

**VB2000-2**  
**Pneumatic Water Level**  
**Data Acquisition System**

Version NOS Algorithm 1.11-2

January 29, 2003

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## Transducer Selection

Meters	Feet	Actual PSI	Order PSI Transducer
10	32.81	14.2	15
15	49.22	21.3	30
20	65.62	28.4	30
25	82.03	35.5	50
30	98.43	42.6	50
35	114.84	49.7	50

## 1. INTRODUCTION

This document describes the installation, setup and use of the VITEL VB2000-2 pneumatic water level data acquisition system.

## 2. HARDWARE SETUP

This section describes the components needed to install a VB2000 at a site. Proceed with the following steps:

- 1) Mount VB2000 enclosure on wall. Unit must be plumb for flow meter to indicate properly.
- 2) Run tubing into the body of water to be measured; fasten securely. Connect water line tubing to the 1/4" NPT Female connector labeled "WATER" on the bottom of the enclosure.
- 3) Open NEMA enclosure to view interior metal enclosure and the visible desiccant. Open the metal door with the two thumbscrews on the right side of the metal door. This will expose the internal pneumatic components and the circuit boards on the back of the metal door.
- 4) View the flow meter and adjust the needle valve for the desired flow.
- 5) Connect a VX1004 DCP serial cable into the DB9 connector at the upper right of the main circuit board.
- 6) Use AWG 22 or larger gauge wire and the two cable grips provided to secure a power and/or SDI-12 cable. Connect ground to terminal 1 and 12 Volt power to terminal 2. The VB2000 draws about 85 mA during a measurement cycle. Assuming a standard NOS setup (3 minutes sampling, 3 minutes idle) the VB2000 will draw an average current of < 50 mA. Connect SDI-12 data line to terminal 3. The following table shows the proper pin identifications:

Pin	Description
1	Ground (power)
2	Battery 12Volt power, 200mA max
3	SDI-12 Data (bi-directional)
4	No connection
5	No connection
6	No connection
7	No connection
8	Ground, analog and signal

- 7) If power ground is not common to SDI-12 data logger, then terminal 8 may be used for signal ground

### 3. SOFTWARE

The VB2000 is designed for communication with a computer running dumb terminal software.

#### 3.1 SOFTWARE FUNCTION

Use Hyper Terminal © running under Microsoft Windows™ or other software capable of supporting dumb terminal operation to communicate with the VB2000.

#### 3.2 SOFTWARE SETUP

The VB2000 is programmed to communicate at 9600 baud, 8 data bits, no parity and 1 stop bit. The baud rate is programmable from the serial port.

When the VB2000 is powered up it will send a message to the serial port as follows:

```
Vitel Model VB2000 Pneumatic Controller
Software Version V1.10 30 Sept 1998
```

```
Next NOS: 16:34:30, Next wake: 16:34:20
```

Hitting any key will wake up the VB2000 and the main menu is sent to the serial port:

```
Vitel Model VB2000 Pneumatic Controller
Software Version V1.10 30 June 1997
```

```
VB2000 Main Menu
D Date          09-30-98
T Time          16:28:18
B Baud:         9600
I Interval:     6 minutes
N Num Samples:  181
U Units:        Meters
S SDI-12 Address: 1
R SDI on RS232: ON
P Port Setup
E rEttrieve data
A Activate
```

Selection:

Menu selections are made by typing the specified key and pressing <ENTER>. The menu choices are fairly self-explanatory. Perform the following basic setup:

- 1) Set Date
- 2) Set Time
- 3) Set Units (Meters standard)

- 
- 4) Set Interval (6 minute standard)
  - 5) Set Number of samples (181 standard)
  - 6) Set SDI-12 address (Do not use the same address as another sensor in your system.)
  - 7) Baud Rate If the baud rate selection is made, the baud rate toggles through the following settings: 1200, 2400, 4800, 9600. The new baud rate does not take effect until the next time the VB2000 wakes up.

### 3.3 SDI ON RS232

This selection enables (ON) or disables (OFF) the SDI/RS232 Redirect Option. If the option is enabled, the RS232 lines may be used to perform SDI-12 protocol I/O commands. All the standard and extended SDI-12 command may be executed over the RS232 port. See the section on SDI-12 commands and responses later in this manual. The baud rate for redirect operation is the same as the baud rate programmed for the setup menus (not necessarily 1200 as required in SDI-12).

Wake-up -- To wake up an SDI-12 sensor, a break is sent on the SDI data line. In the RS232 redirect mode, any character received wakes up the VB2000. A linefeed <LF> character, 0A Hex, is recommended to wake up the VB2000. The <LF> character is not saved in the VB2000 internal buffers and is ignored in SDI-12 command processing. The external logger should wait 100 mS between the <LF> character and remainder of the SDI-12 protocol command. See the flowchart on the next page.

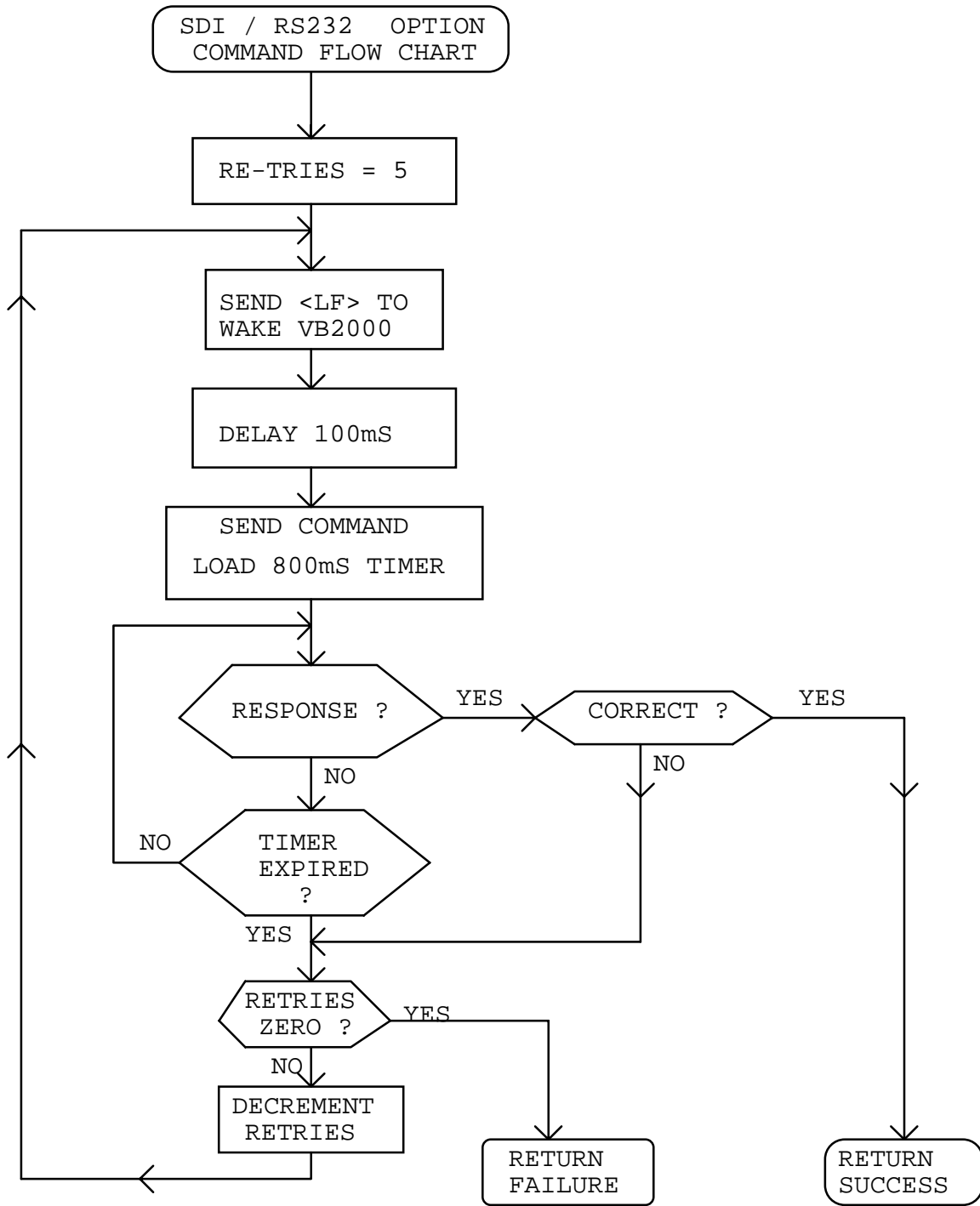
Retries -- If the external logger does not receive the expected response within 800mS, it should retry. Up to 5 retries may be necessary if the VB2000 is in a mode where it cannot be interrupted. If the commands are executed between measurement cycles, the VB2000 will respond quickly. If the commands are executed in the middle of an NOS cycle, retries may be necessary. The 800 mS time-out value is selected because the VB2000 may be in a NOS measurement cycle where it is performing measurements at a 1-second interval. Use of a different time-out prevents the logger from repeatedly accessing the VB2000 at a time when the VB2000 cannot respond. See the flowchart on the next page.

Accessing Setup Menus -- If the SDI/RS232 Redirect Option is enabled the user must hit the <ESC> key once or twice to enter the ASCII setup menus. If the VB2000 is in the middle of a NOS-style data acquisition cycle, the VB2000 will return the string "BUSY". In this case the user must wait until the end of the current measurement cycle to enter the ASCII menus. The VB2000 will NOT respond to SDI protocol commands over the RS232 port when the user is in the setup/download menus.

Regular SDI-12 Commands -- The VB2000 will respond to normal SDI-12 actions whether or not the SDI/RS232 redirect option is enabled.

Other RS232 Activity -- If the redirect option is OFF the VB2000 sends the following information to the serial port as measurements are taken:

date, time, battery voltage, temperature, atmospheric pressure in counts, water level, standard deviation, and outliers. If the redirect option is enabled, this information is suppressed.



SDI/RS232 REDIRECT OPTION FLOW CHART

### 3.4 PORT SETUP

After the basic setup is completed, press P <ENTER> and go to the port setup. There will be a 1-2 second delay as the VB2000 initializes its analog circuits. The following menu will appear:

```
Port Setup
P Purge Interval:  0 minutes
U pUrge Seconds:  2
O Offset:         0.000 meters
M Measure Water
S Set Stage
I Installation
Selection:
```

Where:

**P** Purge Interval -- This is the interval at which a purge will be executed. The purge connects the raw external tank pressure (25 PSI max) to the water port for a programmable number of seconds. Since it uses a lot of gas you may not want to purge more a few times per day. If this parameter is set to zero then no purge cycles will occur.

**U** Purge Seconds -- This is the number of seconds that the raw tank pressure will be connected to the water port for every purge cycle.

**O** Offset -- The VB2000 measures the depth of water above the tubing opening. The user may add an offset to this to align the reading with the local elevation, stage, etc. (See Stage for more discussion of setting the stage.)

**M** Measure Water -- This causes the VB2000 to execute a measurement cycle. The final value includes any offset that has been entered. The following steps are involved:

- Measure the battery voltage.
- Measure the temperature.
- Measure atmospheric pressure.
- Connect PT to water line.
- Take a series of pressure readings, one per second. For regular measurements, the programmed number of samples (default 181) are taken. For a forced cycle, only 5 measurements are taken.
- Perform the standard NOS processing algorithm on the samples (average, standard deviation, outliers, etc.).
- Calculate the depth of water and add any user entered offset.
- Log the data for normal measurements (not for forced cycles).
- Update display and SDI-12 response registers.

**S** Set Stage -- The VB2000 will calculate the required offset to make the instrument read the desired stage. The VB2000 will prompt the user for the desired reading and ask the user to confirm the value. Then the VB2000 will use the previous measurement to calculate the new required offset. The new offset is automatically updated by the VB2000 and will be used for all future measurements.

I Installation -- Selecting this causes another menu to be displayed that contains many functions that are useful during installation. The following menu is displayed:

```
Port Install
F Bubble Line Fast
A Read Atmosphere
L Leak Check
U Purge
Selection:
```

F Bubble Line Fast -- This is useful in installation to pump water out of a newly installed water line. The VB2000 will send 5 short pressure pulses into the line, wait a second and then take a pressure measurement. The pressure and the change from the previous pressure are printed out. The routine times out after 30 seconds. The user may press <ESC> at any time.

A Read Atmosphere -- This causes the VB2000 to vent the PT to atmosphere and take a pressure (zero) reading.

L Leak Check -- This selection causes the VB2000 to connect the PT to the water line and take pressure readings. The reading and the change from the previous reading are printed out. The pressure should not drop more than a few counts unless the line is leaking. The routine times out in 30 seconds. The user may press <ESC> at any time to exit the routine.

U Purge -- This causes the purge cycle to be executed, regardless of the Purge Interval setting.

### 3.5 DATA LOGGING/RETRIEVAL

Pressing E <ENTER> from the main menu causes the following menu to be displayed:

```
Data Menu
L Location ID: NOS SITE 1091
S Start Time: 09/17/98 13:10
E End Time: 09/19/98 14:30
F Format: ASCII
D Download Data
I Initialize Logging RAM
Selection:
```

The VB2000 can log up to 12750 readings in the internal non-volatile RAM. For each sample time the VB2000 logs five integer values: water level, standard deviation, number of outliers, temperature, and battery voltage. At a six-minute logging interval this provides 10.6 days of backup information. At a 30 minute logging interval, this provides 53 days of backup data.

The data can be downloaded into a laptop PC in ASCII or XMODEM-CRC format. The VB2000 will acquire data and service any SDI-12 requests during data download. The data logging RAM is backed up by a 10-year lithium battery, which also backs up the real time clock.

**L** Location ID -- This is an ASCII string which is inserted at the beginning of all data downloads. The user can insert a site name, number, etc.

**S** Start Time -- The user can specify the start and end time of every download to limit file size and download time. If only one or two days of data are missing due to DCP malfunction, the user can obtain just the desired data by specifying the start and end time.

**E** End Time -- End of desired data, see Start Time above.

**F** Format -- The user can specify ASCII or XMODEM-CRC for data downloads. ASCII downloads are simple and require no decoding but are time consuming. XMODEM-CRC downloads are fast but yield binary data files which must be decoded with PC software.

**D** Download Data -- Pressing this selection causes the VB2000 to examine the data logs. If no data is available in the specified time range, the VB2000 prints out a no data message and returns. If data is available, the VB2000 prints a message telling the user to prepare the PC to accept data. After the PC is ready, the user presses <ENTER> and the VB2000 starts sending data to the serial port.

**I** Initialize Logging RAM -- The user should initialize the RAM when a site is installed. This causes the VB2000 to initialize pointers, etc. Any previously stored data is unavailable after an initialization. For this reason, the user must confirm the action by typing YES <ENTER> after making this selection.

## 4. QUICK SETUP INSTRUCTIONS

### Main Menu

- Set Date.
- Set Time.
- Set Units.
- Set Interval.
- Set Number of Samples.
- Set SDI-12 address.

### Port Setup

- Set Purge Interval.
- Set Purge Seconds.
- Set Offset To Zero.
- Port Install.
  - Bubble Line Fast.
  - Leak Check.
  - Vent To Atmosphere.
  - <ESC> Back To Port Setup.

Measure water several times, making sure water level is consistent.

Read staff if available and note desired stage. (Or use an alternate source, such as previous Aquatrak cycle reading.)

Do Stage procedure and let VB2000 calculate offset.

Measure water again; check for desired stage.

<ESC> back to main menu.

### Go to Retrieve Data

Initialize logging RAM. Confirm.

<ESC> back to main menu.

Activate.

Check SDI-12 communications with data logger / DCP.

Setup logger to acquire at proper interval.

Watch one or two measurement cycles to verify proper operation.

## 5. OPERATION

After the VB2000 is installed and the SDI-12 data transfer has been verified, the VB2000 can enter the normal operating mode. This mode is entered by pressing A <ENTER> (activate) from the main menu. This causes the VB2000 to go into a low power sleep mode (less than 1mA current). If the user forgets to activate the system, it will time out and enter the operating mode in about 2 minutes.

The VB2000 will wake up once per minute and clear its watchdog timer and check to see if it is time for a measurement or a purge. It wakes up at the even minute mark prior to a NOS algorithm measurement and begins the measurement sequence about 10 seconds early. After the measurement is complete the VB2000 returns to sleep.

Immediately after each measurement, if purges are enable, the VB2000 checks to see if another purge is due. If so, the purge is executed and then the VB2000 returns to sleep. The purges are executed immediately after measurements in order to provide the maximum time for the transient from the purge to dissipate before the next measurement cycle.

A break on the SDI-12 data line wakes up the VB2000. It waits for commands and if the address matches it will generate the proper response. It will also interrupt menu, download, and measurement operations to respond to SDI-12 breaks.

### 5.1 DISPLAY OPERATIONS

The SE512 display can be specified as an option. This display always contains the most recent water level data. The buttons can be used to adjust the stage without using a PC.

### 5.2 STAGE ADJUSTMENTS

Wait until the VB2000 appears to be idle (no flashing 'S' in the display). Press both buttons for about 2 seconds and release. The character C (for Calibration) will appear in the left most position in the display; this is the stage adjustment mode. Press the UP or DOWN buttons to adjust the stage to the desired level. The level will change by 0.001 units for each button press. If the button is held down continuously the display will change faster after about 2 seconds.

When the desired stage is displayed, press both buttons for two seconds and release. The character S will flash in the left most position. The VB2000 will calculate the required offset and that will be used for all future measurements.

The new stage procedure is now complete and no special characters are displayed; the current stage is shown in the display.

If the VB2000 is servicing an SDI-12 command during a measurement sequence the character 'I' is flashed in the left-most character of the display.

## 6. SDI-12 COMMANDS

VB2000-1 Pneumatic Water Level System  
 NOS-Algorithm Version  
 Single Point Measurement, SDI-12 Data Transfer

**NOTE:** The sensor sends a carriage return-line feed after each response.

Command	Response	Comments
Standard Commands		
a!	a	Address Check, where 'a' is the sensor SDI-12 address, ASCII 0 through 9.
aM!	a0005	Initiate Measurement Command, response is 5 values ready in zero seconds. Actually means that stored measurement is available. It is not necessary to execute this command. The output data buffers are updated after every NOS cycle.
aD0!	a+ff.fff	For values in feet.
	a+mm.ddd	For values in meters.
aD1!	a+mm.ddd	Standard deviation in current units.
aD2!	a+nnn	Number of outliers, 000 to 999.
aD3!	a+tt.t	Temperature, degrees C.
aD4!	a+bb.b	Battery voltage.
aI!	a10 VITEL VB2000110VB2000	Identification Query and Response. Response indicates VITEL VB200 using firmware version 1.10.

Command	Response	Comments
Extended Commands		
aAn!	NEW ADDRESS:n	Change address command, where 'a' is the current address and 'n' is the desired address.
aU?!	UNITS = Meters	Units Query response for meters.
	UNITS = Feet	Units Query response for feet.
aUM!	UNITS = Meters	Set units to meters.
aUF!	UNITS = Feet	Set units to feet.
aXT?!	hh:mm:ss	Time Query, responds with VB2000 time in hours, minutes and seconds.
aXTShh:mm:ss!	hh:mm:ss	Set Time, responds with new time in hours, minutes and seconds.
	INVALID	If time is invalid, i.e. hours > 23, minutes > 59 or seconds > 59.
aXD?!	mm-dd-yy	Date Query, responds with VB2000 date in month, date, and year.
aXDSmm-dd-yy	mm-dd-yy	Set Date, responds with new date in month, date, and year.
	INVALID	If date is invalid, i.e. month > 12.

## 7. USING THE VITEL VX1100 WITH THE VB2000

The VB2000 always returns the most recent completely processed data to the SDI-12 master (the VX1100 in this case). Assuming that the VB2000 is set to a 6-minute interval, it will return the same data to an SDI-12 request no matter how many times that request is received.

### VX1100 Setup

- Setup a sensor as a SDI-12 sensor.
- Set the SDI-12 address to one that is not used.
- Set the M command to '0'.
- Set the D command string to '01234'. This will return all data values. If fewer data values are desired, modify the string accordingly.
- Confirm the sensor operation using the extended mode.
- Confirm the sensor operation using the "check sensor" procedure.
- Set the desired logging interval. This doesn't need to be the same as the interval for the VB2000 acquisition. The VB2000 may be set to 6 minutes and the VX1100 set to 30 minutes for a backup function.
- Set the first log minutes to 2. This causes the VX1100 to wait until 2 minutes after the hour to poll the VB2000 for data. This will retrieve the most recent data from the VB2000.

### VB2000 Setup

- Set the SDI-12 address to match the address programmed in the VX1100.

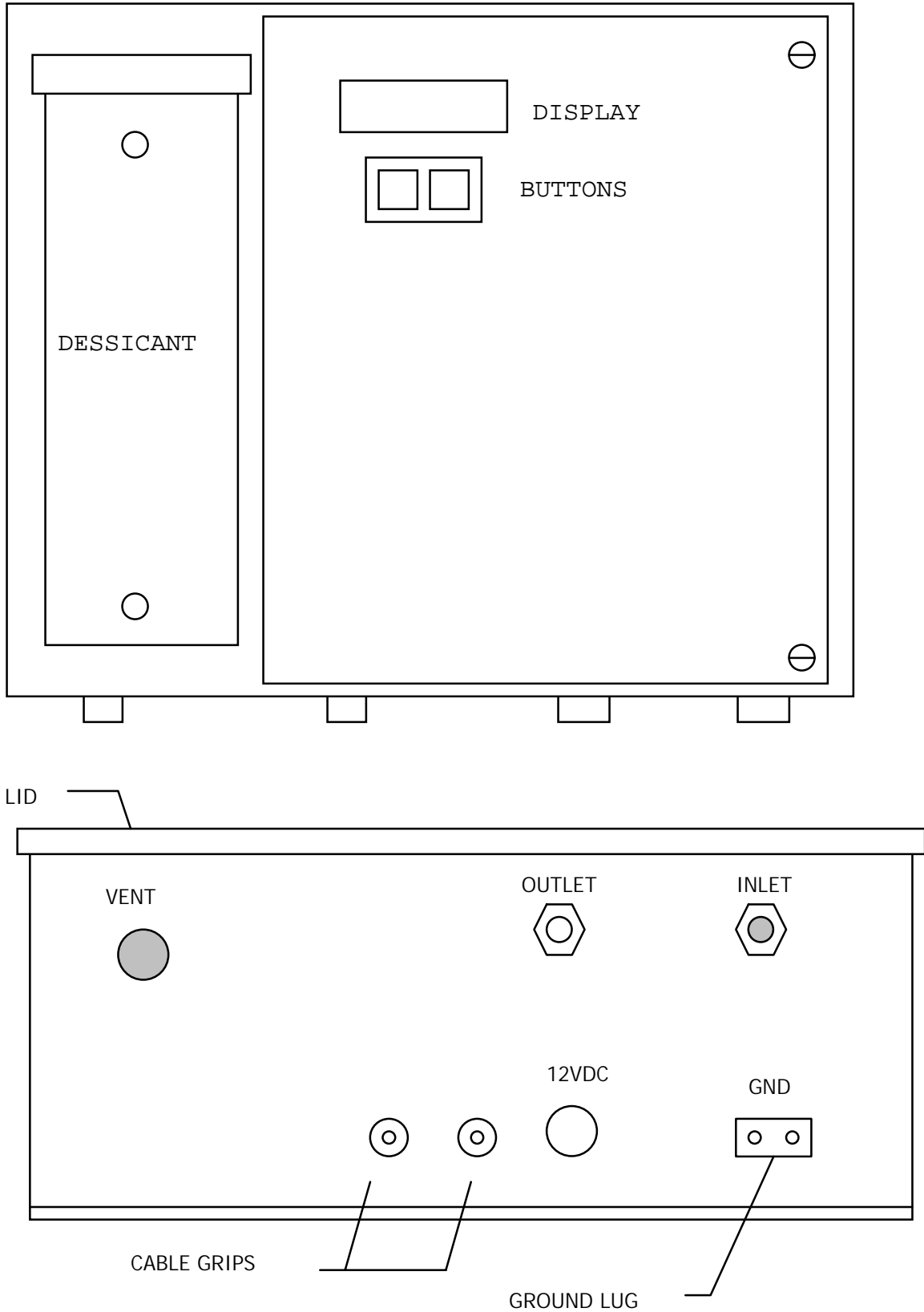


FIGURE 1. VB2000 ENCLOSURE

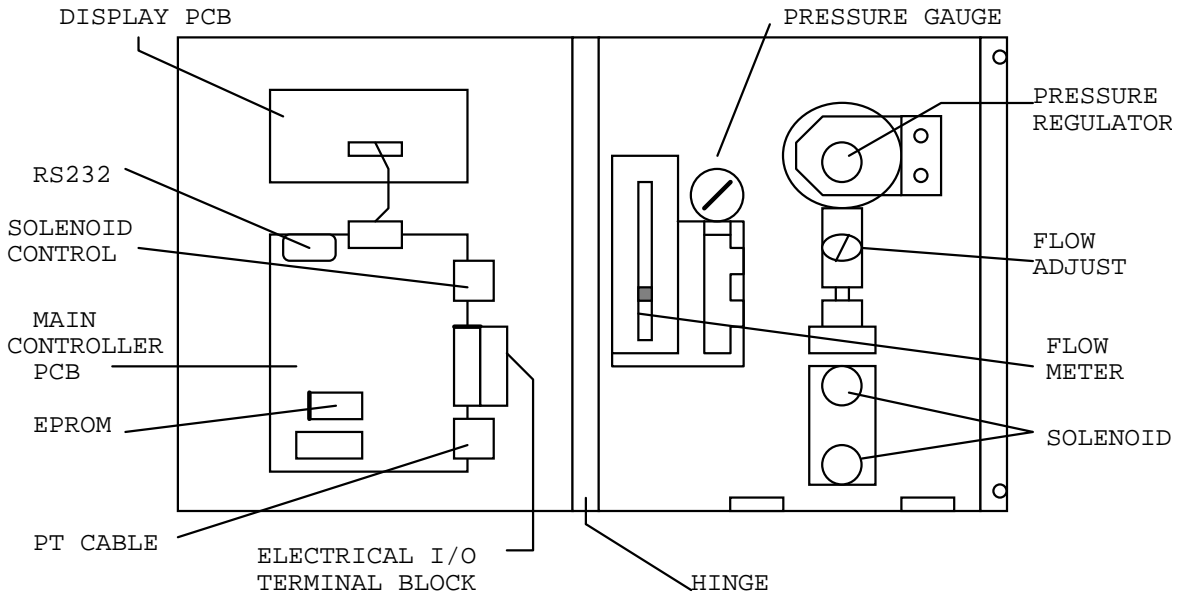


FIGURE 2. CONTROL ENCLOSURE (OPEN)

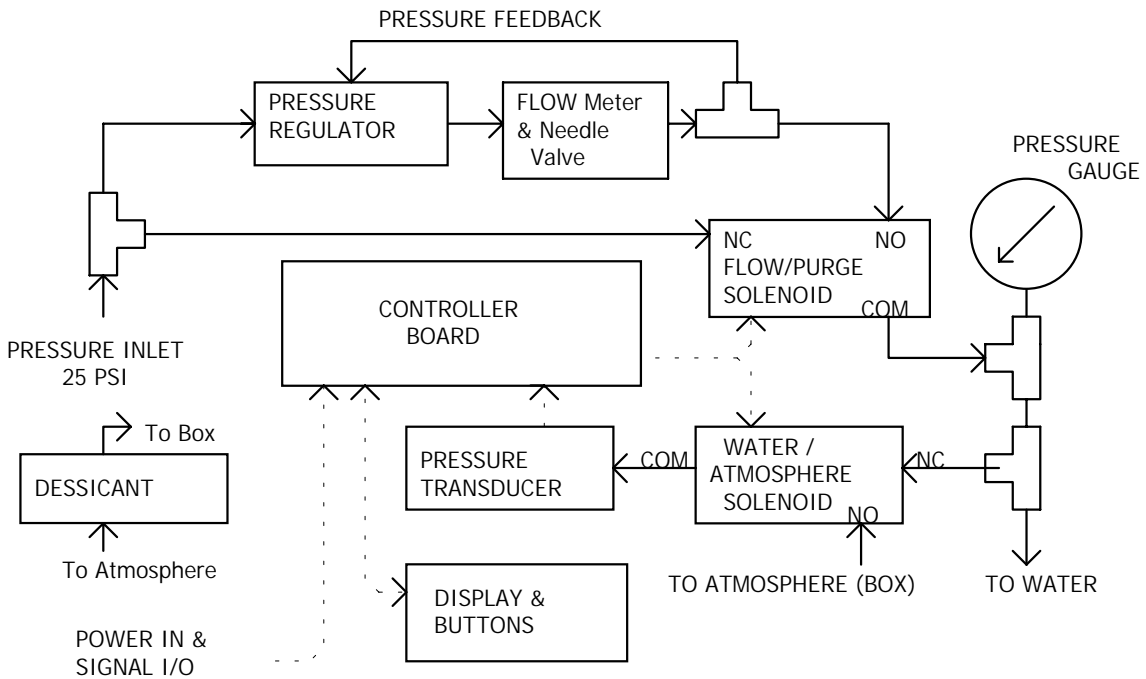
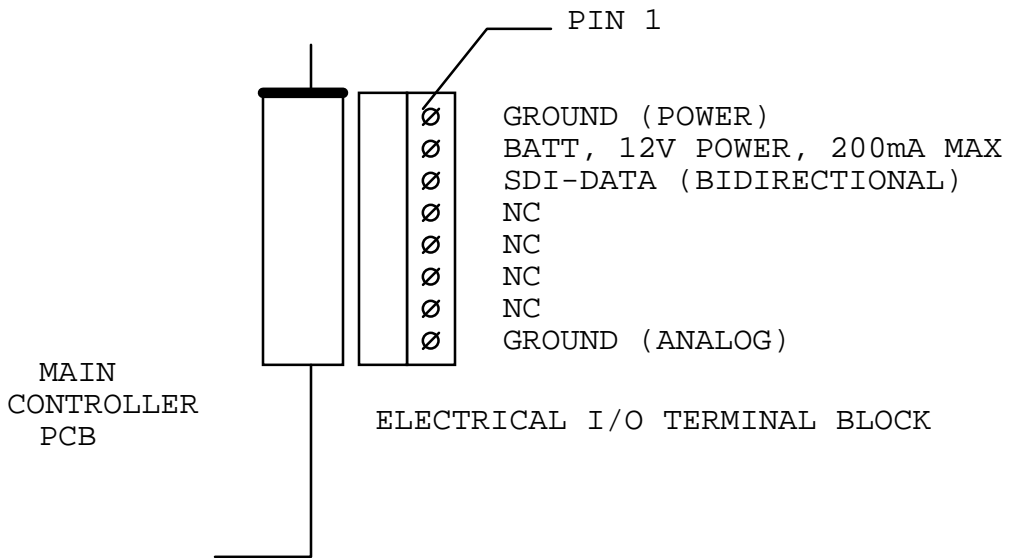
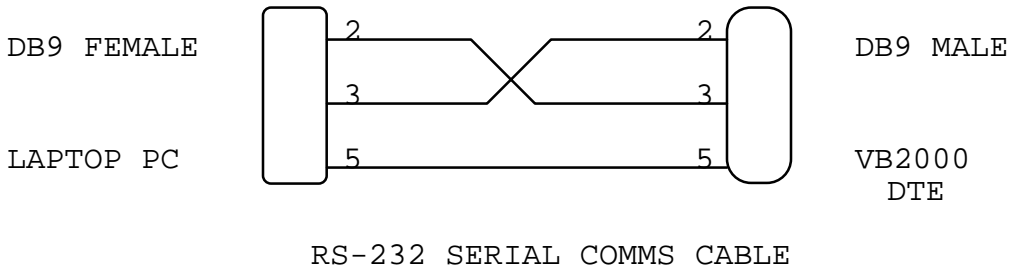
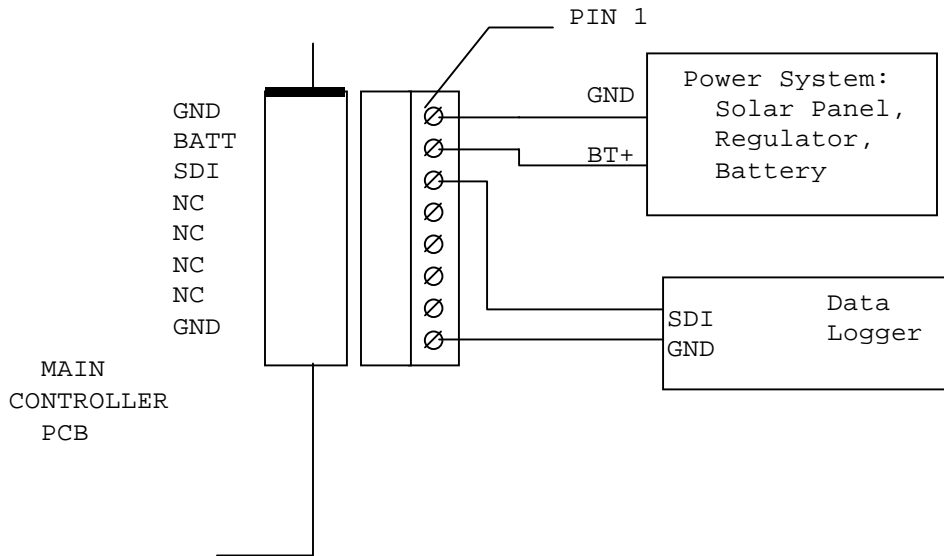


FIGURE 3. ELECTRICAL / PNEUMATIC BLOCK DIAGRAM



PRESSURE INLET: 1/4" NPT FEMALE  
WATER LINE CONNECTION: 1/4" NPT FEMALE

**Figure 4. Input / Output Connections**



**Figure 5. Electrical Connections for Independent Power System**