DIGITAL PRESSURE CONTROLLER

MODEL 7610

USER'S MANUAL

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REVISION NOTICE

RELEASE NUMBER	REV	DATE OF RELEASE	DESCRIPTION
7610-1D01	A	11/10/95	Original release
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RELEASE 7610-1D01 **Revision D (05/29/02)**
Added Appendix C per DC/RO-23315.

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 systems 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 7610 Digital Pressure Controller (DPC) manufactured by Ruska Instrument Corporation, Houston, Texas. This portion of the manual provides general information about the DPC and presents its features and options.

1.2 GENERAL INFORMATION

The Ruska Model 7610 DPC uses transducers to provide the precise measurement of pressure. During normal operation, the DPC performs in either Measure Mode or Control Mode.

In Control Mode, the DPC simultaneously measures and controls pressure. Control Mode is commonly used in the calibration and testing of pressure gages, transducers, pressure switches, and production pressure instruments.

In Measure Mode, the DPC measures pressure. Typically, Measure Mode finds applications in research laboratories, testing of gages and transducers.

1.3 FEATURES

The following features are standard on all Model 7610 DPC's.

NIST Traceability: All DPC's are calibrated per MIL-STD-45662A using Ruska deadweight gages, which are directly traceable to the National Institute of Standards and Technology (NIST).

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

Measurement While Control: The DPC 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 DPC's full scale pressure.

Friendly Display: The DPC'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 DPC easy to use. Frequently used selections such as the units of measure are restored to memory each time the DPC powers up.

Easily Programmable: The DPC'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 hydraulic/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 DPC's hydraulic, pneumatics, electronics, and user controls. Hydraulic and electronics modules are standard 19" EIA chassis and can easily fit into a rack mount system.

Power On Self Test (POST): Upon power-up, the DPC quickly tests its hardware and software. After the DPC completes this test, the user can select more extensive self-tests for the hydraulic 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 DPC's software automatically performs the zero adjustment, with no potentiometers to tune.

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

Choice of Medium: The hydraulic DPC can be used with various non-corrosive fluids as pressure media.

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 DPC through the Standard Commands for Programmable Instruments (SCPI) protocol. *The DPC can also be configured to accept existing software written for the Ruska Series 6000 DPG.*

1.4 STANDARD EQUIPMENT & OPTIONS

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

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

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

Memory Card: The DPC 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 7010 DPC

Option	Ruska Part Number
Communication Software	contact Ruska
Memory Card	35-403
User's Manual	7610-1D01
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

SECTION 2.0
THEORY OF OPERATION

2.1 INTRODUCTION

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

2.2 THE POWER SUPPLY

The DPC'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 DPC's electronics module consists of the Control Board, the Microprocessor Board, the Option Board, the optional 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 DPC.

Data that is subject to change after the DPC 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 DPC's software resides in non-volatile, 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 DPC, as well as the conversion factors that the DPC uses to translate the detected pressure into the units selected by the user. These factors are given in Table 2-1.

When the DPC 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 DPC'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 DPC.

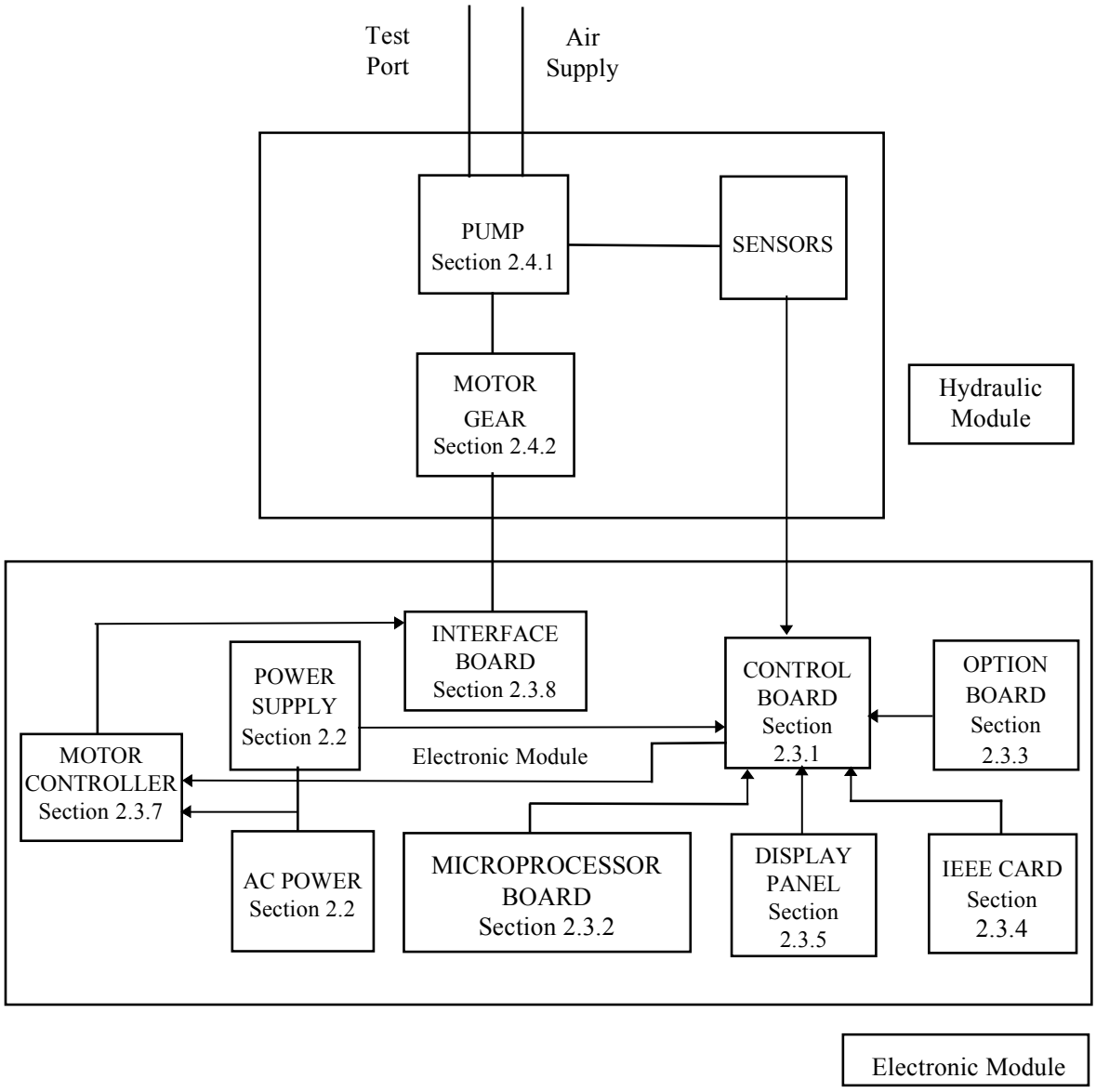


Figure 2-1
DPC Block Diagram

2.3.3 THE OPTION BOARD

Future models of the DPC may include an Option Board that plugs directly into the Control Board. In the future, this board could be used to provide non-standard 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)	= kPa x 0.1450377 (for 100 psi models)

2.3.4 THE IEEE-488 INTERFACE

The DPC's IEEE-488 (GPIB) Interface card, which plugs directly into the Control Board, provides the DPC 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 DPC.

The DPC 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 hydraulic section of the DPC. The motor controller receives its analog signal (+/-10VDC) from the control board and in turn it runs the motor at variable seed. 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 low accuracy transducer (pump transducer), pump position pot, pump compression limit switch, pump expansion limit switch and reservoir low level switch signals. The board interfaces these signals between the electronic and hydraulic module. The pump transducer and position pot signals are conditioned to 0-2VDC on this board.

2.4 THE HYDRAULIC/PNEUMATIC MODULE

The hydraulic/pneumatic module shown on figure 2-2 houses components which generates and accurately measures hydraulic pressure.

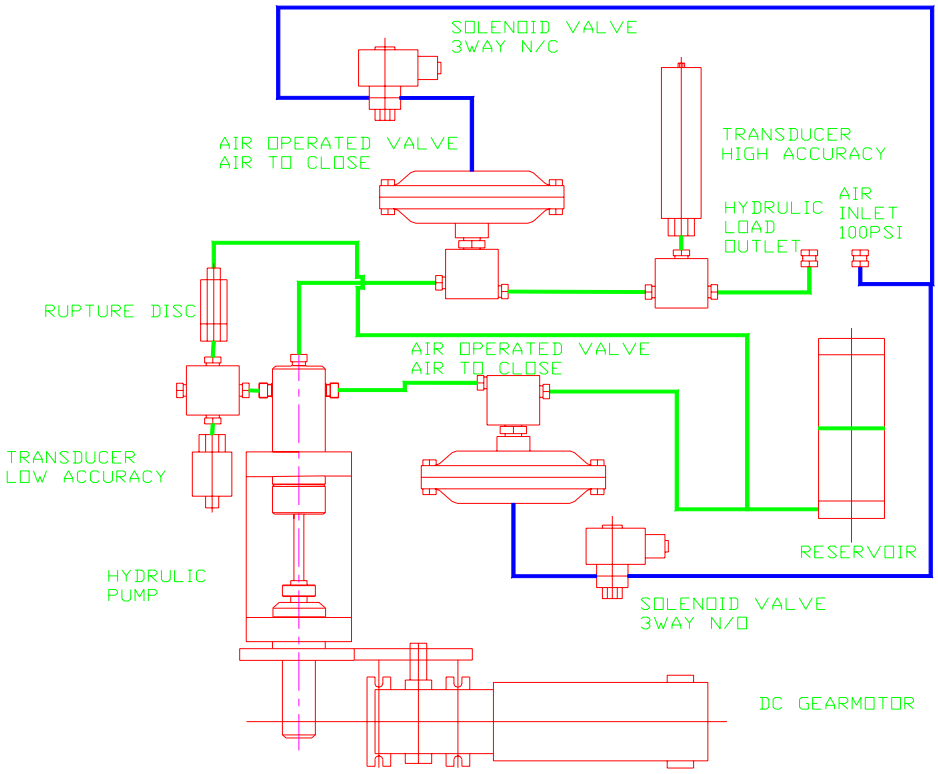


FIGURE 2-2
MODEL 7610 DPC HYDRAULIC/PNEUMATIC DIAGRAM

2.4.1 HYDRAULC PUMP

The hydraulic pump is a Ruska positive displacement pump which varies the system pressure by compressing and expanding system fluid. The pump is driven by a variable speed gearmotor. The pump has a position sensor which tracks the position of the pump plunger. It has two travel limit switches at each end of its stroke. The pump and the system is protected from the over pressure by a rupture disc. The pump pressure is monitored by a pressure transducer.

2.4.2 GEARMOTOR

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

2.4.3 RESERVOIR VALVE

The reservoir valve isolates the pump from the reservoir. It is a high pressure air operated valve. This valve has a diaphragm operator which 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 FLUID RESERVOIR

The reservoir supplies system fluid to the pump through the reservoir valve. The reservoir has a 750 cc capacity and is provided with a low level sensor.

2.4.5 SYSTEM VALVE

The system valve isolates pump from the system. It is a high pressure air operated valve. This valve has a diaphragm operator which 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 closed solenoid valve.

2.4.6 SYSTEM TRANSDUCER

The system transducer is the high accuracy sensor that is used to measure and control pressure. This pressure is communicated through a RS-232 port to the control board. This transducer should be calibrated at regular interval to maintain its stated accuracy.

2.4.7 TEST PORT

The device under test is connected to this port.

2.4.8 AIR SUPPLY PORT

The supply air is connected to the supply port. The supply air should be set between 60 to 100 psi. The pneumatic side is protected by a relief valve set at 110 psi.

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 4-5.

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 DPC's front panel.
4-14, 19-23 (user-defined)	Intended for Output. Responses may be controlled through the DPC's front panel.

The user's Opto 22 mounting rack connects to a 50 pin connector on the DPC's rear panel. The DPC'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 DPC's rear panel. Connect the desired external devices to the modules according to Table 4-5, and provide power to the mounting rack.
2. To control the board from the DPC'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.

SECTION 3.0
INSTALLATION

3.1 INTRODUCTION

This portion of the manual discusses initial installation for the Model 7610 DPC. Installing the DPC is a relatively simple process of unpacking the DPC, powering it up, and then using the front panel to configure the system.

3.2 UNPACKING THE DPC

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

- a Model 7610 DPC,
- 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 DPC should not be subjected to mechanical shocks during installation or use. It should be mounted on a rigid bench or in a sturdy 19" rack. Although the zeroing process will compensate for a slightly unlevel mounting, the DPC 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	30 min.	all

[1]**NOTE:** If there is any condensation, the DPG 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 DPC.

- 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 DPC

First, plug the power cord supplied with the DPC into the power connector on the DPC's rear panel. See Figure 3-1.

NOTE: Grounding for the DPC 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 DPC by flipping the POWER switch on the rear panel. *In about 10 seconds*, the MEASURE screen will appear on the vacuum fluorescent display, and the front panel will be fully operational.

The High Pressure DPC uses either 115V or 230V AC. Therefore there are both a 115V and a 230V model available for these units. Unlike other DPC models, they do not allow a wide range of power line voltages and must be ordered for the proper use.

3.5 HYDRAULIC/PNEUMATIC CONNECTIONS

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

3.5.1 AIR SUPPLY PORT

The supply port must be connected to a well regulated source of shop air. Air supply should be between 50-100 psi. Supply port is a ¼ 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 10 in^3 (160 cc) is recommended.

The test port is ¼ high pressure connection (autoclave F250C)

3.5.3 RESERVOIR

The system reservoir must be filled with a non-corrosive fluid and the system bled to remove all air from the system. Any air in the system will make the pressure controller erratic.

3.5.4 PURGE HYDRAULIC SYSTEM

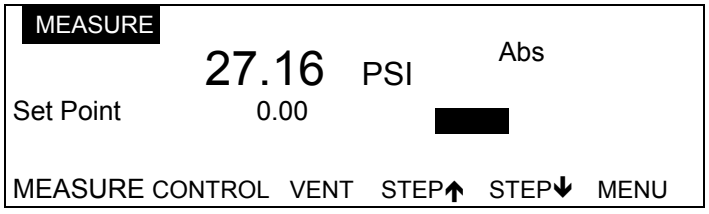
Purge menu allows to operate the hydraulic pump and valves in manual mode which is useful in purging the system. The pump can be driven in either direction while observing the percentage of the stroke. The reservoir valve and the system valve can be opened or

closed. This menu also displays the pump and the system pressures. From this menu, the operator can remove air from the system by pressuring the system to a few 100 psi and loosing fittings at high points within the system so that the air can escape. This process may be repeated a few times to remove most of the air. On systems that incorporate the optional Fill-Pump, this menu is used to operate the fill pump. The fill pump is a high volume low pressure pump that can be used to quickly fill a manifold with fluid.

1. The purge operation can be done from the PURGE Menu. From the Main Menu (press PREV until Main Menu appears) press Menu (F6), then press TEST (F5) and PURGE (F5).
2. In this menu the system is graphically shown.
3. Press PREV to exit the menu.

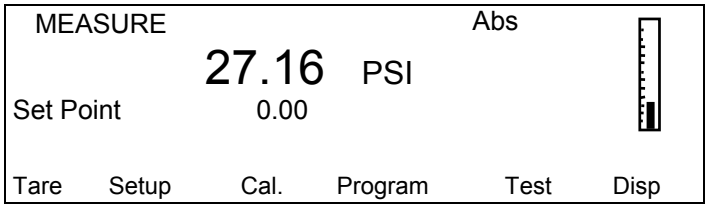
3.6 TUTORIAL

At this point, The DPC should be in the power-up state and the hydraulic/pneumatic connections made. The DPC should be displaying 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**.)

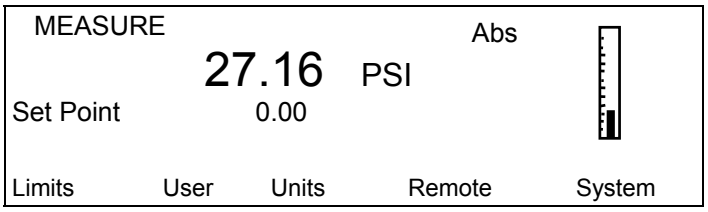


This is called the Main Menu. It is at the top level of the menu tree and all descriptions in this manual start from this point. The top center of the display shows the current pressure (27.16 psi gage). The upper left corner shows the current mode of the DPC ("MEASURE" or "CONTROL"). The right side 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 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.

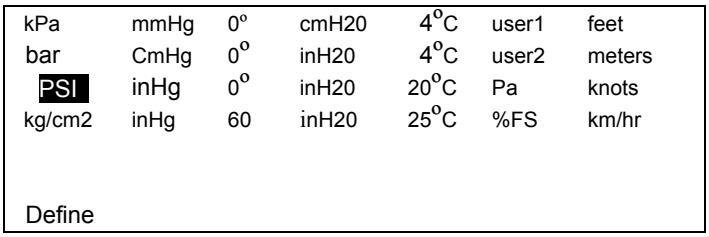
Step 1 The first thing we will do is change the pressure units. The units are changed from the screen **MENU/SETUP/UNITS**. This means from the Main Menu press Menu (the **F6** key). This will display the **MENU** screen:



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.

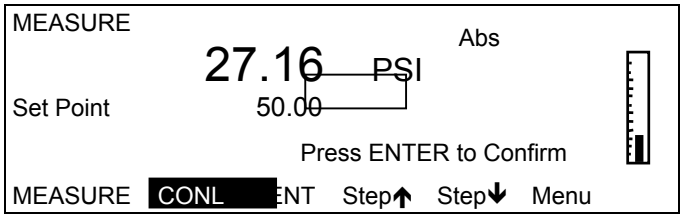
Step 7 Press **PREV.** again to return to the Main Menu.

The second part of this tutorial illustrate these of the DPC to generate pressure. This requires the system be fully charged with fluid, the air supply connected, and the test port connected to a closed volume full of fluid.

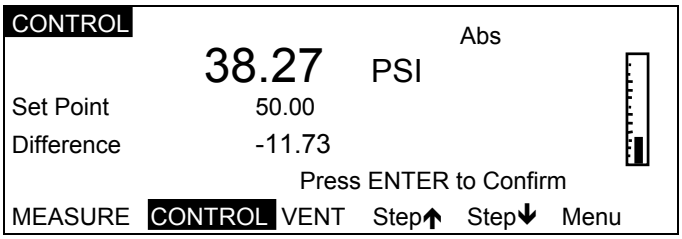
Step 8 From the Main Menu use the numeric keypad to enter the set point pressure. The pressure is entered in the units set in the previous illustration. As you enter the pressure each digit will be displayed in the numeric scratchpad (the highlighted box in the middle of the display). If you make a mistake 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 DPC stays in Measure mode until the change is confirmed.



Step 11 Press **ENTER** to confirm the mode change. The upper left corner will change to CONTROL and the pressure will start moving towards the setpoint.



Step 12

pressure is stabilized press the Step?↑ or Step ↓ key. The scratchpad will be 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 13 Press **ENTER** to accept the new setpoint. The controller will move to the new setpoint.

Step 14 Press **MEASURE** (the F1 key). The DPC will change to Measure mode. No confirmation is necessary to leave Control mode.

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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.

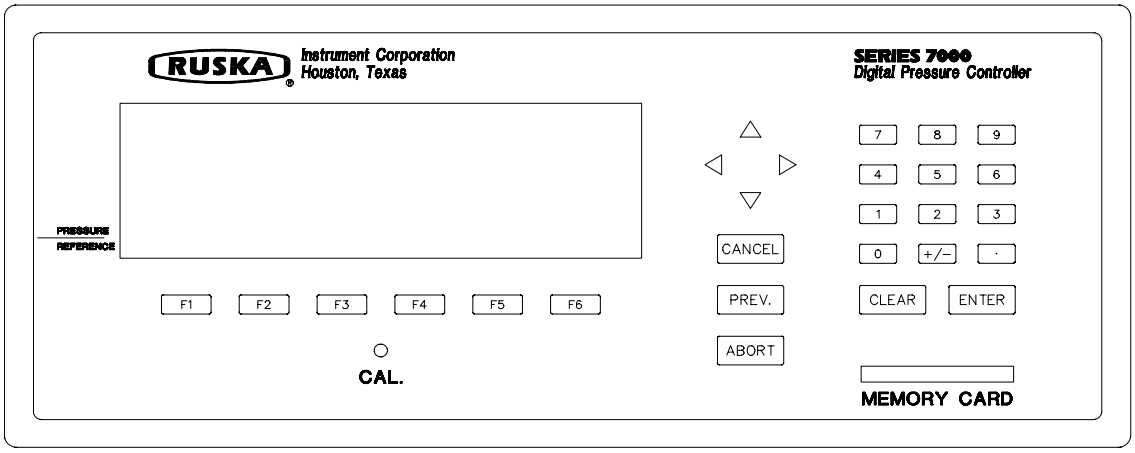


Figure 4-1
Model 7610 Front Panel

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.

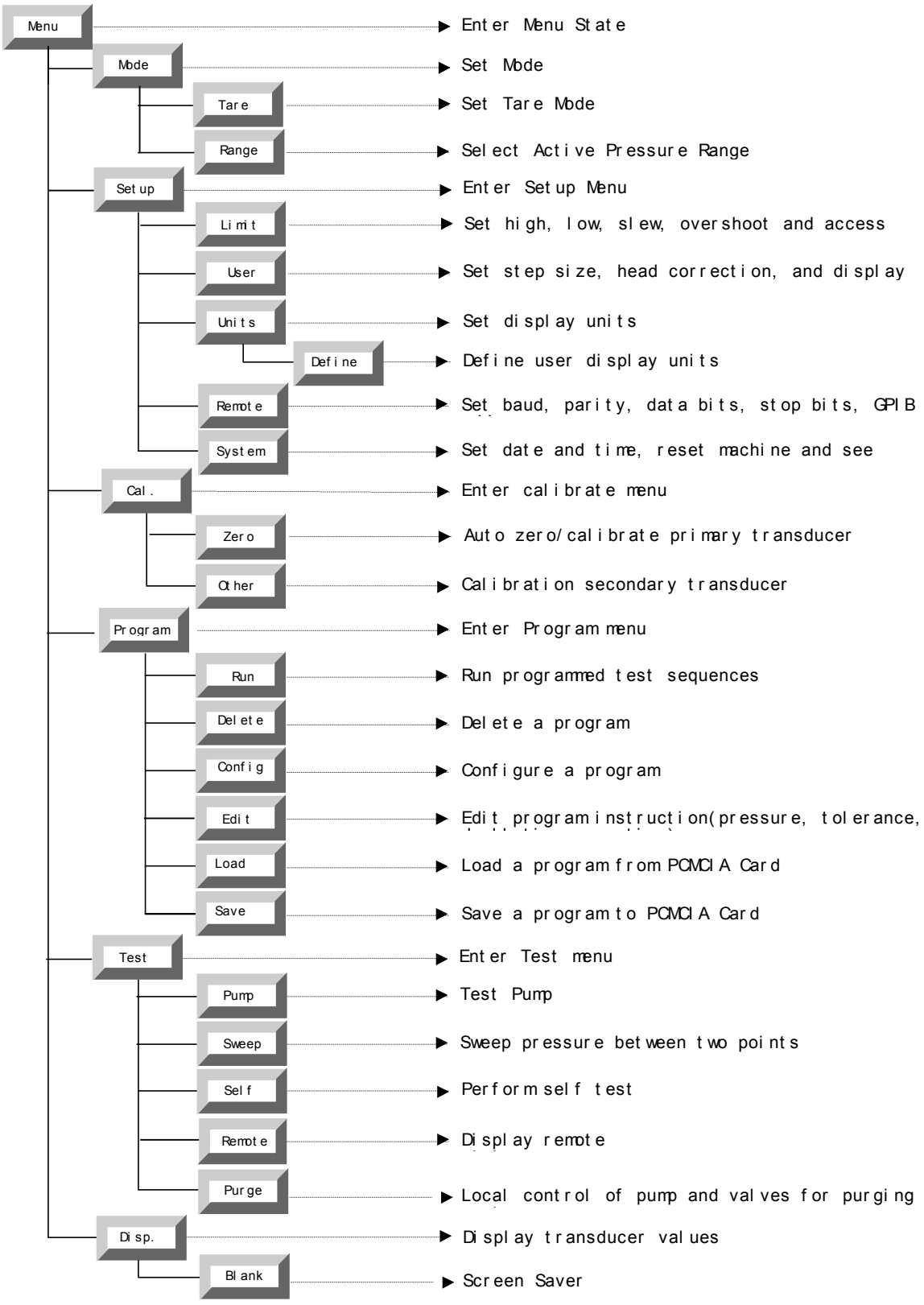
Function Keys: The **F1** through **F6** keys are used to navigate the menus and perform pre-defined functions. The name of the function is displayed above the key on the bottom line of the display.

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.

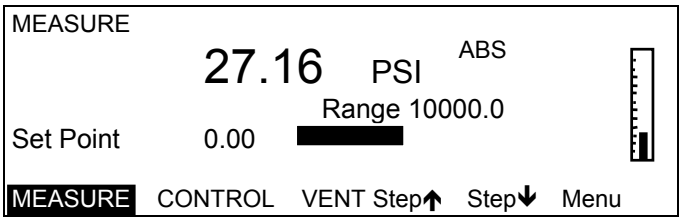
Table 4-1 is a menu tree showing the relationship between all the menus in the system. To move to a lower menu press the function key with the correct label. To move towards the main menu press the **PREV.** key. To go to one of the menus from the main menu press the **F6** key. The **F1** key places 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 size numbers. To the right of the pressure is the current unit and type (Tare or Absolute). Tare can be utilized to operate the instrument in a "gauge" mode. The Main Menu can always be reached by repeatedly pressing **PREV.**



4.1.1 MULTI-RANGE SENSOR - OPTIONAL

The 7610 are available with multiple sensor ranges integrated into a single instrument. The number of sensors available in an instrument can range from one to six. To select an active range in units that have multiple sensor ranges, from the main menu, select the **MENU/MODE** keys. The **F5** function key is labeled as "range", and by pressing the **F5** key, the system will scroll through the various available full-scale pressure ranges. In the example shown above, a 10,000 psi range sensor is selected as the active range. The full-scale ranges are displayed in the same unit of measure that the current pressure is actively being displayed.

NOTE: To switch between pressure ranges, the actual measured pressure must be less than 100 psi.

4.1.2 SELECTING PRESSURE UNITS

The DPC uses the conversion factors listed in Table 2-1 to translate the pressure from kiloPascals to one of the DPC's units of measure. These include inches of mercury, kilopascals, bars, pound per square inch, feet, meters, knots, and kilometer 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.

4.1.3 DEFINING A NEW PRESSURE UNIT

In addition to the standard units of measure provided by the DPC, 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 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.

4.1.4 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 1 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.

4.1.5 SETTING THE ALARM LIMITS

The DPC 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.

4.1.6 USING HEAD PRESSURE CORRECTION

The term *head height* refers to the vertical distance between the sensing element in the device under test and the DPC's sensor. Once the user inputs the head height and

specific gravity of fluid used the DPC automatically corrects for head pressure.

1. Determine the **PRESSURE REFERENCE** line on the DPC's front panel. This line indicates the vertical location of the DPC'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 **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 DPC.
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.

4.1.7 SET TARE MODE

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

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 DPC to start at 30 psi, go up to 50 psi, then come back down to 20 psi. Test sequences like this may be stored in the DPC'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 DPC 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 DPC 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 DPC, 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 set points - Before entering the sequence, the user should determine the number of upscale *and* downscale set points required to complete the exercise.

Set point pressure and tolerance - Each set point in the program requires both a *pressure* and a *tolerance*, in the current units of measure. For example, one set point might require a tolerance as low as 0.5 (min control) psi, whereas another set point 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 DPC starts a timer that runs for a certain number of seconds. As long as this timer is running, the DPC will not continue to the next set point 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 DPC switches to manual control once it gets within the tolerance value of the set point 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 DPC can spend on one step of the program. After the max time elapses, the DPC will automatically proceed to the next set point in the program, even if the current set point has not been achieved. Thus, the max time selection limits the amount of time that the DPC can spend on any one set point.

Mode of entry - If the upscale portion of the sequence *and* the downscale portion of the sequence both have the same highest and lowest set points *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 set points 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 set point is 30 psi and the ending set point 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 DPC, the operator simply uses the keys on the front panel to change values on the DPC's program editing screen. Instructions for entering each step of a new program are included below.

1. Insure 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 DPC 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 DPC 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 theMain 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 DPC 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 DPC 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 DPC 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 DPC stored with the program is restored, the pressure setpoint is set to the pressure value in the first step and DPC 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 DPC 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 DPC 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 DPC 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 DPC 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 DATE/TIME

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

1. The Date and Time 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 DPC 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 DPC. The calibration information is specific to the device and can only be loaded into the DPC it was saved from.

4.5.1 THE DPC SUPPORTS STATIC RAM CARDS CONFORMING TO THE PCMCIA TYPE 1 SPECIFICATION

4.5.2 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.**

4.5.3 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 DPC that saved it.

4.5.4 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 DPC. If a program with the same name already exists in the DPC it is overwritten. **Delete (F2)** can be used to erase the highlighted program from the card.

SECTION 5.0
REMOTE OPERATION

The DPC can be operated remotely by a computer. Three interfaces are supported: IEEE-488, RS-232, RS-485. All three interfaces support SCPI (Standard Commands for Programmable Instruments). The IEEE-488 interface additionally supports emulation of a Ruska Single Channel Interface Panel (Models 6005-701 and 6005-761). The IEEE-488 interface conforms to the following standards.

ANSI/IEEE Std 488.1-1987 IEEE Standard Digital Interface for Programmable Instrumentation

ANSI/IEEE Std 488.2-1987 IEEE Standard Codes, Formats, Protocols, and 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 DPC. 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 RS232 interface supports standard serial operation from a computer to a single DPC. RS232 supports the IEEE-488.2 and SCPI commands. The DPC 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 DPC. 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 DPC's. The IEEE-488.2 and SCPI commands are supported. The DPC 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 DPC. 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 DPC is operated manually through the front panel. Section 4, Local Operation, covers local operation. The DPC always powers up in the local mode. In

remote mode, the DPC 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 DPC 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 DPC 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 DPC 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 semi-colons. 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 1 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 1 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
: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	
:POINts?	read number of calibration constants
:VALue<n>?	read label, calibration constants
:CALibration	
:POINts?	read number of calibration points
:VALue<n>?	read nominal calibration point
:VALue<n> <number>	perform calibration point
: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
  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] <number>                  set sensor range (full scale in current 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 Status 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 instrument 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 Instrument Summary bit. Always 0.
Bit 14 Command Warning. Set whenever a command ignores a parameter.
Bit 15 0

5.5 INTERFACE PANEL EMULATION

The 7000 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 7000 emulation has the following differences:

(1) The DPG 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 7000 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 DPC 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.

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SECTION 6.0
MAINTENANCE

6.1 INTRODUCTION

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

6.2 OBSERVING THE DPC'S FULL SCALE RATING

Instructions for observing the DPC'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 DPC'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 DPC'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 DPC is designed to be nearly maintenance free, occasional preventive maintenance is required to keep the DPC's performance optimal.

6.4.1 INITIATING THE DPC'S SELF TEST

To test the DPC'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 PUMP LUBRICATION INSTRUCTION

The threaded portion of the Ruska pump plunger requires periodic lubrication. Please follow the following procedure to lubricate the pump plunger.

6.4.2.1 Approved Lubrications

Moly-Grade Part Number MT-3 Anti-seize
Jet Lube Part Number MP-50 Moly-paste

6.1.1 6.4.2.2 Frequency of Lubrication

It is recommended that the lubrication on the pump be checked on a monthly basis. The pump should be lubricated when the pump shows signs of loss of lubrication along the face of the pump threads.

If a pump position error occurs, along with checking the condition of the pump and pump over-travel limit switches, please check the pump lubrication. An inadequately lubricated pump can result in the pump position error detection by the system software.

6.4.2.3 Lubrication Procedure

The threaded portion of the pump plunger requires periodic lubrication. The pump may be lubricated by either injecting the lubricant through the grease fitting located on the top of the pump, or by applying the grease directly to the threads of the pump plunger. Either way, the power to the system should be removed when applying lubrication to the pump.

When applying grease directly to the pump, extend the pump plunger such that the majority of the threads are exposed. Using the tube of lubrication provided with the system or one of the lubrications noted in the approved lubrication list, disperse a generous amount of lubrication all along the threaded portion of the pump plunger.

WARNING: Only the lubrication defined on the approved lubrication list above can be used. Substituting this lubrication can cause permanent damage to the pumping mechanism.

6.4.3 ALIGN THE PUMP POSITION TRANSDUCER

NOTE: Verify that the calibration coefficients are properly entered for the primary system pressure sensors prior to performing this operation. Additionally, assure that the transducers are functioning by verifying that the A/D counts are between 0 and 39999 in the MENU/TEST/SHOP1 menu. In this menu, you can also verify that the limit switches are operating properly by tripping the switch and observing this activity in this menu. If these signals are not being properly reported on this menu, check the ribbon cable between the pump and the electronics chassis for proper connections.

To calibrate the pump position indicator;

1. Select the following functions keys **MENU/TEST/PUMP/CAL PUMP**
2. The pump will drive in both directions until it contacts the limit switches and then internally generates new coefficients for this sensor.

6.4.4 PUMP AND SYSTEM PRESSURE SENSOR ALIGNMENT

NOTE: Verify that the calibration coefficients are properly entered for the primary system pressure sensors prior to performing this operation. Additionally, assure that the transducers are functioning by verifying that the A/D counts are between 0 and 39999 in the MENU/TEST/SHOP1 menu. In this menu, you can also verify that the limit switches are operating properly by tripping the switch and observing this activity in this menu. If these signals are not being properly reported on this menu, check the ribbon cable between the pump and the electronics chassis for proper connections.

To calibrate the pump pressure transducer;

1. Select the following functions keys **MENU/TEST/PURGE.**
2. Close the **RESERVOIR** valve and open the **SYSTEM** valve.
3. Compress the pump to generate a pressure between 80% to 100% of the maximum full scale of the DPC.
4. If a recharge is needed, record the reading of the pump pressure transducer, close the **SYSTEM** valve, **EXPAND** slightly to relieve the pump pressure, open the **RESERVOIR** valve, **EXPAND** for a full stroke. Then close the **RESERVOIR** valve, **COMPRESS** until the pump pressure sensor is set back to the previously recorded pressure and **STOP** the pump. Open the **SYSTEM** valve and **COMPRESS** the pump until the 80% to 100% of full scale pressure is reached. Repeat this step if multiple strokes are required to obtain the desired pressure.
5. Once at the desired pressure, hit the **PREVIOUS** key 3 times.
6. Enter as a setpoint a pressure the pressure that was obtained that was between 80% and 100% of the maximum full scale of the instrument. Select the **CONTROL** function key. Once a stable control is achieved at the set point, the controller will automatically generate new coefficients for the pump pressure transducer.

WARNING: Do not allow the unit to automatically recharge when attempting to calibrate the pump pressure transducer. Place the instrument in MEASURE mode immediately if it initiates an automatic recharge cycle. If the DPC tries to recharge prior to the pump pressure transducer obtaining a valid calibration, there is a risk that the system will blow the rupture disk.

7. Go to MEASURE/MENU/TEST/SHOP1 and verify that the pump pressure and the system pressure are at similar pressure values. If not, repeat step 6.

6.4.5 SYSTEM PURGE PROCEDURE

NOTE: The system and pump transducers must be aligned to one another prior to performing this operation. See section 6.4.3 & 6.4.4.

There are a variety of conditions that can exist where air could be introduced into the system and require purging. In a hydraulic system, air will raise to the highest points within the piping set of the system. To purge the system thoroughly, each individual "high" point in the system must be purged of air.

At this point, it is recommended to test the system in order to identify which section of the system may require purging. There are three main sections in the system that should be considered. These are the Pump, the System and finally the customers test line and manifold. It is often recommended to place a valve at the output port of the 7610 to assist in trouble shooting the system. With the valve closed (or with the test port plugged), the operator can determine if air exist inside the 7610 controller itself or if it is primarily isolated to the users test lines and manifolds.

The following procedure can be used to remove air from any section of the system. If the operator can isolate which section of the system has air present, they can save a considerable amount of time by purging only those sections that have air present.

6.4.5.1 Test for Air in the Pump

To purge air from the pump, place the instrument in the measure mode. Go into the purge menu by selecting the **MENU/TEST/PURGE** function keys. A schematic of the system should appear on the display.

Close the **"SYSTEM VALVE" <F6>.** When the valve is closed, an **X** will appear in the schematic shown on the display.

Open the **"RESERVOIR VALVE" <F1>.** When the valve is opened, an = will appear in the schematic shown on the display.

EXPAND the pump to a full charge position (95%) by pressing the **<F4>** function key. The motor speed can be adjusted by pressing the up arrow key (faster) or the down arrow key (slower).

When the Pump is completely charged (95%), close the **RESERVOIR** valve **<F1>.** When the valve is closed, an **X** will appear in the schematic shown on the display.

> **WARNING:** Be prepared to stop the Pump quickly using the **STOP** function key! There is very little volume in the pump with both the RESERVOIR and the SYSTEM valve closed. Therefore, with a air free pump, pressure should start building rapidly when the pump is compressed.

With both the RESERVOIR and SYSTEM valves closed, the pump can be compressed in order to determine the amount of air that is in the pump. With an air free pump, you should be able to see the pump pressure increasing within 3 to 5 seconds after the pump starts to compress. If there is air in the pump, it will required multiple revolutions of the pump prior to building any significant pressure. Make sure that you are observing the reading from the pump pressure sensor and not the system pressure sensor. This reading is located in the middle of the screen between the two valves. Be prepared to hit the STOP key once the pressure starts to increase. Once all of the air in the system is compressed, the system will start pressurizing quickly. It is also not recommended to use the arrow keys to increase or decrease the pump speed due to the potential rapid increase in pressure associated with the small volume.

To initiate this test, select the **COMPRESS** key. Once the pressure starts to increase to 100 to 200 psi, select the **STOP** key. If the pump is air free, you should see pressure change within 3 to 5 seconds after selecting the COMPRESS key. If this is the case, there is no appreaciable air in the pump and you can move onto other sections of the system.

6.4.5.2 Purge the Pump

If there is air in the system as determined in section 6.4.5.1, with the SYSTEM and RESERVOIR valve closed, carefully build pressure in the pump section of the system to approximately 200 psi using the COMPRESS key and the STOP key once the pressure is achieved. Place a towel or rag beneath the pump cylinder to absorb any fluid during the

purging process. With a 5/8th inch wrench, loosen the plug fitting located on the top of the pump cylinder until the pressure drops. This is one of the high points in the system that air can be trapped and removed from the system.

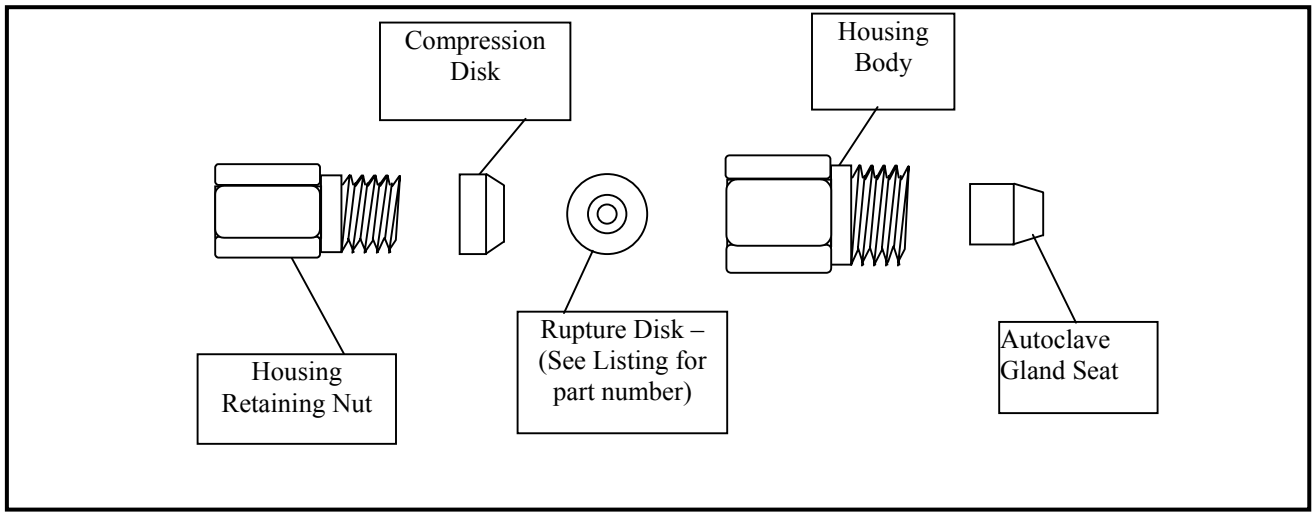
This process can be repeated until the pressure response with the pump pressure sensor response is within 3 to 5 seconds as described in section 6.4.5.1.

6.4.5.3 Test for Air in the System

To purge air from the system, place the instrument in the measure mode. Repeat the test and purge procedure as outlined in section 6.4.5.1 and 6.4.5.2 with the exception of plugging the rear test port (or closing an isolation valve mounted to the rear test port). Additionally, the **SYSTEM** valve will remain open when testing and purging the system such that the entire system is pressurized. With the **SYSTEM** valve opened, the overall volume is increased, so the response time will increase. Ideally, it would be recommended that the system was able to respond to the pump compressing within one to three full rotations of the pump drive nut. If the system is found to have air, select various high points in the piping set and purge the air from these points as described in section 6.4.5.2 but with the **SYSTEM** valve opened.

6.4.6 RUPTURE DISK REPLACEMENT

There are one to two rupture disks internal to the 7610 hydraulic system based on the number of Sensors installed in the system. The rupture disk can readily be located by following the rupture disk return pressure line connected to the top pressure port in the fluid reservoir back to the actual rupture disk. If you are trying to generate a pressure and after multiple strokes of the pump, no pressure is generated there is a potential that the rupture dick has been over-pressurized and ruptured. The easiest way to determine if the rupture disk has failed is by examining the rupture disk fluid return line and seeing if fluid is being pumped through the line while the pump is trying to pressurize the system. If fluid is being pumped through this line, the rupture disk has burst and will need to be replaced.



To replace the rupture disk,

1. Remove the nylon return lines from the fittings, then remove the rupture disk housing from the connector block and plug the block with a ¼ inch autoclave fitting plug.
2. Disassemble the housing and remove the damaged rupture disk, and thoroughly clean the housing components.
3. Apply a thin film of grease to the disk surface and the compression disk face. Insert the proper disk based on the pressure rating (see Table 6-1) and the compression disk into the housing . Make sure that the disk is inserted the correct way by matching the shape of the disk to the shape of the compression disk.
4. Screw the retaining nut together and torque the nut to 100 ft. lbs.
5. Remove the plug from the connector block and assemble the rupture disk housing into the connector block. Reconnect the return lines to the fittings.

TABLE 6-1
BURST DISK REFERENCE SHEET

Part No.	psi	Part No.	psi	Part No.	psi	Part No.	psi
69-811	1228	69-802	11200	69-810	16038	69-814	22577
69-820	1455	69-799	11712	69-818	16833	69-797	27075
69-816	2323	69-824	13500	69-787	18321	69-815	33900
69-808	3370	69-798	14622	69-813	22313	69-779	51067
69-817	6679						

6.4.7 REMOVING THE DPC'S COVER

The DPC should be kept clean and completely assembled at all times. Operating the DPC without its cover affects the DPC's thermal gradients and therefore reduces accuracy. If it becomes necessary to remove the DPC's cover, follow the instructions below. Refer to Figure 3-1.

CAUTION: The DPC 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 DPC and disconnect the power cord from the power supply.
2. Locate the two screws that secure the cover to the rear panel.
3. Unscrew these two screws and remove the two screws in side of rack mount.
4. To remove the cover, place hands near the middle of the cover, and slide the cover towards the DPC's rear 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 6.4.7.
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 DPC operating within its specified accuracy (Appendix A), the calibration procedure described below must be performed. Use appropriate DWG, such as Ruska Model 2485.

> **NOTE:** The calibration procedure automatically generates coefficients which are stored in memory on the DPC'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 DPC at any time by "editing the coefficients" (Section 6.5.2).

6.6.1 CALIBRATION INSTRUCTIONS – SINGLE AND DUAL SENSOR

To calibrate the DPC, the user simply connects a calibration standard to the DPC's Test Port then follows the 4-step calibration procedure on the DPC's display. On dual sensor versions, the operator would be instructed to select one of the two sensors to be calibrated. The calibration procedure is a menu driven procedure that steps the user through the pressures that are required to calibrate each pressure range that is included in the DPC. The user generates the defined pressures utilizing an adequate standard to calibration the DPC. The pressure steps will vary based on the pressure range and number of sub ranges that are included with the 7610. Typically, for a single range instrument, the operator would be prompted to generate Atmosphere, 50%, 100%, and 50% of the DPC's full scale operating range of a sensor (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 DPC has been at stable operating temperature for *at least* two hours
- Verify that the DPC is in MEASURE mode (Section 4).

- Verify that the Reservoir valve is closed and the SYS valve is open.
- Verify that the head height is set to 0.
- If desired, change the DPC'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. Since the 7610 have absolute pressure sensors, it is common to zero the 7610 at the current barometric pressure. Assure that all of the fluid head pressures that exist in the system are accounted for when performing the zero.

1.2 Wait until the zero procedure completes. This may take several minutes. When the DPC 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 of the range of the sensor being calibrated requested by the DPC. As pressure is admitted into the Test Port, the **Measured pressure** on the DPC's screen will change accordingly.

2.2 When the Measured pressure stabilizes, use the DPC's numeric keypad and OK to enter the actual pressure applied by the calibration standard. *Do not enter the* **Measured pressure** *reported by the DPC*. 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 of the range of the sensor being calibrated requested by the DPC. As pressure is admitted into the Test Port, the **Measured pressure** on the DPC's screen will change accordingly.

3.2 When the Measured pressure stabilizes, use the DPC's numeric keypad and OK to enter the actual pressure reported by the calibration standard. Do not enter the Measured pressure reported by the DPC. If necessary, use the CLEAR key to

correct a mistake in the edit field. If the **actual pressure applied** is acceptable, the Calibration step 4 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.

Step 4

4.1 To begin Step 4, use the calibration standard to again **Apply** the mid-point pressure of the range of the sensor being calibrated requested by the DPC. As pressure is admitted into the Test Port, the **Measured pressure** on the DPC's screen will change accordingly.

4.2 When the Measured pressure stabilize, use the DPC's numeric keypad and **OK** to enter the **actual pressure** reported by the calibration standard. *Do not enter the* **Measured pressure** *reported by the DPC*. 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.

STORING THE COEFFICIENTS

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

Step 5

Calibration is complete. To exit the calibration procedure without storing the calibration coefficients in memory, press **CANCEL**. To store the calibration coefficients, select **OK.**

Step 6

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 CALIBRATION INSTRUCTIONS – MULTI-RANGED SENSOR

To calibrate the DPC, the user simply connects a calibration standard to the DPC's Test Port then follows the 4-step calibration procedure on the DPC's display. Optional pressure ranges are available with the 7610 provided up to six ranges in a single instrument. Each independent range would be calibrated as a separate pressure range.

On multi-ranged sensor versions of the 7610, when activating the calibration procedure, after completing zero, the operator is instructed to select one of the multiple available pressure ranges that the operator wishes to calibrate. The operator then has the option to define the number of calibration points that they wish to set in an up scale and a downscale direction. The menu driven calibration procedure then steps the user through the pressures that are required to calibrate the selected pressure range. The user

generates the defined pressures utilizing an adequate standard to calibration the DPC. The pressure steps will vary based on the number of points the operator enters into the 7610. Typically, it is recommended that the operator select a 3 point up and a 3 point down calibration adjustment procedure. This would prompt the operator to generate Atmosphere, 50%, 100%, and the 50% of full scale of the range being calibrated (Section 6.2). Following the actual adjustment to the sensor, it is recommended to perform a number of verification points to assure that the instrument was adjusted properly.

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 DPC has been at stable operating temperature for *at least* two hours
- Verify that the DPC is in MEASURE mode (Section 4).
- Verify that the head height is set to 0.
- Verify that the Reservoir valve is closed and the SYS valve is open.
- If desired, change the DPC'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. The operator will select the sub-range of the sensor to be calibrated following the zeroing process.

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

Step 1

a. To begin Step 1 of the calibration process, select **ZERO.** Enter the actual pressure applied and press ok. Since the 7610 have absolute pressure sensors, it is common to zero the 7610 at the current barometric pressure. Assure that all of the fluid head pressures that exist in the system are accounted for when performing the zero.

b. Wait until the zero procedure completes. This may take several minutes. When the DPC completes Step 1, the DPC will request which sub-range of the triple range sensor is to be calibrated. Use the Arrow keys to highlight the desired range and hit **OK**.

c. The system will then prompt the operator to enter the number of points that should be included in the calibration. Typically, it is recommended to select 3 points up and 3 points down. This will generate a calibration procedure that includes atmosphere, 50%, 100% in the increasing direction and then 50% and

atmosphere in the decreasing direction for the sub-range of the sensor being calibrated. When the DPC completes Step 1, the Calibration step 2 screen will appear.

Step 2

NOTE: The number of steps noted in this example are based on the operator selecting a 3 points up and 3 points down procedure. If a higher or lower number of points is specified by the operator, the actual pressures that the 7610 calculates will very to reflect these changes.

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

2.2 When the Measured pressure stabilizes, use the DPC's numeric keypad and OK to enter the actual pressure applied by the calibration standard. *Do not enter the* **Measured pressure** *reported by the DPC*. 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 of the sub-range of the sensor being calibrated requested by the DPC. As pressure is admitted into the Test Port, the **Measured pressure** on the DPC's screen will change accordingly.

a. When the Measured pressure stabilize, use the DPC's numeric keypad and **OK** to enter the **actual pressure** reported by the calibration standard. *Do not enter the* **Measured pressure** *reported by the DPC*. If necessary, use the **CLEAR** key to correct a mistake in the edit field. If the **actual pressure applied** is acceptable, the Calibration step 4 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.

Step 4

4.1 To begin Step 4, use the calibration standard to again **Apply** the mid-point pressure of the range of the sensor being calibrated requested by the DPC. As pressure is admitted into the Test Port, the **Measured pressure** on the DPC's screen will change accordingly.

4.2 When the Measured pressure stabilize, use the DPC's numeric keypad and **OK** to enter the **actual pressure** reported by the calibration standard. *Do not enter the* **Measured pressure** *reported by the DPC*. 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.

STORING THE COEFFICIENTS

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

Step 5
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 6
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.

6.6.3 EDITING THE CALIBRATION COEFFICIENTS
If the DPC's memory is erased but the calibration coefficients are known, the user can restore the coefficients to the DPC 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 DPC 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 DPC'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.

6.6.4 ZEROING

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

Verify that the DPC's test port is open to atmosphere.

Verify that the DPC has been at stable operating temperature for at least two hours.

Verify that the DPC 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. Since the 7610 have absolute pressure sensors, it is common to zero the 7610 at the current barometric pressure. Assure that all of the fluid head pressures that exist in the system are accounted for when performing the zero. Press **OK** when the measured pressure is stable.

Step 4

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

SECTION 7.0
PREPARATION FOR STORAGE & SHIPMENT

7.1 DISCONNECT 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 hydraulic pneumatic pressure from the DPC.
2. Turn the DPC power switch off.
3. Disconnect the power cable from the DPC power receptable.
4. Disconnect all hydraulic pneumatic lines from the DPC's rear 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 DPC 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 DPC.

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 DPC. 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 DPC. If the DPC is being packed for long-term storage (more than 30 days), place a desiccant bag inside the unit. In general, prepare the DPC for shipment as follows.

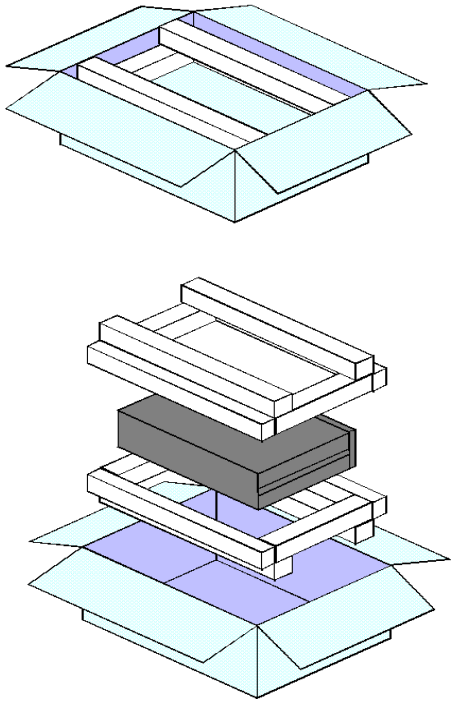
1. Ruska Instrument has an RMA procedure in place. Please contact the Customer Service Center to obtain an RMA number prior to returning any equipment to Ruska. Have the following information available when contacting Ruska:
   a. the part number,
   b. the serial number,
   c. the purchase order number,
   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. There will be a minimal charge for inspection and/or evaluation of returned goods.

2. Enclose the DPC 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" of polyfoam. Use four strips 4" to 6" wide and 50" to 60" long. Arrange strips to cross each other inside carton (see Figures 7-1 and 7-2). Cover sides and top, completely filling entire carton. Tape carton closed.
4. The Exterior Carton must be a double wall of corrugated or fiber board box. Use four 3 x 3 x 84 inch strips of polyfoam crossing each other inside the carton. Place interior carton inside (see Figure 7-3) 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.



7.1

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.

APPENDIX A
SUMMARY OF SPECIFICATIONS

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 DPC may not be able to achieve a final steady state controlled pressure within the settling time specification. Finally, if the DPC 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

Standard Pressure Ranges: 3,000 6,000 10,000 15,000 20,000 30,000 40,000 psia

Triple Range – Optional Ranges

Low (psia)	Mid (psia)	High (psia)
15,000	25,000	40,000
10,000	20,000	30,000
6,000	12,000	20,000
5,000	10,000	15,000
3,000	6,000	10,000
2,000	4,000	6,000
1,000	2,000	3,000

Precision[1]: High Ranges to 20,000 psia: 0.01% FS of Active Range
High Ranges >20,000 psia: 0.02% FS of Active Range

Stability: High Ranges to 20,000 psia: 0.01% /Year
High Ranges >20,000 psia: 0.02% /Year

Resolution: 0.01% 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

Overpressure Protection: Relief valves and rupture disk set at 110% FS

Pressure port:Test port: Autoclave F250C
Supply Port: 1/4 O.D. Swagelok

Display: Graphical vacuum fluorescent

Pressure Medium: Any noncorrosive fluid

Pressure Supply:	70–100 psi of air supply
Recommended Recalibration Interval:	1 year
Communications:	Standard: RS-232C and IEEE-488 Optional: RS-485 Syntax: SCPI (standard commands for programmable instruments)
Dimensions:	19"W x 24"D x 17"H (49 x 61 x 43 cm)
Weight:	110 lbs
Electrical Power:	115 VAC or 240 VAC, 50/60 HZ, single phase.
Humidity:	5 to 95% noncondensing
Temperature:	Operating: 5– 50 °C (40 to 122 °F) Storage: -20 to 70 °C (-4 to 158 °F)

[1]Precision is defined to include the combined effects of linearity, hysteresis, repeatability throughout the operating temperature range of the instrument.

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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 incorrect. 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 they are correct.
-330	Self-Test Failed. Check the display for the test that failed.
-350	Queue Overflow. The error queue was full and messages were lost.
-400	Query Error. A read request was received when there was nothing to read.
-500	Controller Malfunction. Internal control failure.
-501	High Limit Exceeded. The pressure was greater than the high limit.
-502	Low Limit Exceeded. The pressure was less 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 DPC.

Value	Description and Corrective Action
-546	Valve Error (Isolation Valve)
-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 form this Unit. The calibration data from another unit cannot be loaded.
-701	Pump Pressure Out of Range
-702	Pump Position Out of Range
-703	Reservoir Level Low
-707	Pressure Too High (To Switch Between Sensor Ranges)

APPENDIX C
7610 AUTOMATIC PUMP LUBRICATION SYSTEM

C-1 AUTOMATIC LUBRICATION SYSTEM

This 7610 has been equipped with an automatic lubrication system for the motorized pump.

This system will require an initialization procedure when the instrument is installed and will require yearly maintenance to replace the automatic lubricator.

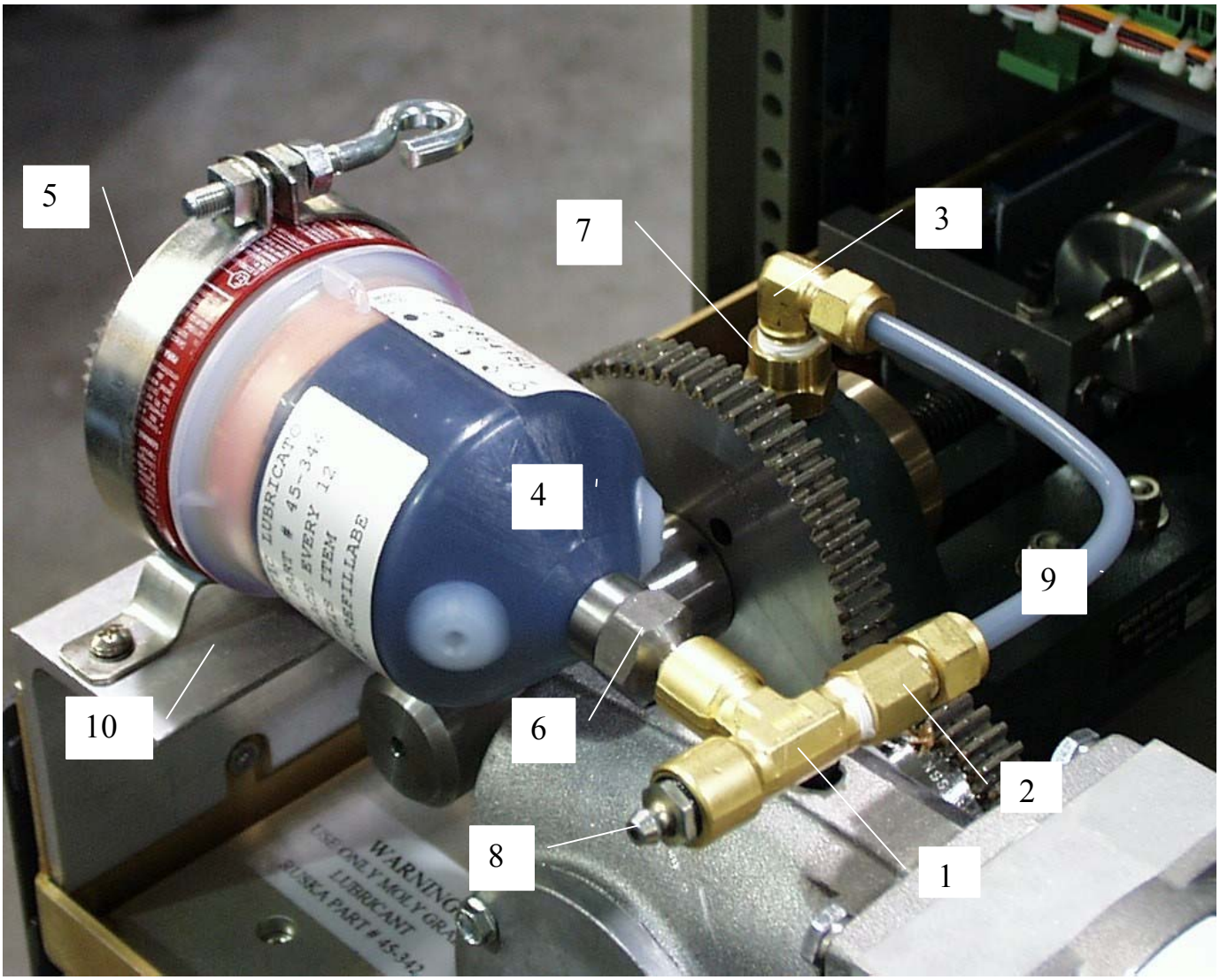

FIGURE C-1
MINI LUBER INSTALLATION

MINI LUBER PARTS LIST		
ITEM	**PART NUMBER**	**DESCRIPTION**
1	25-126	FITTING, STREET TEE 1/8 NPT B-2-ST
2	25-427	FITTING, CONN 1/8NPTFX1/4TBG B-400-7-2
3	25-17	FITTING, ELBOW 1/4NPTX1/4TBG B-400-2-4
4	45-344	MINI-LUBER (125 cc) WITH JETLUBE AP-5
5	45-345	BRACKET FOR MINI-LUBER (125 cc)
6	45-346	ADAPTER FITTING 1/4 X 1/8 BRASS FOR MINI LUBER
7	45-347	ADAPTER 1/4NPT X 1/4-28 SCREW THD BRASS FOR MINI
8	55-593	GREASE FITTING 1/8NPT STRAIGHT
9	86-800	TUBING NYLON 1/4OD TYPE H
10	7610-100-033	BRACKET, MINI-LUBER MOUNTING

Do not attempt to refill the empty mini-luber.

Do not attempt to disassemble the empty mini-luber, it may contain up to 50 psi (3.4 bar) pressure.

C-2 MINI LUBER OPERATION

The Mini-Luber is an automatic electronic grease dispenser. It has an internal power supply (batteries) and comes pre-filled with Jetlube AP-5 grease. The Mini-Luber will operate for approximately one year after activation. The Mini-Luber is not refillable, however, replacement Mini-lubers are available at an economical cost (RIC P/N 45-344).

Working Principal

When one of the selector switches is closed, an electro-chemical reactor cell is activated. An electro-chemical reaction takes place by which electrical energy is converted into nitrogen gas. The gas is trapped in a hermetically sealed bellows type gas chamber. As the gas is produced, an internal pressure builds up, which is applied against a piston. The piston forces the grease out of the cylinder an into the lube point. The strength of the electrical current determines the amount of gas produced, which in turn, controls the rate of grease flow and the length of time the Mini-Luber will operate. The maximum internal pressure is approximately 50 PSI (3.4 Bar)

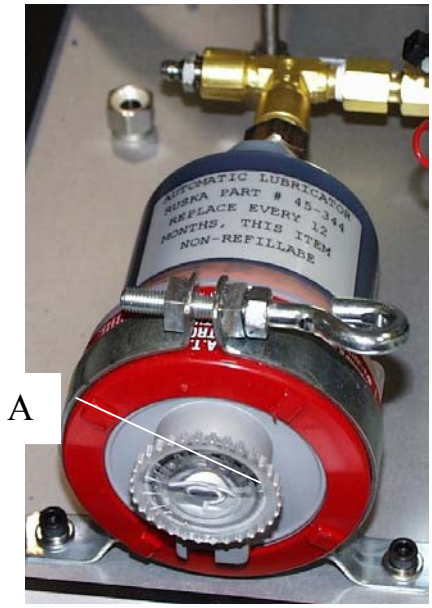

FIGURE C-2
THE MINI-LUBER

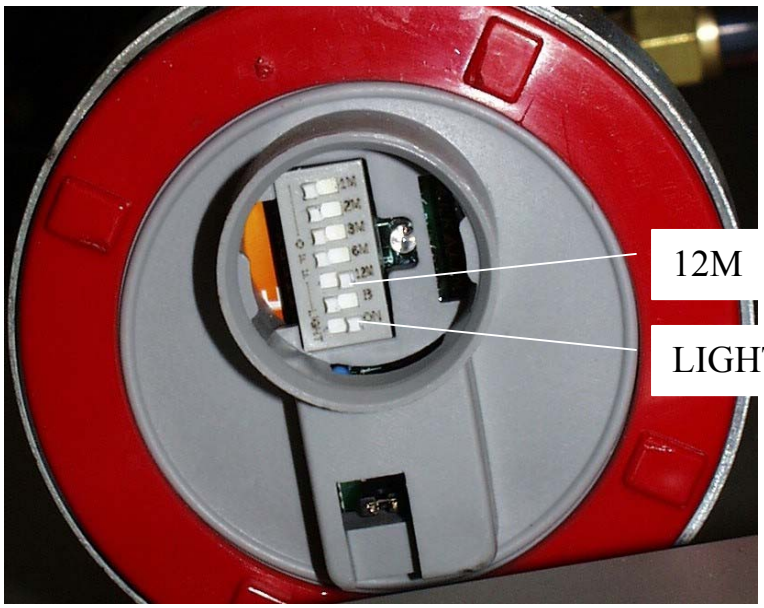

FIGURE C-3
RATE SETTING SWITCHES

Starting Procedure

Remove (unscrew) the clear cover (A) from the top of the Mini-Luber (Figure C-2). This will expose the dip switches (Figure C-3). Different settings of the dip switches determine the rate at which the Mini-Luber will dispense.

For this application the necessary switch setting is 12M. The 12M setting will dispense approximately .3 cc/day and operate for 360 days until empty. Also click on the "LIGHT" switch. The LED will soon flash and will repeat every 15 to 20 seconds for as long as the circuit is closed. The presence of the LED assures that the device is in working order.

With the Mini Luber, after the circuit is closed there is a delay before enough gas is formed to start moving the piston. Because we require an uninterrupted flow of lubrication, it is necessary to "pre-start" the device for 12 hours with all of the switches in the "ON" position. After this time, return all switches to the "off position" except for the 12M and "LIGHT" switches.

DIP SWITCH SETTINGS:

(AFTER PRE-START HAS BEEN PERFORMED)

1M	→ (OFF)
2M	→ (OFF)
3M	→ (OFF)
6M	→ (OFF)
12M	(ON) ←
B	→ (OFF)
LIGHT	(ON) ←

Perform this "pre-start" procedure whenever installing a new 2492 or, replacing an empty Mini-Luber.

DO NOT ATTEMPT TO DISASSEMBLE THE EMPTY MINI-LUBER, IT MAY CONTAIN UP TO 50 PSI (3.4 BAR) PRESSURE.

C-3 YEARLY MAINTENANCE

The Mini-luber should be replaced on a yearly basis. Fresh Mini-lubers are available from Ruska under the Ruska P/N 45-344.

Mini-Luber replacement

See Figures 1-1 and 1-3 in section 1.0

1. Remove the lower portion of the front panel to gain access to the Mini-Luber.
2. Set all dip switches on the Mini-Luber to the OFF position.
3. Loosen Luber bracket Item 5.
4. Hold item 6 with a wrench and unscrew the Mini-luber from the fitting.
5. Install fresh Mini-Luber.
6. Tighten the Luber bracket.
7. If any air has been introduced into the lubrication system, connect a grease gun to item 8 and fill the system with grease (use Jetlube AP-5 grease).
8. Perform the Pre-Start procedure as described in section 2.

If the luber is empty and a replacement luber is not available, the pump can be manually lubricated. Use a grease gun filled with Jetlube AP-5 grease. Connect the grease gun to the grease fitting (item 8). Lubricate the pump twice weekly (more often for severe service).

DO NOT ATTEMPT TO REFILL THE EMPTY MINI-LUBER

DO NOT ATTEMPT TO DISASSEMBLE THE EMPTY MINI-LUBER, IT MAY CONTAIN UP TO 50 PSI (3.4 BAR) PRESSURE.