Operation ManuaL - PN 0014896001 J1

DIGITAL PRESSURE GAUGE

Series 2100

CODE _____

SN _____

MODEL _____

VERSION _____

This Manual contains important information.
PLEASE READ PRIOR TO USE.

ISO 9001 BSI REGISTERED FM 59031

CE

ACCREDITED 2066.01

WARRANTY

All products manufactured by Mensor® Corporation are warranted to be free of defects in workmanship and materials for a period of one year from the date of shipment. No other express warranty is given, and no affirmation of Seller, by words or actions, shall constitute a warranty. SELLER DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSES WHATSOEVER. If any defect in workmanship or material should develop under conditions of normal use and service within the warranty period, repairs will be made at no charge to the original purchaser, upon delivery of the product(s) to the factory, shipping charges prepaid. If inspection by Mensor Corporation or its authorized representative reveals that the product was damaged by accident, alteration, misuse, abuse, faulty installation or other causes beyond the control of Mensor Corporation, this warranty does not apply. The judgment of Mensor Corporation will be final as to all matters concerning condition of the product, the cause and nature of a defect, and the necessity or manner of repair. Service, repairs or disassembly of the product in any manner, performed without specific factory permission, voids this warranty.

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

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

WARNINGS AND CAUTION NOTES

WARNING: HIGH PRESSURE!
High pressure gases are potentially hazardous. Energy stored in these gases and liquids can be released suddenly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been trained in proper safety practices.

WARNING: NOT EXPLOSION PROOF!
Installation of this instrument in an area requiring devices rated as intrinsically safe is not recommended.

WARNING: POSSIBLE INJURY!
The tubing, valves and other apparatus attached to the gauge must be adequate for the maximum pressure which will be applied, otherwise physical injury to the operator or bystanders is possible.

CAUTION: USE THE PROPER PRESSURE MEDIUM. Use only clean, dry non-corrosive gases unless otherwise specified by Mensor. This instrument is not designed for oxygen use.

CAUTION: AS WITH MOST SENSITIVE ELECTRONIC EQUIPMENT, SWITCH THE POWER SWITCH OFF BEFORE CONNECTING OR DISCONNECTING TO A POWER SOURCE TO PREVENT DATA LOSS.

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

PLEASE NOTICE...

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

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

TEL: 1.512-396.4200
TEL: 1.800.984.4200 (USA only)
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WEB SITE: www.mensor.com
E-MAIL: tech.support@mensor.com, sales@mensor.com, and quality@mensor.com

MENSOR SERVICE PLUS

Mensor's concern with the welfare of this instrument is not limited to the warranty period. We provide complete repair, maintenance and calibration services, available beyond the warranty, for a nominal fee. Call Mensor for details.

Calibration Services

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

Accreditations

Mensor Corp. is registered to BS EN ISO 9001:2000. The calibration program at Mensor is accredited by A2LA, as complying with both the ISO/IEC FDIS 17025:1999 and the ANSI/NCSL Z540-1-1994 standards.

PACKAGING FOR SHIPMENT

If the product must be shipped to a different location or returned to Mensor for any reason through a common carrier it must be packaged properly to minimize the risk of damage.

The recommended method of packing is to place the instrument in a container, surrounded on all sides with at least four inches of shock attenuation material such as styrofoam peanuts.

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This is not a sale of such intellectual property.

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MENSOR BACKGROUND

HISTORY: Mensor is an ISO-9001 certified manufacturer of precision pressure products. Mensor was established in 1969 in Houston, Texas as an independent spin-off from the Texas Instruments (TI) Pressure Instrument Group. As a private corporation, Mensor's objective was to design and produce high accuracy, high quality, easy to use pressure instruments. In 1978 Mensor moved to its present location in San Marcos, on Interstate 35 (the Austin-San Antonio corridor). Two and a half years after the move, the plant was destroyed by fire on Friday, February 13, 1981. Mensor resolved to come back, and almost before the ashes had cooled, construction of a new building began on the same site. Six months after the disaster Mensor moved into its present facility and began shipping products to customers who had waited patiently for the recovery.

PEOPLE: The key to Mensor's strength in the marketplace is the concentration of experienced people in the field of precision pressure measurement and control. The company's founders previously worked in various capacities in the Pressure Instrument Group of Texas Instruments, including engineering, production and marketing. These founders were involved in the design of the original quartz bourdon pressure gauge at TI. Mensor's CEO, Jerry Fruit, is co-holder of the patent on using a fused quartz bourdon tube to accurately measure pressure. Mensor full-time employees have an average tenure of sixteen years. That's a lot of pressure experience!

PRODUCTS: Mensor's portfolio of products consists of an extensive line of precision pressure instruments, including digital gauges, pressure controllers, transducers and pressure calibrations systems. All of these products feature computer interface capability. Mensor products are used in metrology labs, calibration labs, research facilities, engineering offices, production test stands, and in other environments where high accuracy pressure measurement and/or control is required. Many of these products include customized features to meet a customer's specific requirement. Mensor products range from about $900 to $30,000.

CUSTOMERS: Typical Mensor customers are pressure sensor manufacturers, aerospace firms, jet engine manufacturers, electric utilities, nuclear power plants, pharmaceutical firms, calibration laboratories, government agencies and research organizations.

APPLICATIONS: In many facilities the highest accuracy pressure measuring or pressure controlling instrument is a Mensor product. A typical application for these Mensor instruments is the calibration of other pressure devices, such as sensors, transducers, transmitters, gauges and pressure switches. The Mensor product is used as the pressure standard to verify pressure calibrations or outputs of the device being produced, checked, tested or certified.

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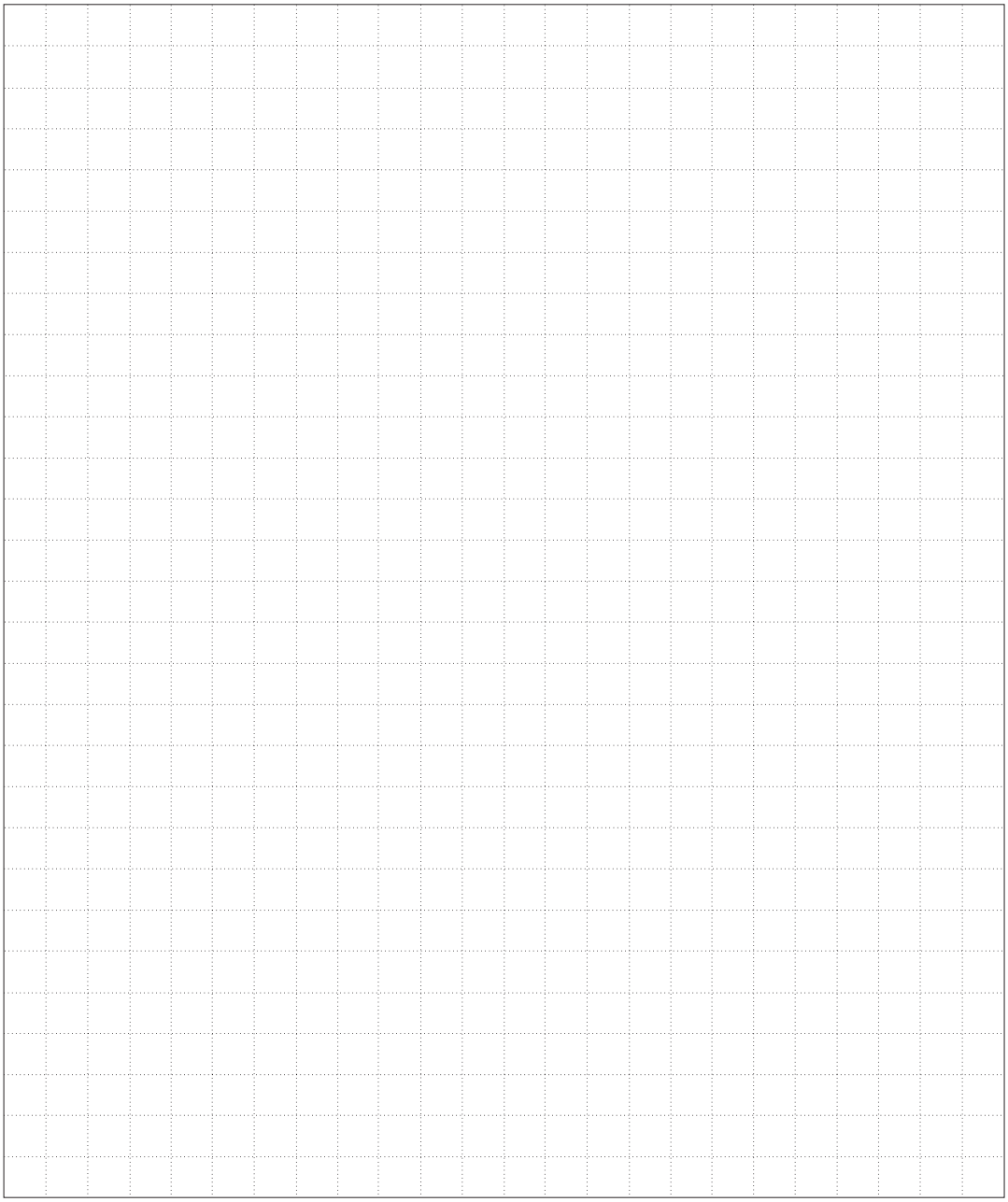


INTRODUCTION

DID YOU GET EVERYTHING?

In addition to this manual you should have:

- Series 2100 Digital Pressure Gauge;
- 12 VDC power module and power cord;
- One 1/4 and one 1/8 inch NPT pressure port fitting adapters. Mensor does not supply fittings for units over 6000 psi;
- Any accessories ordered;
- An envelope containing the Calibration Certificate.

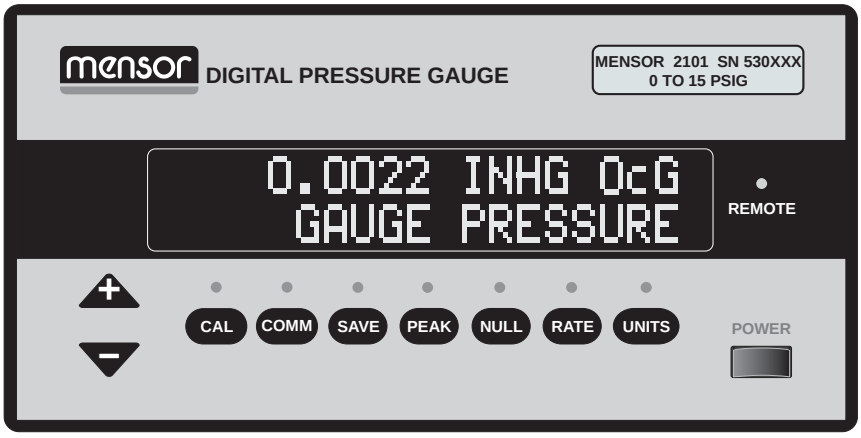


Figure 1.1 - Front View (Typical)

INITIAL INSPECTION

After Mensor completed all of the functional testing to qualify your Digital Pressure Gauge (DPG), it was finally inspected at the factory for appearance including the absence of dings, dents and scratches. Please examine it now for signs of shipping damage. Report any apparent damage to the carrier immediately.

SERIES 2100 BASICS

This is the third generation of the high accuracy Digital Pressure Gauge from Mensor. The Series 2100 has the same outside dimensions and weight as its predecessor, the DPG II. Either instrument mounts to the same panel cutout.

Each 2100 includes a Silicon Pressure Transducer (SPT). The SPT modifies the output signal from a micro-machined silicon wafer pressure sensor. This sensor, with its built-in temperature circuitry, and associated external programming, has a history of extreme accuracy over a wide temperature range, and has proven to be stable over time and in adverse environments.

MODELS

The Series 2100 family of Digital Pressure Gauges consists of several models as shown in the following table. A model number is assigned according to the type of instrument, the accuracy (uncertainty as a percent of full scale, or percent of reading), and the compensated temperature range specification for the instrument. All of the models listed here are described within this manual.

Table 1.1 - Series 2100 Models

Model	Type	Uncertainty	Compensated Temperature
2101	Pressure Gauge	0.010% FS	15° to 45° C
2102	Pressure Gauge	0.025% FS	15° to 45° C
2103	Barometer	0.010% R	0° to 50° C
2104	Barometer	0.010% R	15° to 45° C
2105	Barometer	0.025% R	15° to 45° C
2106	Pressure Gauge	0.010% FS	0° to 50° C
2107	Pressure Gauge	0.025% FS	0° to 50° C
2108	Altitude Gauge	0.010% FS	15° to 45° C
2109	Airspeed Gauge	0.010% FS	15° to 45° C

FRONT PANEL SWITCHES

There are ten switches on the front panel, each with an identifying legend. Starting at the left end, there is an up/down pair labeled **+** and **–**. These two keys are used either to increase or decrease values, or to step through a list of choices depending on the current operation, or to display the current instrument status. Next are the seven function keys, each with an LED indicator which lights when the associated function is active. Remote "KEYLOCK" commands can render all of the above keys inoperative, or restore their functionality. The far right switch is the power switch. The power switch is a push-push switch which toggles the power on or off with each push. A brief explanation of the seven function keys follows below. A more detailed explanation of all of the front panel function keys is presented in Section 3, *Local Operation*.

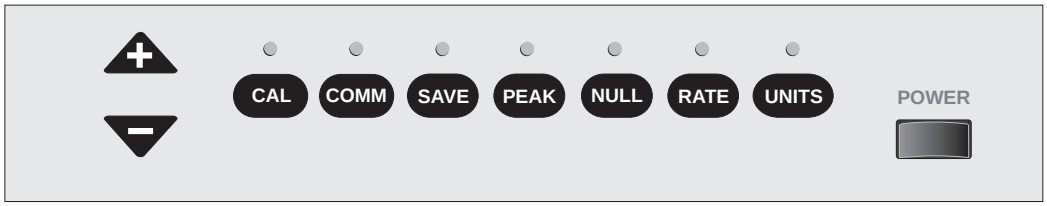


Figure 1.2 - Front Panel Switches

Function Keys

The seven function keys located on the front panel, and their uses are:

CAL Calibrate the zero offset, the span value, and for barometers, the sea level reference value.

COMM Set the IEEE-488 (GPIB) address, and if the serial option is included, set up the serial operation parameters.

SAVE Save to non-volatile memory the latest changes made to various settings.

PEAK Monitor the lowest and the highest pressure values present since activating this function.

NULL Set the pressure reading to zero (0.0000) by compensating for any current offset.

RATE Set the rate of pressure change in measurement units per time period (inHg/sec, etc.).

UNITS Select the measurement units from a list of eight available units for the displayed pressure.

REAR PANEL SWITCHES

The three rear panel switches are used in conjunction with the front panel CAL key, and the **+** and **–** incrementing keys. They are normally OFF (down), except that the SEA LEVEL ADJUST switch might be left ON (up) for some barometer operations. The ZERO and SPAN switches are switched to ON to change the associated calibration points.

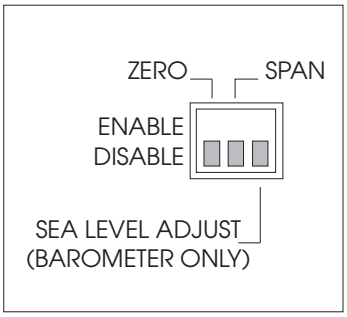


Figure 1.3 - Rear Panel Switches

POWER UP!

You can confirm that your DPG is operational right now. Check that the included power cord is correct for your line voltage, then apply 12 VDC from that module to the power connector on the rear of the gauge. Remove any plastic plugs from the PRESSURE port, and if included, the REFERENCE port, then push the front panel power switch ON. The DPG will run an initialization procedure and display a series of screens similar to those shown below.

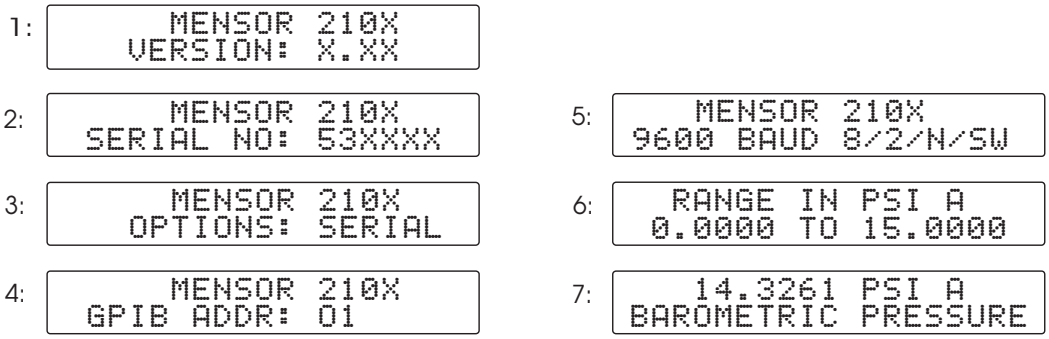


Figure 1.4 - Initialization Screens

Notice that only the bottom line changes in screens one through five, while the top line remains the same. Screen three which shows the serial option will vary according to which options are installed. Screen five, which shows the RS-232 configuration, will appear only if the serial interface option is included.

The last screen is the normal operating display. With no pressure connected, an absolute instrument of sufficient range will display atmospheric pressure, while a gauge instrument will display at or very near zero pressure. In any case the pressure will be displayed in the measurement units that were specified when the instrument was ordered. Upon completion of all of the initialization displays and a brief warm-up, the DPG is ready for work.

If this is your first time to use a Series 2100 please review the Warnings and Cautions information inside the front cover. Then take the time to familiarize yourself with the *Installation* and *Local Operation* sections of this manual.

ABOUT THE MANUAL

All of the current Series 2100 models are described within this manual. Some information is general to the whole series, while other information may apply exclusively to one or to several specific models. With no models cited, or where 'DPG' is stated inside text without brackets, the information applies to all models. Otherwise, where the information is exclusive the text will be preceded by bold square brackets enclosing the related models as shown below.

[All]: This designation may be used in some places where otherwise it might not be clear that the text applies to all pressure, barometer and avionics models.

[Avi]: The topic relates only to the Avionics models, 2108 (altitude) and 2109 (airspeed).

[Baro]: The information applies to the three Barometer models, 2103, 2104 and 2105 only.

[DPG]: The text applies only to the four Pressure models, 2101, 2102, 2106, and 2107.

Specific **[model number(s)]**: The information applies only to the model(s) listed inside the brackets.

The DPG has two operating modes, LOCAL, which is hands-on, and REMOTE, which is from a computer over a communication bus. The LOCAL mode of operation for standard instruments is covered in Section 3 immediately following *Installation*. REMOTE operation is covered after that in Section 4. Section 5, *Maintenance and Calibration*, provides information on performing specific calibration procedures both in the local and the remote modes, while Section 7, *Options*, gives details on non-standard operating modes for the various optional features, and also describes several hardware options.

INSTALLATION

The DPG combines the precision of a laboratory instrument with the ruggedness of a field meter. For most situations it will perform equally well on a table top, mounted in a rack, or in the field as a portable, battery powered instrument. See Section 7, *Options*, for details on rack adapters, carrying handles and battery packs.

MOUNTING

All current Series 2100 DPGs use a Silicon Pressure Transducer (SPT) which is relatively insensitive to vibration, shock and tilt (attitude). However, to assure the greatest possible accuracy and stability, excessive vibration of the mounting surface should be avoided. For information on rack-mount installation or portable operation refer to Section 7, *Options*.

PRESSURE CONNECTIONS

The pressure port is a female 7/16 - 20 (straight threads) SAE/MS per MS16142 and SAE J514 table 14. The port requires a tube fitting boss seal with an o-ring per MS33656. Mensor provides a female 1/4 NPT and a 1/8 NPT adapter fitting with each instrument. We recommend the use of either Loctite hydraulic sealant or fresh teflon tape on the threads of the male pipe (NPT) fitting. (Do not use thread sealant on fittings sealed with an o-ring.) In making up connections the integrity of each seal is important since even microscopic leaks can cause errors in pressure measurements. A leak test is advised after all connections are made.

NOTE: *When making up connections to the o-ring adapter use a back-up wrench to prevent over-stressing the threads in the aluminum block.*

For units with two ports: The pressure to be measured is applied to the top port labeled Pressure on the back of the DPG. The reference connection for gauge pressure is made to the port labeled Reference. On gauge transducers the reference port is normally left open to atmosphere. If the transducer is used in a differential mode, static line pressures may affect the calibration. The reference port is plugged at the factory for absolute pressure transducers.

High Pressure Connections

[DPG]: Mensor can provide a DPG (absolute or gauge) with a full scale rating between 6,000 and 10,000 psi. Such units are delivered with special high pressure tubing and fittings, and with a liquid pressure medium installed. The particular medium used must be specified when the instrument is ordered.

When setting up a high pressure DPG the appropriate high pressure tubing and fittings must be used throughout the measuring and calibration systems. Sources for this tubing and the matching fittings are listed in the *Appendix* section. Most of the sources listed can also provide instructions, specifications and detailed drawings relating to these parts.

Before making the high pressure connections the transducer port must be filled with the liquid pressure medium using the method given under 'Liquid-filled Transducer' in the *Options* section of the manual. The entire pressure system must be free of entrapped air to ensure the greatest achievable accuracy with the DPG.

POWER ON

[All]: After all pressure connections are secure, apply power to the DPG, then push the front panel power switch ON. The instrument will go through a brief initialization process and system check. If no errors are detected the DPG is ready for use. To achieve maximum accuracy allow the system to warm up for at least fifteen minutes, then proceed to Section 3, *Local Operation.*

If the DPG detects a problem during initialization an error message will appear in the display. Table 2.1 lists the possible error messages and suggests actions to correct some of these.

ERROR CONDITIONS AND SUGGESTED ACTIONS

Table 2.1 - Error Messages and Suggested Actions

Description	Suggested Action
NO ERROR	
RAM DATA ERROR	Contact the factory.
RAM BATTERY ERROR	Contact the factory.
STACK ERROR	Contact the factory.
COMMAND SYNTAX ERROR	Check the command string for extra or incorrect characters.
DATA RANGE ERROR	Check the numeric parameter to see if it is in the valid range.
IN BUFFER OVERFLOW	Too many characters were sent before an X was received. Resend.
OUT BUFFER OVERFLOW	Send a command and read it back to keep buffer empty.
GPIB ERROR	A problem has been detected with the GPIB control lines. Check the controller and cables for proper connection.
SERIAL PORT DISABLED	Contact the factory.
DISPLAY FAULT	The display cannot be updated. Contact the factory.
A/D FAULT	Contact the factory.
ALTITUDE DISABLED	Results from setting to altitude units on a non-altitude unit. Reset device to an appropriate unit.
NUMERIC OVERFLOW	Contact the factory.
CALCULATION OVERFLOW	Power up, send GPIB commands ZOX, SOX, then power OFF and back ON. This sequence clears the zero and span offsets. Otherwise,contact the factory.
DIVISION BY ZERO	Contact the factory.
SERIAL RX OVERRUN	73 characters received w/o x. Resend.
SERIAL FRAMING ERROR	Check all switch settings of S1 and S2 on the optional Communications Board, then resend.

Continued on next page...

Table 2.1 continued...

Description	Suggested Action
SERIAL PARITY ERROR	Parity incorrect if enabled. Check and resend.
NO PRESSURE FREQ	Contact the factory.
NO TEMPERATURE FREQ	Contact the factory.
NO REFERENCE FREQ	Contact the factory.
PARSER ERROR	Contact the factory.
UNAUTHORIZED COMMAND	Contact the factory.
MASTER CAL DISABLED	See *Maintenance and Calibration.*
ZERO CAL DISABLED	See *Maintenance and Calibration.*
TARE CAL DISABLED	See *Maintenance and Calibration.*
SEA LEV CAL DISABLED	Barometer only; see *Maintenance and Calibration.*
PRESSURE BELOW 50% FS	Increase pressure to 50% of span, or greater.

LOCAL OPERATION

This section describes using the Series 2100 in a hands-on manner. Remote operation is covered in the next section.

STANDARD DISPLAY

The display is normally set for standard pressure readings as seen in figure 3.1. Other information will displace the standard display when the function keys are actuated.

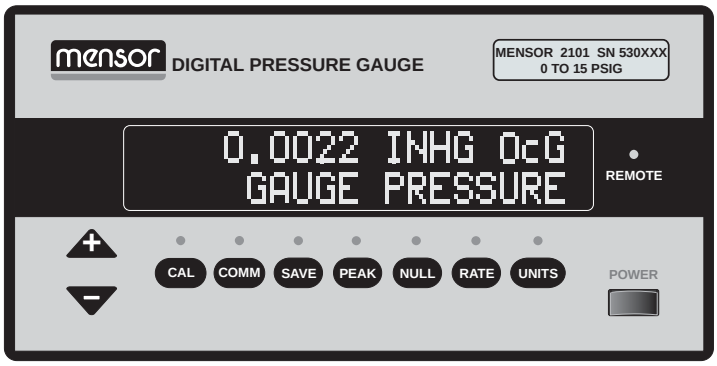


Figure 3.1 - Typical Pressure Display

During normal operation line one (the top line) of the display shows the current pressure in the measurement units set at the factory, or those units subsequently selected by the user. Line two (the bottom line) displays the type of measurement such as absolute, gauge, barometric or delta pressure.

ALTERNATIVE DATA FORMATS

There are some alternative ways to display the data by using certain commands over a remote bus (either GPIB or serial). One feature allows the user to set the full scale resolution for a maximum of six digits (from one part in 50,000 to 500,000 parts) or for five digits (from one part in 5,000 to 50,000 parts). Refer to the *DIGITS* command in the *Remote Operation* section.

Another feature allows the user to transpose the top and bottom lines such that line one, normally on top, appears on the bottom, and vice versa. See the *LINEREV* command in the *Remote Operation* section. Any references to the top or bottom lines in this manual refer to the standard orientation.

Still another feature allows the user to create a custom message for line two (normally on the bottom). Refer to the "C" command under *Remote Operation*.

REMOTE INDICATOR

When the instrument is addressed via a GPIB controller the front panel REMOTE indicator (LED) is lit. Serial operation has no effect on this indicator.

FRONT PANEL SWITCHES

The power switch is a push-push toggle switch which turns the power on or off with each push. All remaining front panel switches are momentary contact membrane keys which function once with each push. However, the display will continue to increment if pressure is maintained on the key. This is true whether the key steps through a series such as the UNITS key and the + and – keys, or the key is a simple on-off toggle such as the NULL or PEAK keys. The data or parameter displayed when a key is released will remain in effect.

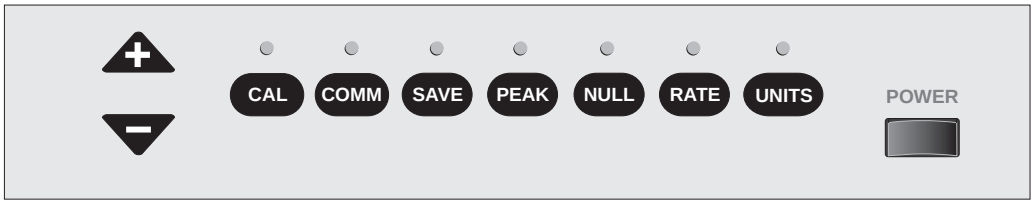


Figure 3.2 - Front Panel Switches

+ and – Keys

The two front panel keys marked + and – are used to:

a. Display the current status of the DPG;

b. Select specific items from lists of choices for remote operation;

c. Enter adjustment values during zero or span calibration;

d. Make a barometric sea level adjustment on a barometer.

To see the eight status screens similar to those shown below, first press both the + and – keys, then release them simultaneously. The software version screen will appear first. Press the + key to advance to the serial number screen, or maintain pressure on the + key to step through all eight status displays. Press the – key to cycle through the same screens in the reverse order.

Additional functions for the + and – keys are covered in detail in the text where their use is called for.

1:
```
STATUS        USE +,-
VERSION: X.XX
```

2:
```
STATUS        USE +,-
SERIAL NO: 53XXXX
```

3:
```
STATUS        USE +,-
OPTIONS: NONE
```

4:
```
STATUS        USE +,-
ZERO: 0
```

5:
```
STATUS        USE +,-
SPAN: 1.00000
```

6:
```
STATUS        USE +,-
SEA LEVEL: 0
```

7:
```
STATUS        USE +,-
NULL: 0
```

8:
```
STATUS        USE +,-
STAT CODE: XXXX
```

Figure 3.3 - Status Screens

CAL

Calibration Key

The CAL key is used to set up the zero offset and the span value adjustments during instrument calibration. On barometers this key also enables the sea level barometric adjustment. If the three rear panel enabling switches are set on DISABLE (see "Rear Panel Switches") pressing the CAL key will show:

```
CAL MODE DISABLED...
```

With the three rear panel switches set on ENABLE press the CAL key once to display the Zero Adjust screen. Press CAL again to see the Span Adjust screen.

```
ZERO ADJUST  USE +,-
   0.0093 PSI A
```

```
SPAN ADJUST  USE +,-
   14.2160 PSI A
```

[Baro]: Press CAL a third time for the Sea Level Adjust feature. The display will show one of the two screens shown below. If the "DISABLED" display is showing press either the + or – key to advance to the "ENABLED" screen.

```
SEA LEVEL    USE +,-
DISABLED
```

```
SEA LEVEL    USE +,-
ENABLED
```

Adjustments: The + and – keys are enabled when the Zero, Span, or Sea Level Adjust screen is showing. Press either + or – to modify the displayed value in the desired direction. Hold either key to continuously increment or decrement the displayed value. Release the key when the proper value is reached, then press CAL once more to display the "USE SAVE KEY ..." prompt.

```
USE SAVE KEY AFTER
ALL CHANGES TO STORE
```

To make the Zero, Span or Sea Level Adjust changes permanent, even after future power OFF-ON cycles, press the SAVE key. The screen will display instructions to complete the save. See the text under the SAVE key for additional information.

If changes made to the Zero, Span or Sea Level Adjust values are temporary do not press SAVE, but rather press CAL again to leave this function. The changes will remain in effect until the unit is powered off. At the next power on the previous values will be restored.

COMM

Communications Key

The COMM key is used to change the GPIB (IEEE-488) address, or to set up the RS-232 (serial) parameters if the serial option is present.

GPIB: All units are shipped with the GPIB address set to 01. To change the address press COMM, then press the + or – key until the desired address is displayed. Notice that the + or – key can be pressed repeatedly, or merely held in to continuously step to the target address. The address is the only setup option available for GPIB communication. With the desired address in the display press SAVE, then + to store the change in non-volatile memory.

Serial: If the DPG is equipped with the RS-232 option (serial communication), continue pressing the COMM key to step through the currently selected setup values for the serial bus. Table 3.1 below lists the available RS-232 setup choices. Factory default settings for each function (each line item) are bolded. To change any of the current settings press the COMM key to display the desired parameter, then press the + or – key to step through the available values. With the desired value showing in the display again press COMM until the "USE SAVE KEY ..." message is displayed. Press the SAVE key and then the + key to preserve the new values in non-volatile memory.

Table 3.1 - RS-232 Setup

FUNC	OPT 1	OPT 2	OPT 3	OPT 4	OPT 5	OPT 6	OPT 7	OPT 8
Baud	150	300	600	1200	2400	4800	**9600**	19200
Parity	**even**	odd	None					
Data bits	**7**	8						
Stop bits	**1**	2						
Handshake	**Hardware**	Software						

SAVE

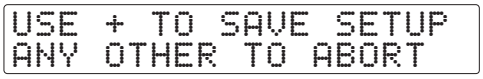
Save Key

The SAVE key is used to save to non-volatile memory certain changes made which are to remain in effect through future power OFF-ON cycles. If changes are made and not saved, the changes will be in effect only until the power is interrupted. At the next power up the previously stored values and conditions will be re-established.

Some key functions will display a 'USE SAVE KEY . . .' prompt as shown previously, but others will not. It is up to the user to recognize when changes have been made that should be preserved, and to run the save routine. The SAVE function will permanently save the following types of values:

[Baro]: Calibration Sea Level Adjust
Calibration Zero value
Calibration Span value
Date of Calibration (DOC)
Delta Pressure (NULL function)
Display Modes (Normal, RATE, or PEAK; Digits of Resolution; Reversed top/bottom lines; Custom display)
GPIB address
Serial Protocols (Serial Option)
UNITS of measure

To complete a save press the SAVE key and the left screen (below) will appear. Press the + key and the screen on the right will appear briefly, and then the normal operating screen will return.



To save the Date of Calibration requires a few additional steps. The procedure for saving the DOC to memory is explained in the *Maintenance and Calibration* section of the manual.

PEAK

Peak Key

Press the PEAK key to monitor the minimum and maximum pressure on the pressure port. The bottom line of the display will report both the lowest (XXXXXX<) and the highest (<XXXXXX) pressures sensed during the period that the peak indicator light is continuously lit. Any interruption to the monitoring process will reset both values and begin a new monitoring series.

NULL

Null Key

The NULL key will null out any pressure offset in whatever mode is currently active. For instance, pressing NULL while in PEAK mode will instantly reset both the minimum and maximum peak values to 0 and begin a new monitoring series. In the normal pressure monitoring mode line one will show the current pressure with null added in, and line two will change to 'DELTA PRESSURE'.

The application features of the NULL function are different for an absolute as compared to a gauge pressure DPG.

Absolute Pressure Models

1. Pressing NULL with the instrument vented to atmosphere allows two different applications:

a. Gauge pressure emulation from the referenced atmospheric pressure, or
b. Compound pressure measurements around the referenced atmospheric pressure, that is from minus one atmosphere to full scale.

2. Pressing NULL at some pressure other than atmospheric allows + and – measurements from that pressure which then is used as a reference pressure.

Notice that the NULL function reduces the apparent full scale range of the instrument. For example, a 0 to 100 psia DPG in the gauge pressure emulation mode will have a full scale pressure of approximately 85 psig. Consequently, the lower the absolute pressure range the greater is the uncertainty of the gauge pressure emulation reading.

Using the NULL function on absolute units which have a full scale range less than one atmosphere will cause an overrange indication until the pressure is within the range of the instrument, then it will read as negative pressure.

Gauge Pressure Models

1. Pressing NULL with the instrument vented to atmosphere is a quick zero procedure, bypassing the calibration routine.

2. Using NULL with the instrument at some pressure other than atmospheric pressure allows plus and minus measurements from that pressure.

RATE

Rate Key

Press the RATE key to see the rate of pressure change over time. A typical application for the Rate feature is to measure the leak rate in a pressure vessel. The figure below illustrates the principle on which this feature is based.

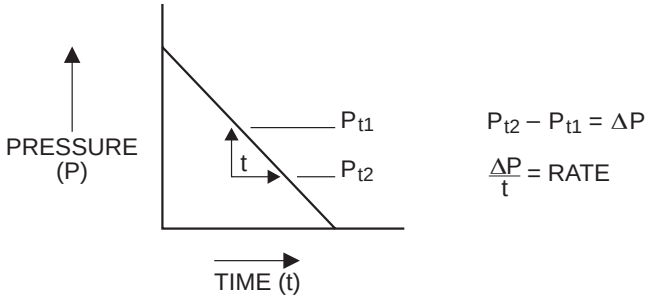


Figure 3.4 - Pressure Rate

When the RATE key is pressed the Rate LED comes on and line one of the display reports the measured pressure while line two shows the rate of pressure change. Each press on the RATE key steps to the next higher time period to report pressure units change per second (/SEC), or per minute (/MIN). A Barometer will also display units change per hour (/HR), or per three hour (/3HR) periods. A DPG will not display these last two from the front panel although they are available over a remote bus.

1:
```
14.3261 PSI A
  0.000 /SEC
```

2:
```
14.3261 PSI A
   0.00 /MIN
```

3:
```
14.3261 PSI A
     0.0 /HR
```

4:
```
14.3261 PSI A
     0.0 /3HR
```

Until the first time cycle is completed the display will append “EST” to line two to indicate that the displayed rate of change is an estimated value. After the first complete time cycle has elapsed the “EST” will disappear from the display. For additional information on the Barometer /HR rate see the text under the heading of “Hourly Rate of Change” later in this section.

UNITS

Units Key

The DPG can output the pressure reading in any of the measurement units listed in table 8.1 in the *Appendix*. The conversion factors used internally to convert from psi to other measurement units are listed in this same table.

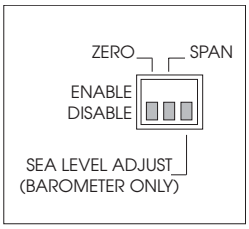
The UNITS key on the front panel provides the means to instantly select the displayed measurement units from a menu of up to eight choices. Hold the UNITS key in to step through the menu of all eight pre-set units. The DPG will be active in the units that are displayed when the switch is released.

Table 3.2 shows the standard measurement units loaded into the eight-line units register at the factory. Line 1 is always psi. Lines 2 through 8 can be different than those of table 3.2 if different units were specified when the DPG was ordered. The user can change or delete items 2 through 8 from this register over a remote bus by use of the UNITS_TABLE command. Refer to the *Remote Operation* section for details.

Table 3.2 - Standard Measurement Units

MENU	[2101 - 2107]	[2108]	[2109]	RESET METHOD
1	psi	psi	psi	Base units – NO RESET.
2	inHg @ 0°C	Feet	Knots	Use the "UNITS_TABLE" command over a remote bus to add, remove, or change units for menu lines 2 through 8. See the *Remote Operation* section.
3	inH_2O @ 4°C	Meters	Meters/sec	
4	mbar	inH_2O @ 4°C	k/Hr	
5	mmHg @ 0°C	inHg @ 0°C	inHg @ 0°C	
6	torr	mbar	mbar	
7	hPa	mmHg @ 0°C	mmHg @ 0°C	
8	kPa	kPa	kPa	

REAR PANEL SWITCHES



[All]: Two of the three DIP switches accessible from the rear panel are identified as ZERO and SPAN. These two switches are used by all models to allow calibration of the low and high end-points of the instrument range and are normally OFF (0). Their functions are covered in detail in the *Maintenance and Calibration* section.

[Baro]: The third switch, SEA LEVEL ADJUST, is used by barometers to permit making a local correction for sea level atmospheric pressure. This correction is accomplished by subtracting out the barometric pressure difference between the instrument's elevation and sea level. This switch might normally be in either condition (0 or 1) depending on the user's requirement.

All three switches are recessed such that a calibration facility might calibrate the DPG, then reset the switches to OFF, then cover them with a calibration sticker to discourage tampering. When any switch is OFF that calibration point cannot be changed either from the front panel, or over a remote bus.

HOURLY BAROMETRIC CHANGE

[Baro]: The Hourly Barometric Change function calculates the hourly change in barometric pressure. This function is always active, but is seen on the display only if RATE is set to Rate/HR.

NOTE: *SEA LEVEL ADJUST will not work if units are in feet or meters.*

The Barometric Change function uses a special tracking buffer to store 60 one-minute rate averages. When this function is enabled the following sequence of events occur:

The buffer is cleared during initialization, then immediately begins accumulating the average pressures over one minute intervals. During the first two one-minute pressure readings line two of the display will show:

0.000 /HR EST

After the second minute, and for the remainder of the first hour, line two will display snnnnnnn /HR EST where:

s = arithmetic sign
nnnnnnn = calculated value up to seven digits
/HR = per hour
and EST indicates the value is an estimate.

Example: +0.123 /HR EST
During this first hour the estimated value is calculated by the formula:

While $n < 60$:

$$\frac{60 \sum_{t=1}^{n} rate\ (t)}{n}$$

Where: t = time period
n = current time
$rate(t)$ = average rate per minute at time t

At the end of the first hour each additional reading received by the buffer displaces the oldest reading stored there (current reading – oldest buffer value). The displayed value is then the difference between the latest one minute average and the oldest one minute average. The display will drop the EST (estimate) and update the hourly change each minute thereafter using the formula:

When $n \geq 60$:

$$\sum_{t=n-60}^{n} rate\ (t)$$

Note that the buffer and the calculations continue to operate at all times while power is applied. Switching to RATE /HR merely sends the results to the display.

Pressure rate per 3 hours is calculated by taking the difference between consecutive one minute pressure averages to obtain the rate for one minute. This difference is stored in one minute data blocks which are summed for 180 minutes.

In metrology a rate of pressure change per three hour period is called a tendency. If a pressure tendency value is reported, the rate of pressure change per three hour period is understood.

SEA LEVEL ADJUST

[Baro]: Local barometric readings can be offset to sea level barometric pressure with the SEA LEVEL ADJUST feature. To enter an elevation offset, move rear panel switch S1-3 up (SEA LEVEL ADJUST = ENABLE). Next, press the front panel CAL key until line two of the display shows SEA LEVEL. In this mode when either the + or – key is pressed line one of the display will read SEA LEVEL ADJ:, and line two will indicate the current elevation as corrected.

Hold either the + or – key down to cause the least significant digit to begin incrementing or decrementing. Continue to hold the switch until the display has reached the correct value for the local elevation. The adjustment resolution is one unit, either foot or meter, per step. The adjustment range is from 3000 feet below sea level (–3000 ft) to 30,000 feet above sea level (+30000 ft).

The elevation units will display in feet for English pressure units, or in meters for metric units. Table 4.2 in the *Remote Operation* section shows which units are English and which are metric.

The Barometer converts the local elevation to an equivalent pressure, subtracts it from standard* sea level, and adds the difference to the local barometric pressure. For English units, the equation is:

InHg = ((FT – 145447.2) / – 76189.042) ^ 5.256
where FT is the local elevation of the barometer.

Adding the two pressures yields the local barometric pressure adjusted for sea level. The result is output to the display and the remote bus. The bottom line of the display will read ADJ. BARO. PRESSURE, to indicate that the current value includes an offset.

The elevation offset pressure will always be positive unless the barometer is below sea level. Table 8.4 in the *Appendix* shows the calculated pressure values at various elevations.

To remove an offset press both the + and the – keys and release them simultaneously. When the sea level offset is as desired move rear panel switch S1-3 down (SEA LEVEL ADJUST = DISABLE) to protect the current settings.

**Standard sea level pressure: 0 feet=29.92126 inches Hg A (0 meters=1013.25 mbar).*

ALTITUDE

[2108]: Altitude pressure units are expressed in feet or meters. An altitude range of from –3000 to 100,000 feet is practical within the normal range of a Model 2108. When feet or meters are selected as the pressure units, and pressure is applied to the pressure port, the instrument will display the equivalent altitude. Other pressure units may be selected.

> **NOTE:** *Altitude in this instrument is calculated according to a set of formulas that match the ICAO 1964 standard atmosphere. The two tables in the Appendix section, relating to the uncertainty of altitude and altitude rate measurements, are based on the published ICAO standard atmosphere tables.*

ALTITUDE RATE

[2108]: Altitude rate pressure units are available only on a Model 2108. When feet or meters are selected as the pressure units, this feature converts a pressure change as a rate of climb or descent in units per second or per minute. Units per hour are not available on Model 2108.

To configure the system from a remote station, see the UNITS command in the *Remote Operation* section, and send the command as directed.

The uncertainty in feet of the altitude rate is given for several altitudes in section 8, *Appendix*. The uncertainty of the altitude rate output is in addition to the other specified uncertainties.

AIRSPEED

[2109]: The Model 2109 can be configured to output airspeed in miles per hour, kilometers per hour, meters per second, or knots. To configure the system for airspeed from a remote station, see the UNITS command in the *Remote Operation* section and send the command as directed. Other pressure units are available to the user. For information on Airspeed Error Uncertainty refer to table 8.8 in the *Appendix* section.

> **NOTE:** *Airspeed is calculated according to Bernoulli's formula as described in NASA Technical Note D-822 and British Standard G.199, March 1967.*

SMOOTHING FILTERS

Filter (All 2100s beginning with V1.16 and after)

An exponential filter is applied to smooth out the small variations in the displayed Pressure reading, or the Rate of pressure change (RATE) reading. Remote commands allow the user to set a filter percent of reading value from 0% (no filter) to 99.99% (maximum filter). Separate filters are provided for Pressure, Altitude, Airspeed, and for the Rate readings for each of these. The available filter commands are listed in table 3.3. Each filter uses the following equation:

$$\text{Reading} = NR\,(1 - (F / 100)) + PR\,(F / 100)$$

where: NR = new reading
PR = previous reading
F = filter setting as a percent of reading

Window (All 2100s beginning with V1.16 and after)

A window defines the range of pressure for which the filter is applied. Values outside of the window will display the current pressure without filtering. Each filter setting requires its own window. Table 3.3 below also includes the available window commands.

Table 3.3 - Series 2100 Filter and Window Commands

Filtered Reading	Models	Filter Command	Default Value	Window Command	Default Value
Pressure Units	All	filter	90	window	0.25% FS
Altitude Units	2108	afilter	80	awindow	100
Airspeed Units	2109				
Pressure Rate	All	rfilter	97	rwindow	10% FS
Altitude Rate	2108	arfilter	90	arwindow	1000
Airspeed Rate	2109				

Earlier Software Versions (All 2100s prior to V1.16)

The filter command for all Series 2100 models with software prior to V1.16 is:

FILTER_FREQ n where n is a corner frequency from 1 to 10 hertz

The associated query is **FILTER_FREQ ?**.

There is no window command for these earlier instruments.

BI-DIRECTIONAL DPG (Compound Pressure)

[DPG]: Bi-directional pressure measurement is the measurement of both positive and negative pressures with respect to an arbitrary reference pressure assigned as zero (usually local barometric pressure). For example, a ±5 psi full scale instrument is calibrated over the full 10 psi range in order to measure up to 5 psi in either direction around a reference pressure defined as zero.

The bi-directional feature is available over a limited range for gauge pressure instruments only. The pressure applied to the pressure port can be either + or – with respect to the reference port.

Exception to High Resolution: This instrument has a maximum of seven character spaces available to represent the pressure value in standard decimal format. For positive pressures in HIGH RESOLUTION mode this can be up to six significant figures and a decimal point. For negative pressures the negative sign occupies one additional space so that the maximum resolution will be five figures, one less digit than is available in the positive direction. See the OUTFORM command in the *Remote Operation* section for a means of deriving the full resolution of negative pressure over a remote bus.

REMOTE OPERATION

The DPG can be operated from a remote computer which communicates over the IEEE-488-STD General Purpose Interface Bus, commonly referred to as GPIB. The computer must contain a GPIB card and must be connected to the DPG with a standard IEEE-488 cable.

Software to install and operate the GPIB, and programming examples, are usually provided by the manufacturer of the GPIB card. The commands listed in this section are the bare commands seen by the DPG, stripped of all programming idioms. Depending on the specific GPIB hardware and the programming language used, it may be necessary to precede or enclose these commands in various symbols for transmission. A brief BASIC program has been included in the *Appendix* for your convenience, as an example.

For additional information on GPIB operation the complete IEEE-488-STD specification is available from the Institute of Electrical & Electronics Engineers Inc., 345 East 47th Street, New York, New York, 10017.

As options, the DPG can be equipped with an RS-232 serial port, or a BCD output port with or without an analog voltage output (see the *Options* section for details).

GPIB

The DPG responds to device dependent commands and GPIB interface commands. The IEEE capability codes are:

SH1 . . . . . full source handshake capability
AH1 . . . . . full acceptor handshake capability
T6 . . . talker with serial poll and unaddress if MLA
L4 . . . . . listener with unaddress if MTA
SR1 . . . . . full service request capability
RL1 . . . . . full remote/local capability including LLO
PP0 . . . . . no parallel poll capability
DC1 . . . . . full device clear capability
DT1 . . . . . full device trigger capability
E2 . . . . . tri-state outputs

Device Address

Press the COMM key to see the current GPIB address. This address was set to 1 at the factory, but it can be any value from 0 through 30. To change the address issue an "ADDRESS' command described later, or refer to the COMM key and the + and – keys as explained in the *Local Operation* section.

Service Request

The service request line on the GPIB (SRQ) will be asserted when an error is encountered. See table 4.1 for a list of the possible error conditions and the suggested actions. If the controlling GPIB handler has automatic serial polling, and this feature is enabled, any errors will be cleared.

Local Lockout

When the DPG is in the REMOTE mode, local lockout (LLO) can be enabled. With LLO in effect all front panel function keys are disabled until returned to the LOCAL mode.

Status Display

When a GPIB controller first sends a message or a query to the DPG the REMOTE indicator on the front panel will light. The indicator will then remain lit until either the controller disengages or power to the DPG is interrupted. Serial communication has no effect on the REMOTE indicator.

GPIB INTERFACE MESSAGES

GPIB interface messages are standardized commands that are a function of the GPIB interface itself. These messages do not apply in any way to serial communications.

The method of sending an interface message to the DPG is dependent upon the specific computer and interface hardware and software being used. The differences occur primarily in the syntax used to invoke the desired command, particularly among different programming languages. Any GPIB controller (i.e., a computer with a GPIB card) should have available the messages defined in this section. They may, however, be identified differently in the actual programming implementation.

DCL

The DEVICE CLEAR (DCL) command is used to reset the internal functions of all devices on the GPIB that respond to this command. All input and output buffers are cleared and the DPG is forced into the REMOTE mode when it receives a DCL. See also SDC.

GET

The GROUP EXECUTE TRIGGER (GET) is used to synchronize the acquisition of data between several instruments connected to the GPIB. When the DPG receives a GET the current GPIB output reading is latched until it is read over the bus. The DPG display will continue to update.

GTL

The GO TO LOCAL (GTL) command restores the DPG into the LOCAL mode after a LOCAL LOCKOUT (LLO) has been issued. This will allow the user to again use all of the functions defined in the *Local Operation* section.

IFC

The INTERFACE CLEAR (IFC) command halts all current operations on the bus.

LLO

The LOCAL LOCKOUT (LLO) command disables the front panel keys to prevent LOCAL operation of the instrument. Use the GTL command to restore the front panel key functions.

SDC

SELECTED DEVICE CLEAR (SDC) is similar in function to DEVICE CLEAR (DCL) except that only the device addressed to listen is reset. If the DPG address is selected it immediately goes into REMOTE mode.

Serial Poll

A SERIAL POLL is a high level function of the GPIB interface used to read the status byte of one particular device. Some GPIB interface manufacturers provide this as an automatic function, reading the most recent status byte from the instrument after each read or write instruction. Others require the user to specifically program the GPIB to do a SERIAL POLL of a device.

A common use of the SERIAL POLL is in a program module designed to respond to the service request (SRQ) line on the GPIB. Many GPIB interface manufacturers provide a way to check the status of the SRQ line. If it is asserted, some instrument on the bus requires service. The service may involve simply acknowledging a change in an instrument's status, completion of an internal function of the instrument, or may indicate the existence of an error. The status byte returned by the serial poll will determine the required service. In the case of the DPG the status byte will always read 0 (zero) unless an error condition exists. Refer to table 4.1 if an error message occurs.

DEVICE DEPENDENT MESSAGES

Device dependent messages are commands or queries specific to the Series 2100 instruments that are sent via a remote port (GPIB or RS-232). These messages are device dependent since they may not be valid for any other equipment.

Notice that all of the messages are insensitive to case, i.e., upper and lower case characters are interpreted the same by the DPG.

Expanded Message Set

In order to maintain compatibility between the Series 2100 and the older DPG II, the 2100 will accept all DPG II commands. Those DPG II commands which have no meaning for the 2100 will simply return a "0". The combined set of all commands acceptable to the Series 2100 are listed in table 8.11 in the *Appendix*.

GPIB Message Transmission

When sending a GPIB command or query, terminate the message by sending a line feed (lf). The line feed may be preceded by a carriage return (cr), or not, as a user option. Each command and query listed below is shown in output string format. The basic keyword is shown in all capital letters. A required command variable, or a returned query data variable is represented by lower case characters.

Commands/Queries

All of the user command and query keywords for the Series 2100 instruments are presented in alphabetical order under the "Keyword" heading. Each listed keyword includes a brief description, and a syntax diagram to illustrate the transmission format. Keywords that are specific to particular models or software versions are so noted.

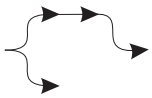
Syntax Diagrams

The command/query examples provided in this section are represented in flow diagrams to show the most common construction. The following symbols are used in these syntax diagrams.

This shape encloses the literal command or query as listed under the "Keywords" heading, to begin each instruction. Enter the precise characters shown in the listing, except that upper and lower case characters are interchangeable.

A circle contains either a required separator between elements, or a command terminator at the end of an instruction. Separators are usually a space (sp) or a comma (,). A command terminator might be a carriage return (cr) or a linefeed (lf).

The rectangle positions the variable data, either <*value*> or <*text*>, or both, that may be sent with a command. This symbol is not used with queries.



The lines and pointers link the command elements, illustrating the correct path. A branched path indicates optional command forms where the use of either form (either path) is acceptable.

Keywords

Following is an alphabetical listing of all current keywords which begin each remote command or query expression. The command format, return strings (if any), and a brief description are included for each keyword.

ACCURACY?

This is a query to find the accuracy of the instrument. The device returns the uncertainty specification as a percent of full scale (FS) for a DPG, or a percent of reading (R) for a Barometer, as determined from the Model number. Send:

The instrument returns:	<*value*><*text*><cr><lf>
where <value> is:	either 0.010 or 0.025 (%)
where <text> is:	either FS (Full Scale) or R (Reading).

ADDRESS

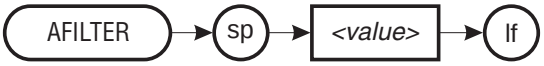
This remote command sets the device address just as the COMM key does in Local operation. The address can be any number from 0 through 30. Single digit numbers can be preceded by a zero (01, etc.), but the zero is not required. The command syntax is:

where <*value*> is: a number from 0 to 30.

NOTE: *Allow at least 0.1 second between an address change command and the next command to allow the system to complete the change.*

AFILTER (Beginning with software Version 1.16)

[Avi]: Sets the percentage of exponential filtering applied to altitude readings (2108) or airspeed readings (2109). The command format is:



where <*value*> is: a number from 0 (no filtering) to 99.99 (max filter).

NOTE: *See table 3.3 in the Local Operation section for related commands.*

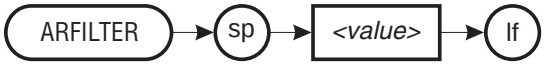
AFILTER? (Beginning with software Version 1.16)

[Avi]: The afilter query returns the percentage of exponential filtering applied to the altitude (2108) or airspeed (2109) readings.

An avionics instrument returns: <*value*><cr><lf>
where <*value*> is: a number from 0 (no filtering) to 99.99 (max filter).

ARFILTER (Beginning with software Version 1.16)

[Avi]: Sets the percentage of exponential filtering applied to the altitude rate reading for a Model 2108, or to the airspeed rate reading on a Model 2109. The command syntax is:



where <*value*> is: a value from 0 (no filtering) to 99.99 (max filter).

NOTE: *See table 3.3 in the Local Operation section for related commands.*

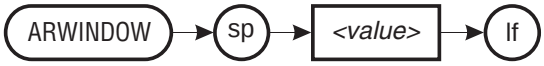
ARFILTER? (Beginning with software Version 1.16)

[Avi]: The arfilter query returns the percentage of exponential filtering applied to the altitude rate reading for a Model 2108, or to the airspeed rate reading for a Model 2109.

An avionics instrument returns: <*value*><lf><cr>
where <*value*> is: a number from 0 (no filtering) to 99.99 (max filter).

ARWINDOW (Beginning with software Version 1.16)

[Avi]: Sets the altitude rate filter window for a Model 2108, or the airspeed rate filter window on a Model 2109. The command format is:



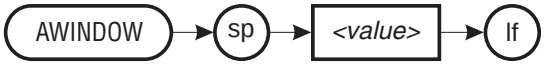
where <*value*> is: a number within the range of the instrument in the current measurement units.

NOTE: *See table 3.3 in the Local Operation section for related commands.*

ARWINDOW? (Beginning with software Version 1.16)
[Avi]: The arwindow query returns the altitude rate filter window setting for a Model 2108, or the airspeed rate filter setting for a Model 2109.

The instrument returns: <*value*><cr><lf>
where <*value*> is: a number within the range of the instrument in the current measurement units.

AWINDOW (Beginning with software Version 1.16)
[Avi]: Sets the filter window for altitude readings (2108) or for airspeed readings (2109). The command format is:



where <*value*> is: a number within the range of the instrument in the current engineering units.

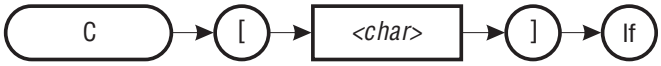
NOTE: *See table 3.3 in the Local Operation section for related commands.*

AWINDOW? (Beginning with software Version 1.16)
[Avi]: The awindow query returns the filter window setting for altitude readings (2108) or airspeed readings (2109).

The instrument returns: <*value*><cr><lf>
where <*value*> is: a number within the range of the instrument in the current engineering units.

C

The **C** command is used to customize line two (the range display) on the DPG. The new message can be from 1 to 20 characters long. The message will be left justified, and unused characters will be blanked to the right. Send:



where "[" and "]" are: square brackets to mark the beginning and end of the new message,

and where <char> is: the new message made up of any combination of up to 20 alphabetic, numeric, and symbol characters.

The restrictions are:
1) The alpha characters in the new message must be upper case; and
2) A question mark (?) or square brackets ([and]) cannot be included in the body of the message.

Examples:

1. Replace a standard display of "ABSOLUTE PRESSURE" with "15.0000 PSI FS" centered (positioned 3 spaces from the left edge). Send:

2. Replace a standard display of "BAROMETRIC PRESSURE" with "MY COMPANY NAME" left justified:

3. To return the factory-loaded message send a pair of empty square brackets:

DEFAULT

This command returns the DPG to the default values set at the factory.

The default values are:

afilter	80	Output format	0
arfilter	90	Peak values	Reset
awindow	100	Rate	Off
arwindow	1000	rfilter	97
Digits	6	rwindow	10% FS
Display	Pressure (normal)	Tare	0.0 (Off)
Filter*	90	window	0.25% FS

**Filter default value is set to 90 for pressure units on all models. See table 3.3 for default values on air data units and rate units.*

DIGITS

The digits command sets the bus and display output resolution to either five digits (full scale converted between 5,000 to 50,000 parts) or six digits (full scale between 50,000 to 500,000 parts). Send:

where <*value*> is: 5 . . . . . for five digits, or
6 . . . . . for six digits of resolution.

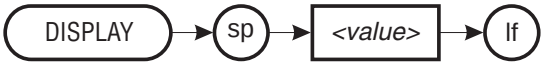
DIGITS?

The digits query returns the number of digits in the output resolution. Send:

The DPG returns: <*value*><cr><lf>
where <*value*> is: either 5 or 6, same as above.

DISPLAY

This command sets the display format. Send:



where <*value*> is:

0. . . . . normal
1. . . . . rate/second
2. . . . . rate/minute
3. . . . . hourly change
4 or 5 . . . . . peak
6. . . . . rate/3 hour
7. . . . . null

DISPLAY 7 is a toggle switch. If DISPLAY 7 is sent to turn on the null feature, DISPLAY 7 must be sent again to disable it. Otherwise, returning to the normal display (DISPLAY 0) will show DELTA PRESSURE.

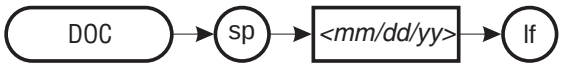
DISPLAY?

Send the following query to determine the current display setting:

The DPG returns: <*value*><cr><lf>
where <*value*> is: 0 to 7, same as above.

DOC (Beginning with software Version 1.10)

This is a Date Of Calibration command. The DOC command allows the user to replace the date of calibration in memory each time the unit is re-calibrated. Before sending DOC the rear panel SPAN switch must be enabled, and the master password invoked. The command format is:



where *mm* is: a two digit value from 01 to 12 for the month
where *dd* is: a two digit value from 01 to 31 for the day
where *yy* is: a two digit value designating the current year.

NOTE: *There is no error checking associated with this command. This means that the system will accept entries which are obviously invalid.*

After entering and checking a new date of calibration use the SAVE command to save the data to non-volatile memory.

DOC?

This query returns the last eight characters saved under the DOC command:

ECHO

Turns ON or OFF the echo string of serial commands. Send:

where <value> is: 1 . . . to turn ON the echo
0 . . . to turn OFF the echo.

Echo ON is the factory default. The ON or OFF state can be saved with the SAVE command.

ERROR?

If there is an error, this query will return an error message from table 4.1 on the following page. Respond to the error as listed under “Suggested Action” in the table.

Table 4.1 - Remote Error Codes

Error Message	Suggested Action
NO ERROR	Send next command or query.
RAM DATA ERROR	Contact the factory.
RAM BATTERY ERROR	Contact the factory.
STACK OVER/UNDER ERROR	Contact the factory.
SYNTAX ERROR	Check the command string for extra or incorrect characters.
PARAMETER INVALID ERROR	Check the numeric parameter to see if it is in the valid range.
INPUT BUFFER OVERFLOW	Too many characters were sent before an X was received. Resend.
OUTPUT BUFFER OVERFLOW	Send a command and read it back to keep buffer empty.
GPIB ERROR	A problem has been detected with the GPIB control lines. Check the controller and cables for proper connection.
SERIAL PORT OFF OR NOT INSTALLED	Contact the factory.
DISPLAY FAULT	The display cannot be updated. Contact the factory. Contact the factory.
A/D FAULT	Contact the factory.
CALIBRATION ERROR	Contact the factory.
RANGE TOO LOW FOR ALTITUDE UNITS	DPG range less than 14.4 psi. Change to pressure units.
NUMERIC OVERFLOW	Contact the factory.
CALCULATION OVERFLOW	Power up, send GPIB commands ZOX, SOX, then power OFF and back ON. This sequence clears the zero and span offsets. Otherwise, contact the factory.
DIVISION BY ZERO	Contact Mensor.
SERIAL RECEIVER OVERRUN	73 characters received w/o x. Resend.
SERIAL FRAMING ERROR	Check all switch settings of S1 and S2 on the optional Communications Board, then resend.
SERIAL PARITY ERROR	Contact the factory.
NO PRESSURE FREQUENCY	Contact the factory.
NO TEMPERATURE FREQUENCY	Contact the factory.
NO REFERENCE FREQUENCY	Contact the factory.

Continued on next page...

Table 4.1 continued...

Error Message	Suggested Action
PARSER ERROR	Contact the factory.
UNAUTHORIZED COMMAND	See table 8.11 for list of commands.
MASTER CAL ENABLE OFF	Send PW.
ZERO CAL ENABLE OFF	Send PWZ.
TARE CAL ENABLE OFF	Send PWT.
SEA LEVEL CAL ENABLE OFF	Send PWSL.
PRESSURE BELOW HALF-SCALE	Increase input pressure.

FILTER (Beginning with software Version 1.16)
[All]: The filter command sets the percentage of exponential filtering applied to the pressure readings. Send:

where <*value*> is:a number from 0 to 99.99 (percent filtering).

NOTE: *See table 3.3 in the Local Operation section for related commands.*

FILTER? (Beginning with software Version 1.16)
[All]: This query returns the percentage of exponential filtering currently applied to the pressure reading:

The DPG returns: <*value*><cr><lf>
where <*value*> is: a value from 0 (no filtering) to 99.99 (max filter).

FILTER_FREQ (All 2100 models with software prior to Version 1.16)
Sets the filter corner frequency where n is a number from 1 to 10 (hertz).

FILTER_FREQ? (All 2100 models with software prior to Version 1.16)
Returns a number from 01 to 10 for the filter corner frequency in hertz.

ID?
To discover the four essential identity characteristics of the 2100, send:

The query returns:	MENSOR, 210X, ssssss, v.vv<cr><lf>
where 210X is:	a model number from 2101 through 2109
where ssssss is:	a six digit instrument serial number
where v.vv is:	the software version number.

KEYLOCK
Invoking the KEYLOCK command makes the front panel keys inoperative.
Send:

where <*value*> is:	1 to lock out the front panel keys
	0 to enable front panel key functions.

LINEREV

A normal display has the current pressure on the top (line 1), and the type of pressure on the bottom (line 2). The LINEREV command reverses the order of the top and bottom lines such that line 2 is on top and line 1 is on the bottom. The line reversal affects all display modes. Send:

where <*value*> is: 1 to reverse the top and bottom lines
0 to restore the normal mode.

A LINEREV change is made permanent only by issuing a SAVE command over the bus. The front panel SAVE key will not save the change to this feature.

MODEL?

This query is used to determine the 2100 model number. Send:

The query returns: <*value*><cr><lf>
where <*value*> is: 2101 (a DPG, 0.010% FS, 15 to 45°C)
or: 2102 (a DPG, 0.025% FS, 15 to 45°C)
or: 2103 (a Barometer, 0.010% R, 0 to 50°C)
or: 2104 (a Barometer, 0.010% R, 15 to 45°C)
or: 2105 (a Barometer, 0.025% R, 0 to 50°C)
or: 2106 (a DPG, 0.010% FS, 0 to 50°C)
or: 2107 (a DPG, 0.025% FS, 0 to 50°C)
or: 2108 (Altitude DPG, 0.010% FS, 0 to 50°C)
or: 2109 (Airspeed DPG, 0.010% FS, 0 to 50°C).

OPT?

The OPT query returns the type of any installed options:

The query returns: <*text*><cr><lf>

where <*text*> is:	SERIAL	(if RS-232 option is installed)
	BCD	(if BCD output option is installed)
	BCD/ANALOG	(if the Analog output is included)
	NONE	(if no options are installed).

OUTFORM

The OUTFORM command sets a particular output format as shown below. This command affects only the remote return string; it has no effect on the front panel display. Send:

where <*value*> is:	0 (Returns pressure, rate, or peak values in fixed decimal format, which is the default format.)
or:	1 (Returns pressure and temperature data in counts for factory use.)
or:	2 (Returns output pressure, pressure rate, or peak values in exponential format.)

OUTFORM 0 is the standard decimal format for the current mode of either pressure, pressure rate, or peak values. OUTFORM 0 returns five or six digits of resolution for positive values, and one less digit and a sign for negative values.

EXAMPLES	OUTPUT STRING	INTERPRETATION
Pressure:	14.3456	Pressure value in the current units
Rate:	14.3456, 0.0000	Current pressure, rate of change
Peak:	14.3210, 14.3456, 14.4567	Min., Current, Max. readings

OUTFORM 1 returns seven digits of raw A/D pressure and temperature data (for factory use) such as:

Counts	1234567, 8901234	Pressure, Temperature (counts)

OUTFORM 2 outputs pressure, rate, or peak values in the same layout as shown for OUTFORM 0, except the string values will be in exponential format including a sign. Since the sign is included with the string in this format a negative pressure value will not lose a digit of resolution. The pressure output string will be a string similar to:

Exponential	-1.43456E+01	Same as decimal -14.3456 (six digits)

Use the SAVE command to retain the latest OUTFORM configuration.

PW (Replace with appropriate password listed on the blue "Attention Calibration Laboratory" card that was inserted into the rear of this manual)

This is a password which must be sent while the rear panel SPAN switch is ON (up) to enable resetting the span calibration factor over the bus. This password also allows access to set the zero and tare offset values, and the sea level adjustment on a barometer. Once issued the password remains in effect until one of the following events occur: an error is detected; a DEFAULT, DCL or SDC command is received; the rear panel SPAN switch is set to OFF (down); or at the next power-up. Any of these actions re-establish the requirement for the password before the span calibration can be changed. To enable calibrations send:

PWSL (Replace with appropriate password listed on a blue "Attention Calibration Laboratory" card that was inserted into the rear of this manual)

[Baro]: This is a password to enable access to the Sea Level offset when the SEA LEVEL ADJUST rear panel switch is ON (up). Once the password is accepted it remains in effect until either an error is detected, a DEFAULT, DCL or SDC instruction is received, the SEA LEVEL ADJUST switch is turned OFF (down), or until the next power-up. The command is:

PWT (Replace with appropriate password listed on a blue "Attention Calibration Laboratory" card that was inserted into the rear of this manual)

This is a password to allow entering or changing a TARE offset. Once the password is issued it remains in effect until either an error is detected; a DEFAULT, DCL or SDC is received; or until the next power-up. Send:

PWZ (Replace with appropriate password listed on a blue "Attention Calibration Laboratory" card that was inserted into the rear of this manual)

This password enables access to change the instrument zero. The ZERO switch on the rear panel must be enabled before sending the password. Once the password is accepted it remains in effect until either an error is detected, a DEFAULT, DCL or SDC command is received, or there is a power interruption.

RANGENEG?

This query will return the lower limit of the range in the pressure units that were used during the instrument calibration. This is usually zero psi for a DPG, or 22 inHg for a Barometer.

A bi-directional DPG will return a negative value in the calibration pressure units as: –10.000 PSI<cr><lf>

where –10.000 is: –10 psi (for a bi-directional DPG)

Notice that the addition of the "–" sign occupies one space of the value. This means that a setting of six digits resolution will display a maximum of 5 digits and a sign for negative values. See the OUTFORM 2 command to overcome this restriction.

RANGEPOS?

This query will return the upper limit of the range in the pressure units that the instrument was calibrated in, such as: 34.000 INHG @ 0 c<cr><lf>

RFILTER (Beginning with software Version 1.16)
[All]: Sets the percentage of exponential filtering applied to the pressure rate reading for all 2100 models. The command format is:

where <*value*> is: a value from 0 to 99.99 (percent of FS).

NOTE: *See table 3.3 in the Local Operation section for related commands.*

RFILTER? (Beginning with software Version 1.16)
[All]: The rfilter query returns the percentage of exponential filtering applied to the pressure rate reading.

The DPG or Barometer returns: <*value*><cr><lf>

where <*value*> is: 0 . . . . . for no filtering, up to
99.99 . . . for 99.99% FS (max) filtering.

RWINDOW (Beginning with software Version 1.16)
[All]: Sets the pressure rate filter window for all 2100 models. The command format is:

where <*value*> is: a value in the current units within the range of the instrument.

NOTE: *See table 3.3 in the Local Operation section for related commands.*

RWINDOW? (Beginning with software Version 1.16)

[All]: The rwindow query returns the pressure rate filter window setting for all models.

The Barometer or DPG returns: <*value*><cr><lf>

where <*value*> is: a value in the current units within the SPS range.

SAVE

Send a SAVE command to preserve changes made to variable parameters. Without the SAVE command recent changes will remain in effect only as long as the power is continuous, or until later changes displace them. If there is a power interruption (power OFF) before the SAVE command is issued, the next power up will return the instrument to its last saved settings.

The SAVE command preserves the current values for the following parameters:

AVIONICS FILTER
AVIONICS RATE FILTER
AVIONICS RATE WINDOW
AVIONICS WINDOW
CUSTOM DISPLAY
DATE OF CALIBRATION
DISPLAY LINE REVERSAL
DISPLAY MODE
ECHO
FILTER
FILTER FREQUENCY
FILTER WINDOW
IEEE ADDRESS
OUTFORM
RATE FILTER
RATE UNITS
RATE WINDOW
RESOLUTION
SEA LEVEL CORRECTION
SERIAL PROTOCOLS
SPAN
UNITS
UNITS TABLE
ZERO

SEA_LEVEL

[Baro]: This command is used to insert a local elevation correction for barometric pressure readings. The command requires that the SEA LEVEL ADJUST switch on the rear panel is ON (up), and must be preceded by either the PWSL or the PW password. If the adjustment command is sent before the required password, "SEA LEV CAL DISABLED" will appear briefly on line 2 of the display and the adjustment value will not be accepted. The command is:

where <*value*> is: a value in FEET if pressure units are English
or: a value in METERS if pressure units are Metric.

The sea level correction may not be immediately reflected in the output. A SEA_LEVEL switch command allows the correction to be alternately applied to, or removed from the pressure reading. Send:

where <text> is: y . . . to have the correction added to the output
n . . . to remove the correction from the output, but still retain the latest value for future use.

Use the SAVE command to save both the sea level value and the switch settings.

SEA_LEVEL?

[Baro]: This query returns the current elevation correction. Send**:**

Returns: <*value*><*text*><cr><lf>
where <*value*> is: the sea level correction value
where <*text*> is: FEET or METERS (units).

SPAN

Use the SPAN command to correct the pressure reading at full scale. This command first requires the PW password to be issued while the SPAN switch on the rear panel is enabled. Send the true pressure value while maintaining at least 50% of the FS pressure on the pressure port. (Refer to the *Maintenance and Calibration* section for details on calibrating an instrument.) Send:

where <*value*> is: true pressure value in current engineering units.

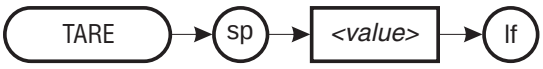
SPAN?

The SPAN query will return the span correction scale factor. Send:

Returns: <*value*><cr><lf>
where <*value*> is: a multiplication factor from 0.90000 to 1.10000 (see example under SPAN command above).

TARE

TARE sets the tare offset in the current engineering units. Either the PWT or the PW password must be sent before the first occurrence of the TARE command. Send:



where <*value*> is: a value between +/– 17.0000 psi.

TARE?

This query returns the current tare calibration variable. Send:

Returns: <*value*><cr><lf>

where <*value*> is: the current TARE offset in the current units.

TEMP?

Returns the compensated temperature range for the instrument. Send:

Returns: <*value*><cr><lf>

where <*value*> is: 15 to 45 C
or: 0 to 50 C
(based on the 2100 Model number.)

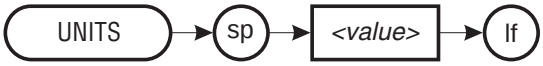
TYPE?

Returns the type of pressure sensor in the instrument:

ABSOLUTE PRESSURE<cr><lf> for an absolute sensor,
or: GAUGE PRESSURE<cr><lf> for a gauge pressure sensor.

UNITS

This command selects the engineering units to be output on the bus and the display for all subsequent pressure readings. Send:



where <*value*> is: a one or two digit units code number from the “n” column of table 4.2 on the following page:

Table 4.2 – UNITS Command Syntax for Measurement Units

n	Description	Output Format	Type
1	pounds per square inch	PSI	ENGLISH
2	inches of mercury @ 0°C	INHG	
3	inches of mercury @ 60°F		
4	inches of water @ 4°C	INH_2O	
5	inches of water @ 20°C		
6	inches of water @ 60°F		
7	feet of water @ 4°C	FTH_2O	
8	feet of water @ 20°C		
9	feet of water @ 60°F		
10	millitorr	MTORR	METRIC
11	inches of sea water @ 0°C	INSW	ENGLISH
12	feet of sea water @ 0°C	FTSW	
13	atmospheres	ATM	
14	bars	BAR	METRIC
15	millibars	MBAR	
16	millimeters of water @ 4°C	MMH_2O	METRIC
17	centimeters of water @ 4°C	CMH_2O	
18	meters of water @ 4°C	MH_2O	
19	millimeters of mercury @ 0°C	MMHG	
20	centimeters of mercury @ 0°C	CMHG	
21	torr	TORR	
22	kilopascals	KPA	
23	pascals	PA	
24	dynes per square centimeter	DY/CM^2	
25	grams per square centimeter	G/CM^2	
26	kilograms per square centimeter	KG/CM^2	
27	meters of sea water @ 0°C	MSW	
28	ounce per square inch	OSI	ENGLISH
29	pounds per square foot	PSF	
30	tons per square foot	TSF	
32	micron of mercury @ 0°C	mHG	METRIC
33	tons per square inch	TSI	ENGLISH

Continued on next page...

Table 4.2 Continued...

n	Description	Output Format	Type
34	hectapascals	HPA	METRIC
36	megapascals	MPA	
37	millimeters of water @ 20°C	MMH_2O	
38	centimeters of water @ 20°C	CMH_2O	
39	meters of water @ 20°C	MH_2O	
40	**[2108]:** feet of altitude	FEET	ENGLISH
41	**[2108]:** meters of altitude	METERS	METRIC
43	**[2109]:** miles per hour	MPH	ENGLISH
44	**[2109]:** knots	KNOTS	ENGLISH
45	**[2109]:** meters per second	M/S	METRIC
46	**[2109]:** kph	KPH	METRIC
47	**[2109]:** mach	MACH	METRIC

Gauge DPGs will not display altitude (units 40 and 40. Absolute DPGs will not display airspeed (units 43, 44 and 45). Subsonic "calibrated" airspeeds and mach numbers are calculated from a differential pressure with the reference pressure at standard sea level, 1013.25 mBars.

UNITS?

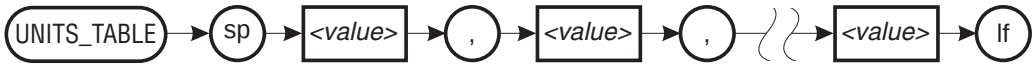
This query returns: the units code and the ASCII string for the units as <*value*><*text*><cr><lf>

where <*value*> is: the units code from column "n" in table 4.2.
and where <*text*> is: the corresponding ascii string listed under "Output Format" in table 4.2.

UNITS_TABLE

The UNITS_TABLE command is used to re-load the last seven of the eight engineering units that can be selected by the front panel UNITS key. These seven units (lines 2 through 8 of table 3.2 in the *Local Operation* section) were set at the factory to a list of standard units (see table 3.2), or were set to units specified

by the customer. To change any or all of these units send all seven values, separated by commas, one value for each of the seven available slots as:



where <*value*> is: a desired unit code from table 4.2,
or: "99" for each table line intended to be left empty.

Example: 2,32,99,99,99,99,99<lf>

Sending the above example command results in a three-unit table made up of psi (default units), inches of mercury @ 0°C (#2 from table 4.2), and microns of mercury @ 0°C (#32 from table 4.2), in that order. The five 99's empty the five remaining slots in the Units Table.

Notice that <*value*> can be either one or two characters. For example, sending either 5 or 05 over the bus would set a units slot to inches of water @ 20°C (INH2O).

UNITS_TABLE?

This query will return one or more lines (eight line maximum) of the current engineering units stored in the register for the front panel UNITS switch (see table 3.2 in the *Local Operation* section). Send:

The query returns:
<*value*>,<*text*><cr>
<*value*>,<*text*><cr>
<*value*>,<*text*><cr>
<*value*>,<*text*><cr>
<*value*>,<*text*><cr>
<*value*>,<*text*><cr>
<*value*>,<*text*><cr>
<*value*>,<*text*><cr><lf>

where <*value*> is: the units code listed in units table sequence
where <*text*> is: the engineering units nomenclature for each unit.

WINDOW (Any 2100 model with V1.16 or later software)
[All]: Sets the filter window for pressure readings. The command format is:

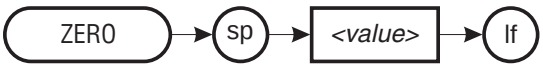
where <*value*> is: a value in the current measurement units within the range of the instrument.

NOTE: *See table 3.3 in the Local Operation section for related commands.*

WINDOW? (Any 2100 model with V1.16 or later software)
[All]: The window query returns the filter window setting for the pressure reading. Send:

The instrument returns: <*value*><cr><lf>
where <*value*> is: a value in the current units within the range of the instrument.

ZERO
This command requires that the ZERO rear panel switch be enabled, and then either the PWZ or the PW password must be issued before the first occurrence of the ZERO command. The ZERO command sets the DPG zero offset to <value> in the current units:



where <*value*> is: a value between +/– 17 psi.

ZERO?
This query returns the current zero calibration offset as: <*value*><cr><lf>

where <*value*> is: current zero value in current engineering units.

MAINTENANCE AND CALIBRATION

IMPORTANT PASSWORD INFORMATION! The confidential passwords for your Series 2100 DPG have been printed onto a blue specially marked password card labeled "Attention Calibration Laboratory". The password card has been placed in the rear of this manual. Pull the password card out of the binding and put it in a safe place. Take care not to lose this information. If lost, contact Mensor.

MAINTENANCE

This instrument was designed for maintenance-free operation. The Main board has an 0.8 amp fuse which may have to be replaced at some time, otherwise, there are no user serviceable components inside the unit.

To gain access to the fuse remove the four corner screws that attach the rear panel to the case. Gently rock the rear panel from side to side while pulling outward. The main circuit board will soon disengage from the front panel connector, and the rear panel/circuit board assembly will slide out from the rear of the case. Refer to figure 5.1 to locate the fuse on the main circuit board.

Mensor provides complete maintenance and calibration services, available beyond the warranty, for a nominal fee. Call 1.512.396.4200 or 1.800.984.4200 (USA only) for details.

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

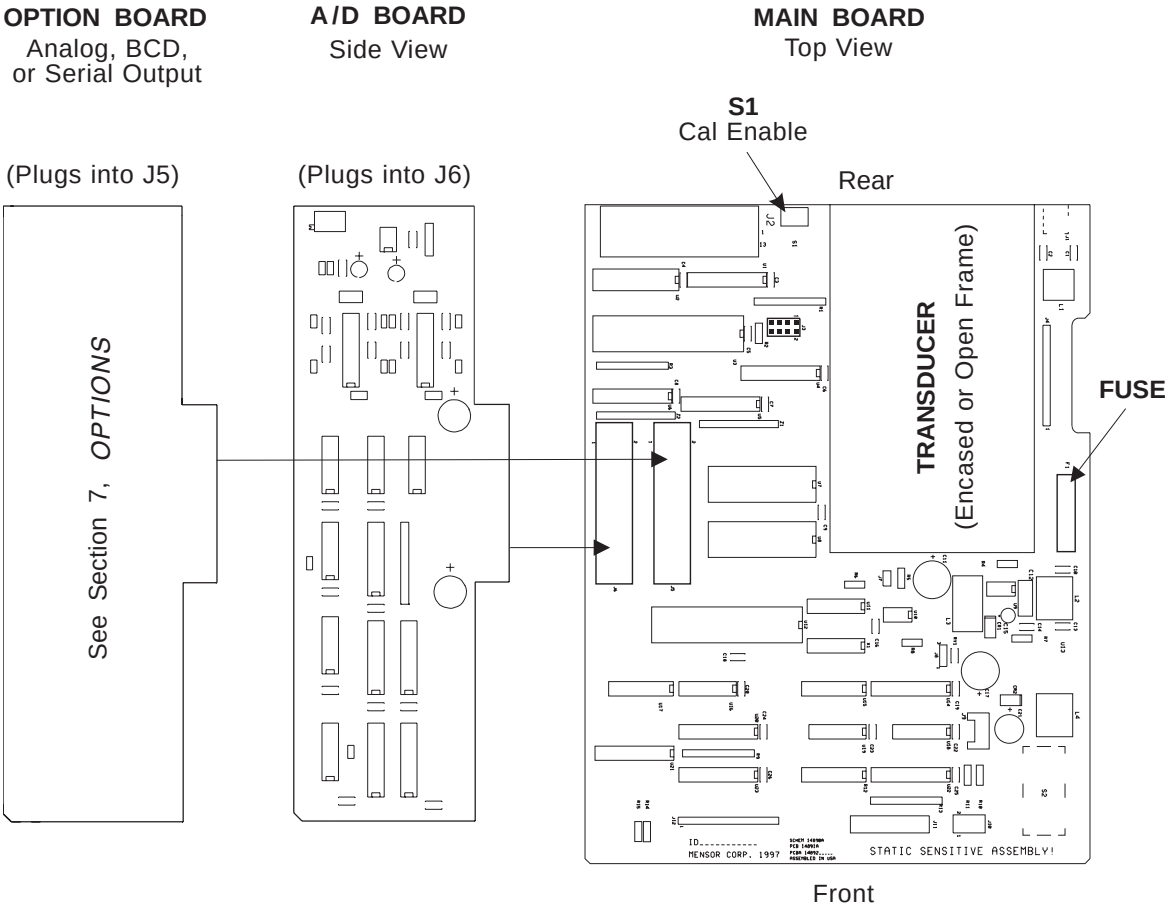


Figure 5.1 - Circuit Boards

CALIBRATION

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

The DPG should have the span verified periodically to insure its stability. Initially, the recommended period between calibrations is six months. This period may be extended as confidence is gained in the span stability.

CALIBRATION ENVIRONMENT

For maximum accuracy the DPG should be operated in an ambient temperature which is within the specified compensated range, and which is stable. In addition the instrument should be at rest on a stable platform which is free of vibration and shock as described under the heading "Mounting" in the *Installation* section.

PRESSURE STANDARDS

Mensor recommends the use of appropriately accurate primary pressure standards when calibrating this instrument. Such standards should be sufficient so that when the techniques of the ISO *Guide to the Expression of Uncertainty in Measurement (GUM)* are applied, the instrument meets its accuracy statements as required by ANSI/NCSL *Z540*, or other applicable standards.

CALIBRATION PROCEDURES

WARNING: POSSIBLE INJURY!
The tubing, valves and other apparatus attached to the gauge must be adequate for the maximum pressure which will be applied, otherwise physical injury to the operator or bystanders is possible.

The procedures for calibrating a DPG from the front panel (Local) are given below, followed by the procedures for calibrating over a bus using a computer (Remote). Figure 5.2 illustrates typical setups for either local or remote calibration. In the illustrations the additional equipment required for remote calibration is shown as optional.

In both of the calibration setup illustrations the “Pressure Standard” is normally a deadweight test instrument, and the “Volume Controller” refers to a hand operated variable-volume pressure vernier device. A diaphragm type vacuum gauge is recommended over the gauge tube type of vacuum sensor for calibrating sub-atmospheric pressures.

SAVING CALIBRATION DATA

After making changes to the zero, span, or sea level data the new data must be saved. Otherwise, the new data will be effective only as long as the power remains on. A power interruption, or certain remote commands will destroy the new data and return to the older data which still resides in non-volatile memory. Refer to either the *Local Operation*, or the *Remote Operation* sections of the manual for additional information on the SAVE feature. Instructions for saving the latest Date of Calibration (DOC) are included in this section under a separate heading.

LOCAL CALIBRATION

Front Panel + and – Keys

During local calibration the front panel CAL key and the +/– keys are used to adjust either the zero or the span (full scale offset) of the instrument. Using the +/– keys affects only the specific value shown in the display. The full explanation for each procedure is presented below under ‘Local Zero Adjustment’ and ‘Local Span Adjustment’.

The maximum adjustment range using the front panel switches is approximately ± 17 psi (less for some ranges) for the zero offset, and ± 0.1% of full scale for the span offset. Either offset can be removed by pressing both the + and – keys and releasing them simultaneously while in the calibration mode.

Local Zero Adjustment

Slide rear panel switch S1-1 up to enable the ZERO calibration. This enables the front panel keys (and the remote bus) for adjusting zero. Press the CAL key on the front panel to display the Zero Adjust screen.

Setting zero stores an offset which is added to the output of the instrument. Zero should be set near the bottom range of the instrument.

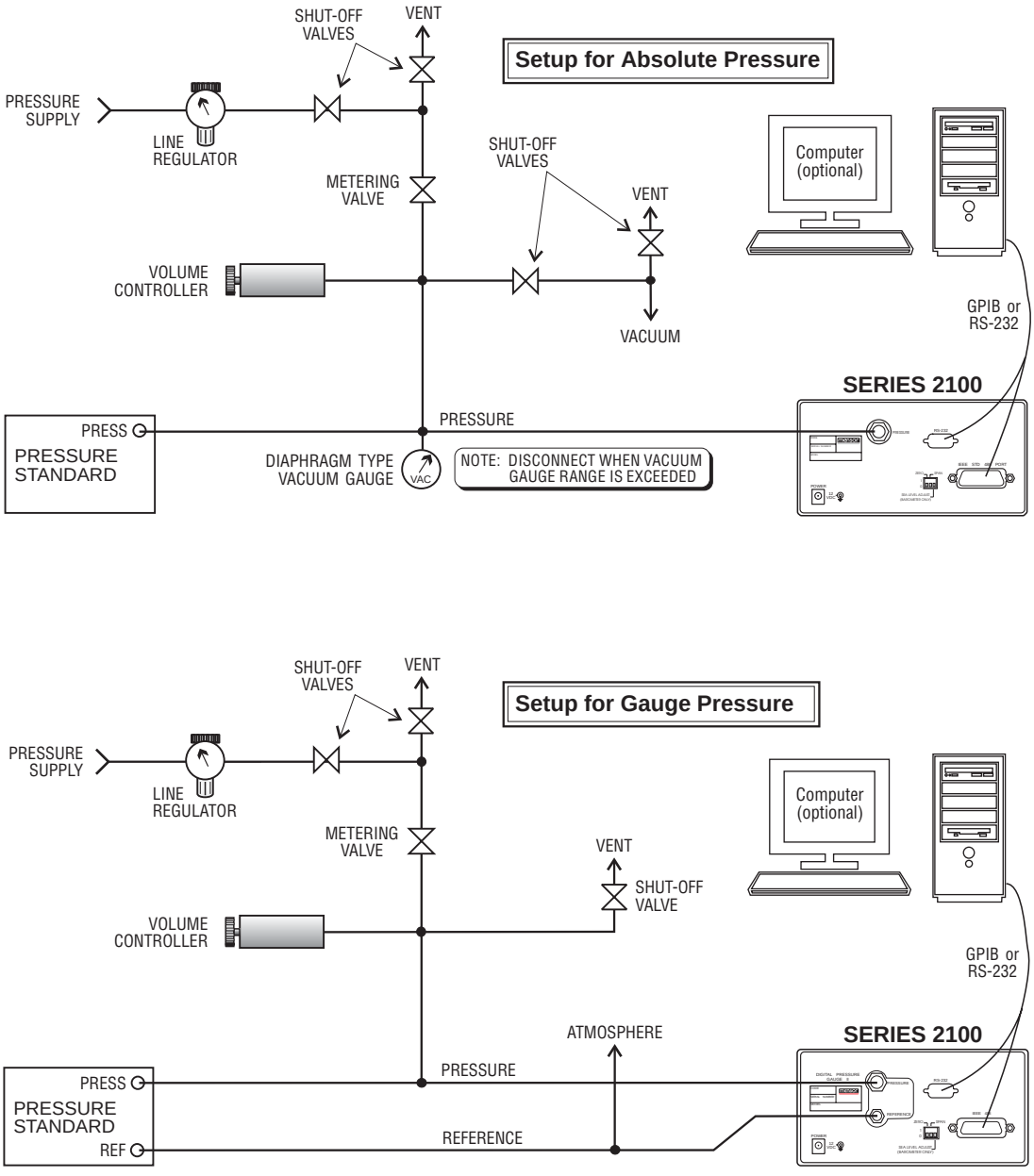


Figure 5.2 - Calibration Setup

With rear panel switch S1-1 up and the Zero adjust screen displayed, use the +/– keys to bring the display to the true pressure. Holding either switch in will cause the least significant digit to step in the appropriate direction. To set zero on a gauge instrument merely vent both the PRESSURE and the REFERENCE ports to atmosphere.

Setting zero on an absolute instrument is more complex. First, connect a vacuum pump of at least 21 liters per minute capacity to the PRESSURE port. Evacuate the transducer to a low pressure that will still maintain a viscous flow, typically 300 millitorr, or greater. (At pressures lower than 300 mTorr the actual pressure at any particular point in the system is questionable.) Allow from five to ten minutes for the target pressure to stabilize, then convert the millitorr reading to an equivalent instrument reading for the active measurement units. Millitorr conversion factors are provided in table 8.2 in the *Appendix*, Section 8.

Use the +/– keys to bring the display to the same value as the calculated pressure in the evacuated transducer. When the displayed value is correct use the SAVE key and the + key to store the new data in non-volatile memory.

Local Span Adjustment

To enable adjustment of the span value (from either the front panel or over the bus), rear panel switch S1-2 must be ON (up). Then press the CAL key to show Span Adjust in the display. Apply a known pressure to the PRESSURE port equal to, or near, the upper end of the range (span) of the instrument. The applied pressure must be greater than 50% of span, or span adjustments will not be accepted. Manipulate the +/– keys to achieve a displayed reading equal to the pressure being applied at the PRESSURE port.

The range of span adjustment available to the +/– keys is plus or minus approximately 0.1% of the instrument full scale value (0.1% FS). When the displayed span value is correct use the SAVE key and the + key to store the new data in non-volatile memory.

Local Sea Level Adjustment

The sea level adjustment is available only on Barometers and is intended to adjust the local barometric pressure reading to sea level. To perform this adjustment set rear panel switch S1-3 to on (up), and press the CAL key until SEA LEVEL appears on line one. If line two shows DISABLED press the + key to change it to ENABLED. Then use the +/– keys as explained above to adjust the altitude to the required value.

With the correct sea level adjustment displayed use the SAVE key routine to store the value in non-volatile memory.

Change Date of Calibration (Local)

When the zero or span calibration values are changed a new Date of Calibration (DOC) can be stored in memory. To set a new DOC, proceed through the normal calibration SAVE procedure as explained in the *Local Operation* section. At the point where screen #1 appears (as shown below), press + to see screen #2, then press SAVE again.

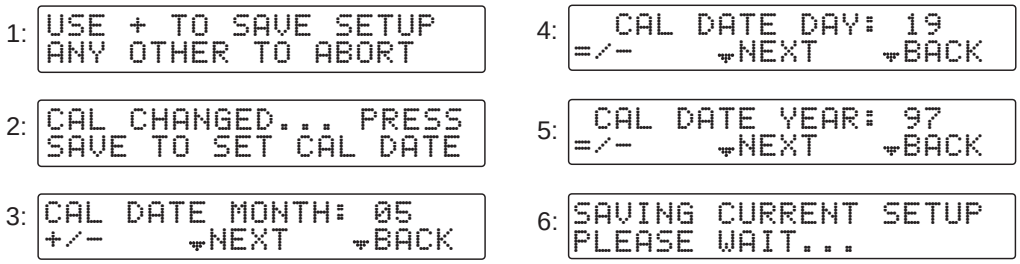


Figure 5.3 - Date of Calibration Screens

Next, with the "CAL DATE MONTH: XX" showing in the display (screen #3, above), use either the + or – key to change the displayed month to the correct value, then press SAVE. Repeat this procedure to set the day of the month, and again for the two digit year (screens #4 and #5). When SAVE is pressed with screen #5 in the display, screen #6 will appear briefly, then step through to the normal measurement mode.

NOTE: *There is no error checking when new dates are being input. This means that nonsense values or characters will be accepted and saved.*

REMOTE CALIBRATION

Refer to figure 5.2 for the type of instrument, absolute or gauge, that will be calibrated. This procedure requires a computer configured for either GPIB or RS-232 communication and the proper interconnecting cable. If RS-232 will be used, that option must be installed in the DPG. See 'RS-232 Serial Communication Port' in Section 7, *Options,* for details.

Please notice that the commands listed in this section are the bare commands seen by the DPG, stripped of all programming idioms. Depending on the specific language used to program them, these commands may have to be preceded by or enclosed in various symbols for transmission.

Remote Zero Adjustment

Zero adjustment requires first, that the ZERO rear panel switch is ON (up), and then either the PWZ or PW password be sent. Next, determine the actual zero pressure, and then send that zero pressure value to the DPG. The techniques for establishing a zero pressure point is different for an absolute instrument than it is for a gauge instrument. Once the zero is known the procedure for sending the zero pressure value, which sets the DPG output to zero, is the same for either type of instrument.

Absolute Zero Offset

To determine the current zero offset on an absolute instrument evacuate the sensor to 300 millitorr or greater. Allow the system to stabilize at that pressure for five to ten minutes, then convert the vacuum reading to an equivalent instrument reading in the active measurement units. Millitorr conversion factors are provided in table 8.2 in the *Appendix*.

Set the Zero rear panel switch S1-1 to ON (up).
Send the PWZ password to enable the zero correction function.
Then send ZERO XXXX where XXXX is the true pressure.

Example: For a 0-15 psia unit with a 300 millitorr vacuum applied, using psi units:
300 millitorr = 0.0058 psi absolute pressure
Send the PWZ password
Then send ZERO 0.0058.

Use the SAVE command to store the new value in non-volatile memory.

Gauge Zero Offset

To determine the current zero offset on a gauge unit vent both the PRESSURE and the REFERENCE ports to atmosphere.

Send the PWZ password.
Then send ZERO 0.

Send the SAVE command to store the value in non-volatile memory.

Remote Span Adjustment

DPG span can be calibrated over either of the communication ports. To do this first set the rear panel SPAN switch to ON (up). Then, send the PW password to enable a change. To complete a new span calibration, apply a known pressure at or very near the specified high end of the range. Finally, send that known value as part of the SPAN command. A maximum of seven characters of correction value, including the decimal point, may be sent.

Example: Send the PW password.
Apply a known pressure equal to the span of the instrument.
Send SPAN xxx.xxx where xxx.xxx is the known pressure.

Use the SAVE command to store the new value in non-volatile memory.

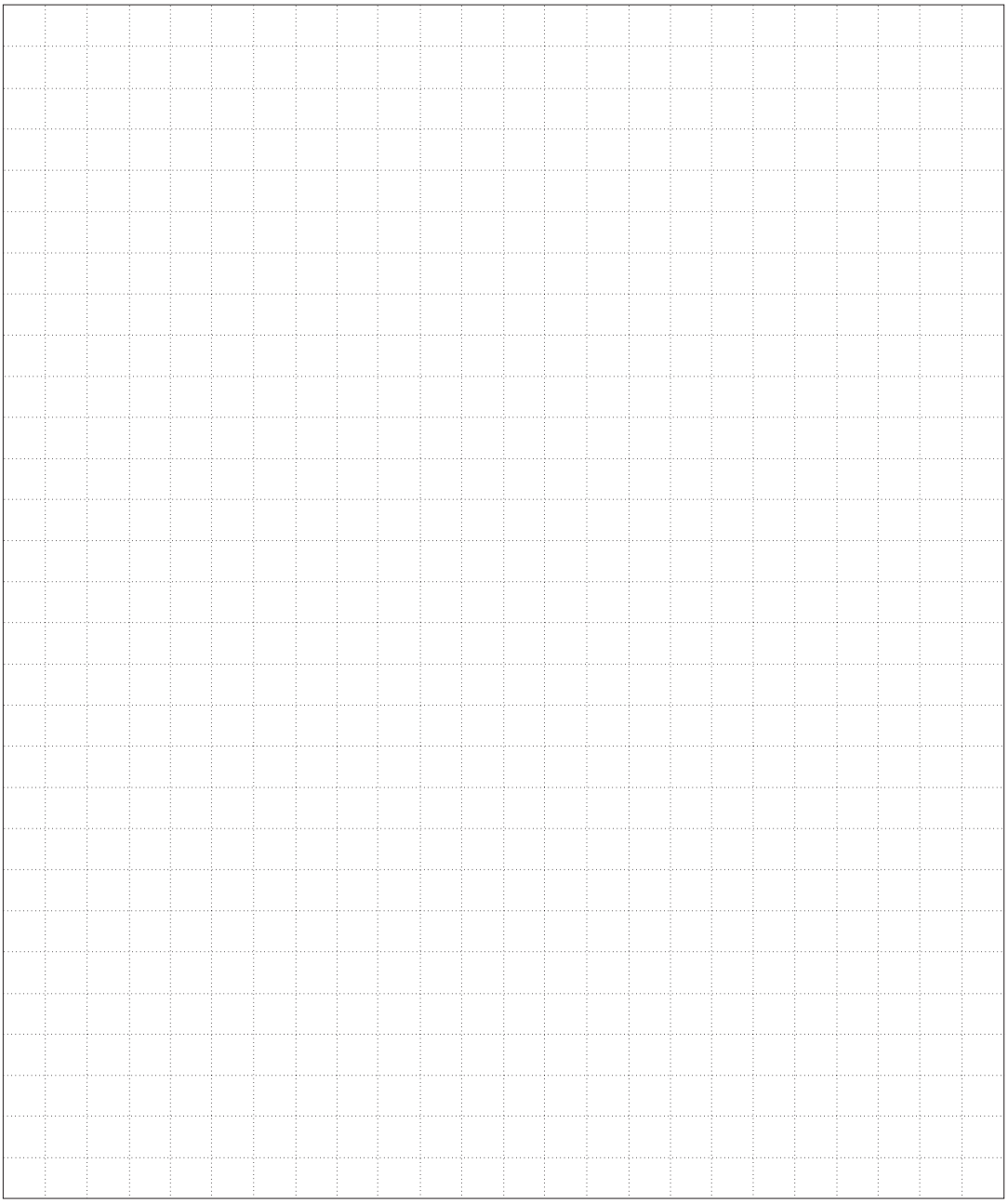
Change Date of Calibration (Remote)

A DOC? query will return the latest recorded calibration date. After changes are made to zero or span a new Date of Calibration can be entered into non-volatile memory using the DOC command. See Section 4, *Remote Operation* for details on using the DOC command.

Correction Value Query

The stored corrections for zero and span can be retrieved over the communications ports using the ZERO? and the SPAN? queries. See 'Device Dependent Messages' in the *Remote Operation* section for specific details. These queries can be useful in determining the actual changes in the instrument zero and span over time. Unauthorized alterations of the values can be detected by comparison with recorded values during succeeding calibrations.

User's Notes:



SPECIFICATIONS

Accuracy specifications presented herein are obtained by comparison with primary standards traceable to the National Institute of Standards and Technology (NIST). These specifications are obtained in accordance with the ISO *Guide to the Expression of Uncertainty in Measurement (GUM)*. Mensor also adheres to ANSI/NCSL-*Z540*. If there is an exception to the requirements and recommendations of *Z540* during a calibration the exception is noted on the individual calibration certificate.

Mensor reserves the right to change specifications without notice.

Accuracy

[2101, 2106, 2108, 2109]: 0.010% FS
[2102, 2107]: 0.025% FS
[2103, 2104]: 0.010% R
[2105]: 0.025% R

Calibration Stability

0.01% FS for 180 days typical.

Pressure Ranges

Series 2100 standard pressure ranges are listed by types of instruments in tables 6.1 through 6.3.

Table 6.1 - DPG Models [2101, 2102, 2106 & 2107]

Type	Minimum Psi	Maximum Psi
Absolute	0 - 5	0 - 10,000
Gauge	0 - 0.36	0 - 10,000
Bi-directional (Compound)	-.36 to .36	-15 to 10,000

Table 6.2 - Barometer Models [2103, 2104 & 2105]

Type	Psi	Inhga
Calibrated Range	10.8 to 16.7 psia	22 to 34 inHga

Table 6.3 - Avionics Models [2108 & 2109]

Type	Minimum	Maximum
[2108]: Altitude	0 to 15 psia	100,000 ft
[2109]: Airspeed	692 knots	1000 knots

Measurement Units

Refer to tables 8.1 and 8.2 in the *Appendix* section for list of pressure units.

Resolution

Up to 2 to 10 parts per million depending on range and units. Low resolution mode is from 20 to 100 ppm.

Rate Option Resolution: The resolution for the RATE option is the same as the displayed pressure resolution if the pressure is all integer values. If the displayed pressure includes decimal values then the RATE resolution is:

Rate per minute: two decimal places less than the pressure display.
Rate per second: one decimal place less than the pressure display.

Size

7.56" wide x 3.78" high x 9.50" deep (19.20 cm x 9.60 cm x 24.13 cm).
7.56" wide x 6.00" high x 9.50" deep with optional battery pack (19.20 cm x 15.24 cm x 24.13 cm). (See figure 6.1)

Weight

4.7 pounds (2.13 kg) without transducer case (absolute types).
6 pounds (2.72 kg) with transducer case (gauge types).
10.2 pounds (4.63 kg) with optional battery pack.

Mounting

Table model is standard. It is suitable for panel mounting into a 3.64 inch high by 7.30 wide cutout (9.25 cm x 18.54 cm). See *Options* for mounting hardware, rack adapters or carrying handles.

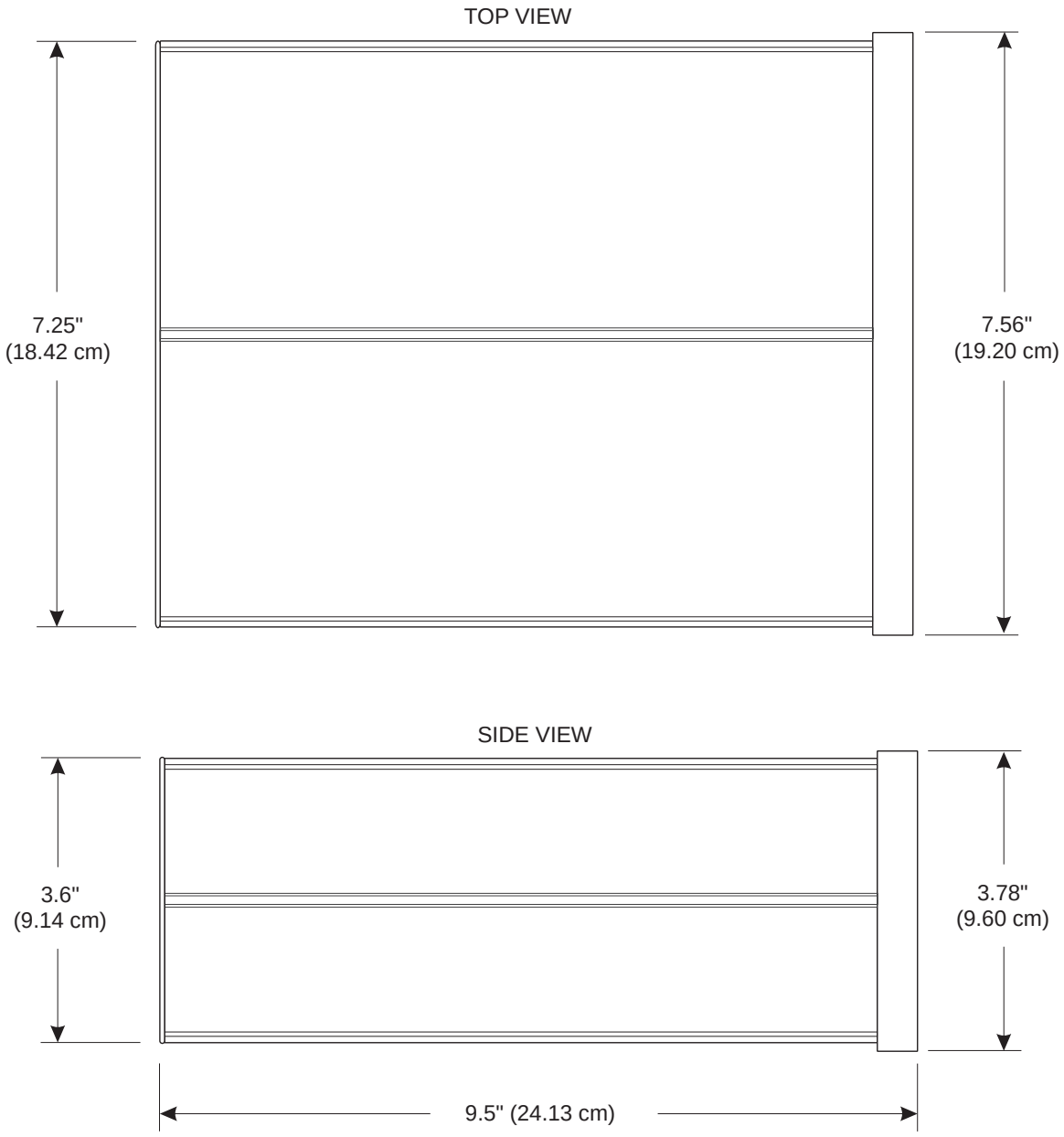


Figure 6.1 - Dimensional Outline

Power Input Requirements

Standard adapter input: 90 to 264V, 47-63 Hz (5 watts nominal)
Adapter output: 12 VDC ± 0.3 VDC @ 312 mA
Direct input voltage without adapter: 10 VDC @ 375 mA, 12 VDC @ 312 mA (nominal adapter output), 15 VDC @ 250 mA
Fuse : 0.8 amp, 250V, fast acting, 5 x 20mm (see figure 5.1 for location)

Pneumatic Interfaces

The pressure port is female 7/16-20 straight thread per MS 16142 and SAE J514, table 14. It requires a tube fitting boss seal with an o-ring adapter per MS33656. Mensor provides one 1/8 NPT and one 1/4 NPT fitting adapters.

>6000 psi: Rear mounted fitting mates to Autoclave Engineers, Inc. No. F250 C, High Pressure Equipment Co. No. HF4 or an equivalent.

Overpressure Rating, Pressure Port

[DPG]: Table 6.4 gives the overpressure ratings in psi for each of the various sensors used in the SPT. There are a limited number of sensors used to cover a large number of SPT ranges. This is accomplished by characterizing the transducer to the desired final range.

Table 6.4 - SPT Overpressure Ratings

Sensor Range	Maximum Pressure
.26 – 2.0 psi	5 psi
2.1 – 7.5 psi	20 psi
7.6 – 16 psi	45 psi
17 – 40 psi	60 psi
41 – 100 psi	200 psi
101 – 250 psi	500 psi
251 – 500 psi	1000 psi
501 – 1000 psi	2000 psi
1001 – 2500 psi	5000 psi
2501 – 6000 psi	7500 psi
6001 – 10000 psi	11500 psi

Compensated Temperature Range

Compensated temperature range is as follows unless otherwise specified in the calibration report. Special calibrations for other temperature ranges are available. Contact Mensor for details.

[2101, 2102, 2104, 2105, 2108, 2109]: 15° – 45° celsius
[2103, 2106, 2107]: 0° – 50° celsius

Operating Temperature Range

0° to 50° celsius

Storage Temperature

–20° to 70° celsius

Outputs

Front Panel Display: 2 lines of 20 each 8mm high characters; reverse image LCD with red backlight.
IEEE 488.1-1978 Interface Bus (GPIB)

Optional: RS-232 Serial Port;
Analog Output 0 to 5 VDC, 0 to 10 VDC, or – 5 to +5 VDC;
Binary Coded Decimal (BCD).

Warm-up

Approximately 15 minutes to rated accuracy.

Case Pressure

15 psia maximum. Consult Mensor for higher reference pressures. Reference media must be clean, dry, non-corrosive gas only.

Reading Rate

15.7/second

Response Time

Less than 0.2 seconds for 100% of FS pressure step input.

Orientation Effects

Negligible in any attitude (orientation). Any effects can be completely removed by re-zeroing.

Shock And Vibration

Minimal vibration.

Pressure Media

Clean, dry, non-corrosive gases, no oxygen. See *Options* for hydraulic media.

Transducer Volume

Table 6.5 - Transducer Volume (cubic centimeters)

Type	Pressure Chamber	Reference Chamber
Gauge Unit	0.6 cc	170 cc maximum*
Absolute Unit	0.6 cc	N/A

* Reference chamber volume depends on the size of the sensor mounted inside the transducer case.

Operating Environment

Up to 95% RH non-condensing.

Compliance

The Series 2100 DPG is compliant to the following CE standards: EN 50081-1, EN 50082-1, EN 50081-2, and EN 50082-2.

OPTIONS

RECHARGEABLE BATTERY PACK (001408000X)

The battery pack (figure 7.1) is a self-contained, rechargeable power source that attaches to and operates the DPG. A new, fully charged battery pack provides up to 10 hours of continuous operation for the instrument. The total operating time will be less if the Analog Output option is included, and will decrease as the batteries age.

The battery pack is installed by sliding its top bar into the T-slot extruded into the bottom side of the DPG. The two thumb-screws on the underside are then tightened to apply clamping pressure against the bottom of the DPG.

The power connector cable is then plugged into the POWER socket of the DPG. An LED on the front of the battery pack will come on when the capacity of the batteries has been reduced to approximately 15 to 20 minutes of DPG operating time.

The Rechargeable Battery Pack is available in two configurations, as follows:

0014080001	Battery Pack, only (spare)
0014080002	Battery Pack, Battery Charger and Handle Kit

If the DPG was ordered as a battery powered instrument it was delivered with the battery pack and handle kit installed, and included a separate battery charger. The 0014080001 battery pack can also be ordered as a spare or backup power supply without purchasing an extra charger or handle.

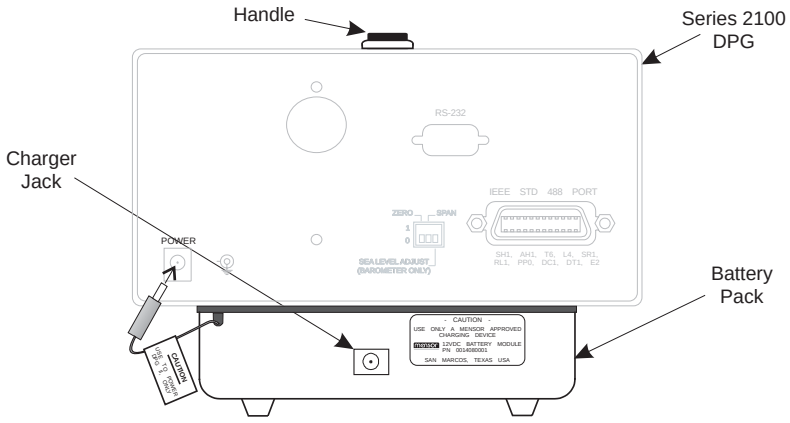


Figure 7.1 - Battery Pack (Rear View)

BATTERY CHARGER (0014545002)

To recharge the battery pack, plug a battery charger into the socket provided in the center on the rear of the battery pack case. Total charging time for a fully discharged battery pack is 10 hours with the DPG turned off.

NOTES:
1. The charger's built-in voltage select switch must be set for the local line voltage (120 or 220 VAC) before plugging it into a power source.
2. While it is possible to operate a DPG from the battery charger while it is charging, the charging time will be greatly extended.

AUTOMOTIVE POWER CORD (0014089001)

The automotive power cord patches between an automobile cigarette lighter and the power connector on the rear of the DPG. The cord includes current limiting circuitry to protect both the instrument and the car battery. Use only a Mensor supplied automotive power cord for this purpose.

RACK MOUNT KIT (001145500X)

A re-inforced rack panel is available with either one or two cut-outs (figure 7.2) for mounting DPGs. The panel fits a 5-1/4 inch opening in a standard 19 inch rack. To mount an instrument into the panel simply insert it into a panel cutout from the front until the DPG front bezel stops it. Then, from the rear of the instrument slide the two clamp bars into the extruded slots on either side of the instrument case until the bars rest against the inside of the rack panel. Finally, run the #6-32 Allen set screws against the tail end of each of the clamp bars to apply clamping pressure against the rack panel.

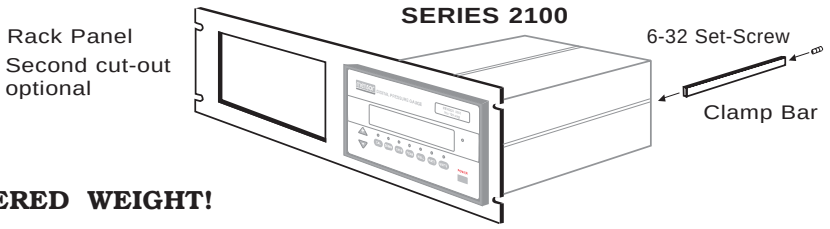


Figure 7.2 - Rack Mount Assembly

CARRYING HANDLE (0014034001)

The 0014034001 Carrying Handle (figure 7.3) is a collapsible, stitched-leather handle with chrome fittings. If the handle is ordered at the time an instrument is ordered it will be mounted by Mensor prior to shipment. However, the handle is available in kit form and can be ordered separately. The handle kit will include all of the necessary hardware and mounting instructions. While it is customary to mount this handle on the top, it can be mounted on either side of the case.

Figure 7.3 - Carrying Handle

CARRYING CASES (0014261001 AND 0014289001)

Mensor offers a vanity case style of carrying case as illustrated in figure 7.4, and a briefcase style of carrying case (not illustrated) for the DPG. Each case is constructed of a high impact plastic exterior, an interlocking tongue and groove opening, a vinyl handle, and nickel-chrome fixtures. Each case has an interior filled with high density polyurethane foam with a die-cut cavity to cushion the instrument. There are additional cavities to store related accessories and the manual. Contact Mensor for assistance in selecting the carrying case that best suits your application.

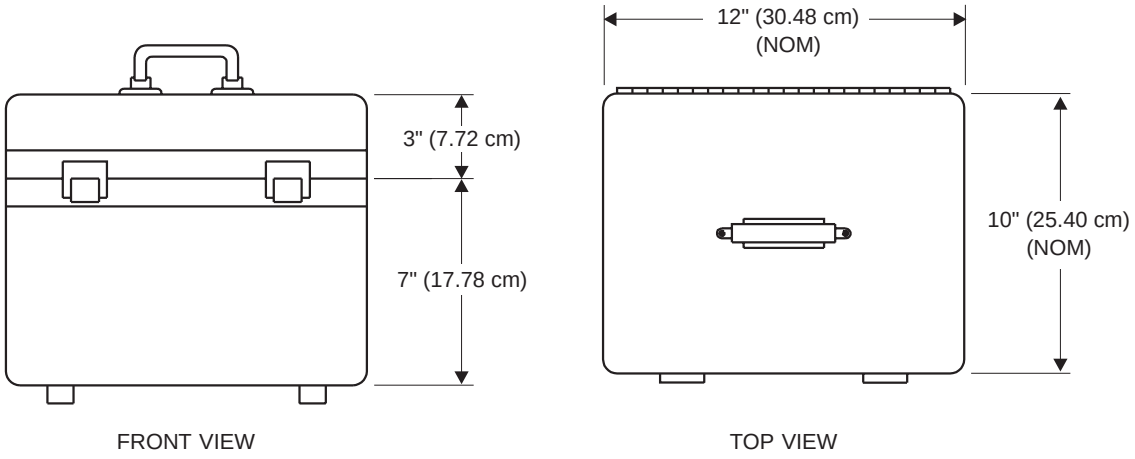


Figure 7.4 - 0014261001 Carrying Case

LIQUID-FILLED TRANSDUCER (0011467001)

[2102, 2107]: Mensor can provide a Pressure Transducer ready for connection to a liquid medium (hydraulic) pressure system. The most common liquid is triple distilled water, but other mediums have been used. The user can specify the desired liquid when the instrument is ordered. Mensor then will use the specified medium for its final calibration. Note that even microscopic impurities or entrapped air bubbles in the medium can significantly degrade the accuracy of the DPG.

Connecting the pressure line to a liquid-filled transducer must be done very carefully as described below to avoid entrapped air.

1. Position the DPG vertically with the pressure ports up.

2. Remove the plastic plug from the pressure port and discard it.

3. There should be visible liquid in the pressure port. If not, use a hypodermic syringe with a small diameter needle and inject additional liquid into the port until the liquid is visible when the syringe is removed. Keep the tip of the needle submerged to avoid air bubbles.

4. When the liquid is visible, install a fitting and top off the liquid to the point of overflowing.

5. Make sure that the pressure line has no air bubbles and that the line is full to overflowing. Then make the connection to the instrument.

NOTE: *If abnormal hysteresis, non-repeatability or non-linearity are noted, repeat the above procedure.*

CAUTION: AVOID PROLONGED STORAGE OF A WATER-FILLED INSTRUMENT! Thoroughly drain and dry out the ports prior to storing. Applying a hard vacuum is the most effective means of drying out the ports in most instances.

RS-232 SERIAL COMMUNICATION PORT (0014014001)

This option, (properly known as EIA-232), requires a male DB–9 serial port connector on the rear panel (figure 7.5) and an internal communication board (figure 7.6) connected to the Main board (see figure 5.1).

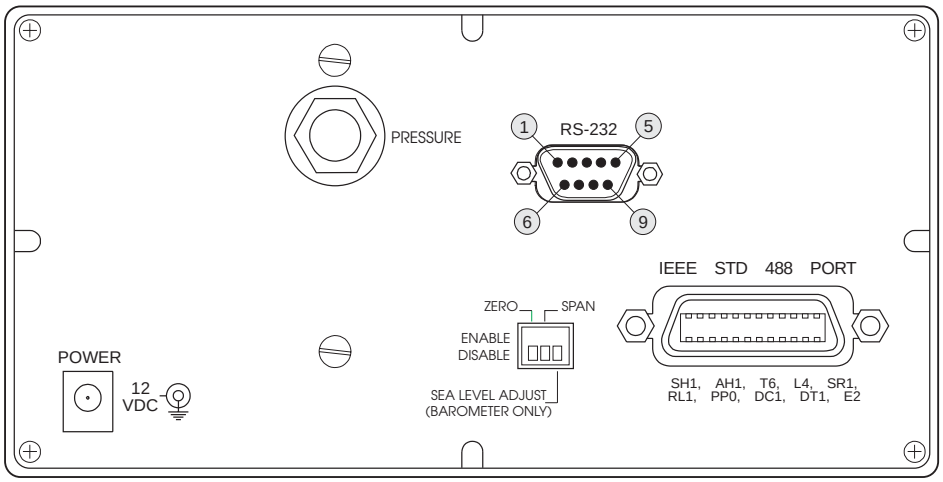


Figure 7.5 - Rear Panel with RS-232 Option

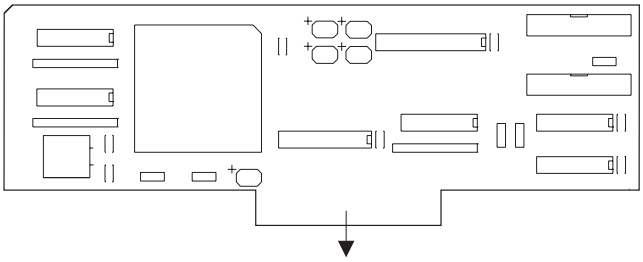


Figure 7.6 - Communication Board

With this option and the appropriate cable a DPG can communicate with either DTE or DCE devices over the bus. To request data output over the serial port the operator must enter the command question mark (?). Upon receipt of the **?** the DPG will output its current data to the serial bus.

All device dependent commands described in the *Remote Operation* section are also valid over the RS-232 bus. Every command sent will be returned to the host if ECHO is on. See ECHO command in the *Remote Operation* section.

RS-232 Setup

Use the COMM key on the front panel to set the RS-232 parameters. The first press of the COMM key displays the GPIB address setup. With the RS-232 option installed the next several depressions of the COMM key steps through the RS-232 menu of functions shown in column 1 of table 7.2. At each menu item the + and – keys will sequence through the specific options available for each menu item, as shown in columns OPT 1 through OPT 8 of table 7.2.

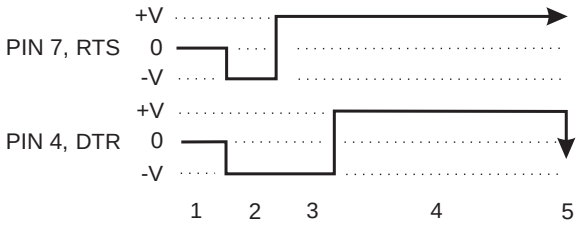
Table 7.2 - RS-232 Setup

FUNC	OPT 1	OPT 2	OPT 3	OPT 4	OPT 5	OPT 6	OPT 7	OPT 8
Baud	150	300	600	1200	2400	4800	**9600**	19200
Parity	**even**	odd	none					
Data bits	**7**	8						
Stop bits	**1**	2						
Handshake	**Hardware**	Software						

After the Handshake option is set the next press of the COMM key displays the Save Changes screen. Press SAVE, then + to save the setup as entered.

Handshaking

Handshaking is provided by the RTS and DTR lines. Buffer size is one character. Figure 7.7 illustrates signal timing:



TIME - STATUS

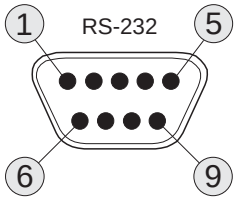
1 - Off
2 - Initializing
3 - Serial port on, not ready for data
4 - Serial port ready for data
5 - Serial port no longer ready for data

Figure 7.7 - RS-232 Signal Timing

RS-232 Cables

The cable configuration to connect the DPG to the external equipment depends on: 1), the type of equipment (DTE or DCE); 2), the equipment connector (9-pin or 25-pin); and 3), the connector gender (male or female). The DPG to DTE cable connections are illustrated in figure 7.9. The user may assemble the necessary cable, but in most cases an inexpensive pre-assembled cable can be purchased. A gender changer may be necessary to complete the interface.

Pinouts for the DPG RS-232 connector and the pin functions are described in figure 7.8, below:

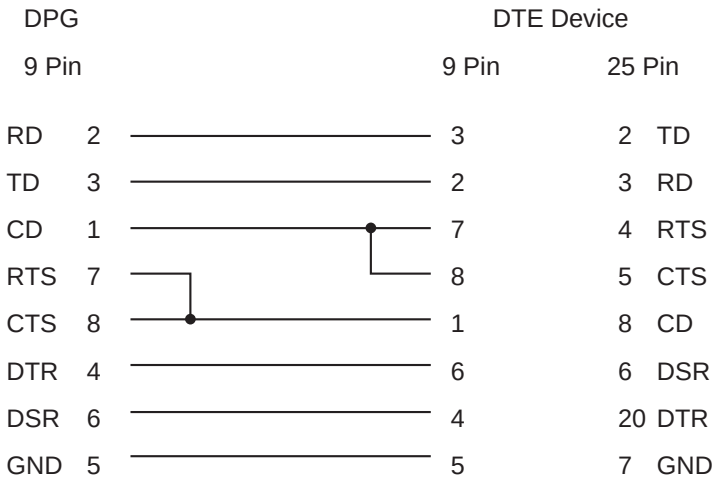


PIN	FUNCTION		
1	CD	Carrier Detect	Input
2	RD	Receive Data	Input
3	TD	Transmit Data	Output
4	DTR	Data Terminal Ready	Output
5	GND	Ground	
6	DSR	Data Set Ready	Input
7	RTS	Ready to Send	Output
8	CTS	Clear to Send	Input
9	RI	Ring Indicator	Not used

Figure 7.8 - RS-232 Connector Pin-outs

RS-232 Serial Port Interface Cable Connections

Connections for operation with hardware handshaking:



Connections for operation with software handshaking:

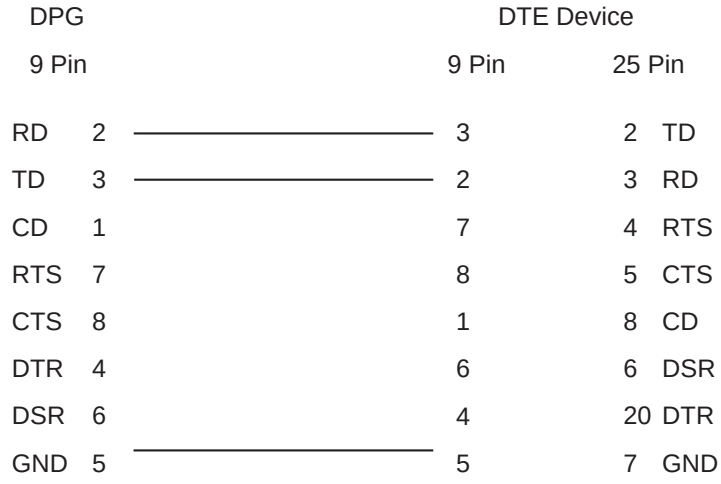


Figure 7.9 - RS-232 Cable Connections

ANALOG OUTPUT (0012976001)

This option requires a special rear panel (figure 7.10) which includes a standard 37 socket (female) D-sub connector labeled ANALOG/BCD OUTPUT. Also required is an optional DAC/BCD printed circuit board (figure 7.11) plugged into J5 of the Main board (refer to figure 5.1). The pin configuration of the output connector is shown in figure 7.10. Pin 1 is the low side of the analog output, and pin 20 is the high (+) side. Analog output and BCD output are independent functions on a common connector. A description of BCD output follows immediately after the Analog Output text.

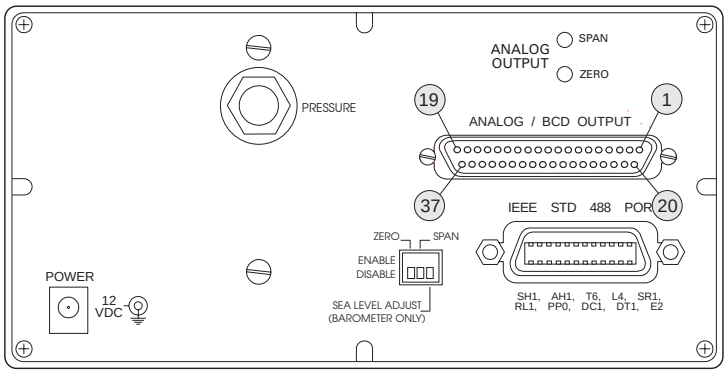


Figure 7.10 - Rear Panel for Analog/BCD Output

An Analog Output signal proportional to the full scale pressure range is available in three different voltage ranges: 0 to +5 VDC, 0 to +10 VDC, or ±5 VDC. (The ±5 VDC is for bi-directional pressure measurement.) Placement of a shunt on the header marked W1, W2 and W3 on the Analog/BCD Output Board (see figure 7.11) determines which voltage range is output. A shunt on W1 selects ±5 VDC, on W2 sets 0-10 VDC, or on W3 for 0-5 VDC output.

Whichever range is selected, this signal is derived by processing the temperature and pressure signals from the transducer into a digital, compensated pressure value. This digital pressure value is output approximately 15 times per second to the front panel display, to the BCD data lines, and to the remote bus. For the Analog Output option this compensated pressure value is also fed to a digital-to-analog converter (DAC) that has a 10V full scale output.

A zero pot and a span pot for the analog signal is mounted on this board. Adjustment of these pots is accessible through the rear panel (figure 7.10). These

two pots allow the operator to bring the analog signal into agreement with the front panel pressure reading during a given process run.

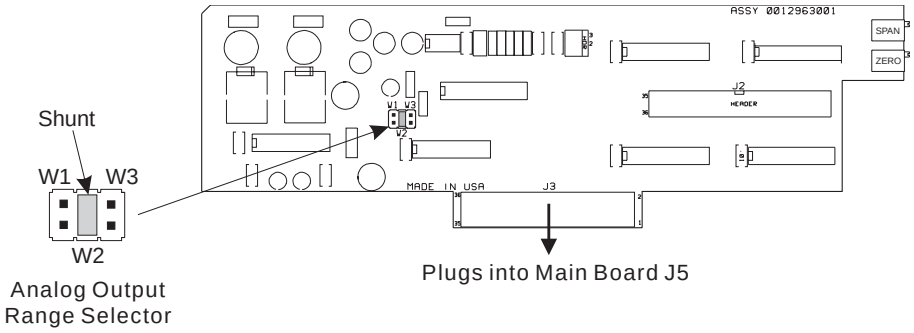


Figure 7.11 - Analog/BCD Output Board

If the low end of the transducer range is 0, the correct value for zero pressure is 0.000 volts out. For any positive pressure the correct upper end voltage is derived from the formula (P/FS) x 10V where P is the front panel pressure reading, FS is the full scale range of the DPG, and 10V is the full scale output voltage from the DAC. For best results carry all values out to their full resolution.

The resulting output may deviate as much as 0.005 volts from the calculated value due to the resolution limits of the DAC.

CAUTION: THERE IS NO OVERRANGE CAPABILITY NOR ANY ERROR INDICATION IF THESE LIMITS ARE EXCEEDED. BE VERY CAREFUL WHEN OPERATING NEAR THE LIMITS.

The Analog Output option will reduce battery operating time on a battery powered instrument.

Optional Analog Output Resolution: 0 to 10 VDC into a 2K ohm (max.) load, provides 1 part in 4096 resolution.

Optional Analog Output Uncertainty: The optional analog output has a 0.05% FS uncertainty within the specified temperature range in addition to the transducer uncertainty.

BCD OUTPUT (0012976002)

This option requires the same rear panel and standard 37 socket (female) D-sub connector labeled ANALOG/BCD OUTPUT already described for the Analog Output option (refer to figure 7.10). Also required is the optional DAC/BCD printed circuit board (figure 7.11) plugged into J5 of the Main board (see figure 2.1). The pin-outs for the 37 pin output connector are shown in the table below.

The BCD output consists of 24 lines of BCD numbers (six decimal digits); three lines to define the decimal point placement or an overrange condition, three lines to identify the engineering units, two ground lines, one polarity indicator, and one BCD Ready indicator. The BCD signals reflect the same pressure reading as the front panel display, and are updated at the same rate. However, the BCD signals are not updated during the time that a GPIB operation is being processed.

Table 7.3 - Analog/BCD Output Pin Assignments

Pin	Function
1	Analog -
20	Analog + [10v potential; DO NOT connect to BCD decoder]
2	GND
21	GND
3	BCD unit code c
22	BCD unit code b } See Table 7.4 - Units Codes
4	BCD unit code a
23	BCD decimal code c
5	BCD decimal code b } See Table 7.5 - Decimal Codes
24	BCD decimal code a
6	BCD Busy (low indicates ready)
25	BCD Positive (low indicates negative number)
7	BCD 1
26	BCD 2
8	BCD 4
27	BCD 8
9	BCD 10
28	BCD 20
10	BCD 40

Continued on next page...

Table 7.3 continued...

Pin	Function
29	BCD 80
11	BCD 100
30	BCD 200
12	BCD 400
31	BCD 800
13	BCD 1k
32	BCD 2k
14	BCD 4k
33	BCD 8k
15	BCD 10k
34	BCD 20k
16	BCD 40k
35	BCD 80k
17	BCD 100k
36	BCD 200k
18	BCD 400k
37	BCD 800k
19	no connection

NOTES:
1. The two analog lines (pins 1 and 20) are 0 to 10v maximum, while all BCD data and status lines are LSTTL compatible.
2. Measurement units programmed remotely by GPIB which are not available to BCD will cause an overrange or error signal on the Decimal Codes lines (pins 5, 23 and 24=high). The error condition will remain on those lines until GPIB reformats to units which are recognizable by BCD, or until the DPG is powered down and reinitialized.

Optional BCD Output Resolution: Six digits (24 lines) BCD data and 8 status lines (LSTTL compatible) capable of 0–999,999.

Table 7.4 - Units Codes

ABC	Engineering Units
000	inHg @ 0C
001	psi
010	inH2O @ 20C
011	mBar
100	mmHg @ 0C
101	kPa
110	mmH2O @ 4C
111	kg/cm2

Table 7.5 - Decimal Codes

ABC	Decimal Placement
000	XXXXXX (no decimal)
001	XXXXX.X
010	XXXX.XX
011	XXX.XXX
100	XX.XXX
101	X.XXXXX
110	.XXXXXX
111	0verrange or Error

RELIEF VALVES

Relief valves are available for pressure ranges from 0.5 psi to 10,000 psi in several different types:

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

Over time, contaminants in the system may enter the valves and prevent proper operations. Servicing the valves by the user is not recommended.

HAND OPERATED PRESSURE/VACUUM PUMP (6100700011)

A Combo·Pump 500 (figure 7.12) is available as an accessory for use with pneumatic systems (not suitable for use with liquids). This device can be either a pressure or a vacuum source during on-site calibrations or comparisons. The pump is capable of generating pressures up to 500 psi (34 bar), and converts to generating vacuum down to -12 psi (25" Hg) simply by pressing a button. This hand pump features dual output ports and a vernier adjustment. Operating instructions are supplied with the Combo·Pump.

Specifications

Range: 25" Hg vacuum to +500 psi

Output Ports: Dual, 1/8" female NPT

Size: 9.5"h x 2"w x 2"d
(24.13 x 5.08 x 5.08 cm)

Weight: 1.1 lbs (0.5 kg)

Materials: Aluminum, stainless steel, acetal, and moly-filled nylon.

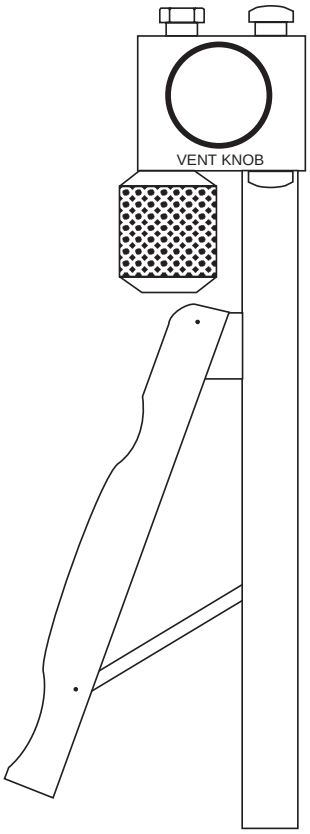


Figure 7.12 - Hand Pump

APPENDIX

CONVERSION FACTORS, PSI

The following table lists conversion factors which should be used as multipliers of the pressure to be converted to or from psi.

Table 8.1 – Conversion Factors, psi

Code	Pressure Unit	To Convert from Psi	To Convert to Psi
1	psi	1.0	1.0
2	inHg @ 0°C	2.036020	0.4911544
3	inHg @ 60°F	2.041772	0.4897707
4	inH_2O @ 4°C	27.68067	0.03612629
5	inH_2O @ 20°C	27.72977	0.03606233
6	inH_2O @ 60°F	27.70759	0.03609119
7	ftH_2O @ 4°C	2.306726	0.4335149
8	ftH_2O @ 20°C	2.310814	0.4327480
9	ftH_2O @ 60°F	2.308966	0.4330943
10	mtorr	51715.08	0.00001933672
11	inSW @ 0°C 3.5% sal	26.92334	0.03714250
12	ftSW @ 0°C 3.5% sal	2.243611	0.445710
13	atm	0.06804596	14.69595
14	bars	0.06894757	14.50377
15	mbar	68.94757	0.01450377
16	mm H_2O @ 4°C	703.0890	0.001422295
17	cm H_2O @ 4°C	70.30890	0.01422295
18	m H_2O @ 4°C	0.7030890	1.422295
19	mm Hg @ 0°C	51.71508	0.01933672
20	cm Hg @ 0°C	5.171508	0.1933672
21	torr	51.71508	0.01933672
22	kPa	6.894757	0.1450377

Continued on next page...

Table 8.1 continued...

Code	Pressure Unit	To Convert from Psi	To Convert to Psi
23	Pa	6894.757	0.0001450377
24	dynes/cm^2	68947.57	0.00001450377
25	g/cm^2	70.30697	0.01422334
26	kg/cm^2	0.07030697	14.22334
27	mSW @ 0°C 3.5% sal	0.6838528	1.462303
28	oz/in^2	16	0.0625
29	psf	144	0.006944444
30	tsf	0.072	13.88889
31	% FS	(PSI/RANGE) x 100	(% FS x RANGE) / 100
32	micron Hg @ 0°C	51715.08	0.00001933672
33	tsi	0.0005	2000
34	hPa	68.94757	0.01450377
36	MPa	0.006894757	145.0377
37	mmH_2O @ 20°C	704.336	0.001419777
38	cmH_2O @ 20°C	70.4336	0.01419777
39	MH_2O @ 20°C	0.704336	1.419777
40	**[2108]:** feet of altitude	See “Uncertainty” in the *Appendix* section for information relating to calculations for air data units	
41	**[2108]:** meters of altitude		
43	**[2109]:** mph		
44	**[2109]:** knots		
45	**[2109]:** meters/second		
46	**[2109]:** kph		
47	**[2109]:** mach		

CONVERSION FACTORS, MILLITORR

The following table lists conversion factors which should be used as multipliers of the pressure to be converted to or from millitorr.

Table 8.2 – Conversion Factors, Millitorr

Code	Pressure Unit	To Convert from mtorr	To Convert to mtorr
1	psi	0.00001933672	51715.08
2	InHg @ 0°C	0.00003936995	25400.08909
3	InHg @ 60°F	0.00003948117	25328.53093
4	InH_2O @ 4°C	0.0005352534	1868.273977
5	InH_2O @ 20°C	0.0005362028	1864.966281
6	InH_2O @ 60°F	0.0005357739	1866.458778
7	ftH_2O @ 4°C	0.00004460451	22419.25773
8	ftH_2O @ 20°C	0.00004468356	22379.59744
9	ftH_2O @ 60°F	0.00004464783	22397.50637
10	mtorr	1.000000	1.000000022
11	inSW@ 0°C 3.5% sal	0.0005206091	1920.827359
12	ftSW @ 0°C 3.5% sal	0.00004338408	23049.92831
13	atm	0.000001315786	760002.2299
14	bars	0.000001333220	750063.6259
15	mbar	0.001333220	750.0636259
16	mm H_2O @ 4°C	0.01359544	73.55409971
17	cm H_2O @ 4°C	0.001359544	735.5409971
18	m H_2O @ 4°C	0.00001359544	73554.09971
19	mm Hg @ 0°C	0.001000000	1000.000022
20	cm Hg @ 0°C	0.0001000000	10000.00022
21	torr	0.001000000	1000.000022
22	kPa	0.0001333220	7500.636259

Continued on next page...

Table 8.2 continued...

Code	Pressure Unit	To Convert from Mtorr	To Convert to Mtorr
23	Pa	0.1333220	7.500636259
24	dynes/cm^2	1.333220	0.750063626
25	g/cm^2	0.001359506	735.561166
26	kg/cm^2	0.000001359506	735561.166
27	mSW @ 0°C 3.5% sal	0.00001322347	75623.11663
28	oz/in^2	0.0003093875	3232.1925
29	psf	0.002784488	359.132477
30	tsf	0.000001392244	718265.0575
31	% FS	(PSI/RANGE) x 100	(% FS x RANGE) / 100
32	micron Hg @ 0°C	1.000000	1.000000022
33	tsi	0.000000009668360	103430160
34	hPa	0.001333220	750.0636259
36	MPa	0.00000013332	7500641
37	mmH_2O @ 20°C	0.0136194	73.424371
38	cmH_2O @ 20°C	0.00136194	734.24371
39	MH_2O @ 20°C	0.0000136194	73424.371
40	**[2108]:** feet of altitude	See “Uncertainty” in the *Appendix* section for information relating to calculations for air data units	
41	**[2108]:** meters of altitude		
43	**[2109]:** mph		
44	**[2109]:** knots		
45	**[2109]:** meters/sec		
46	**[2109]:** kph		
47	**[2109]:** mach		

TEMPERATURE CONVERSION (Table 8.3)

Find the known value in a center (shaded) column. If the known value is in °C, then the equivalent value is found in the °F column, or if the known value is in °F, then the conversion is found in the °C column.

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

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

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

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

STD SEA LEVEL PRESSURE AT VARIOUS ELEVATIONS (Table 8.4)

ELEVATION		PRESSURE UNITS		
FEET	METERS	PSI	INHG @ 0C	MMHG @ 0C
-3000	-914.40	16.36067	33.31075	846.09349
-2500	-762.00	16.07310	32.72524	831.22156
-2000	-609.60	15.78963	32.14809	816.56201
-1500	-457.20	15.51023	31.57922	802.11253
-1000	-304.80	15.23484	31.01852	787.87078
-900	-274.32	15.18024	30.90735	785.04716
-800	-243.84	15.12580	30.79651	782.23174
-700	-213.36	15.07151	30.68599	779.42450
-600	-182.88	15.01739	30.57579	776.62542
-500	-152.40	14.96342	30.46591	773.83449
-400	-121.92	14.90961	30.35635	771.05169
-300	-91.44	14.85596	30.24711	768.27699
-200	-60.96	14.80246	30.13819	765.51039
-100	-30.48	14.74912	30.02958	762.75185
0	0	14.69594	29.92130	760.00138
100	30.48	14.64291	29.81333	757.25894
200	60.96	14.59003	29.70567	754.52451
300	91.44	14.53731	29.59833	751.79809
400	121.92	14.48475	29.49131	749.07965
500	152.40	14.43233	29.38460	746.36918
600	182.88	14.38008	29.27820	743.66666
700	213.36	14.32797	29.17211	740.97206
800	243.84	14.27602	29.06634	738.28537
900	274.32	14.22422	28.96087	735.60658
1000	304.80	14.17257	28.85572	732.93567
2000	609.60	13.66441	27.82108	706.65580
3000	914.40	13.17110	26.81669	681.14420
4000	1219.20	12.69231	25.84186	656.38356
5000	1524.00	12.22771	24.89593	632.35686
6000	1828.80	11.77698	23.97823	609.04734
7000	2133.60	11.33980	23.08812	586.43850
8000	2438.40	10.91585	22.22495	564.51410
9000	2743.20	10.50483	21.38811	543.25820
10000	3048.00	10.10644	20.57696	522.65508
15000	4572.00	8.29351	16.88579	428.89932
20000	6096.00	6.75340	13.75009	349.25242
25000	7620.00	5.45352	11.10351	282.02934
30000	9144.00	4.36410	8.88542	225.68990

PRESSURE OFFSETS AT VARIOUS ELEVATIONS (Table 8.5)

ELEVATION		OFFSET PRESSURE		
FEET	METERS	PSI	INHG @ 0C	MMHG @ 0C
-3000	-914.40	-1.66474	-3.38945	-86.09211
-2500	-762.00	-1.37716	-2.80394	-71.22018
-2000	-609.60	-1.09370	-2.22680	-56.56064
-1500	-457.20	-0.81429	-1.65792	-42.11115
-1000	-304.80	-0.53890	-1.09722	-27.86941
-900	-274.32	-0.48430	-0.98605	-25.04578
-800	-243.84	-0.42986	-0.87521	-22.23036
-700	-213.36	-0.37558	-0.76469	-19.42312
-600	-182.88	-0.32145	-0.65449	-16.62405
-500	-152.40	-0.26749	-0.54461	-13.83311
-400	-121.92	-0.21368	-0.43505	-11.05031
-300	-91.44	-0.16002	-0.32581	-8.27561
-200	-60.96	-0.10653	-0.21689	-5.50901
-100	-30.48	-0.05319	-0.10829	-2.75048
0	0	0.00000	0.00000	0.00000
100	30.48	0.05303	0.10797	2.74244
200	60.96	0.10590	0.21562	5.47686
300	91.44	0.15862	0.32296	8.20328
400	121.92	0.21119	0.42999	10.92172
500	152.40	0.26360	0.53670	13.63219
600	182.88	0.31586	0.64310	16.33472
700	213.36	0.36796	0.74919	19.02932
800	243.84	0.41992	0.85496	21.71600
900	274.32	0.47172	0.96042	24.39479
1000	304.80	0.52336	1.06558	27.06571
2000	609.60	1.03153	2.10022	53.34558
3000	914.40	1.52484	3.10461	78.85718
4000	1219.20	2.00363	4.07944	103.61781
5000	1524.00	2.46823	5.02537	127.64451
6000	1828.80	2.91896	5.94307	150.95404
7000	2133.60	3.35614	6.83318	173.56288
8000	2438.40	3.78008	7.69635	195.48727
9000	2743.20	4.19110	8.53319	216.74318
10000	3048.00	4.58950	9.34434	237.34630
15000	4572.00	6.40243	13.03551	331.10205
20000	6096.00	7.94254	16.17121	410.74895
25000	7620.00	9.24241	18.81779	477.97204
30000	9144.00	10.33183	21.03587	534.31148

UNCERTAINTY

Pressure Rate Uncertainty: For a steady, non-pulsing pressure rate the additional uncertainty using seconds as the timebase is ± 0.01% of the pressure rate reading. When using minutes as the timebase the uncertainty is ± 0.03% of reading.

Altitude Pressure Units Uncertainty [2108]*: Altitude pressure units (Feet, Meters) have an additional uncertainty according to the following table:

Table 8.6 - Additional Uncertainty of Altitude/Feet

Altitude, Feet	Additional Uncertainty
–3000 to 44999	± 2 feet
45000 to 59999	± 3 feet
60000 to 74999	± 10 feet
75000 to 89999	± 15 feet
90000 to 100000	± 20 feet

Altitude Rate Uncertainty [2108]*: Altitude rate errors increase altitude uncertainty according to the table below.

Table 8.7 - Altitude Rate Uncertainty

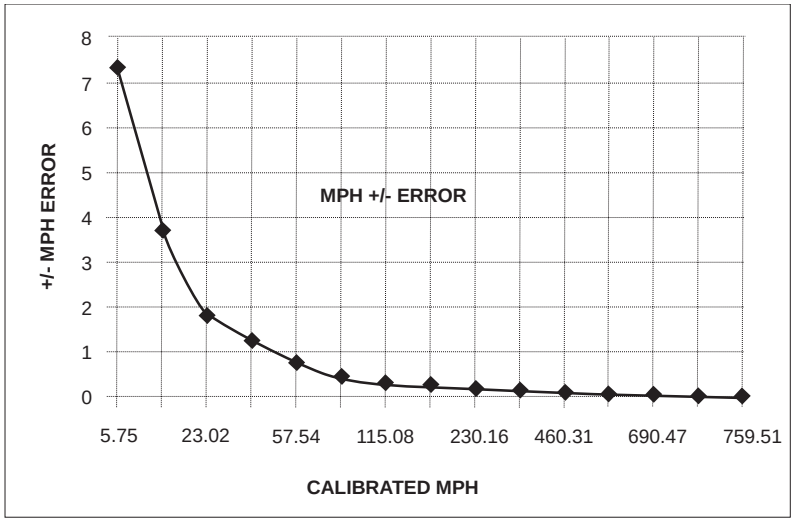
Altitude, Feet	Additional Uncertainty
–3000 to 44999	± 1 foot/sec or 60 feet/min
45000 to 59999	± 2 feet/sec or 120 feet/min
60000 to 64999	± 3 feet/sec or 180 feet/min
75000 to 89999	± 5 feet/sec or 300 feet/min
90000 to 100000	± 9 feet/sec or 540 feet/min

**Altitude in this instrument is calculated according to a set of formulas that match the ICAO 1964 standard atmosphere. Tables 8.6 and 8.7 above, relating to the uncertainty of altitude and altitude rate measurements, are based on the published ICAO standard atmosphere tables.*

Airspeed Error Uncertainty [2109]: These airspeed calculations are derived from British Standard G.199, March 1967. The Series 2100 DPG does not display readings above the speed of sound (1000 knots at sea level and 15°C). Airspeed in table 8.8 is referenced to standard atmosphere (sea level) pressure. The error data in the table is calculated based on a 15 psig transducer with 0.01% uncertainty.

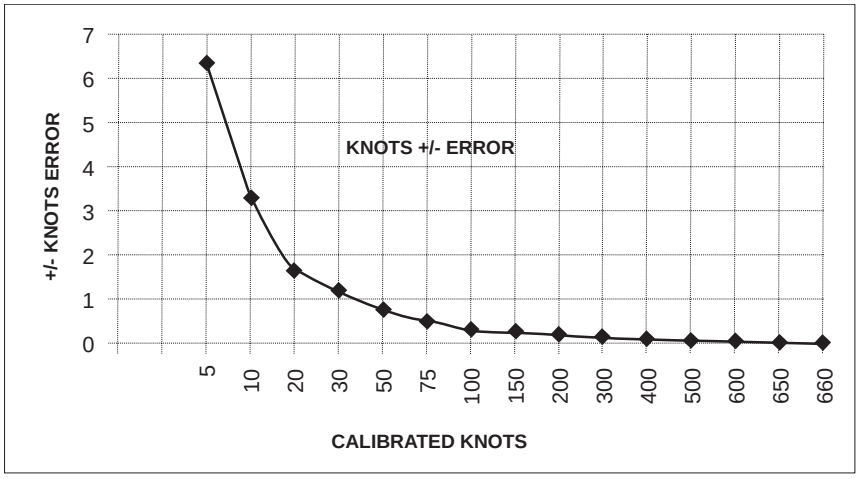
Table 8.8 - Airspeed Error

MPH			KNOTS	
Standard MPH	**MPH +/- Error**		**Standard Knots**	**Knots +/- Error**
5.754	7.358		5	6.394
11.508	3.693		10	3.209
23.016	1.862		20	1.618
34.523	1.262		30	1.097
57.539	0.754		50	0.655
86.308	0.502		75	0.436
115.078	0.377		100	0.328
172.617	0.247		150	0.215
230.156	0.191		200	0.166
345.234	0.123		300	0.107
460.312	0.090		400	0.079
575.390	0.070		500	0.061
690.467	0.056		600	0.049
748.006	0.052		650	0.045
759.514	0.051		660	0.045



MPH ERROR = (KNOTS ERROR) * 1.150779 MPH per KNOT

Figure 8.1 - Calibrated MPH Airspeed Error



KNOTS ERROR = (KNOTS/mBAR from standard)/(0.0145038 PSI per mBAR) * (0.0015 PSI error for 0.01% of 15 PSI span) + (calculated knots error - true knots) + 0.01 LSD

Figure 8.2 - Calibrated Knots Airspeed Error

HEAD PRESSURE CORRECTION

The accuracy of pressure measurement depends on several factors, one of which is the consideration of the head pressure in the system. The pressure medium, whether a gas or liquid, can cause an error in the measurement if not considered. In some cases the offset may be insignificant, and it may be ignored. The following information provides instructions for determining the density of the pressure medium and how to calculate the head pressure effect.

Gas Density (Table 8.9)

Liquids and gases have mass and are affected by gravity. The extent of the effect is dependent upon the density of the pressure medium. Liquids normally have a constant density that does not change with pressure. Gases, however, increase in density as the pressure increases. To determine the density of a gas at a specific pressure, multiply the absolute pressure by the density from the table below. For gas, the head pressure difference due to temperature changes within the compensated temperature range will be insignificant.

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

Liquid Density (Table 8.10)

In the table below, the density of water at various temperatures is given. The density of a liquid is commonly specified in grams per milliliter ($^g/_{ml}$). To convert to pounds per cubic inch ($^{lbs}/_{cu\ in}$) multiply the density by 0.0361.

Liquid	Density pounds/in3 (D)
Pure Water @ 15°C	.0360958
Pure Water @ 20°C	.0360624
Pure Water @ 25°C	.0360213
Pure Water @ 30°C	.0359708
Pure Water @ 35°C	.0359126

Head Pressure Calculation

The pressure at input port (P_2 in figure 8.3) of the Device Under Test (DUT) will be a positive number if the standard is positioned higher than the DUT. If the standard is lower than the DUT the head pressure correction will be a negative value. The equation used to calculate the head pressure for a gas medium is:

$$P2 = P1 (1 + h \times Dpsi)$$

h = Difference in vertical height between the center lines of the two pressure ports.

Dpsi = Gas density (refer to the "Gas Density" table).

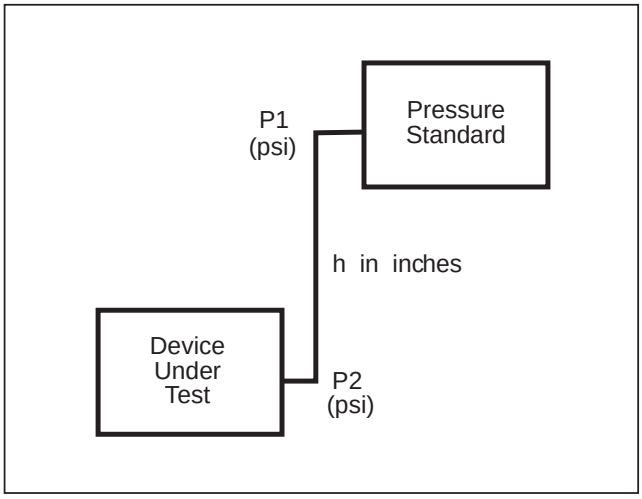


Figure 8.3 - Head Pressure Calculation

SOURCES FOR HIGH PRESSURE TUBING AND FITTINGS

Listed below are several sources for tubing, fittings and detailed specifications for equipping a pressure system compatible with the high pressure (6,000 to 10,000 psi) DPG:

Source	Fitting
1. Autoclave Engineers, Inc. 2930 West 22nd St. PO Box 4007, Erie, PA 16512 Tel: 814-838-3806 or 800-458-0409	F 250 C
2. High Pressure Equipment Co. 1222 Linden Ave. Erie, PA 16505 Tel: 814-838-2028 or 800-289-7447 FAX: 814-838-6075	HF4
3. Swagelok Co. (Crawford Fitting Co.) Solon, Ohio 44139 Tel: 216-248-4600	Sno-Trik ¼" OD tube fitting
4. Newport Scientific Superpressure Hygrodynamics 8246 E. Sandy Court Jessup, MD 20794 0189 Tel: 301-498-6700	

SAMPLE IEEE PROGRAM

The following is a sample program in Microsoft QuickBASIC that will read the DPG output over the IEEE bus:

```
' ********************************************************************
' GENERAL PROGRAM DESCRIPTION

' This program demonstrates functions of the DPG IEEE commands.
' IEEE address 3 is for the DPG under test. This program uses the
' National Instruments GPIB drivers.
' ********************************************************************

' this file has the IEEE driver calls for Nat. Inst. software
' $INCLUDE: 'QBDECL4.BAS'
CLS

* * * * * * * * INITIALIZE EQUIPMENT * * * * * * * * * *

' ASSUMES CONTROLLER BOARD 0 IS USED
      BDNAME$ = "GPIB0
      CALL IBFIND(BDNAME$, BRD0%)
      IF BRD0% < 0 THEN PRINT "GPIB0 INITIALIZATION ERROR": STOP

' ASSUMES DPG WITH GPIB ADDR. #3
      BDNAME$ = "DEV3": CALL IBFIND(BDNAME$, BRD3%)
      IF BRD3% < 0 THEN PRINT "DPG INITIALIZATION ERROR": STOP

' * * * * * * * * SET UP DPG * * * * * * * *

' Set output to be psi, standard output
      CALL IBWRT(BRD3%, "display 0")
      CALL IBWRT(BRD3%, "units ")

' This program section reads the range and units from the DPG
' and prints it to the screen

   CALL IBWRT(BRD3%, "Q3X")
   RD$ = SPACE$(50)
   CALL IBRD(BRD3%, RD$)
   PRINT RD$
```

QUICK REFERENCE LIST OF COMMANDS

Table 8.11 lists all of the user commands for the DPG II, DPG II Barometer, and all series 2100 DPGs. All of these commands are accepted by the 2100, however, the 2100 will not respond to those commands listed as exclusive to the DPG II or DPG II Baro. Any such queries issued to a 2100 will return a “0" to indicate that it is not applicable. Commands exclusive to the 2100 will have no meaning when issued to a DPG II or a DPG II Barometer.

Table 8.11 - Quick Reference List of Commands

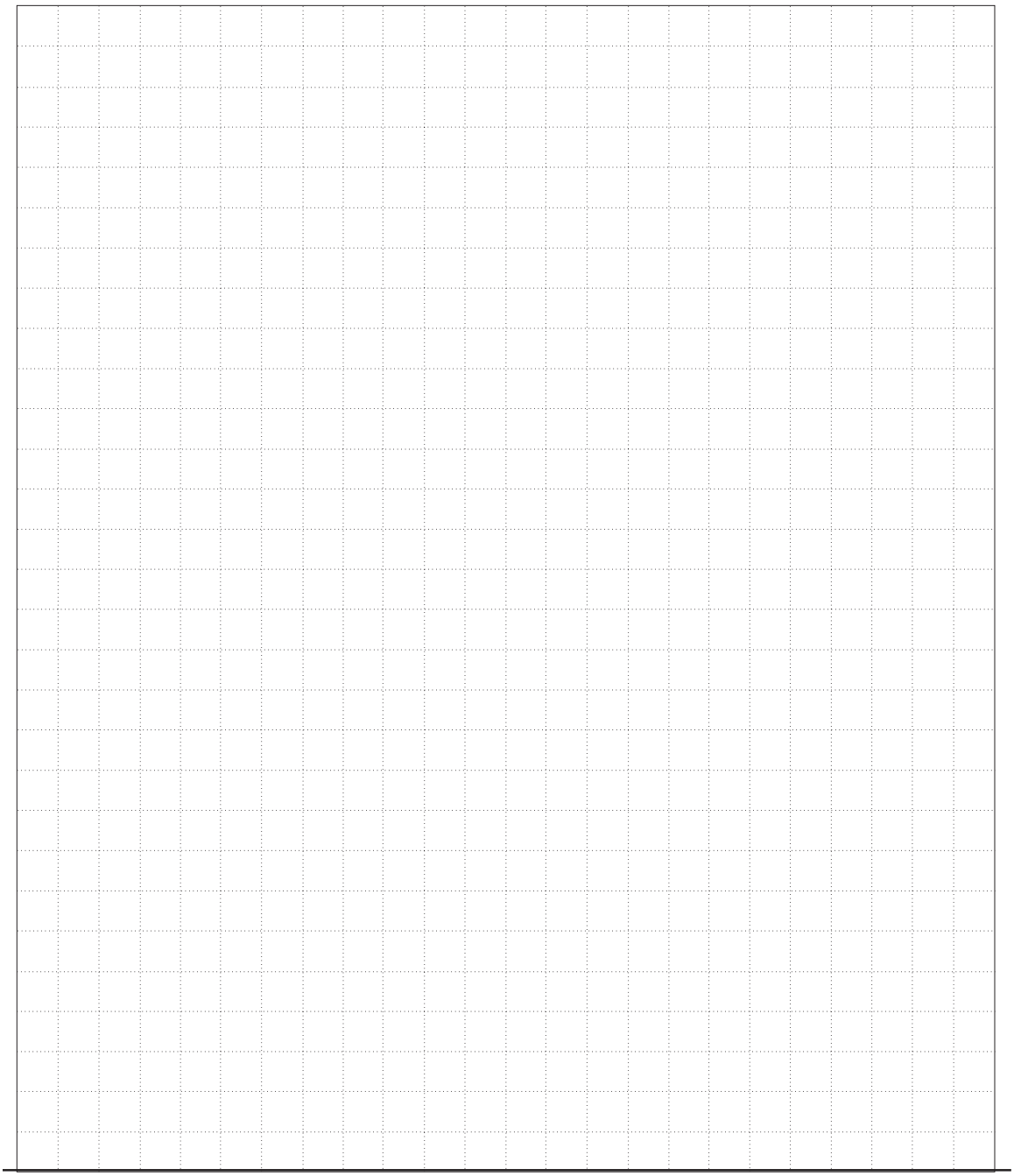
Command	Query	Ref Pages	Exclusive
	?	7-8	RS-232
A			DPG II
	ACCURACY?	4-5	2100
ADDRESS		4-6	2100
AFILTER	AFILTER?	3-15, 4-6	2100 (^{3} V1.16)
ARFILTER	ARFILTER?	3-15, 4-7	2100 (^{3} V1.16)
ARWINDOW	ARWINDOW?	3-15, 4-7, 4-8	2100 (^{3} V1.16)
AWINDOW	AWINDOW?	3-15, 4-8	2100 (^{3} V1.16)
C		4-9	
D			Baro
DEFAULT		4-10	
DIGITS	DIGITS?	4-10	
DISPLAY	DISPLAY?	4-11	
DOC	DOC?	4-11, 4-12	2100
E			DPG II/Baro
ECHO		4-12	RS-232
	ERROR?	4-12	
F			DPG II
FILTER	FILTER?	3-15, 4-14	2100 (^{3} V1.16) & DPG II/Baro
FILTER_FREQ	FILTER_FREQ?	4-15	2100 (<V1.16) & DPG II/Baro
	ID?	4-15	
KEYLOCK		4-15	2100
LINEREV		4-16	2100

Continued on next page...

Table 8.11 continued...

Command	Query	Ref Pages	Exclusive
	MODEL?	4-16	2100
	OPT?	4-16	
OUTFORM		4-17	2100
PW		4-18	2100
PWSL		4-18	2100
PWT		4-18	2100
PWZ		4-19	2100
Q			DPG II/Baro
	RANGENEG?	4-19	
	RANGEPOS?	4-19	
RATE_FILTER	RATE_FILTER?		DPG II
RATE_UPDATE	RATE_UPDATE?		DPG II
RATE_WINDOW	RATE_WINDOW?		DPG II
RFILTER	RFILTER?	3-15, 4-20	2100 (^{3} V1.16)
RWINDOW	RWINDOW?	3-15, 4-20, 4-21	2100 (^{3} V1.16)
S			DPG II/Baro
SAVE		4-21	2100
SEA_LEVEL	SEA_LEVEL?	4-22	
SPAN	SPAN?	4-23	
T			DPG II/Baro
TARE	TARE?	4-23	
	TEMP?	4-24	2100
	TYPE?	4-24	
U			DPG II/Baro
UNITS	UNITS?	4-24 - 4-26	
UNITS_TABLE	UNITS_TABLE?	4-26, 4-27	2100
W			DPG II
WINDOW	WINDOW?	3-15, 4-28	2100 (^{3} V1.16) & DPG II/Baro
Z			DPG II/Baro
ZERO	ZERO?	4-28	

User's Notes:



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Operation Manual
PN 0014896001 J1
February, 2006