitude. Generally, the source is simple to detect and is represented by the specific parameter. The type is usually a function of the instrument's design and manufacturing process. Within a given instrument, an error can be either random or systematic as well as random or systematic within the instrument's population. The user is free to consult Ruska for recommended methods of minimizing error source contributions.

In summation, total error can and should be managed by the control of the three general error sources: Input Specifications, which includes the user's chosen calibration standards; General Specifications, which includes the user's chosen processes; and Performance Specifications, which includes the user's chosen applications for the instrumentation. The parameters and value limits listed in the following specifications indicate the product line's general acceptance limits and are not a report of any unit's specific error contribution. Any parameter exceeding the specified limits should be considered in need of maintenance.

A.2 SPECIFICATIONS

Pressure Ranges:	0-3000, 0-6000, 0-10,000 psia
Accuracy:	0.01% FS
Resolution:	0.001% FS or better
Control Stability:	Typically 0.01% FS
Control Response:	20–90 seconds controlling into a 15 cu. in. volume depending on full scale range and increment step size
Control Range:	300-3000, 600-6000, 1000-10,000 psia
Control Volume:	3 in^3 (50cc) to 35 in^3 (570cc) all ranges
Overshoot:	0.01% of Full Scale
Overpressure Protection:	Relief valve set at 110% FS
Connections	Supply port: $^1/_8$ NPT Test port: $^1/_8$ NPT
Display:	Graphical vacuum fluorescent
Pressure Medium (test and control gas):	Clean, dry, non-corrosive gas with a dew point of -40 °C and a particulate size <100 microns.
Gas Consumption:	Zero at commanded pressure with a leak tight system
Pressure Supply:	110 to 120 psi gas pressure for controller circuit. Test gas supply to be higher than full scale pressure (may require an external booster system).
Recommended Recalibration Interval:	1 year
Communications: Optional: RS-485	Standard: RS-232 and IEEE-488 Syntax: SCPI (standard commands for programmable instruments)
Dimensions:	19"W x 24"D x 17"H (49 x 61 x 43 cm)
Weight:	120 lbs
Electrical Power:	115 VAC or 230 VAC, 50/60 HZ, single phase. (Separate part numbers for 115VAC and 230VAC)
Humidity:	5 to 95% noncondensing
Temperature:	Operating: 5 to 50 °C (40 to 122 °F) Storage: -20 to 70 °C (-4 to 158 °F)

APPENDIX B
SUMMARY OF ERROR MESSAGES

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

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 incorrected. Check for numeric versus string data.
-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 your 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 setpoint is out of range.
-313	Calibration Data Lost. The calibration data has been lost and the unit must be recalibrated.
-315	Configuration Data Lost. The configuration data has been lost. Check all parameters to be sure that they are correct.

Value	Description and Corrective Action
-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 than 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 7310.
-600	Factory Data Lost. Internal factory constants have been lost. Contact Ruska for more information.
-601	Calibration Mode. The CAL. button must be pressed before SCPI calibration commands can be executed.
-610	Memory Card Not Inserted. A memory card must be inserted.
-611	Error Reading Memory Card. The requested data was not found on the memory card.
-612	Error Writing Memory Card. Unable to save information on card.
-613	Memory Card Write Protected. The memory card is write protected.
-614	Data Not From This Unit. The calibration data from another unit cannot be loaded.