



LIGHTHOUSE
WORLDWIDE SOLUTIONS

Intelligent Differential Pressure Controller

Operating Manual

Lighthouse Worldwide Solutions

Intelligent Differential Pressure Controller

OPERATING MANUAL

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Table of Contents

About this Manual

Text Conventions	i
Additional Help	ii

Chapter 1 Introduction

Basic Concepts	1-2
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Chapter 2 Installing the IDP

Mounting the IDP	2-1
Zeroing the Sensor	2-2
Placing the Pressure Reference Points	2-2
Connecting the IDP to the Air Handler	2-3
Preparing for Pressure Testing	2-4
Setting the Maximum and Minimum Speeds	2-4
Setting the Alarm Limits	2-5
Determining the Optimal Pressure	2-6
Entering the Pressure Setpoint Value	2-7
Specifying Positive or Negative Pressure	2-7
Setting the PID Terms	2-8

Chapter 3 Connecting the IDP to LMS

Connecting the IDP to LMS or a Terminal	3-1
Configuring the IDP from LMS	3-2

Chapter 4 Control Panel Commands

How to Use the Buttons and Menus	4-1
Menus and Commands	4-3
RUN Menu	4-3
SETPOINT Menu	4-3
CONFIG Menu	4-4
CONTROL Menu	4-5
FIXED Commands	4-5
AUTO Commands	4-5

REMOTE Menu	4-7
SENSOR Menu	4-7
DIAGNOSTIC Menu	4-8
VERSION Menu	4-9

Chapter 5 Example Applications for the IDP

DB15 Connector Pin Out and a List of Options	5-1
Interface Options	5-2
Stand-Alone Sensor	5-2
Connecting to an SIU	5-3
Using the Analog Output	5-4
Connecting to a Relay	5-5
Working with a Mini-Environment	5-7
Working with an Exhaust Hood	5-8
Multi-functional Application	5-9

Chapter 6 Remote Configuration

Assigning Addresses and the BAUD Rate (RS-485 Only)	6-1
Serial Commands for Remote Configuration	6-2
Help and Version Commands	6-2
Run Commands	6-3
Setpoint Commands	6-3
Configuration Commands	6-4
Control Commands	6-5
Remote Communication Commands	6-6
Sensor Commands	6-7
Diagnostic Commands	6-9
Pressure Commands	6-10

Chapter 7 Air Control and the PID Algorithm

Setting Up the Air Controller	7-1
Set point Control and Alarms	7-1
Specifying Positive or Negative Pressure	7-2
Control Type	7-2
Controlling the Air Handler Value Directly	7-2
Manual Control	7-2
Maximum and Minimum Air Handler Values	7-2
Using the PID Algorithm	7-3
P (Proportional Term) — Speed of Response	7-4
I (Integral Term) — Dampens Oscillations	7-5
D (Derivative Term) — Minimizes Overshoot	7-6

Appendix A IDP External Connector Pinouts

Appendix B Sensor Types & Pressure Conversions

Sensor Type Definitions B-1

Pressure Unit Conversion Constants B-3

Appendix C Physical Dimensions

Index

About this Manual

This manual describes the detailed operation and use of the Lighthouse Intelligent Differential Pressure (IDP) controller. It also explains the various configurations and possible applications for the IDP.

Text Conventions

The following typefaces have the following meanings:

Note: *A note appears in a paragraph like this one. A note gives further information regarding a topic.*

WARNING: *A warning appears in a paragraph like this and warns that doing something incorrectly could result in personal injury, damage to the instrument or loss and/or improper storage of data.*

italics

Represents information not to be typed or interpreted literally. For example, *file* represents a file name. Manual titles are also displayed in italics.

boldface

Introduces or emphasizes a term.

Courier font

Indicates IDP command syntax or text displayed.

Bold Courier

Indicates commands and information that you type. You can use uppercase or lowercase letters; in this manual, commands are shown in uppercase.

Helvetica Italics

Indicates a description of a serial configuration command.

Additional Help

For more information about the Intelligent Differential Pressure controller or the Lighthouse Monitoring System, contact Lighthouse Worldwide Solutions.

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1 *Introduction*

This chapter introduces the IDP and defines terms, then explains how to install the IDP.

The Intelligent Differential Pressure (IDP) controller is a flexible unit suited to a wide variety of applications. An on-board microprocessor takes pressure measurements, displays readings (if the model has the LCD display option), and communicates with other devices.

The IDP has built-in closed-loop control that can dynamically adjust the operation of an air handler (such as a fan, damper, valve, or HVAC unit) to maintain a pressure setpoint. Applications include mini-environments, exhaust hoods, equipment, or any area where pressure measurement or pressure regulation is required.

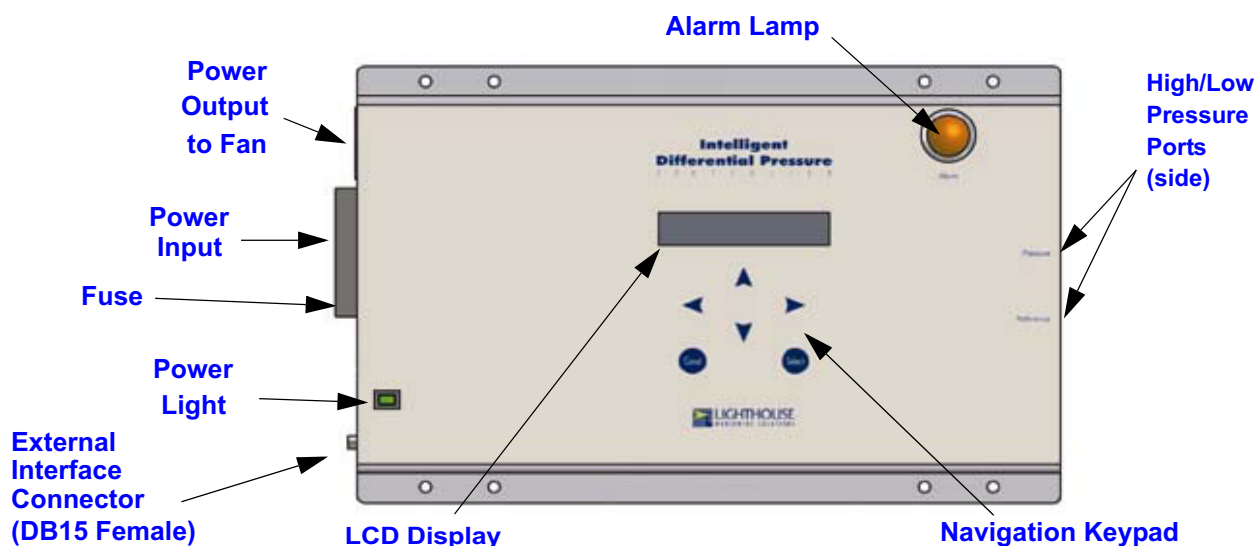


Figure 1-1 IDP Controller with LCD

Pressure setpoints and alarms are configurable. You can configure the IDP locally via the control panel (refer to Chapter 4) or remotely via a terminal or computer connected to the DB15 port (refer to Chapter 6).

There are many different applications for the IDP. See Chapter 5 for detailed descriptions.

The IDP has the following additional, optional features:

- Front access or side access for different sensors.
- Different pressure ranges, from $\pm 0.1'' \text{ H}_2\text{O}$ to $25'' \text{ H}_2\text{O}$. Appendix B lists all the ranges.
- LCD for display and control panel for configuration.
- Alarm lamp.
- Alarm buzzer. To turn off the buzzer, press any key on the control panel. If the IDP has no panel, a button that turns off the buzzer is located in one of the unused pressure ports.
- Can be configured via a terminal emulator and an RS-232 or RS-485 interface. The RS-485 interface can accommodate up to 31 IDPs.
- Sends a signal to an indicator such as a light stick or bell if the pressure is beyond acceptable limits.
- Sends data to a monitoring system such as the Lighthouse Monitoring System (LMS) via a 0 - 10 kHz output or an RS-485 serial interface.
- Generates an analog signal proportional to the pressure difference. This allows the IDP to interact with BAS and HVAC systems. The output can be either of the following:
 - 0 - 5V
 - 4 - 20 mA

Basic Concepts

The following table lists terms and concepts relevant to the IDP.

Air Control The feature that allows the IDP to control an air handler to maintain the setpoint pressure.

Air Handler A device that controls air flow, such as a fan, damper, valve, HVAC unit.

Alarm A condition in which the differential pressure is above or below thresholds defined by high and low alarms. You can define these thresholds if your IDP has the alarm lamp or alarm output feature installed. See the discussion of the SETPOINT menu in Chapter 4 for details.

Alarm Beginning The delay between the sensing and the reporting of an alarm. The minimum delay is the sampling rate of the sensor.

Alarm Ending The delay between the end of an alarm condition and the end of the reporting of that alarm condition. The minimum delay is the sampling rate of the sensor.

Auto Control Control of the air handler based on the difference between the measured differential pressure and the setpoint. The alternative is fixed control.

Building Automation System (BAS) Controls environmental conditions such as temperature, humidity, and air flow. An IDP with the analog output option can send data to a BAS.

Closed Loop Control A type of control system that uses feedback to dynamically adjust system parameters to maintain a desired setpoint.

Control Type The type of electronic control the IDP uses to interface to the air handler. This is very important in determining how well the air handler works in your environment. Try both Type A and Type B to see which works best. The default is A.

Differential Pressure The difference between two pressures.

Fixed Control Control of the air handler using a fixed percentage of the maximum value, for example a percentage of the maximum fan speed. The alternative is auto control.

Heating, Ventilation, and Air Conditioning system (HVAC) Controls temperature and air flow. An IDP with the analog output option can send data to an HVAC system.

High Alarm The differential pressure above which the IDP indicates an alarm condition.

Intelligent Differential Pressure controller (IDP) A controller that measures differential pressure and controls an air handler (such as a fan, damper, valve, or HVAC system) to maintain a differential pressure setpoint.

Liquid Crystal Display (LCD) The alphanumeric display on the face of the unit, used for displaying the current pressure, setpoint, alarm thresholds, and other information, and for viewing and changing configuration settings.

Lighthouse Monitoring System (LMS) A complete data-acquisition system that provides access to monitored sites via a distributed network. Each site operates independently and connects to other sites.

Low Alarm The differential pressure below which the IDP indicates an alarm condition.

Maximum Air Handler Value The maximum speed or setting of an

air handling device, for example the maximum speed of a fan.

Mini-Environment An enclosed area with a controlled environment.

Minimum Air Handler Value The minimum speed or setting of an air handling device, for example the minimum speed of a fan.

Multidrop Communications A method of communication that allows an RS-485 cable to connect multiple IDPs to one host computer. Each IDP has a unique address and can be individually configured by the host computer.

Negative Pressure A state in which the pressure on the reference pressure port is greater than the pressure on the port that samples the air you are monitoring. The reference pressure port is normally the Low port of the IDP.

Password A combination of arrow button presses up to four presses long that allows access to the configuration menus.

PID Algorithm This is a calculation that regulates the air handler in order to maintain the pressure setpoint. Each value (P, I, D) participates in the algorithm to increase power to the air handler, smooth out the oscillations over time, and control over/undershooting the setpoint. For a more detailed explanation, refer to Chapter 7.

Positive Pressure A state in which the pressure on the reference pressure port is less than the pressure on the port that samples the air you are monitoring. The reference pressure port is normally the Low port of the IDP.

Pressure Setpoint The desired differential pressure for the system. The IDP will work to maintain this pressure via closed loop control.

Sensor Interface Unit (SIU) Controls real-time data collection from sensors (such as the IDP's sensor) and sends data to the Lighthouse Monitoring System.

Sensor Rate The configurable rate at which the differential pressure sensor reports pressure readings. The default rate is half a second.

Setpoint See Pressure Setpoint

Zero Offset The offset from zero that is subtracted from all pressures gathered while in RUN mode. Determined during calibration.

2

Installing the IDP

Note: *This chapter assumes your IDP has a control panel. If your IDP does not have a control panel, see Chapter 6 for information about how to set up the RS-232 and RS-485 interfaces. Every menu command in this Quick Guide has an equivalent serial interface command.*

WARNING: DO NOT manufacture products in the environment until you have completed all steps of IDP installation.

This chapter covers basic installation and air control. It does not cover every application of the IDP. It includes references to parts of the manual where topics are discussed in more detail.

Installing the IDP involves these basic steps:

1. Mount the IDP.
2. Zero the sensor.
3. Place the pressure reference points.
4. Connect the IDP to the air handler.
5. Prepare for pressure testing.
6. Determine the optimal differential pressure.
7. Enter the differential pressure setpoint.
8. Specify positive or negative pressure.
9. Set the PID terms to fine-tune how the IDP controls the air handler.
10. Change other configuration settings (optional).

The following sections describe these steps in detail.

Mounting the IDP

Note: *The IDP is position sensitive and performs best when mounted vertically. Gravity affects the diaphragm that measures the pressure.*

Note: *Do not connect the IDP to the air handler yet.*

To mount the IDP, connect the sensor tubes, and connect the power cord, follow these steps:

1. Turn off all process equipment.
2. Mount the IDP near the area you want to monitor. You can mount the IDP using the flange screw holes or with an adhesive backed dual lock system.
3. Connect the IDP to a wall socket using a standard power cord. Plug the power cord into the male outlet on the side of the IDP, which is just above the fuse as shown in Figure 2-2.

Zeroing the Sensor

To zero the IDP's sensor, follow these steps:

1. Disconnect the sensor tubes so the high and low ports are sensing the same pressure.
2. Make sure the IDP is mounted in the location and position in which it will run. For best results, the IDP should be vertical. If you change the location or position of the IDP, you should re-zero it.
3. Press any button (or enter your password and press SELECT if you now have a password) to display the configuration menus.
4. The RUN menu is displayed. Press the UP key three times to display the SENSOR menu.
5. Press the SELECT key then the DOWN key to display the AUTO ZERO command.
6. Press the SELECT button. The IDP will begin collecting pressure samples to determine the zero offset. The AUTO ZEROING message is displayed.
7. Press the SELECT button again to stop the sampling, or press CANCEL to abort auto zeroing.
8. To view the new zero offset, press the UP key to move back to the ZERO= command.

Placing the Pressure Reference Points

1. Connect the high and low pressure areas you want to monitor. For example, if you are monitoring a mini-environment, you will typically connect the high (pressure) port to the inside of the mini environment and the low (reference) port to a room reference point.

Note: *The placement of the pressure reference point can greatly affect the IDP's performance. This reference point must be a stable representation of the reference pressure. Once placed, the tubes should not move.*

For example, if the IDP is mounted outside a mini-environment and the inside is the high-pressure area, use a tube from the high (pressure) port to the inside of the mini-environment. If the IDP is mounted in an area where the pressure is stable, you can leave the low (reference) port open, as shown in the following figure.

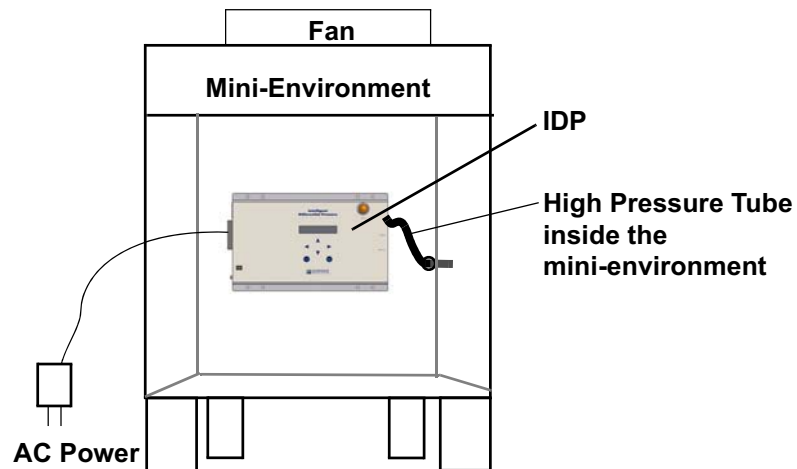


Figure 2-1 IDP on a Mini-Environment

Connecting the IDP to the Air Handler

To connect the IDP to the air handler and start controlling the air flow, follow these steps:

1. Be sure that all doors and vents in the environment are in their typical positions so that you can monitor normal air flow.
2. If you are adding the IDP to an environment for which the optimal air flow is already determined, mark the original setting of the air handler so you can reset it if necessary. For example, mark the position of the dial that controls fan speed. Also note the pressure reading on the IDP, which will be the setpoint.
3. Set the air handler to its maximum. For example, turn the fan speed dial all the way up.

Note: *For instructions on how to connect the IDP to an SIU or alarm indicator, or how to use the analog output, see Chapter 5.*

4. Connect the air handler by plugging the air handler's power cord into the female outlet of the IDP as shown below. An adapter for this outlet is supplied with the IDP.

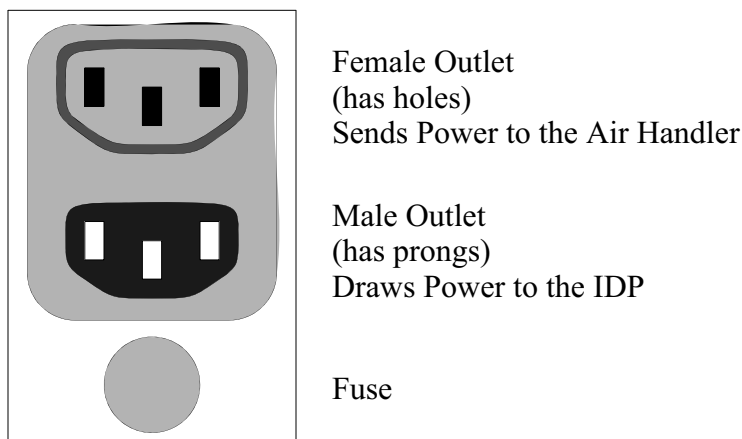


Figure 2-2 Outlets for IDP Power and Air Handler

Preparing for Pressure Testing

To prepare for pressure testing, set the maximum and minimum air handler speeds to the maximum and minimum possible. If your IDP has the alarm lamp or alarm output feature, you may also want to set the alarm limits to a wide range so the alarms do not distract you while you are testing the pressure.

Setting the Maximum and Minimum Speeds

Follow these steps to set the maximum and minimum air handler speeds. Both are a percentage of the maximum speed.

1. Press any button (or enter your password and press SELECT if you now have a password) to display the configuration menus.
2. Press the DOWN key three times to go to the CONTROL menu.
3. Press the Select key. You should see CONTROL=AUTO. If you see CONTROL=FIXED, select the LEFT or RIGHT key and then the SELECT key.
4. Press the DOWN key. You should see MAX_VAL=100.
5. If you see any other value, press the SELECT key to display an underscore, then use the LEFT and RIGHT keys to move the underscore and the UP and DOWN keys to change the digits. When you have changed the value to 100, press the SELECT key.
6. Press the DOWN key again. You should see MIN_VAL=0.

Note: *If you press CANCEL or wait more than 30 seconds before you press SELECT, the value reverts back to its previous value.*

7. If you see any other value, press the SELECT key to display an underscore, then use the LEFT and RIGHT keys to move the underscore and the UP and DOWN keys to change the digits. When you have changed the value to 0, press the SELECT key.
8. Press the CANCEL key twice to exit the configuration menus.

Setting the Alarm Limits

If your IDP has the alarm lamp or alarm output feature, you can also set the high and low alarms. Follow these steps:

1. Press any button (or enter your password and press SELECT if you now have a password) to display the configuration menus.
2. Press the DOWN key to go to the SETPOINT menu.
3. Press the SELECT key, then press the DOWN key. The HI_ALARM= command is displayed (if your IDP has the alarm lamp or alarm output feature).
4. Press the SELECT key again to select the HI_ALARM= command for editing.
5. The leftmost zero in the pressure value is underlined. Press the UP key to increase the value of the first digit until it is 5 or more.
6. Press the SELECT key. The underline disappears, and the value you entered is activated.
7. Press the DOWN key again. The LO_ALARM= command is displayed (if your IDP has the alarm lamp or alarm output feature).
8. Press the SELECT key again to select the LO_ALARM= command for editing.
9. The leftmost zero in the pressure value is underlined. Press the DOWN key to decrease the value of the first digit until it is -5 or less.
10. Press the SELECT key. The underline disappears, and the value you entered is activated.
11. Press the CANCEL key twice. The first press displays the SETPOINT menu again, and the second press returns you to Run mode.

Determining the Optimal Pressure

Note: *To optimize the environment for lower contamination levels, use a 1 cfm particle counter with sample sizes set according to the class of cleanroom or work surface at which you are operating. As you monitor pressure, also monitor the particle counts. This is optional.*

1. Press any button (or enter your password and press SELECT if you now have a password) to display the configuration menus.
2. The RUN menu is displayed. Press the DOWN key three times to display the CONTROL menu.
3. Press the SELECT key then the RIGHT key to display CONTROL=FIXED. Press the SELECT key again.
4. Press the DOWN key to display the FIXED_VAL command. This command determines the fixed speed of the air handler as a percentage of the maximum speed.
5. Press the SELECT key. An underscore appears below the first digit of the number. Press the UP key once, then press SELECT. This sets the air handler speed to 100%, or its maximum value.
6. Press the CANCEL key twice to exit the configuration menus.
7. Note the differential pressure when FIXED_VAL=100.
8. Repeat steps 1 through 4 to return to the FIXED_VAL command. Press the SELECT key. An underscore once again appears below the first digit of the number.
9. Use the LEFT and RIGHT arrow keys to move the underscore, and use the UP and DOWN keys to change the digit values. Use the SELECT key to activate a value. Try different values as you monitor the pressure.
10. If you already know what the setpoint pressure should be (see step 2 under “Connecting the IDP to the Air Handler”), adjust the FIXED_VAL setting until you achieve that pressure.
11. Continue to monitor differential pressure for 10 minutes. Imitate the actions of operators to test the effects on pressure, for example, open a door and reach in as if you are placing something in the environment. Try raising and lowering the FIXED_VAL setting to find the optimal pressure during operator actions. This will be the final setpoint pressure of the IDP.
12. Return all doors and vents to their typical positions and note the normal pressure fluctuations. Write down the maximum and minimum. You will use this later when you minimize oscillations using the PID algorithm.

Note: *Typical setpoints are between 5 and 15 m" H₂O.*

Entering the Pressure Setpoint Value

Note: *For other sensors with different ranges, the pressure values look different; see Appendix B for details.*

To enter the differential pressure setpoint value for the IDP, follow the steps outlined in this section.

The example in this section shows changing the setpoint pressure of a $\pm 0.1''$ SDB.1 sensor to 5.2 milli-inches H_2O . The example sets the alarms to 10.5 and 0.5 milli-inches H_2O .

Your setpoint should be the optimal pressure you determined in the previous section entitled, “Determining the Optimal Pressure.”

1. Press any button to display the configuration menus (if you have a password, type the password followed by the SELECT key). The RUN menu is displayed first.
2. Press the DOWN key to go to the SETPOINT menu.
3. Press the SELECT key to display the first SETPOINT command, which is PRESSURE=.
4. Press the SELECT key again to select the PRESSURE= command for editing.
5. The leftmost zero in the pressure value is underlined. Press the RIGHT key once to move the selection to the digit just to the left of the decimal.
6. Press the UP key five times. This displays the number 5 just to the left of the decimal. (This value is an example.)
7. Press the RIGHT key, then press the UP key twice. This displays the number 2 just to the right of the decimal. (This value is an example.)
8. Press the SELECT key. The underline disappears, and the setpoint pressure you entered is activated.

Specifying Positive or Negative Pressure

Use the PRESSURE= command on the CONTROL menu (not the SETPOINT menu) to specify whether the IDP should maintain a positive or negative pressure.

The high (pressure) port measures the pressure in the environment you are monitoring, which is compared to the reference pressure. The low (reference) port measures the reference pressure. If the pressure port should sense a higher pressure than the reference port, specify PRESSURE=POS. If the pressure port should sense a lower pressure, specify PRESSURE=NEG.

Setting the PID Terms

The PID terms determine how the IDP controls the air handler. You should set the P, I, and D terms in that order; the I and D terms refine the effect of the P term. All of these terms are on the CONTROL menu and are available when CONTROL=AUTO. The following table summarizes these terms.

Table 2-1 PID Term Summary

Term Name	Command	Description
P (proportional)	P-TERM= Range: 0.00 - 9.99	Determines the speed of air handler response. If this value is high in relation to the other terms, the response is fast, but the pressure value oscillates widely because the sudden change causes the IDP to overshoot or undershoot the setpoint.
I (integral)	I-TERM= Range: 0.00 - 9.99	Diminishes pressure oscillation over time. If this value is high in relation to the other terms, the pressure oscillations decrease over time, but the initial pressure change still causes overshooting and undershooting.
D (derivative)	D-TERM= Range: 0.00 - 9.99	Counteracts overshooting and undershooting. If this value is high in relation to the other terms, the air handler responds slowly as the pressure approaches the setpoint, but overshooting and undershooting are decreased.

Note: *The PID terms are setpoint-dependent. If you change the pressure setpoint, you must change the PID terms.*

When these terms are optimal for the environment, the air handler adjusts smoothly when you open or close doors and vents, with little or no oscillations or overshooting of the setpoint.

In addition to these terms, you can also set maximum and minimum limits for the air handler speed (you verified the defaults in the “Preparing for Pressure Testing” section earlier in this chapter).

For more details about the PID terms and air control, see Chapter 7.

Follow this procedure to set the P, I, and D terms for your environment:

1. Create a table of P, I, and D values and the air handler response you observe for those values. Your table should look something like this after you have tried a few combinations:

Table 2-2 Example Table of P, I, and D Values

P	I	D	Adjustment Response
0.01	0.01	0.01	The pressure changes quickly enough, but then the fan oscillates too much.
0.03	0.02	0.01	Oscillations even out, but the fan overshoots the setpoint.
0.03	0.02	0.02	Okay for this environment.

2. Lower the P-TERM, I-TERM, and D-TERM values to 0.01. Open and close doors and vents for varying lengths of time to see how the air handler adjusts. Write down your observations.
3. Increase the P-TERM value until the air handler responds as quickly as you want it to. Test how the air handler adjusts and write down your observations.
4. If the air handler oscillates too much after big changes, increase the I-TERM value until the oscillation stops quickly. Test how the air handler adjusts and write down your observations.
5. If the air handler overshoots and undershoots the setpoint pressure, increase the D-TERM value until the approach to the setpoint is smooth. Test how the air handler adjusts and write down your observations.
6. If the air handler still doesn't adjust smoothly to doors and vents opening and closing, repeat steps 3 through 5.
7. To further refine the air handler response, you can change the MAX_VAL and MIN_VAL values as described earlier in this chapter in "Setting the Maximum and Minimum Speeds."

For example, if you want the air handler to be on all the time, regardless of the pressure, make sure MIN_VAL exceeds 0.

As another example, if the D-TERM value doesn't completely eliminate overshooting of the setpoint, you can lower MAX_VAL to eliminate the overshoot by limiting the air handler speed.

Note: In step 12 of "Determining the Optimal Pressure," you observed how much the pressure varied when the air handler speed was constant. No matter how high you set the I-TERM, you cannot eliminate this minimum oscillation.

Note: If you can't find optimum PID terms after several tries, examine the airflow. If not enough air flows out of the environment, back-pressure will cause continuous oscillations. If not enough air flows into the environment, pressure will adjust very slowly.

Changing Default Settings (Optional)

The default configuration settings you are most likely to want to change are listed below. See Chapter 4 or 6 for a complete list of configuration commands.

Table 2-3 Default Configuration Settings

Menu	Command	Default/ Range	Description
RUN	RUN=	CYCLE	Cycles the display between the measured pressure, the air handler value, and the alarm state if your IDP has the alarm lamp or alarm output feature. Other values are PRESSURE, AIR_VALUE (% max. air handler value), and ALARMS. Use the LEFT and RIGHT keys to display the options. Use SELECT to select an option.
SETPOINT	HI_ALARM=	For $\pm 0.1''$ sensor, default is 10 m".	Sets the pressure threshold above which an alarm is triggered. To determine the range of the sensor and the units displayed, see Appendix B. This option appears only if your IDP has the alarm lamp or alarm output option installed.
	LO_ALARM=	0	Sets the pressure threshold below which an alarm is triggered. To determine the range of the sensor and the units displayed, see Appendix B. This option appears only if your IDP has the alarm lamp or alarm output option installed.
CONFIG	ALARM BEGIN= (appears if alarm lamp or alarm output feature installed)	000 / 0 - 999	Specifies the time in seconds the IDP waits before signaling an alarm. Delaying avoids short alarms due to short pressure changes that may be an acceptable part of normal operation. A zero value disables the delay and signals an alarm as soon as it is detected.
	ALARM END= (appears if alarm lamp or alarm output feature installed)	000 / 0 - 999	Specifies the time in seconds the IDP keeps signaling an alarm after it has ended. Delaying avoids fluttering alarms due to short pressure changes that may be an acceptable part of normal operation. A zero value disables the delay and stops an alarm as soon as its end is detected.

Menu	Command	Default/ Range	Description
	PASSWORD= (used only if LCD and keypad are installed)	none	If you want to require a password for personnel who change IDP configuration values, enter a password of up to four arrow key presses. The letters U, D, L, and R represent the arrow keys. Use the LEFT and RIGHT keys to move the underline to different positions in the password. Use the UP and DOWN keys to cycle through the U, D, L, R, and space values. The IDP reads the password from left to right and ignores anything after a space. If you put a space in the leftmost position, this changes the password back to “none”.
CONTROL	CONTROL=	AUTO	The AUTO setting specifies that the IDP determines the air handler value based on the pressure setpoint, the measured pressure, the PID values, and other control menu settings. The alternative setting is FIXED, which allows you to set the air handler to a fixed value, for example a fixed fan speed. Use the LEFT and RIGHT keys to display the options. Use SELECT to select an option.
	FIXED VAL= (appears only if CONTROL= FIXED)	0.0 / 0 - 100%	Specifies the fixed air handler value as a percentage of the maximum possible value.
	TYPE=	A	Whether control type A or B is best depends on your air handler and environment. Try both. Use the LEFT and RIGHT keys to display the options. Use SELECT to select an option.
	PRESSURE=	POS	Specifies whether the optimal differential pressure is positive or negative. The high (pressure) port measures the pressure in the environment you are monitoring, which is compared to the reference pressure. The low (reference) port measures the reference pressure. If the pressure port should sense a higher pressure than the reference port, specify PRESSURE=POS. If the pressure port should sense a lower pressure, specify PRESSURE=NEG.

3

Connecting the IDP to LMS

This chapter describes how to connect the IDP to and configure the IDP from the Lighthouse Monitoring System. It also describes how to connect the IDP to a terminal so you can use the remote commands described in Chapter 6.

Connecting the IDP to LMS or a Terminal

Note: *You can also connect the frequency outputs of the IDP to an SIU as described in Chapter 5. If you do this, you cannot configure the IDP via LMS.*

To connect the IDP to the LMS ECS Lite or ACU or to a host computer with a terminal emulator, use one of the cables described below. Male or female connector designations are for the cables, not the devices the cables connect.

To connect a single IDP to LMS or a terminal emulator using RS-232 protocol, use one of the following cables. If the COM port of the diagnostic terminal has a DB9 connector, use the MIO Panel cable.

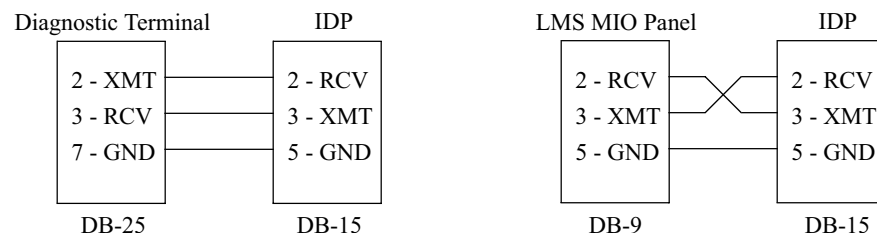


Figure 3-1 IDP RS-232 Cable

To connect multiple IDPs to LMS or a terminal emulator using RS-485 protocol, use the following cable. If the COM port of the diagnostic terminal has a DB25 connector, you can plug the RS-232 end of the B & B converter directly into it.

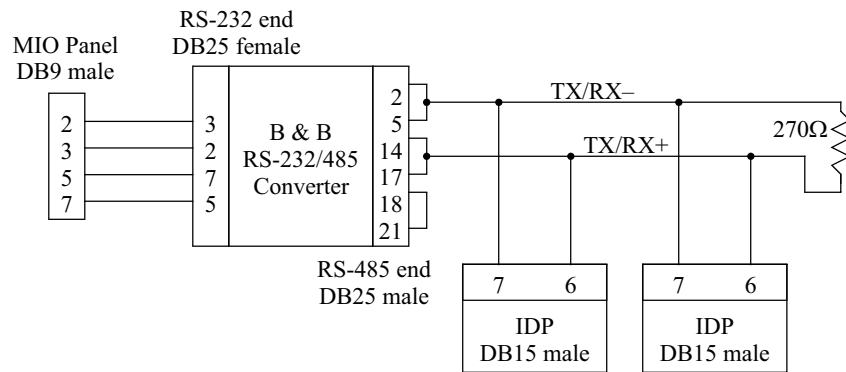


Figure 3-2 IDP RS-485 Cable

You can choose multiple IDPs only if your IDPs have the RS-485 option installed.

Configuring the IDP from LMS

To configure the IDP from the LMS ECS Lite or ACU, follow these steps:

1. Mount the IDP as described above.
2. Determine the optimal pressure as described above.
3. Connect the IDP to the air handler as described above.
4. Connect the IDP to LMS using an RS-232 or RS-485 cable as described in the previous section.
5. Configure the IDP port. Its port configuration User Type is IDP/AIU. The baud rate is 9600, and the data bits, stop bits, and parity are 8, 1, and none, respectively.
6. Configure the IDP DCP as described in this section.
7. Zero the sensor as described above.

When you perform DCP configuration for an IDP, the LHA SNSR window appears:

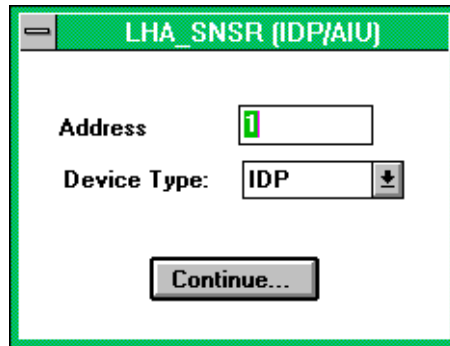
The image shows a software window titled "LHA_SNSR (IDP/AIU)" with a green header bar. Inside the window, there are two input fields. The first is labeled "Address" and contains the number "1". The second is labeled "Device Type:" and contains the text "IDP" next to a small downward-pointing arrow icon. At the bottom center of the window is a button labeled "Continue...".

Figure 3-3 LHA_SNSR Window

If the IDP is one of a series on an RS-485 cable, enter the RS-485 address. Select IDP as the Device Type. Select the Continue button.

The IDP DCI window appears:

DCI-IDP Configuration

Reporting Rates

Normal: secs

Warning: secs

Alarm: secs

Output Type

☒ A ☐ B

Pressure Type

☒ Positive ☐ Negative

Mode

☒ Auto ☐ Fixed

Fixed Mode

Output Value: %

Auto Mode

Setpoint

Output Range

Maximum: %

Minimum: %

PID

Proportional:

Integral:

Differential:

Local Alarm

Delay (secs) Duration: (secs)

OK

Figure 3-4 IDP DCI Window

Enter values in the following settings before selecting the OK button:

Normal, Warning, Alarm Enter the rates of data reporting for normal, warning, and alarm conditions in seconds. The defaults are 900 sec. (15 min.) for normal conditions, 300 sec. (5 min.) for warning conditions, and 60 sec. for alarm conditions. The minimum value for all rates is 60 sec.

Output Type Whether Output Type A or B is best depends on your air handler and environment. Try both.

Pressure Type The high (pressure) port measures the pressure in the environment you are monitoring, which is compared to the reference pressure. The low (reference) port measures the reference pressure. If the pressure port should sense a higher pressure than the reference port, select Positive. If the pressure port should sense a lower pressure, select Negative.

Mode In **Auto** mode, the IDP determines the air handler value based on the pressure set point, the measured pressure, the PID values, and other Auto Mode settings. In **Fixed** mode, you set the air handler to a fixed Output Value, for example a fixed fan speed.

Output Value (Fixed) Specifies the fixed air handler value as a percentage of the maximum possible value.

Setpoint (Auto) Sets the optimal pressure, which the IDP tries to maintain.

Maximum (Auto) Sets the maximum air handler value the IDP allows as a percentage of maximum possible value. For example, sets maximum fan speed.

Minimum (Auto) Sets the minimum air handler value the IDP allows as a percentage of maximum possible value. For example, sets minimum fan speed.

Proportional (Auto) Determines the speed of air handler response. Enter a value between 0.00 and 9.99. If this value is high in relation to the other terms, the response is fast, but the pressure value oscillates widely because the sudden change causes the IDP to overshoot or undershoot the set point. See Chapter 7 for details.

Integral (Auto) Diminishes pressure oscillation over time. Enter a value between 0.00 and 9.99. If this value is high in relation to the other terms, the pressure oscillations decrease over time, but the initial pressure change still causes overshooting and undershooting. See Chapter 7 for details.

Derivative (Auto) Counteracts overshooting and undershooting. Enter a value between 0.00 and 9.99. If this value is high in relation to the other terms, the air handler responds slowly as the pressure approaches the set point, but overshooting and undershooting are decreased. See Chapter 7 for details.

Delay Sets the number of seconds to wait before starting to signal an alarm. The default is 0 seconds. Possible values are between 0 and 999 seconds. This is the same as the Alarm Begin (ALBG) serial command.

Duration Sets the number of seconds to wait before ending an alarm signal. The default is 0 seconds. Possible values are between 0 and 999 seconds. This is the same as the Alarm End (ALEN) serial command.

4

Control Panel Commands

The IDP can be configured locally using the control panel built into the unit or using a terminal that is remotely connected via the serial port. This chapter explains how to configure the IDP using the control panel. For information about remote configuration, see Chapter 6.

How to Use the Buttons and Menus

The following figure shows how the UP, DOWN, LEFT, RIGHT, CANCEL, and SELECT buttons on the IDP allow you to cycle through menus and commands and edit command values.

A command is almost always followed by an equal sign and either an option or a numeric value. For example, the command to set the pressure set point is `PRESSURE=nnnn`.

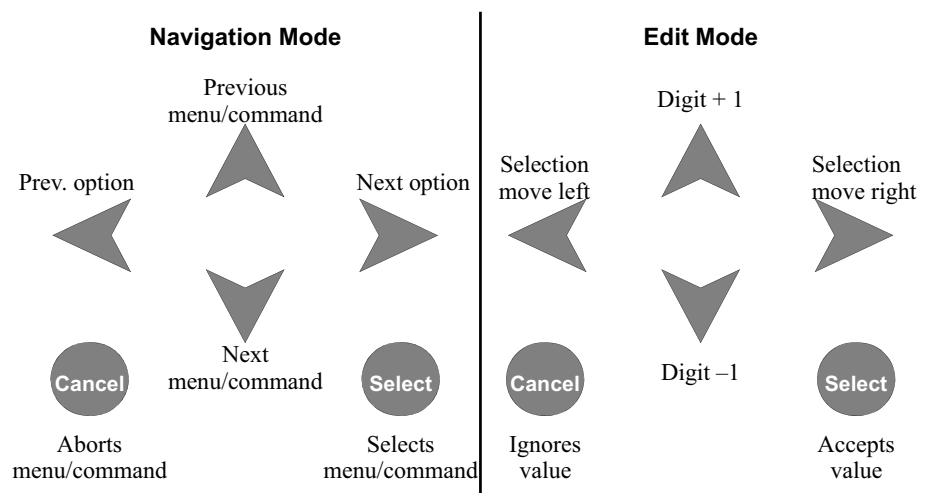


Figure 4-1 Summary of Navigation and Command Selection

Note: *If you hold down any button, it will automatically repeat until you release it. This is useful for cycling through menus or commands quickly or for cycling through digits in edit mode.*

The IDP has three operating modes, and you shift between these modes when you configure the IDP. The IDP collects data and controls the air handler in all modes. The modes are as follows:

Run Mode Displays data collected by the IDP and operating conditions. This is the default mode. To go to Navigation mode, you must type in a password composed of arrow button presses followed by the SELECT key. Press any key if no password is set.

Navigation Mode Presents the menus and commands, which you can navigate through and select. If you select a command that requires a numeric value, such as PRESSURE on the SETPOINT menu, you enter Edit mode. To return to Run mode, press CANCEL repeatedly or just wait 30 seconds without pressing any buttons.

Edit Mode Allows you to edit the numeric value of a command. When you press SELECT or CANCEL, you return to Navigation mode.

Note: For an example of step-by-step instructions on how to use the menus, see Chapter 2.

The following figure shows how to use two of the commands on the REMOTE menu using the control panel buttons.

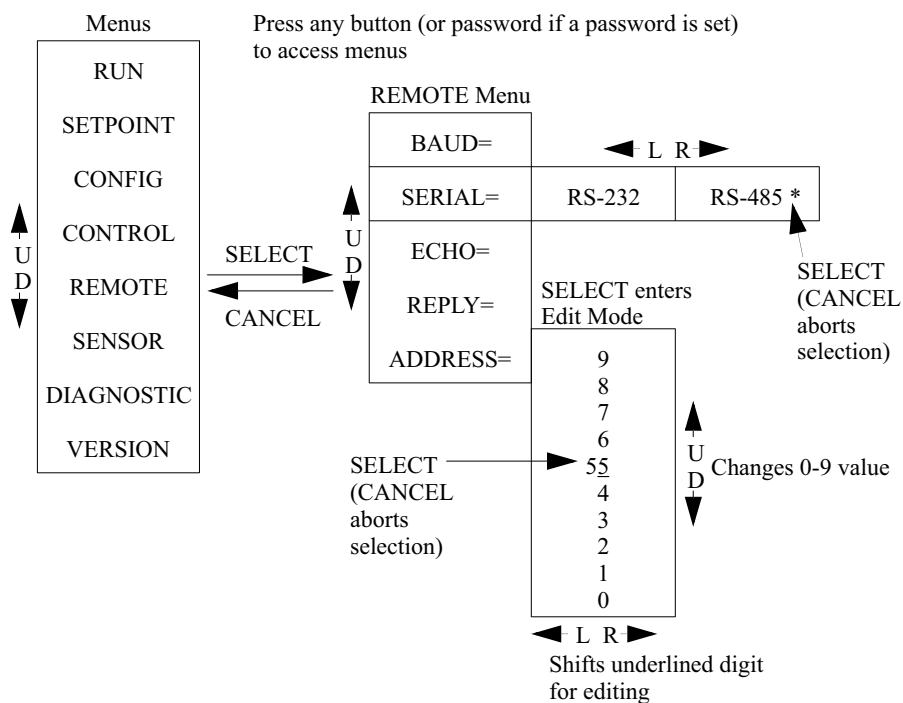


Figure 4-2 Accessing REMOTE Menu Commands Using the Control Panel

Menus and Commands

This section lists all the commands and options under each menu, and gives instructions on how to use each command. Menus and commands are listed in the order in which they appear when you are cycling through menus or commands. Default options are marked with asterisks.

RUN Menu

The RUN menu has one command, RUN=, which determines what the IDP displays when it is in Run mode, collecting and displaying data. The RUN= command has the following options. The currently selected option is displayed first.

CYCLE * Cycles the display between the pressure, air handler value, and alarms.

PRESSURE Displays the differential pressure measured by the IDP in the appropriate range and units for the installed sensor.

AIR VALUE Displays the air handler value as a percentage of the maximum value.

ALARMS Displays the value of the output signal that indicates an alarm condition: NONE, HIGH PRS, or LOW PRS. This option appears only if your IDP has the alarm lamp or alarm output option installed.

SETPOINT Menu

The SETPOINT menu commands determine the set point and alarm limits for the IDP.

PRESSURE= Specifies the set point pressure, which the IDP tries to maintain. For a ± 0.1 " sensor, the default value is 05.00 m". To determine the range of the sensor and the units displayed, see Appendix B.

HI ALARM= Sets the pressure threshold above which an alarm is triggered. For a ± 0.1 " sensor, the default value is 10.00 m". To determine the range of the sensor and the units displayed, see Appendix B. This option appears only if your IDP has the alarm lamp or alarm output option installed.

LO ALARM= Sets the pressure threshold below which an alarm is triggered. The default value is 0. To determine the range of the sensor and the units displayed, see Appendix B. This option appears only if your IDP has the alarm lamp or alarm output option installed.

CONFIG Menu

The CONFIG menu commands determine the password and the delay between an alarm-level pressure and the reporting of the alarm.

ALARM BEGIN= Specifies the time in seconds the IDP waits before signalling an alarm. Delaying avoids short alarms due to short pressure changes that may be an acceptable part of normal operation. A zero value disables the delay and signals an alarm as soon as it is detected; the alarm begin time is set equal to the sampling rate. This option appears only if your IDP has the alarm lamp or alarm output option installed.

ALARM END= Specifies the time in seconds the IDP keeps signalling an alarm after it has ended. Delaying avoids fluttering alarms due to short pressure changes that may be an acceptable part of normal operation. A zero value disables the delay and stops an alarm as soon as its end is detected; the alarm end time is set equal to the sampling rate. This option appears only if your IDP has the alarm lamp or alarm output option installed.

PASSWORD= Specifies a password, which is a combination of control panel arrow key presses up to four presses long. The default is no password. The letters U, D, L, and R represent the arrow keys.

Use the LEFT and RIGHT keys to move the underline to different positions in the password. Use the UP and DOWN keys to cycle through the U, D, L, R, and space values.

The IDP reads the password from left to right and ignores anything after a space. If you put a space in the left-most position, this changes the password back to “none”.

This command appears only if your IDP has an LCD and keypad.

CONTROL Menu

The CONTROL menu commands determine how the IDP controls the pressure.

CONTROL= Selects one of the two basic methods of pressure control.

FIXED Specifies that a fixed air handler value controls the pressure.

AUTO * Specifies that the IDP automatically controls the pressure based on the set point.

FIXED Commands

If CONTROL=FIXED, only two additional commands are displayed, which sets the fixed air handler value.

FIXED VAL= Sets the fixed air handler value as a percentage of maximum value. The default value is 0.

TYPE= Specifies the type of electronic control the IDP uses to interface to the air handler. This command is very important in determining how well the air handler works in your environment. Try both TYPE=A and TYPE=B to see which works best. The default is A.

A list of the air handling types preferred by different air handlers is available, but trying each one also works. If the difference between the types is unnoticeable, then either will work.

AUTO Commands

If CONTROL=AUTO, the following additional commands are displayed.

MAX. VAL= Sets the maximum air handler value the IDP will allow as a percentage of the maximum possible value. The default value is 100.0.

This command can help the IDP's responsiveness by limiting the range of control. If you know the usual range of the air handler when the pressure is near the set point, you can use this command to prevent overshoot by setting the MAX. VAL to yield a slight pressure but not too much larger than the set point.

MIN. VAL= Sets the minimum air handler value the IDP will allow as a percentage of the maximum possible value. The default value is 0.0.

Setting a MIN. VAL above zero ensures that the air handler will not completely cut off the flow of air even if the pressure is very high. This may be necessary for maintaining a unidirectional air flow.

TYPE= Specifies the type of air handling. This is the same command that is displayed when CONTROL=FIXED; it is described above.

PRESSURE= Specifies whether the pressure sampled by the High port is positive (POS., the default) or negative (NEG.) when compared to the reference pressure sampled by the Low port.

P-TERM= Specifies the proportional (speed of response) term, which determines how fast the IDP changes the pressure to get it back to the set point. Enter a number in the format *n.n* between 0.00 and 9.99. The default value is 0.10.

A high P-term in relation to the I and D terms means a fast response but a high overshoot or undershoot.

I-TERM= Specifies the integral (oscillation dampening) term, which minimizes air handler value fluctuations over time. Enter a number in the format *n.n* between 0.00 and 9.99. The default value is 0.10.

A high I-term in relation to the P and D terms means a steady pressure under most conditions, but slower and less responsive pressure changes.

D-TERM= Specifies the derivative (overshoot minimization) term, which slows the change in air handler value as the set point approaches. Enter a number in the format *n.n* between 0.00 and 9.99. The default value is 0.10.

A high D-term in relation to the P and I terms means very little overshoot, but a slower response.

REMOTE Menu

The REMOTE menu commands configure the remote interface. For more about this interface, see Chapter 6.

BAUD= Specifies the baud rate for remote communications with a host computer. Choose 1200, 2400, or 9600. The default is 9600.

Note: *The data is transmitted at 8 data bits, no parity, and 1 stop bit.*

SERIAL= Specifies the mode of communication with the host computer.

RS-232 * Specifies that communication is through an RS-232 interface, and that only one IDP is connected to the host computer.

RS-485 Specifies that communication is through an RS-485 interface, and that up to 120 IDPs are connected to the cable. Selectable only if RS-485 option is installed.

ECHO= Determines whether transmitted information is echoed back to the host computer. Choose ENABLE or DISABLE. The default is ENABLE. If SERIAL=RS-485, ECHO must be set to DISABLE.

REPLY= Determines the information format for IDP replies. Choose VERBOSE or TERSE. The default is VERBOSE.

ADDRESS= Sets the IDP's RS-485 address. This command appears only if SERIAL=RS-485. Enter a number between 1 and 120. The default is 120. You cannot connect more than 120 IDPs to the same cable. Each IDP must have a unique address.

SENSOR Menu

The SENSOR menu commands display the sensor type and allow you to zero the sensor.

ZERO= Specifies an offset to correct the sensor's reading of a zero value. The default value is 0. To determine the range of the sensor and the units displayed, see Appendix B.

AUTO ZERO Allows you to automatically zero the sensor. Follow these steps:

1. Disconnect the sensor tubes so the high and low ports are seeing the same pressure.
2. Make sure the IDP is mounted in the location and position in which it will run. For best results, the IDP should be vertical. If you change the location or position of the IDP, you should re-zero it.
3. Press the SELECT button. The IDP will begin collecting pressure samples to determine the zero offset. The AUTO ZEROING message is displayed.
4. Press the SELECT button again to stop the sampling, or press CANCEL to abort auto zeroing.

If you want to view the new zero value, move back to the ZERO command.

RATE= The number of seconds between updates of the displayed pressure, air handler value, and alarm condition information. Enter a number in the format *nn.n*. The default value is 0.5 seconds.

MODEL= Displays the sensor model number. Use this model number to look up the range of the sensor and the units displayed in the table in Appendix B.

DIAGNOSTIC Menu

The DIAGNOSTIC menu commands allow you to troubleshoot the IDP. Use the commands on this menu if the power light starts blinking.

ERR= Displays error conditions within the IDP. To cycle through the errors, use the LEFT and RIGHT buttons. If there are no errors, the display shows ERR=NONE.

CLEAR ERRORS Clears all the error conditions within the IDP.

REM= Shows the remote communications as they happen. For a list of remote commands, see Chapter 6.

TEST= Starts the IDP's self-test. The IDP reports on the results of each part of the test.

VERSION Menu

The VERSION menu has no commands; it displays information about the installed features of your IDP.

VER:	Displays the firmware version.
LCD:	Displays whether the IDP has an LCD display.
232:	Displays whether the RS-232 option is installed.
485:	Displays whether the RS-485 option is installed.
LAMP:	Displays whether the alarm lamp is installed.
EXT_OUT:	Displays whether the alarm signal output feature is installed.
0-5v:	Displays whether the analog output feature (0 - 5V) is installed.
4-20ma:	Displays whether the analog output feature (4 - 20 mA) is installed.
0-10 kHz:	Displays whether the frequency output feature (0 - 10 kHz) is installed.
SERIAL #:	Displays the serial number of the IDP.

5

Example Applications for the IDP

The IDP has several interface options and can be used in a variety of environments with a variety of configurations. This chapter describes the interface and application options and the DB15 connector through which you access these options.

This chapter also describes air control, which is done through a socket for the air handler power line located on the upper left corner of the IDP.

DB15 Connector Pin Out and a List of Options

Most of the interface options and special applications are accessed through the DB15 connector on the lower left corner of the IDP. This section briefly describes the DB15 pin outs. For a more detailed description, see Appendix A.

Table 5-1 IDP DB15 Connector Pin outs and Corresponding Options

<u>Pin Number</u>	<u>Pin Name</u>	<u>Description: Interface or Application Option</u>
10	EXT_OUTA	Alarm output. This signal can turn on a light stick, bell, or other device.
11	EXT_OUTB	
12	EXT_FRQA	These lines transmit data to an SIU. Pin 12 connects to Channel + (pin 3 or 5) on the SIU DB15 connector. Pin 13 connects to Channel – (pin 2 or 4). The range of this signal is 0 - 10 kHz.
13	EXT_FRQB	
14	ANALOG_OUT	The analog output (proportional to the measured differential pressure). The range can be 0 - 5 VDC or 4 - 20 mA.
15	ANALOG_GND	

Interface Options

The interface options for the IDP are as follows:

- Stand-Alone Sensor
- Connecting to an SIU
- Using the Analog Output
- Connecting to a Relay

Stand-Alone Sensor

The simplest configuration uses the IDP as a stand-alone sensor in an environment. This could be a mini-environment, an exhaust hood, or a piece of equipment with a chamber. The IDP is mounted to the side of the environment. Nothing is connected to the DB15 connector.

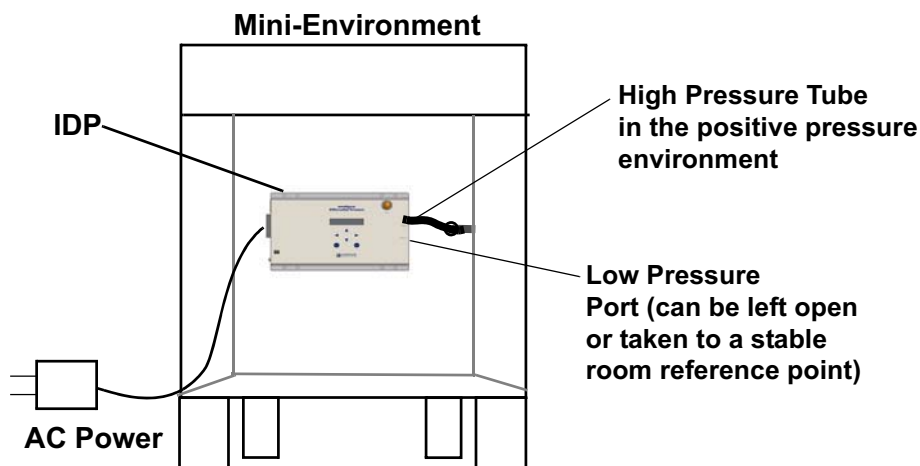


Figure 5-1 The IDP as a Stand-alone Sensor

The high pressure tube is fed into the mini-environment or into the area where a positive pressure is desired. The low pressure port is either left open or has a tube that feeds into another environment. This allows the differential pressure measurements to be taken.

Connecting to an SIU

This next scenario involves the LMS Sensor Interface Unit (SIU). The IDP sends its pressure data to the SIU. The SIU controls real-time data collection from sensors (such as the IDP's sensor) and sends the data to the Lighthouse Monitoring System (LMS) for display and analysis.

Note: *You cannot use LMS to configure the IDP via the SIU; you must use an RS-232 or RS-485 cable as described in Chapter 3.*

Connection to an SIU requires a cable from the DB15 interface connector on the IDP to a sensor connector on the SIU. The SIU requires a male DB15 connector.

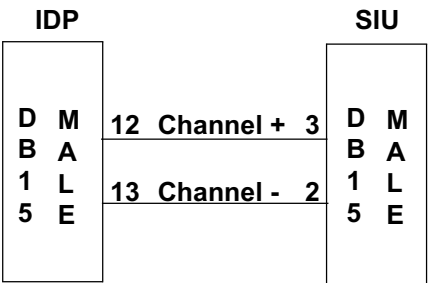


Figure 5-2 IDP - SIU Pinouts

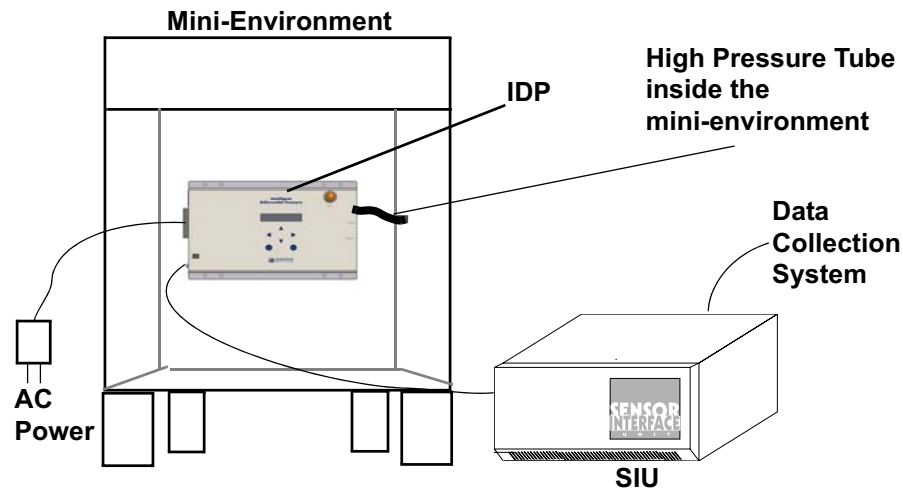


Figure 5-3 IDP to SIU Connection

Using the Analog Output

The IDP can use an analog signal to connect to a building automation system (BAS) or an HVAC system, providing feedback to regulate the differential pressure in the various rooms of the building.

The analog signal (0-5 VDC or 4-20 mA) is on pins 14 and 15 of the DB15 interface connector.

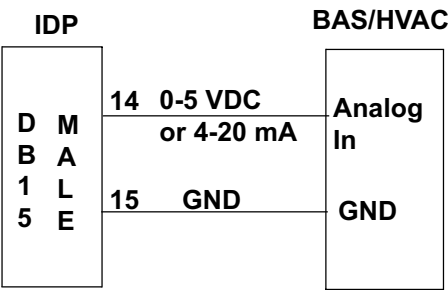


Figure 5-4 IDP - BAS/HVAC Pinouts

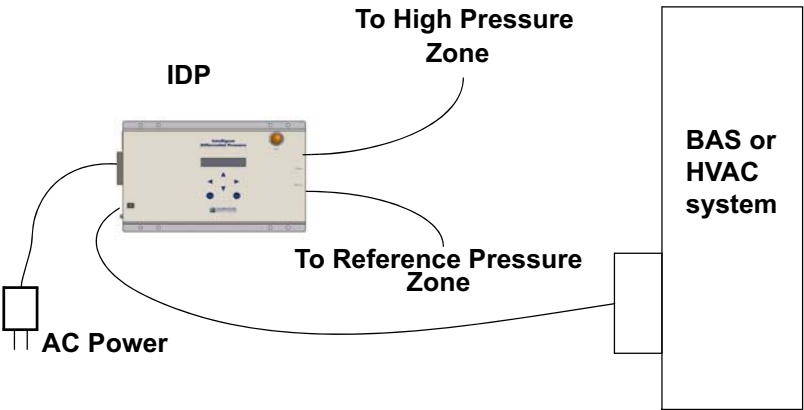


Figure 5-5 IDP to BAS/HVAC System Connection

Connecting to a Relay

Two of the pinouts (10 and 11) allow the option of displaying the high alarm and the low alarm responses. This can allow for relay control of lights, buzzers, sirens, etc. to indicate an alarm, or even a shutdown of equipment if pressure moves outside alarm boundaries.

To determine the optimal pressure set point, the upper and lower alarm limits, and the alarm beginning and ending settings, use the commands on the SETPOINT and CONFIG menus, which are described in Chapter 4, or the equivalent remote configuration commands described in Chapter 6.

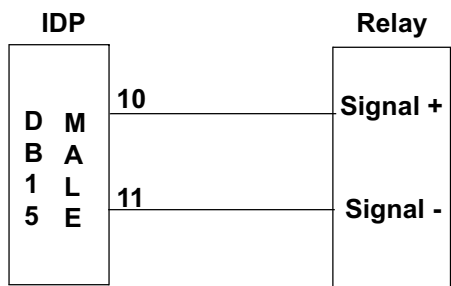


Figure 5-6 IDP - Relay Pinouts

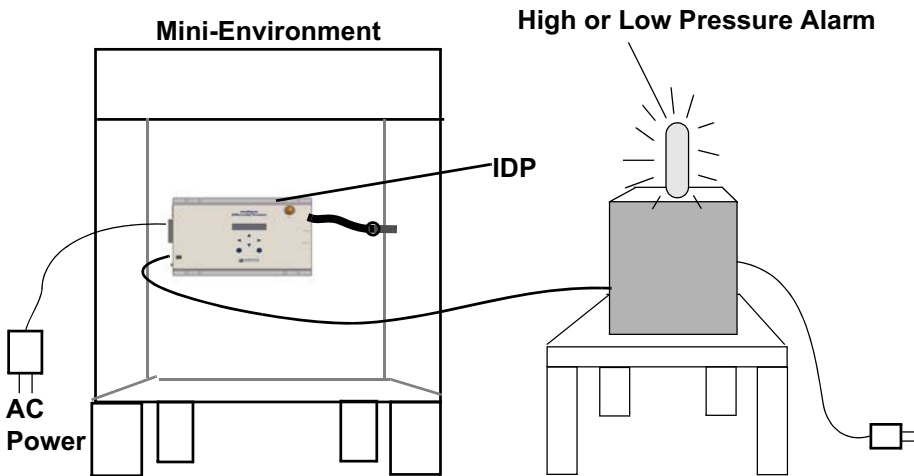


Figure 5-7 Example of Relay Control

A machine sits near the mini-environment and is connected to the IDP using pins 10 and 11, which are for the low and high alarms. If the pressure dips below the low alarm threshold or rises above the high alarm threshold, the IDP sends a signal to a relay, causing the high/low pressure alarm light to flash. This light scenario can be substituted for buzzers or another warning system.

Example Applications Using the Air Control Feature

The air controller is a standard IDP feature. Most IDP applications use this feature.

The air control feature regulates the value of an air handler (for example the speed of a fan) in a mini-environment, an exhaust hood, other equipment, or even an entire cleanroom. To use this feature, plug the power cord of the air handler into the outlet in the top left corner of the IDP.

The IDP varies the value of the air handler to keep the pressure as near the set point selected as possible. To set the set point, use the PRESSURE command in the SETPOINT menu (Chapter 4) or the STPR remote configuration command (Chapter 6).

You can also set maximum and minimum air handler values so the air handler always stays within a range of values. To set the maximum and minimum value, use the MAX.VAL and MIN. VAL commands on the CONTROL menu (Chapter 4) or the CTMX and CTMN remote configuration commands (Chapter 6). These commands can minimize turbulence within an environment.

The IDP uses the PID algorithm with the terms selected to adjust the air handler value. Refer to Chapter 7 for more details on the air controller and the PID algorithm.

This section describes the following applications:

- Working with a Mini-Environment
- Working with an Exhaust Hood
- Multi-functional Application (showing all IDP features)

Working with a Mini-Environment

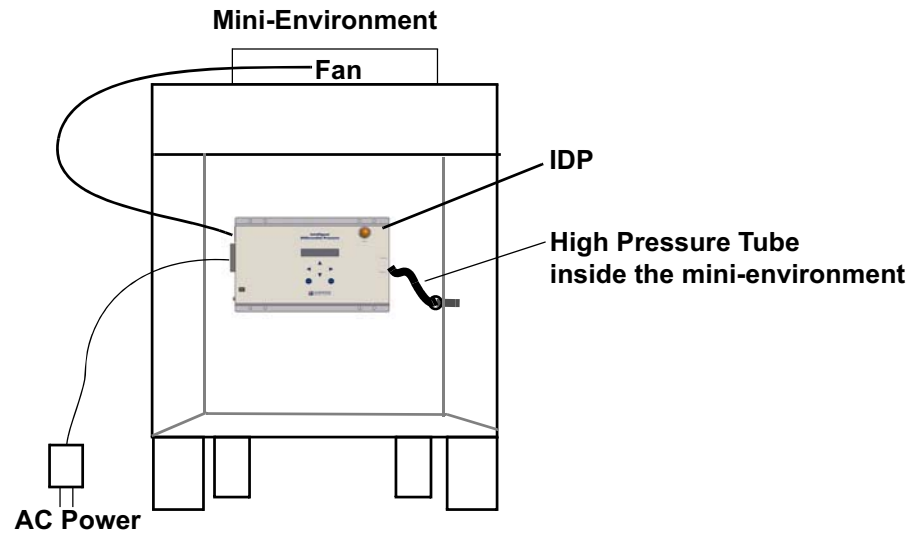


Figure 5-8 IDP and Air Controller on a Mini-Environment

This figure demonstrates a system that regulates and maintains positive pressure within a mini-environment. As the pressure inside the mini-environment changes, the IDP adjusts the air handler value dynamically to keep the differential pressure near the set point.

Working with an Exhaust Hood

You can also use an IDP with the air controller feature for an exhaust hood over a wet bench.

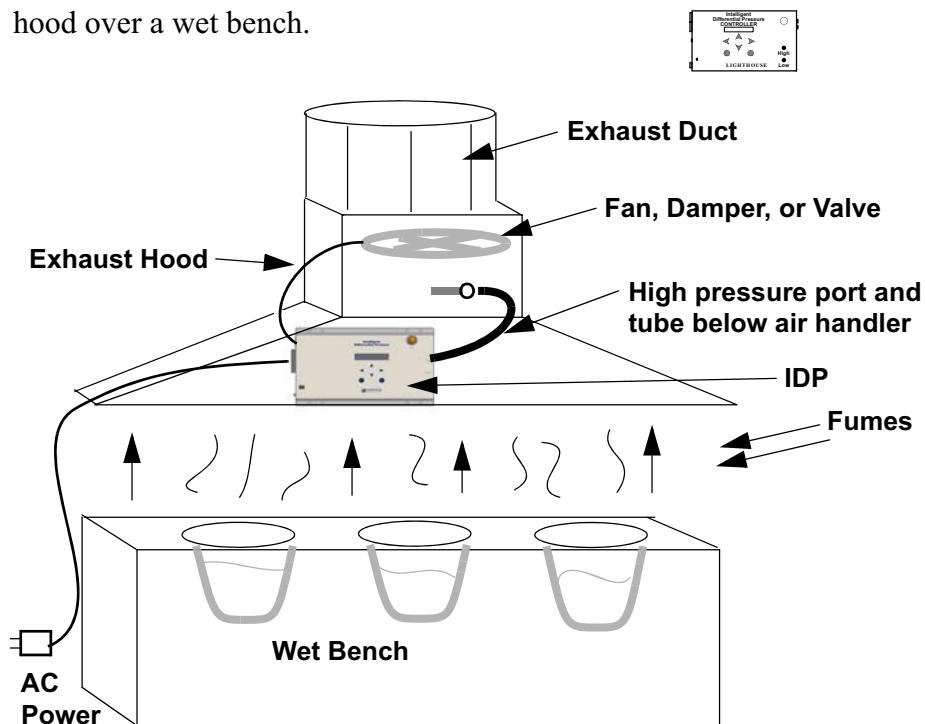


Figure 5-9 IDP on an Exhaust Hood

Note: To use the IDP to maintain a negative pressure, use the High (pressure) port to measure the low pressure area and the Low (reference) port to measure the reference pressure, and use the `PRESSURE=` command on the `CONTROL` menu (or the CTPR remote configuration command) to change the default pressure to NEG. (or N).

When doors are opened and then closed in a chemical bay, fumes may blow into the room because of the turbulence created by the low to high pressure change.

To prevent this situation, the IDP uses the air controller to maintain a negative pressure under the exhaust hood relative to the room. This draws the chemical fumes away from operators and prevents cross contamination. The IDP regulates the air handler in the hood or duct to maintain the pressure near the set point.

Multi-functional Application

The IDP can connect directly to a host computer, an HVAC system, an SIU, and a relay at the same time. The following example uses most of the features of the IDP in one system and requires most of the pins in the DB15 connector.

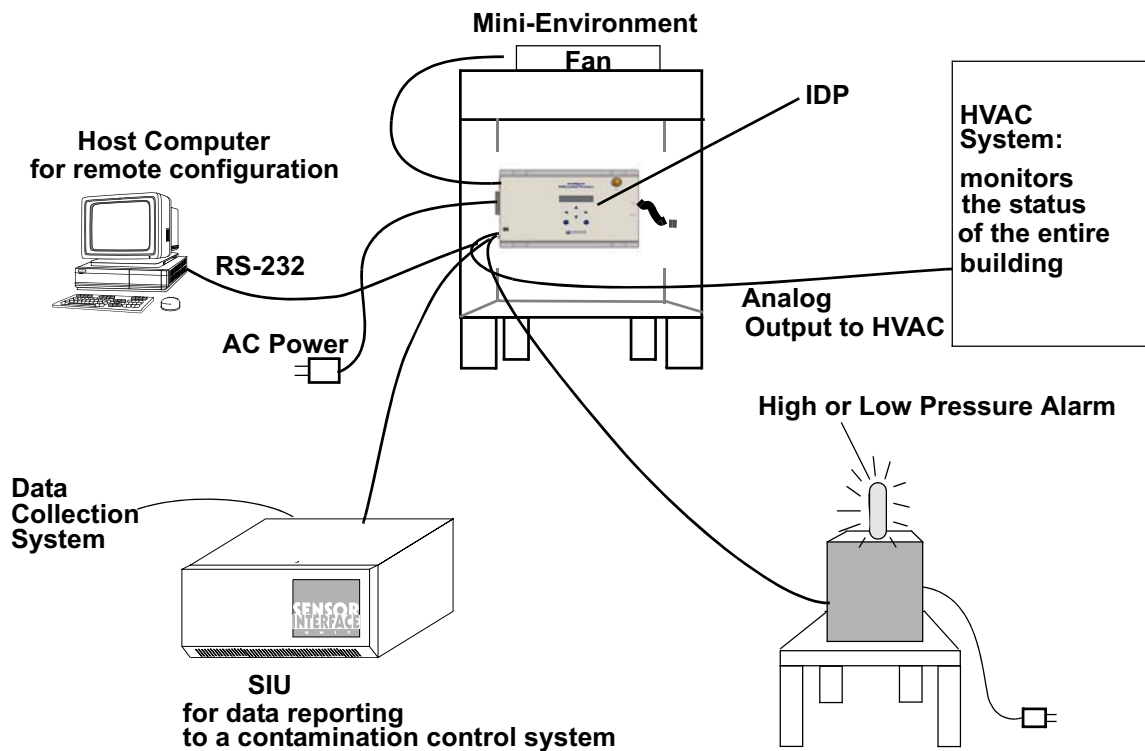


Figure 5-10 Multi-functional Application

The host computer configures the IDP and stores data from the IDP. The SIU also stores data from the IDP and reports it to a contamination control monitoring system such as LMS. The HVAC reports the status of all the rooms in the building to a centralized building map. The high-pressure and low-pressure alarm lights signal abnormal pressures in the mini-environment.

6

Remote Configuration

Connecting the IDP to a terminal emulator or a host computer running terminal emulator software allows you to configure the IDP remotely; if your IDP lacks a control panel, using a host computer is the only way to fully configure the IDP. To configure an IDP remotely using a host computer, you must perform these steps:

1. Decide whether you want to configure a single IDP (RS-232) or multiple IDPs (RS-485), then make a cable to connect the host computer and the IDP(s). You can choose multiple IDPs only if your IDPs have the RS-485 option installed. See Chapter 3 for cabling information.
2. Configure the address and baud rate of each IDP if you are using RS-485 communication. You can do this via the control panel or the RS-232 interface.
3. Be sure that the IDP's serial setting matches the cable you are using. For RS-232 protocol, select SERIAL=RS-232 on the REMOTE menu or use the equivalent RMSR 2 remote configuration command. For RS-485 protocol, select SERIAL=RS-485 on the REMOTE menu or use the equivalent RMSR 4 remote configuration command.
4. Use the other serial commands to fully configure the IDP(s).

This chapter describes these steps and lists the serial commands.

Assigning Addresses and the BAUD Rate (RS-485 Only)

You must manually configure each IDP with an address (1-120) by using the control panel (described in Chapter 4) or the RS-232 interface. You must also assign the same baud rate to each IDP if the baud rate is not the default, which is 9600. If you are using the RS-232 interface, enter the following commands for each IDP:

- | | |
|------------------|------------------------------|
| RMBD <i>nnnn</i> | Sets the baud rate. |
| RMAD <i>nn</i> | Sets the multi-drop address. |

Note: *The data is transmitted at 8 data bits, no parity, and 1 stop bit.*

Once you have assigned the IDPs addresses and baud rates, the remaining configuration settings of all the IDPs may be completed using the RS-485 interface. The baud rate and addresses you set remain even if you turn off the IDPs.

Serial Commands for Remote Configuration

Use the following commands to configure the IDP. Most of these commands correspond to commands discussed in Chapter 4.

To send a command to one of the IDPs in a multi-drop arrangement, prefix the command with the multi-drop address. For example, to set the setpoint pressure of the IDP at address 5 to 3 milli-inches H₂O (for a $\pm 0.1''$ H₂O sensor), use this command:

5STPR 300

Help and Version Commands

? Displays a list of all serial commands, as follows:

```
*Run mode-----Setpoint-----Configuration--
*RURD -read          STRD -read          CFRD -read
*RUMD -mode          STPR -pressure       CFAB -alarm begin
*Control-----STHI -high alarm    CFAE -alarm end
*CTRD -read          STLO -low alarm    CFPS -password
*CTMD -mode          Remote-----Sensor-----
*CTFV -fixed value  RMRD -read          SNRD -read
*CTMX -max. value  RMBD -baud          SNZS -zero
*CTMN -min. value  RMSR -serial mode  SNZA -auto_zero
*CTTY -type        RMEC -echo          SNRT -rate
*CTPR -pressure    RMRP -reply         SNTY -type
*CTTP -term P      RMAD -address       SNTR -type read
*CTTI -term I      Diagnostics-----Pressure-----
*CTTD -term D      DIER -show errors  PRRD -read/clear
*Version-----DICL -clear errors  PRCN -read cont.
*VRRD -read                DIWK -wink
```

VRRD Reads and displays the IDP firmware version and information about the features installed on the IDP. An IDP with all but the mutually exclusive features installed would display the following information (in verbose mode for the RMRP command):

```
*Version read
*Number:      IDP 3.00e
*LCD:         ON
*232:         ON
*485:         ON
*Lamp:        ON
*Ext Out:     ON
*0-5v:        ON
```

```
*4-20 ma:    OFF
*0-10 kHz:    OFF
*Serial #:    12345678
```

Run Commands

RURD Reads and displays the current run mode setting.

Verbose display:

```
*Run read
*Mode:    PRESSURE
```

Terse display:

```
*RUN: Mode=PRESSURE
```

RUMD [C | P | A | L] Determines what the LCD displays in run mode. C, the default, cycles the display between the pressure, air handler value, and alarm value. Each value is displayed for 5 seconds. P displays only the differential pressure. A displays only the air handler value. L displays only the alarm value.

The alarm value is displayed only if your IDP has the alarm lamp or alarm output feature installed.

Setpoint Commands

STRD Reads and displays the current setpoint settings.

Verbose display:

```
*Setpoint read
*Pressure:  1000
*Alarm hi:  2500
*Alarm lo:   0
```

Terse display:

```
*SET: Pressure=1000, Alm_hi=2500, Alm_lo=0
```

STPR *nnnn* Sets the setpoint pressure. Type the number with no decimal point. To determine the range of the sensor and the units displayed, see Appendix B. The default for a $\pm 0.1''$ sensor is 500 (5.00 m" H₂O).

STHI *nnnn* Sets the upper limit of pressure beyond which an alarm is triggered. Type the number with no decimal point. To determine the range of the sensor and the units displayed, see Appendix B. The default for a $\pm 0.1''$ sensor is 1000 (10.00 m² H₂O). This command is available only if your IDP has the alarm lamp or alarm output feature installed.

STLO *nnnn* Sets the lower limit of pressure beyond which an alarm is triggered. Type the number with no decimal point. To determine the range of the sensor and the units displayed, see Appendix B. The default is 0. This command is available only if your IDP has the alarm lamp or alarm output feature installed.

Configuration Commands

CFRD Reads and displays the current configuration settings.

Verbose display:

```
*Configuration read
*Alarm begin: 0
*Alarm end: 0
*Password: none
```

Terse display:

```
*CFG: Alm_beg=0, Alm_end=0, Pswd=none
```

CFAB *nnn* Sets the Alarm Begin value, which is the number of seconds to wait before starting to signal an alarm. The default is 0 seconds, which sets the Alarm Begin value equal to the sampling rate. Possible values are between 0 and 999 seconds. This command is available only if your IDP has the alarm lamp or alarm output feature installed.

CFAE *nnn* Sets the Alarm End value, which is the number of seconds to wait before ending an alarm signal. The default is 0 seconds, which sets the Alarm End value equal to the sampling rate. Possible values are between 0 and 999 seconds. This command is available only if your IDP has the alarm lamp or alarm output feature installed.

CFPS *xxxx* Sets the configuration password to the combination of control panel arrow buttons you type in. The password can be up to four button presses long. Use the following letters to represent the panel buttons in serial mode:

U	Up
D	Down
L	Left
R	Right

The default is no password. To erase the password, enter “CFPS none”.

Control Commands

CTRD Reads and displays the current control settings.

Verbose display:

```
*Control read
*Mode:      AUTO
*Fixed value: 0
*Max. value: 700
*Min. value: 0
*Type:      B
*Pressure:   POSITIVE
*Term-P:     10
*Term-I:     3
*Term-D:     7
```

Terse display (all on one line):

```
*CTL: Mode=AUTO, Fixed=0, Max=700, Min=0,
Type=B, Prs=POS, P=10, I=3, D=7
```

CTMD [A | F] Sets the control mode to A (auto) or F (fixed). Auto control, the default, allows the IDP to determine the air handler value based on the measured pressure and control parameters. Fixed control locks in a percent maximum air handler value and tells the IDP not to vary from it.

CTFV *nnnn* Sets the percent maximum value at which the air handler stays if you specify the FIXED control mode. The value 1000 represents 100%. The default is 0.

CTMX *nnnn* Sets an upper limit on the value of the air handler, expressed as a percentage of the maximum value. The value 1000, which is the default, represents 100%.

CTMN *nnnn* Sets a lower limit on the value of the air handler, expressed as a percentage of the maximum value. The value 1000 represents 100%. The default is 0.

CTTY [A | B] Selects control mode A or B as the type of electronic air control the IDP uses. The default is A.

CTPR [P | N] Specifies whether the pressure sampled by the High port is positive (P, the default) or negative (N) when compared to the reference pressure sampled by the Low port.

CTTP *nn* Sets the control P-term. Enter a value between 0 and 999. The value you enter is divided by 100. For example, if you enter 20, the value is set at 0.20. The default is 10, or 0.10.

CTTI *nn* Sets the control I-term. Enter a value between 0 and 999. The value you enter is divided by 100. For example, if you enter 20, the value is set at 0.20. The default is 10, or 0.10.

CTTD *nn* Sets the control D-term. Enter a value between 0 and 999. The value you enter is divided by 100. For example, if you enter 20, the value is set at 0.20. The default is 10, or 0.10.

Remote Communication Commands

RMRD Reads and displays remote communication settings.

Verbose display:

```
*Remote read
*Baud:      9600
*Serial:    232
*Echo:      Enable
*Reply:     Verbose
*Address:   120
```

Terse display (all on one line):

```
*REM: Baud=9600, Serial=232, Echo=Enable,
Reply=Terse, Address=120
```

RMBD *nnnn* Sets the baud rate. Options are 1200, 2400, and 9600. The default is 9600.

Note: *The data is transmitted at 8 data bits, no parity, and 1 stop bit.*

RMSR [2 | 4] Selects RS-232 (2) or RS-485 (4) as the communication setting. An RS-232 cable connects a host computer and a single IDP. An RS-485 cable connects a host computer to up to 120 IDPs. The default is RS-232.

RMEC [E | D] Enables (E, the default) or disables (D) echoing of commands.

RMRP [V | T] Determines the information format for IDP replies. Choose verbose (V, the default) or terse (T).

RMAD *nn* Sets the multi-drop (RS-485) address. The default value is 120.

Sensor Commands

SNRD Reads and displays the model and range of the installed sensor.

Verbose display:

```
*Sensor read
*Zero: 627
*Rate: 5
*Model: SDB.1"
```

Terse display:

```
*SNS: Zero=627, Rate=5, Model=SDB.1"
```

SENTY *tt* Sets the sensor type for the IDP. The *tt* is a number that represents the sensor type according to the following table:

<u>No.</u>	<u>Sensor Type</u>	<u>Description String</u>	<u>Range</u>
00	SETRA 264 \pm 0.1" H ₂ O	SDB.1"	0.099"
01	SETRA 264 \pm 0.25" H ₂ O	SDB.25"	0.250"
02	SETRA 264 \pm 0.5" H ₂ O	SDB.5"	0.500"
03	SETRA 264 \pm 1" H ₂ O	SDB1"	0.999"
04	SETRA 264 \pm 2.5" H ₂ O	SDB2.5"	2.500"
05	SETRA 264 \pm 5" H ₂ O	SDB5"	5.000"
06	SETRA 264 \pm 0.1" H ₂ O	SDB.1"	0.099"
07	SETRA 264 \pm 0.25" H ₂ O	SDB.25"	0.250"
08	SETRA 264 \pm 0.5" H ₂ O	SDB.5"	0.500"
09	SETRA 264 0 - 1" H ₂ O	SDU1"	0.999"
10	SETRA 264 0 - 2.5" H ₂ O	SDU2.5"	2.500"
11	SETRA 264 0 - 5" H ₂ O	SDU5"	5.000"
12	SETRA 264 0 - 10" H ₂ O	SDU10"	9.999"
13	SETRA 264 0 - 25" H ₂ O	SDU25"	25.00"
14	MODUS T10 \pm 0.1" H ₂ O	MDB.1"	0.999"
15	MODUS T10 \pm 0.2" H ₂ O	MDB.2"	0.200"
16	MODUS T10 \pm 0.3" H ₂ O	MDB.3"	0.300"
17	MODUS T10 \pm 0.5" H ₂ O	MDB.5"	0.500"
18	MODUS T10 \pm 1" H ₂ O	MDB1"	0.999"

19	MODUS T10 \pm 2" H ₂ O	MDB2"	2.000"
20	MODUS T10 \pm 3" H ₂ O	MDB3"	3.000"
21	MODUS T10 \pm 5" H ₂ O	MDB5"	5.000"
22	MODUS T10 \pm 10" H ₂ O	MDB10"	9.999"
23	MODUS T10 0 - 0.1" H ₂ O	MDU.1"	0.099"
24	MODUS T10 0 - 0.2" H ₂ O	MDU.2"	0.200"
25	MODUS T10 0 - 0.3" H ₂ O	MDU.3"	0.300"
26	MODUS T10 0 - 0.5" H ₂ O	MDU.5"	0.500"
27	MODUS T10 0 - 1" H ₂ O	MDU1"	0.999"
28	MODUS T10 0 - 2" H ₂ O	MDU2"	2.000"
29	MODUS T10 0 - 3" H ₂ O	MDU3"	3.000"
30	MODUS T10 0 - 5" H ₂ O	MDU5"	5.000"
31	MODUS T10 0 - 10" H ₂ O	MDU10"	9.999"

SNTR Displays the supported sensor types. The sensor type number, description string, units, and range are displayed for each supported sensor type. (For a more detailed list of sensor types, see the SNTY description above.)

The range is displayed as four numbers: a minimum value, a maximum value, the total number of digits, and the number of decimal digits. For example, the following sensor type has a minimum value of 0, a maximum value of 2500, four display digits, and one decimal place:

```
*#   type   units  min   max #dig #dec
*-----
* 7 SDU.25"  m"           0  2500   4   1
```

This means that the maximum value is 0.2500".

The SNTR display looks like this:

```
*Sensor Type read
*#   type   units  min   max #dig #dec
*-----
* 0 SDB.1"   m"    -9999  9999   4   2
* 1 SDB.25"  m"    -2500  2500   4   1
* 2 SDB.5"   m"    -5000  5000   4   1
* 3 SDB1"    m"    -9999  9999   4   1
* 4 SDB2.5"  "      -2500  2500   4   3
* 5 SDB5"    "      -5000  5000   4   3
* 6 SDU.1"   m"         0  9999   4   2
* 7 SDU.25"  m"         0  2500   4   1
* 8 SDU.5"   m"         0  5000   4   1
* 9 SDU1"    m"         0  9999   4   1
*10 SDU2.5"  "         0  2500   4   3
*11 SDU5"    "         0  5000   4   3
*12 SDU10"   "         0  9999   4   3
```

*13	SDU25"	"	0	2500	4	2
*14	MDB.1"	m"	-9999	9999	4	2
*15	MDB.2"	m"	-2000	2000	4	1
*16	MDB.3"	m"	-3000	3000	4	1
*17	MDB.5"	m"	-5000	5000	4	1
*18	MDB1"	m"	-9999	9999	4	1
*19	MDB2"	"	-2000	2000	4	3
*20	MDB3"	"	-3000	3000	4	3
*21	MDB5"	"	-5000	5000	4	3
*22	MDB10"	"	-9999	9999	4	3
*23	MDU.1"	m"	0	9999	4	2
*24	MDU.2"	m"	0	2000	4	1
*25	MDU.3"	m"	0	3000	4	1
*26	MDU.5"	m"	0	5000	4	1
*27	MDU1"	m"	0	9999	4	1
*28	MDU2"	"	0	2000	4	3
*29	MDU3"	"	0	3000	4	3
*30	MDU5"	"	0	5000	4	3
*31	MDU10"	"	0	9999	4	3

SNZS *nnnn* Determines the offset necessary for the IDP to correctly determine a zero pressure differential. Type the number with no decimal point. To determine the range of the sensor and the units displayed, see Appendix B. The default is 0.

SNZA Automatically zeros the sensor. Follow these steps:

1. Disconnect the sensor tubes so the high and low ports are seeing the same pressure.
2. Make sure the IDP is mounted in the position in which it will run. For best results, the IDP should be vertical. If you change the position of the IDP, you should re-zero it.
3. Enter the SNZA command. The IDP will begin collecting pressure samples to determine the zero offset. The AUTO ZEROING message is displayed on the LCD.
4. Press any key on the host computer keyboard to stop the sampling.

SNRT *nnn* Determines the rate in tenths of seconds that the IDP reports changes in pressure, air value, or alarm status. The default is 005, or 0.5 seconds. Possible values are between 0.1 and 99.9 seconds.

Diagnostic Commands

DIER Displays current error conditions within the IDP.

Verbose display:

```
*ERR= NONE
```

Terse display:

```
*ERR= NONE
```

DICL Clears current IDP errors.

DIWK Makes the power light blink at a half-second rate. This command is useful if you forget which of a long series of IDPs has a particular RS-485 address.

Pressure Commands

PRRD Reads and displays the current pressure, cumulative pressure count, and number of pressure measurements, then clears the cumulative pressure.

Verbose display:

```
*Pressure read
*Current: 977
*Total: 215186164
*Count: 18584
*Rate: 5
```

Terse display (all on one line):

```
*PRS: Current=985, Total=387917, Count=385,
      Rate=5
```

PRCN Continually reads the current pressure measurement and sends it to the host computer. The LCD displays “PRESSURE XMIT.” Turn off this command by pressing any key on the host computer keyboard.

7

Air Control and the PID Algorithm

This chapter explains how to configure the IDP to control air flow. The IDP adjusts the air handler value, which could be a fan speed, valve setting, damper setting, or other setting that determines air flow.

Throughout this chapter, you will see references to menu commands and remote configuration commands. For more information about menu commands, see Chapter 4; for remote configuration commands, see Chapter 6.

Setting Up the Air Controller

WARNING: *If the fuse burns, check all connections. Don't ever use a fuse greater than the rating allowed. Doing this may damage internal components or present an electrical hazard that could make the unit dangerous to operate or to service.*

The air controller feature regulates the air handler value within a mini-environment, an exhaust hood, or another piece of equipment. The range of the air handler value is 0-100%.

Plug the air handler into the female AC line connector on the IDP. The male AC line connector supplies power to the IDP and air handler. The size of the fuse is 3AG; the rating is 10 amps.

Set point Control and Alarms

The IDP can maintain a pre-configured pressure set point and adjust the air handler value as necessary. Use the PRESSURE= command on the SETPOINT menu or the STPR remote configuration command.

To set alarms for high and low pressure limits, use the HI ALARM= and LO ALARM= commands on the SETPOINT menu or the STHI and STLO remote configuration commands. These commands are available only if your IDP has the alarm lamp or alarm output feature installed.

Specifying Positive or Negative Pressure

Use the PRESSURE= command on the CONTROL menu (not the SETPOINT menu) or the CTPR remote configuration command to specify whether the IDP should maintain a positive or negative pressure.

The high (pressure) port measures the pressure in the environment you are monitoring, which is compared to the reference pressure. The low (reference) port measures the reference pressure. If the pressure port should sense a higher pressure than the reference port, specify PRESSURE=POS. If the pressure port should sense a lower pressure, specify PRESSURE=NEG.

Control Type

The IDP supports two types of air handler control, A and B. The type that works best depends on your air handler and the environment. It is important to try both types to see which works best, because the type you choose may drastically affect the IDP's performance. Use the TYPE= command on the CONTROL menu or the CTTY remote configuration command.

Controlling the Air Handler Value Directly

You can directly control the air handler value by either setting a fixed value or setting maximum and minimum value limits. You can set maximum and minimum value limits in conjunction with controlling the air handler using the PID algorithm.

Manual Control

You can set the air handler value to a fixed value between 0% and 100% using the CONTROL= FIXED and FIXED VAL= commands on the CONTROL menu or the CTMD F and CTFV remote configuration commands. If you set a fixed air handler value, pressure set points and PID terms are ignored.

Maximum and Minimum Air Handler Values

You can set a maximum and minimum air handler value in addition to using the PID algorithm to control the pressure.

The maximum air handler value, which is configured by the IDP, sets the upper threshold of the air handler value. This can be important to minimize the amount of turbulence that can be caused when the environment experiences a sudden change from low to high pressure.

In a mini-environment, when a door is opened wide, the pressure drops,

Note: *Setting the maximum and minimum values too tightly limits the effect the IDP can have on the environment via closed loop control. It is best to adjust the PID terms first and then lightly adjust the maximum and minimum values to optimize performance.*

which can cause the IDP to bring the air handler to its 100% value in order to attempt to maintain the pressure set point. If the door is suddenly closed, the IDP reacts quickly to adjust the air handler value, but many air handlers cannot respond as quickly when slowing down. This could cause a pocket of turbulence within the mini-environment. By setting a maximum air handler value, the air handler won't reach its full value when the door is opened, and when the door is closed, the air handler slows down much more quickly and with less impact on the pressure in the environment.

You can also set a minimum value to ensure that the pressure never drops too low to effectively control the air flow.

To set a maximum or minimum air handler value, use the CONTROL=AUTO and MAX. VAL= or MIN. VAL= commands on the CONTROL menu or the CTMD A and CTMX or CTMN remote configuration commands.

Using the PID Algorithm

The PID Algorithm determines characteristics of the response of the air handler to changing conditions. The PID algorithm works using 3 terms: P (proportional, or speed of response), I (integral, or oscillation dampening), and D (derivative, or over/undershoot minimization). These terms are calculated in a sum to achieve a flexible control strategy that works in your environment.

To set the P, I, and D terms, use the P-TERM=, I-TERM=, and D-TERM= commands on the CONTROL menu or the CTPP, CTTI, and CTTD remote configuration commands.

You should set the P term first, then the I term, then the D term. The I and D terms refine the effect of the P term.

“High” and “Low” in the descriptions that follow refer to a term's value in relation to the other terms, not to the absolute values of the terms.

P (Proportional Term) — Speed of Response

This term controls how fast the unit responds to changes in pressure. It affects how forcefully the air handler moves towards the set point when a change in pressure moves it away from the set point. This term is based on the difference between the current pressure and the pressure set point.

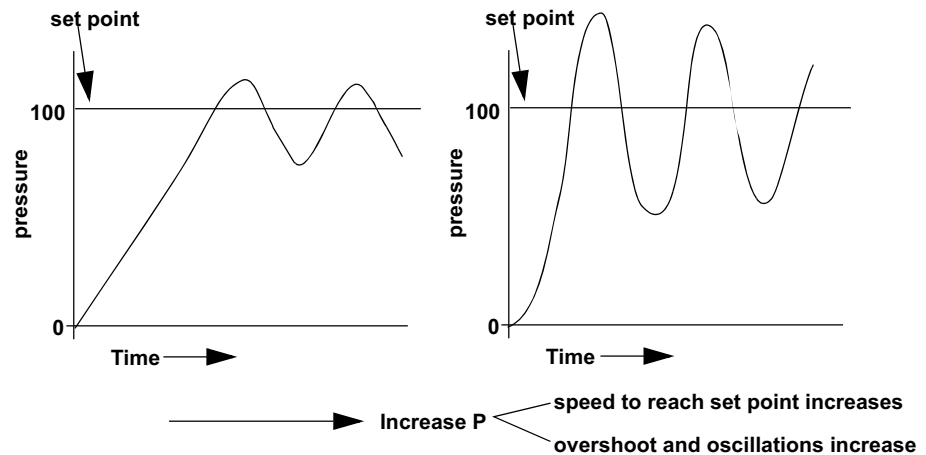


Figure 7-1 Effect of increasing the P term on reaching the set point

This graph shows the affect that the Proportional term has on the differential pressure. As the P term increases, the air handler responds more quickly and forcefully to changes in pressure, but has a tendency to overshoot or undershoot the set point and to oscillate more wildly. A lower P term will minimize overshoot and undershoot but will also make the air handler respond much more slowly to changes in pressure.

I (Integral Term) — Dampens Oscillations

The I term tends to smooth out the oscillations (overshoot and undershoot) over time. This term keeps a running total of pressure differences from the set point and uses this sum to dampen oscillations over time. This sum tends to lag the instantaneous change and work to offset it.

Initial movements toward the set point tend to be quick, but the I term smooths oscillations once the set point is reached.

When you add the I term and the P term, the oscillations of the differential pressure smooth out over time.

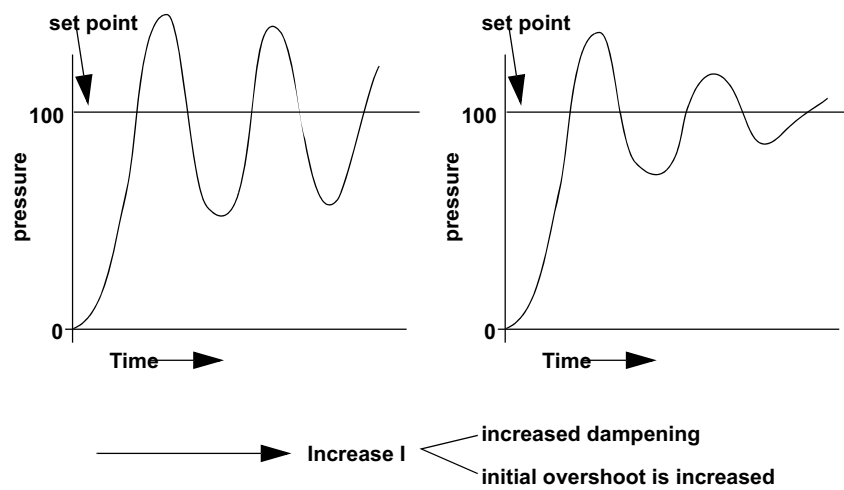


Figure 7-2 Effect of increasing the I term on reaching the set point

This graph shows the pressure immediately overshooting the set point, then making a downward turn undershooting the set point. But gradually, the overshooting and undershooting is toned down, bringing the actual pressure closer and closer to the set point.

D (Derivative Term) — Minimizes Overshoot

This term is the difference between the error (pressure - set point) on the current pass and the previous pass. It is a measure of acceleration, of how quickly the pressure is closing in on the set point. This term adjusts acceleration of the pressure towards the set point, tending to slow adjustment down as the pressure nears the set point. The larger the D term, the less overshooting or undershooting of the set point. A large D term, though, also delays the time to reach the set point.

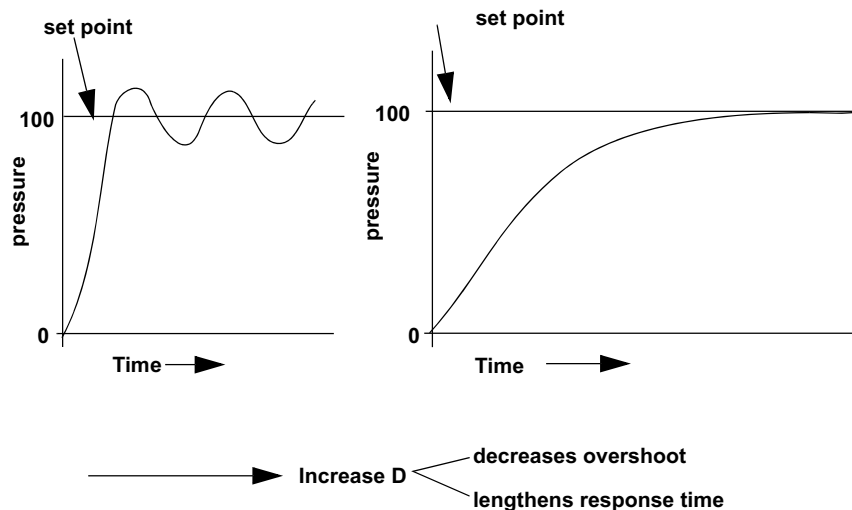


Figure 7-3 Effect of increasing the D term on reaching the set point

The PID terms are applied to the calculation according to the weights defined in the configuration. The weights will vary with each air handler and each area as the pressure dynamics will be different in each environment. The terms can be adjusted to yield optimum results.

A

IDP External Connector Pinouts

Note: *All pins are not necessarily used at the same time. Pin selections will depend on your particular configuration and application of the IDP.*

The IDP serial port requires the use of a male DB15 connector. The following table shows the connector pin outs.

Table A-1 Description of Pinouts

<u>Pin No.</u>	<u>Pin Name</u>	<u>Description</u>
1	Chassis GND	This is the safety ground wire that is tied to the IDP box. This should be connected to the shield on shielded cable at the IDP end only. The IDP should be tied to earth ground for electrical safety. This is done internally via the ground pin on the AC line cord.
2	RD_232	These are the RS-232 lines for communication with a host computer (GND, which is also required, is pin 5). You must create a null-modem cable to connect these pins with the RD and TD pins on the computer's serial port. For more information, see Chapter 6.
3	TD_232	
4	5V	This supplies 5V to a device needing power (for example, an external relay). Be sure that the device is electrically isolated and draws no more than 50 mA. Use pin 5 as GND.
5	GND	This is the ground line for the RS-232 and RS-485 lines and the 5V power supply.
6	TX/RX+	These are RS-485 lines for communication with a host computer. For more information, see Chapter 6.
7	TX/RX-	

<u>Pin No.</u>	<u>Pin Name</u>	<u>Description</u>
		<p>The computer's RS-485 interface must be half-duplex, that is, the TX+ and RX+ lines are tied together and the TX- and RX- lines are tied together.</p> <p>The TX/RX+ line from the computer must connect with pin 6 of each IDP, and the TX/RX- line must connect with pin 7.</p> <p>At both ends of the cable, the TX/RX+ and TX/RX- lines must be terminated, that is, they must be connected together via a resistor with the characteristic impedance of the cable (see the cable specifications; it is usually 50 - 200Ω).</p>
8	EXT_LWRA	<p>These lines are for a lower alarm output. This signal can turn on a light stick, bell, or other device. A voltage is applied to pin 10 and returns on pin 11 in an alarm condition and is blocked during normal conditions. This circuit is opto-isolated for electrical safety.</p>
9	EXT_LWRB	
10	EXT_UPRA	<p>These lines are for an upper alarm output. This signal can turn on a light stick, bell, or other device. A voltage is applied to pin 10 and returns on pin 11 in an alarm condition and is blocked during normal conditions. This circuit is opto-isolated for electrical safety.</p>
11	EXT_UPRB	
12	EXT_FRQA	<p>These lines transmit data to an SIU. Pin 12 connects to Channel + (pin 3 or 5) on the SIU DB15 connector. Pin 13 connects to Channel - (pin 2 or 4). The range of this signal is 0 - 10 kHz.</p>
13	EXT_FRQB	
14	ANALOG_OUT	<p>This is the analog output, which is proportional to the measured differential pressure. The range can be 0 - 5 VDC or 4 - 20 mA; the scale is linear. The signal is output on pin 14 and returned on pin 15.</p>
15	ANALOG_GND	

B Sensor Types & Pressure Conversions

This appendix lists pressure ranges and display units for all the supported sensors and conversion factors for commonly used pressure measurements.

Sensor Type Definitions

Use the following table to find the units of the pressures you enter using the SETPOINT menu commands and the ZERO= command on the SENSOR menu (STPR, STHI, STLO, and SNZS in serial mode). Use the MODEL= command on the SENSOR menu (SNRD in serial mode) to display the type of sensor your IDP has, then use Tables B-1 and B-2 to find the display units.

See Chapter 4 for more information on the menu commands or Chapter 6 for more information on the serial commands.

WARNING: *It is important not to exceed the overpressure limit for the sensor. Exceeding this pressure may cause irreparable damage to the sensor.*

The following table lists the types of sensors that can be configured for the IDP. Each IDP is configured to the customer's specifications at the time of manufacture. You can also list sensor types using the SNTR serial command.

In addition to the maximum and minimum pressure range, each sensor has an overpressure limit that specifies the point at which the sensor's diaphragm can be damaged.

Table B-1 Front-Mounted Sensor Type Definitions

Sensor Type (MODEL=)	Sensor Range	Serial Mode Entry Range	LCD Lower Limit	LCD Upper Limit	Overpressure Limit
SDB.1"	± 0.1" H ₂ O	-9999 to 9999	-99.99 m"	99.99 m"	10" H ₂ O
SDB.25"	± 0.25" H ₂ O	-2500 to 2500	-250.0 m"	250.0 m"	10" H ₂ O
SDB.5"	± 0.5" H ₂ O	-5000 to 5000	-500.0 m"	500.0 m"	10" H ₂ O

Sensor Type (MODEL=)	Sensor Range	Serial Mode Entry Range	LCD Lower Limit	LCD Upper Limit	Overpressure Limit
SDB1"	± 1" H ₂ O	-9999 to 9999	-999.9 m"	999.9 m"	10" H ₂ O
SDB2.5"	± 2.5" H ₂ O	-2500 to 2500	-2.500"	2.500"	10" H ₂ O
SDB5"	± 5" H ₂ O	-5000 to 5000	-5.000"	5.000"	25" H ₂ O
SDU.1"	0 to 0.1" H ₂ O	0 to 9999	0 m"	99.99 m"	10" H ₂ O
SDU.25"	0 to 0.25" H ₂ O	0 to 2500	0 m"	250.0 m"	10" H ₂ O
SDU.5"	0 to 0.5" H ₂ O	0 to 5000	0 m"	500.0 m"	10" H ₂ O
SDU1"	0 to 1" H ₂ O	0 to 9999	0 m"	999.9 m"	10" H ₂ O
SDU2.5"	0 to 2.5" H ₂ O	0 to 2500	0"	2.500"	10" H ₂ O
SDU5"	0 to 5" H ₂ O	0 to 5000	0"	5.000"	25" H ₂ O
SDU10"	0 to 10" H ₂ O	0 to 9999	0 m"	9.999"	50" H ₂ O
SDU25"	0 to 25" H ₂ O	0 to 2500	0"	25.00"	125" H ₂ O

Table B-2 Side-Mounted Sensor Type Definitions

Sensor Type (MODEL=)	Sensor Range	Serial Mode Entry Range	LCD Lower Limit	LCD Upper Limit	Overpressure Limit
MDB.1"	± 0.1" H ₂ O	-9999 to 9999	-99.99 m"	99.99 m"	1" H ₂ O
MDB.2"	± 0.2" H ₂ O	-2000 to 2000	-200.0 m"	200.0 m"	1.6" H ₂ O
MDB.3"	± 0.3" H ₂ O	-3000 to 3000	-300.0 m"	300.0 m"	2.4" H ₂ O
MDB.5"	± 0.5" H ₂ O	-5000 to 5000	-500.0 m"	500.0 m"	4" H ₂ O
MDB1"	± 1" H ₂ O	-9999 to 9999	-999.9 m"	999.9 m"	8" H ₂ O
MDB2"	± 2" H ₂ O	-2000 to 2000	-2.000"	2.000"	16" H ₂ O
MDB3"	± 3" H ₂ O	-3000 to 3000	-3.000"	3.000"	24" H ₂ O
MDB5"	± 5" H ₂ O	-5000 to 5000	-5.000"	5.000"	40" H ₂ O
MDB10"	± 10" H ₂ O	-9999 to 9999	-9.999"	9.999"	80" H ₂ O
MDU.1"	0 to 0.1" H ₂ O	0 to 9999	0 m"	99.99 m"	1" H ₂ O

Sensor Type (MODEL=)	Sensor Range	Serial Mode Entry Range	LCD Lower Limit	LCD Upper Limit	Overpressure Limit
MDU.2"	0 to 0.2" H ₂ O	0 to 2000	0 m"	200.0 m"	1.6" H ₂ O
MDU.3"	0 to 0.3" H ₂ O	0 to 3000	0 m"	300.0 m"	2.4" H ₂ O
MDU.5"	0 to 0.5" H ₂ O	0 to 5000	0 m"	500.0 m"	4" H ₂ O
MDU1"	0 to 1" H ₂ O	0 to 9999	0 m"	999.9 m"	8" H ₂ O
MDU2"	0 to 2" H ₂ O	0 to 2000	0"	2.000"	16" H ₂ O
MDU3"	0 to 3" H ₂ O	0 to 3000	0"	3.000"	24" H ₂ O
MDU5"	0 to 5" H ₂ O	0 to 5000	0"	5.000"	40" H ₂ O
MDU10"	0 to 10" H ₂ O	0 to 9999	0"	9.999"	80" H ₂ O

Pressure Unit Conversion Constants

The following table outlines the most commonly used pressure unit conversion constants, per international conventions.

Table B-3 Pressure Unit Conversion Constants

	PSI ⁽¹⁾	in. H ₂ O ⁽²⁾	in. Hg ⁽³⁾	K Pascal	milli Bar	cm H ₂ O ⁽⁴⁾	mm Hg ⁽⁵⁾
PSI ⁽¹⁾	1.000	27.680	2.036	6.8947	68.947	70.308	51.715
in. H ₂ O ⁽²⁾	3.6127x10 ⁻²	1.000	7.3554x10 ⁻²	0.2491	2.491	2.5400	1.8683
in. Hg ⁽³⁾	0.4912	13.596	1.000	3.3864	33.864	34.532	25.400
K Pascal	0.14504	4.0147	0.2953	1.000	10.000	10.1973	7.5006
milli Bar	0.01450	0.40147	0.02953	0.100	1.000	1.01973	0.75006
cm H ₂ O ⁽⁴⁾	1.4223X10 ⁻²	0.3937	2.8958X10 ⁻²	0.09806	0.9806	1.000	0.7355
mm Hg ⁽⁵⁾	1.9337X10 ⁻²	0.53525	3.9370X10 ⁻²	0.13332	1.3332	1.3595	1.000

NOTES:

(1) PSI - Pounds per square inch

(2) at 39 degrees Fahrenheit

(3) at 32 degrees Fahrenheit

(4) at 4 degrees Celsius

(5) at 0 degrees Celsius

C *Physical Dimensions*

The IDP is compact and easy to mount. Its front and side dimensions are shown in the following figures. Note especially the distances between the holes on the mounting flanges.

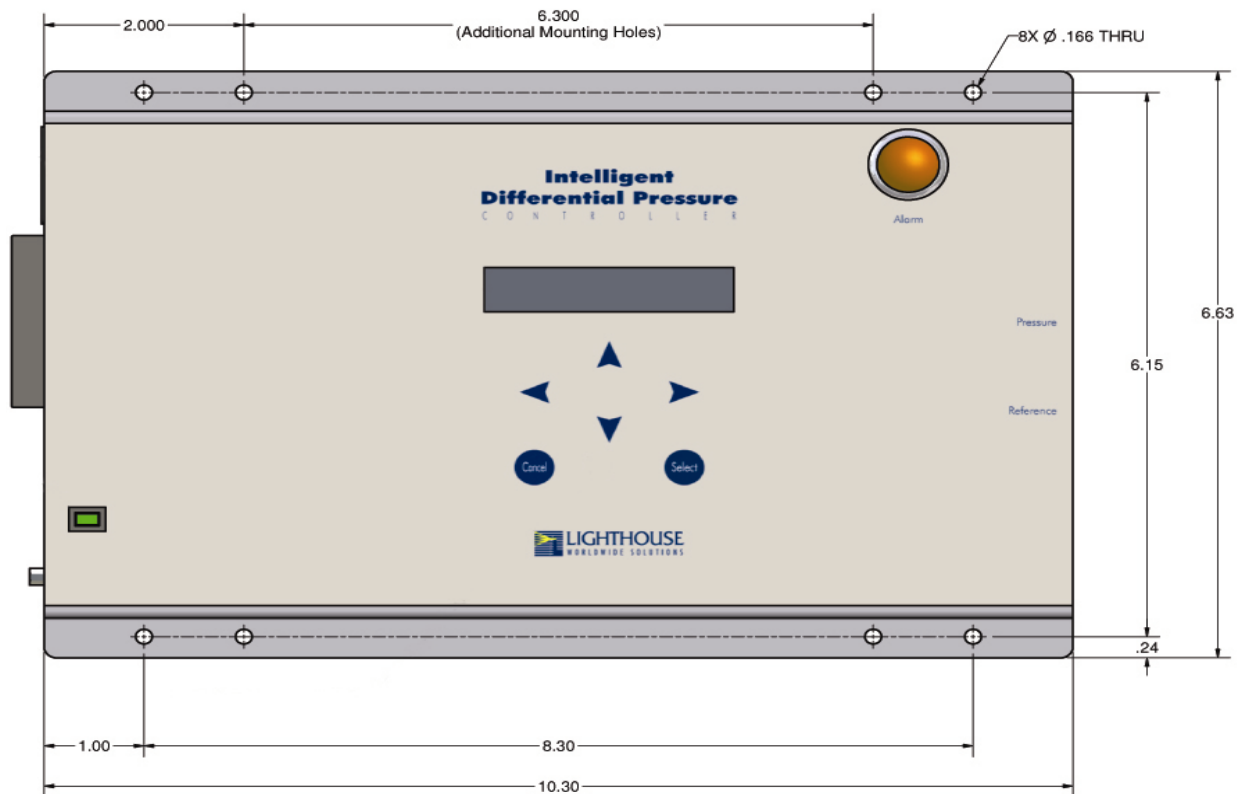


Figure C-1 Front View Dimensions for the IDP

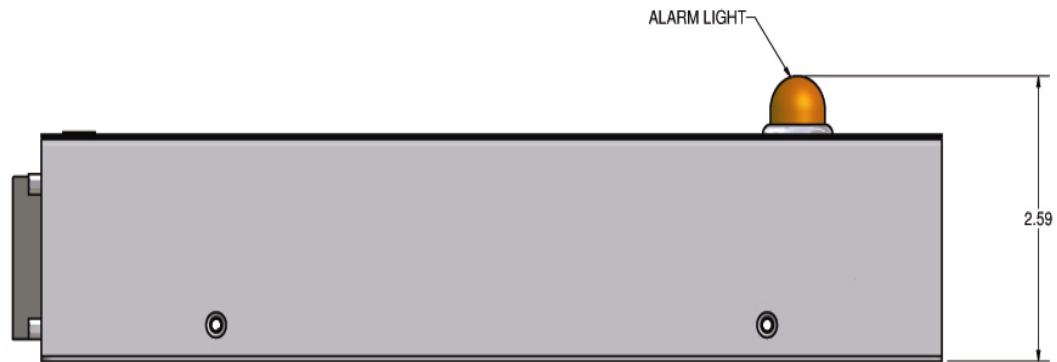


Figure C-2 Side View Dimensions

Index

Symbols

? command 6-2

A

ADDRESS command 4-7

Air control 1-2, 7-1

 applications 5-6

 determining parameters of 2-8, 4-6, 6-6, 7-3

 exhaust hood application 5-8

 initiating 2-3

 maintaining air flow 4-6, 7-3

 mini-environment application 5-7

 multifunctional application 5-9

 using a fixed value 2-11, 4-5, 6-5

Air handler 1-2

 controlling oscillation 2-8, 3-5, 4-6, 7-5

 maximum value 1-3, 4-5, 6-5, 7-3

 minimum value 1-4, 4-6, 6-5, 7-3

 power connector from IDP 2-4

 speed of response 2-8, 3-5, 4-6, 7-4

Alarm

 beginning 1-2

 controlling a relay with 5-5

 definition of 1-2

 ending 1-3

 setting levels 2-7, 4-3, 6-3, 7-1

ALARM BEGIN= command 2-10, 4-4

Alarm beginning 2-10, 4-4, 6-4

ALARM END= command 2-10, 4-4

Alarm ending 2-10, 4-4, 6-4

Analog output 5-4, A-2

Arrow keys 4-1

 using in passwords 2-11, 4-4, 6-4

Auto control 1-3, 2-11, 4-5, 6-5, 7-3

AUTO ZERO command 4-8

B

BAS 1-3

Baud rate, setting 4-7, 6-1, 6-6

BAUD= command 4-7

Building Automation System 1-3, 5-4

Buttons on control panel, functions of 4-1

C

CFAB command 6-4

CFAE command 6-4

CFPS command 6-4

CFRD command 6-4

CLEAR ERRORS command 4-8

Closed loop control 1-3

Commands

 control panel 4-3

 serial interface 6-2

CONFIG menu 2-10, 4-4

Configuration

 remote 6-1, 6-2

 via control panel 4-3

Connecting the IDP 2-1

Constants for conversion of pressure units B-3

Control

 auto 1-3, 2-11, 4-5, 6-5, 7-3

 fixed 1-3, 2-11, 4-5, 6-5, 7-2

CONTROL menu 2-8, 2-11, 4-5

Control panel

 example of use 2-7

 how to use 4-1

Control type 1-3, 2-11, 4-5, 6-6, 7-2

CONTROL= command 2-11, 4-5, 7-2, 7-3

Conventions, text i

Conversion constants for pressure units B-3

CTFV command 6-5, 7-2

CTMD command 6-5, 7-2, 7-3

CTMN command 6-5, 7-3

CTMX command 6-5, 7-3
CTPR command 6-6
CTRD command 6-5
CTTD command 6-6, 7-3
CTTI command 6-6, 7-3
CTTP command 6-6, 7-3
CTTY command 6-6, 7-2

D

Damper control 1-2
Data bits 4-7, 6-2, 6-6
Data output options 1-2, 4-9, 5-4, 6-2, A-2
Default settings 2-10
Derivative term (PID) 2-8, 4-6, 7-6
DIAGNOSTIC menu 4-8
Diagnostics 6-9
DICL command 6-10
DIER command 6-9
Differential pressure 1-3
 displaying on host computer 6-10
Dimensions of IDP C-1
Display options 2-10, 4-3, 6-3
DIWK command 6-10
D-TERM= command 2-8, 4-6, 7-3

E

ECHO= command 4-7
Edit mode 4-2
ERR= command 4-8
Errors 4-8, 6-9
Exhaust hood application 5-8

F

Fan control 1-2
Feature overview 1-1
Features, optional 1-2, 4-9, 6-2
 pinout of 5-1, A-2
Firmware version 4-9, 6-2
Fixed control 1-3, 2-11, 4-5, 6-5, 7-2
FIXED VAL= command 2-11, 4-5, 7-2
Front access for sensors 1-2

H

Help, additional ii
HI ALARM= command 4-3, 7-1
High alarm 1-3, 6-4
High pressure port 5-2
Host computer 6-1
House vacuum 1-3
HVAC 1-2, 1-3, 5-4

I

IDP, overview of features 1-1
Installation instructions 2-1
 mounting and connecting 2-1
Integral term (PID) 2-8, 4-6, 7-5
I-TERM= command 2-8, 4-6, 7-3

L

LCD 1-3
Lighthouse Monitoring System (LMS) 1-3, 1-4, 5-3
 connecting to IDP 3-1
 connecting to via an SIU 5-3
 using to configure IDP 3-2
LO ALARM= command 4-4, 7-1
Low alarm 1-3, 6-4
Low pressure port 5-2

M

MAX VAL= command 4-5, 7-3
Maximum value 1-3, 4-5, 6-5, 7-3
Menu
 displaying and selecting 4-1
 of serial interface commands 6-2
MIN VAL= command 4-6, 7-3
Mini-environment 1-4
 application 5-7
Minimum value 1-4, 4-6, 6-5, 7-3
MODEL= command 4-8
Modes of operation 4-2

Mounting

- dimensions C-1

- instructions 2-1

Multidrop communication 1-4**N****Navigation mode 4-2**

Negative pressure 1-4, 2-7, 2-11, 4-6, 5-8, 6-6, 7-2

- maintaining 5-8

O**Operating modes 4-2**

Optional features 1-2, 4-9, 6-2

- pinout of 5-1, A-2

Oscillation

- controlling 2-8, 3-5, 4-6, 7-5

Overpressure Limit B-1

Overshoot, controlling 2-8, 3-5, 4-5, 4-6, 7-6

P**Panel**

- example of use 2-7

- how to use 4-1

Parity 4-7, 6-2, 6-6

Password 1-4

- entering to access menus 2-7, 4-2

- setting 2-11, 4-4, 6-4

PASSWORD= command 2-11, 4-4

Physical dimensions of IDP C-1

PID algorithm 1-4

- setting terms 2-8, 4-6, 6-6, 7-3

Pinout

- and optional features 5-1, A-2

- complete listing of A-1

- of alarm output 5-5, A-2

- of analog signal 5-4, A-2

- of relay control 5-5, A-2

- of RS-232 communication A-1

- of RS-485 communication A-1

- of SIU communication 5-3, A-2

Position of IDP

- effect on measurements 2-1, 2-2, 4-8, 6-9

Positive pressure 1-4, 2-7, 2-11, 4-6, 5-8, 6-6, 7-2

Power for IDP 2-1

PRCN command 6-10

Pressure

- determining positive or negative 2-7, 2-11, 4-6, 5-8, 6-6, 7-2

- displaying on host computer 6-10

- overshoot, controlling 2-8, 3-5, 4-5, 4-6, 7-6

- ranges supported 1-2, B-1

- setpoint 1-4, 2-7, 4-3, 6-3, 7-1

- undershoot, controlling 2-8, 3-5, 4-6, 7-6

- unit conversion constants B-3

PRESSURE= command 2-7, 2-11, 4-6, 5-8, 6-6, 7-1, 7-2

- CONTROL menu 4-6

- SETPOINT menu 4-3

Proportional term (PID) 2-8, 4-6, 7-4

PRRD command 6-10

P-TERM= command 2-8, 4-6, 7-3

R

Range specifications of sensor B-1, B-2

Ranges of pressure supported 1-2, B-1

Rate of sensor 1-4, 4-8, 6-9

RATE= command 4-8

Relay control application 5-5, 5-10

REM= command 4-8

Remote communication 6-1

- displaying in LCD 4-8

Remote configuration 6-1

REMOTE menu 4-7

REPLY= command 4-7

RMAD command 6-7

RMBD command 6-6

RMEC command 6-6

RMMD command 6-6

RMRD command 6-6

RMRP command 6-7

RS-232 communication 4-7, 6-6

- pinout of A-1

RS-485 communication 1-4, 4-7, 6-6, A-1
setting address 4-7, 6-1, 6-7

RUMD command 6-3

RUN menu 2-10, 4-3

Run mode 4-2, 6-3

RUN= command 2-10, 4-3

RURD command 6-3

S

Self-test 4-8

Sensor Interface Unit 1-4
use with IDP A-2

SENSOR menu 4-7

Sensor range specifications B-1, B-2

Sensor rate 1-4, 4-8, 6-9

Sensor type, determining 4-8, B-1

Serial interface 6-1

SERIAL= command 4-7

SETPOINT menu 2-7, 4-3

Setpoint of pressure 1-4
setting 2-7, 4-3, 6-3, 7-1

Settings, default 2-10

Side access for sensors 1-2

SIU 1-4

SNRD command 6-7

SNRT command 6-9

SNTR command 6-8

SNTY command 6-7

SNZA command 6-9

SNZS command 6-9

Speed of air handler response 2-8, 3-5, 4-6, 7-4

STHI command 6-4, 7-1

STLO command 6-4, 7-1

Stop bit 4-7, 6-2, 6-6

STPR command 6-3, 7-1

STRD command 6-3

T

Terminal emulator 6-1

TEST= command 4-8

Text conventions in manual i

Type of air handler control 1-3, 2-11, 4-5, 6-6,
7-2

Type of sensor, determining 4-8, B-1
TYPE= command 2-11, 4-5, 7-2

U

Undershoot

controlling 2-8, 3-5, 4-6, 7-6

V

Vacuum 1-3

Valve control 1-2

VERSION menu 4-9

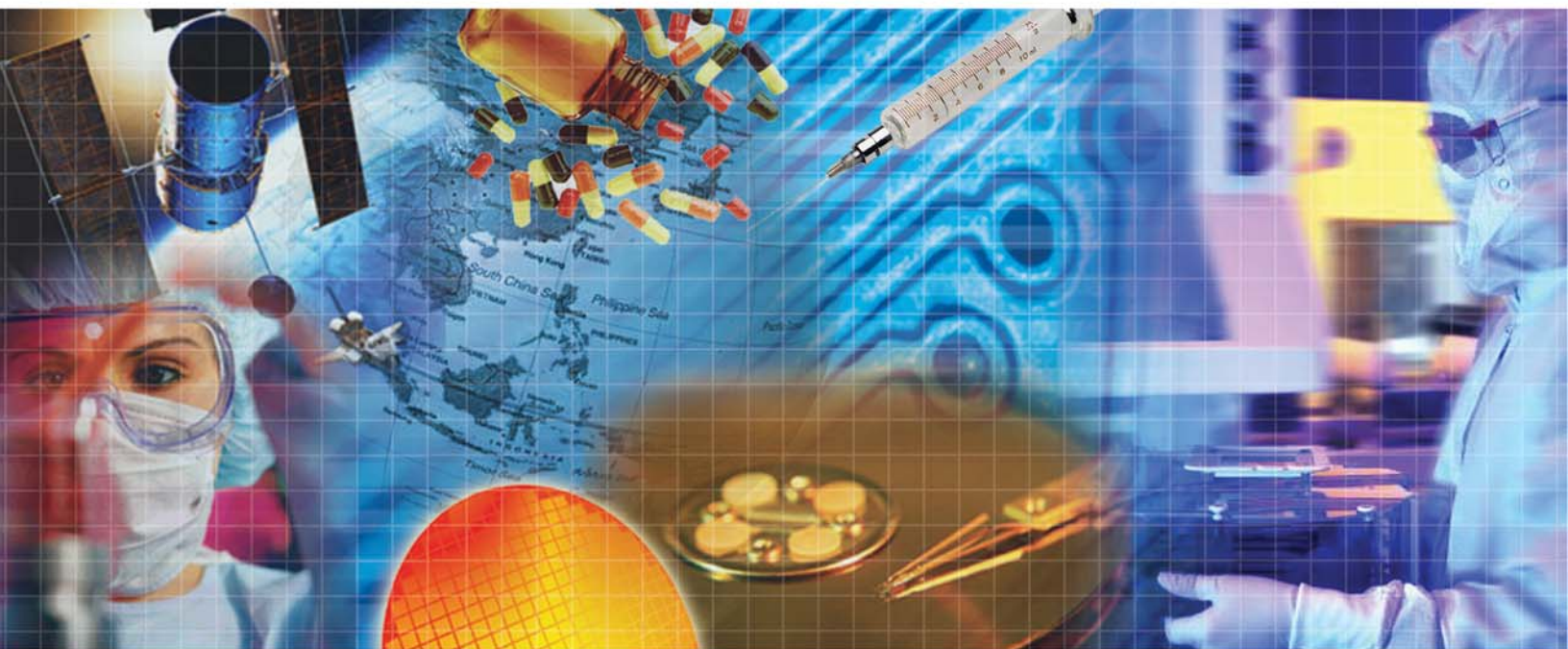
VRRD command 6-2

Z

Zero offset 1-4

ZERO= command 4-7

Zeroing the sensor 2-2, 4-7, 6-7



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