

# Performance Trends' "EZ Flow"

EZ Flow is a kit which allows engine builders build a computerized flow bench from materials available at most any hardware store. First you must build a bench following the parts list, plans and suggestions below.

## Parts List

Qty	Part Number	Source/Description
1	PFAEZBA	Std Bore Adapter, part of Performance Trends EZ Flow System with SB Chevy and SB Ford bolt patterns and approx 4.03" ID (other bolt patterns available)
1	PFAEZO-x.xx	Flow Orifice (x.xx is diameter), part of Performance Trends EZ Flow System Available sizes are 2.5" (400 CFM), 2" (250 CFM), 1.5" (150 CFM), 1.0" (75 CFM)
3	PFAEZTB.125	24" lengths of 1/8" clear PVC tubing for routing pressure to sensors in Black Box, part of Performance Trends EZ Flow System
3	PFAEZPP.125	1/8" NPT to 1/8" barbed hose fitting (Ace Hdwe 4013108)
2	PFAEZFL4	4" PVC flanges w 6" bolt circle holes (NIBCO 4851 Genova 75141) Note that these may have to be drilled to match the bolt pattern of the PFAEZO-x.xx orifice, and have the face sanded or ground smooth to provide an air tight seal using the PFAEZFT.
1	PFAEZMPT	4" PVC to male pipe thread adapter (NIBCO 4084, Genova 70440)
1	PFAEZ90-4	4" PVC 90 deg streamlined elbow (NIBCO 4807, Genova 72840, Genova 73840 for a more gradual bend)
2	PFAEZPVC4-19	19" length of 4" schedule 40 PVC straight tubing
2	PFAEZPVC4-10	10" length of 4" schedule 40 PVC straight tubing
2	PFAEZFT	24" lengths of light foam tape/weather stripping
1	PFAEZRDx.x	Rubber reducers, 4" to x.x inch (available sizes, 4", 3", 2.5" and 2")
1	PFAEZOX.xx	6" square calibration orifice plate with x.xx inch diameter sharp edged orifice (available sizes are 3.0, 2.5, 1.875, 1.5 and 1.0 inches)
1	PFAEZFS-4	4" grid flow straightener (2'x4' cut from white egg crate Home Depot ceiling "lighting panel" 74507 43200)
1	OFPB	Optional Flow Plenum Box
1	OBA	Optional Fabricated bore adapter, for heads other than SB Ford or SB Chevy
1	OFCV	Optional Flow Control Valve, to help maintain a constant test pressure

## For "High Flow" 6" PVC EZ Flow Systems

1	PFAEZBA6	6" Bore Adapter, part of Performance Trends EZ Flow System with SuperFlow™ flow bench bolt pattern for your bore adapter.
2	PFAEZFL6	6" PVC flanges w 9.5" bolt circle holes (McMaster Carr 4881K221). Note, use the PFAEZFT to provide an air tight seal. Visit <a href="http://www.mcmaster.com">www.mcmaster.com</a> to order.
1	PFAEZMPT6	6" PVC to male pipe thread adapter (McMaster Carr 4880K161). Visit <a href="http://www.mcmaster.com">www.mcmaster.com</a> to order.
1	PFAEZ90-6	6" PVC 90 deg elbow (Lowe's Charlotte Pipe 6" PVC 90° Elbow Item #: 53037 Model #: PVC 00300 1600 or McMaster Carr 4880K598). Visit <a href="http://www.lowes.com">www.lowes.com</a> to order.
1	PFAEZP-6-5	5 ft length schedule 40 PVC pipe McMaster Carr 48925K25

## For "Super High Flow" 8" PVC EZ Flow Systems

1	PFAEZBA8	8" Bore Adapter, part of Performance Trends EZ Flow System with SuperFlow™ flow bench bolt pattern for your bore adapter.
2	PFAEZFL8	8" PVC flanges w 9.5" bolt circle holes (McMaster Carr 4881K224). Note, use the PFAEZFT to provide an air tight seal. Visit <a href="http://www.mcmaster.com">www.mcmaster.com</a> to order.
1	PFAEZMPT8	8" PVC to male pipe thread adapter (McMaster Carr 4880K162). Visit <a href="http://www.mcmaster.com">www.mcmaster.com</a> to order.
1	PFAEZ90-8	8" PVC 90 deg elbow (McMaster Carr 4880K102). Visit <a href="http://www.mcmaster.com">www.mcmaster.com</a> to order.
2	PFAEZ86R	8" to 6" reducer to allow using 6" EZ Flow parts, but 8" tubing and flange for the flow orifice (McMaster Carr 4880K689). Visit <a href="http://www.mcmaster.com">www.mcmaster.com</a> to order.

### Notes for assembly:

The diagrams given here are just a couple of assembly layouts. Due to space constraints, your shop layout, etc, you may decide to do things differently. Here are some tips to keep in mind for all systems.

Leaks are a major contributor to flow bench inaccuracies and non-repeatable readings. Take precautions to eliminate all leaks. If you construct portions of your flow system out of wood, be sure to laminate or paint with several coats to eliminate the porosity of the wood.

Generally, the more the volume between the head (or test piece) and the flow orifice the better, if it doesn't introduce leaks. The system shown on the next page with the plenum shows this extra volume, so the air can "stabilize" between the head and the flow orifice. If you use a plenum, be sure that the air stream from either the head or the flow orifice are well separated, so the flow velocity from one does not influence flow on the other.

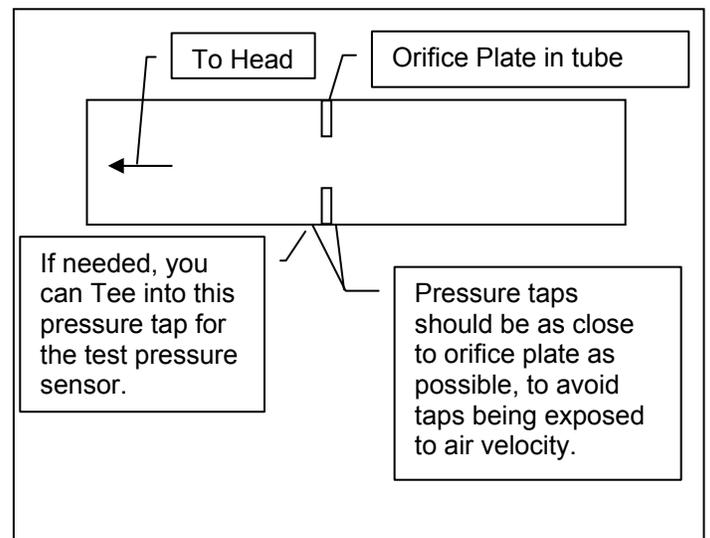
You must measure the Test Pressure from a relatively "quiet" area, away from flow velocity. If you use a plenum, tap into a remote corner of the plenum. If you use just the 90 deg elbow, Tee into the flow orifice pressure tap on the side nearest the head (test piece) .

Pressure taps to record pressure across Flow Orifice should be as close to orifice as practical, to be in the "dead flow" area in corners. See Detail to right.

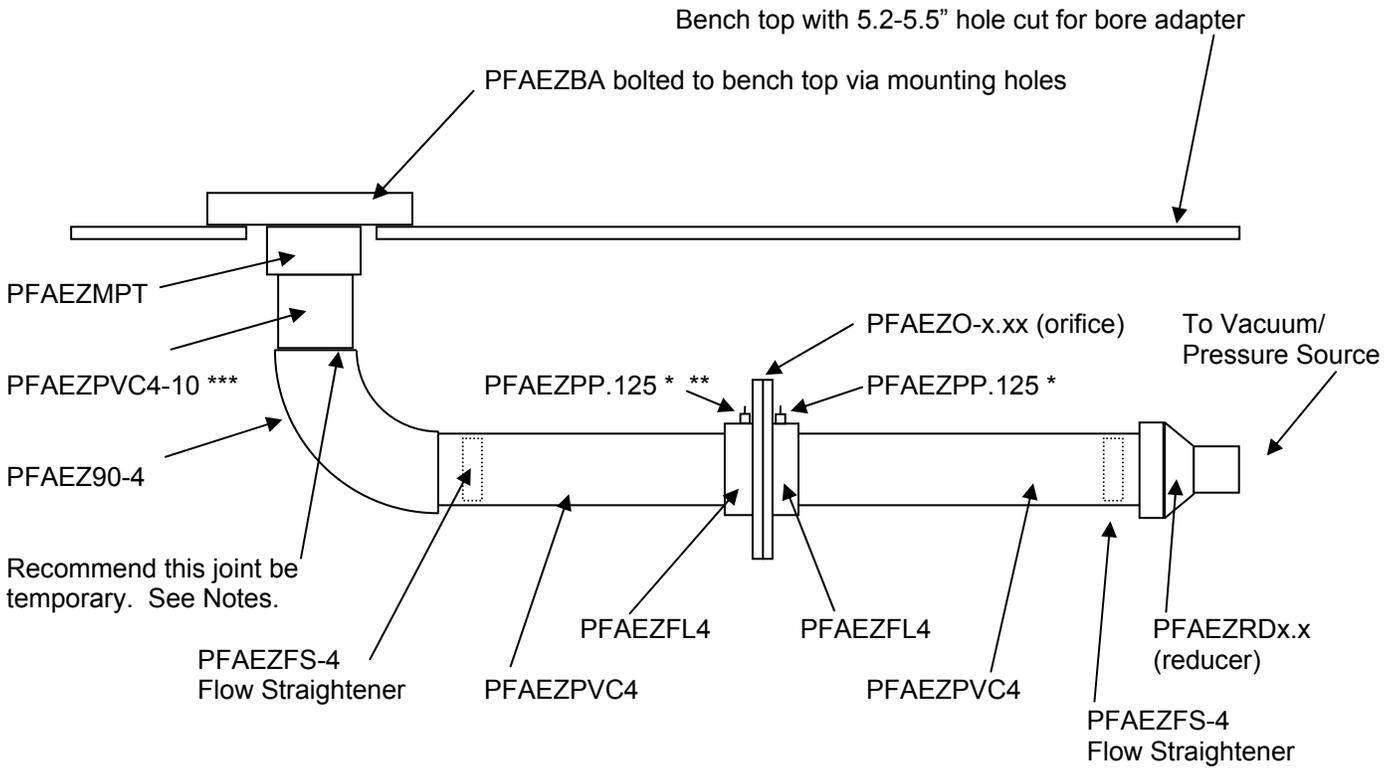
For best accuracy/repeatability, keep the amount of straight PVC tubing before and after the flow orifice to 15" minimum (30" total). If space allows, longer is better.

For ease of assembly, it is recommended that the joint between PFAEZPVC4-10 and PFAEZ90-4 be easily assembled and disassembled. You may want to seal this with heavy grease or tape, and attach the 2 pieces with screws or bolts instead of PVC cement or some other type of sealant.

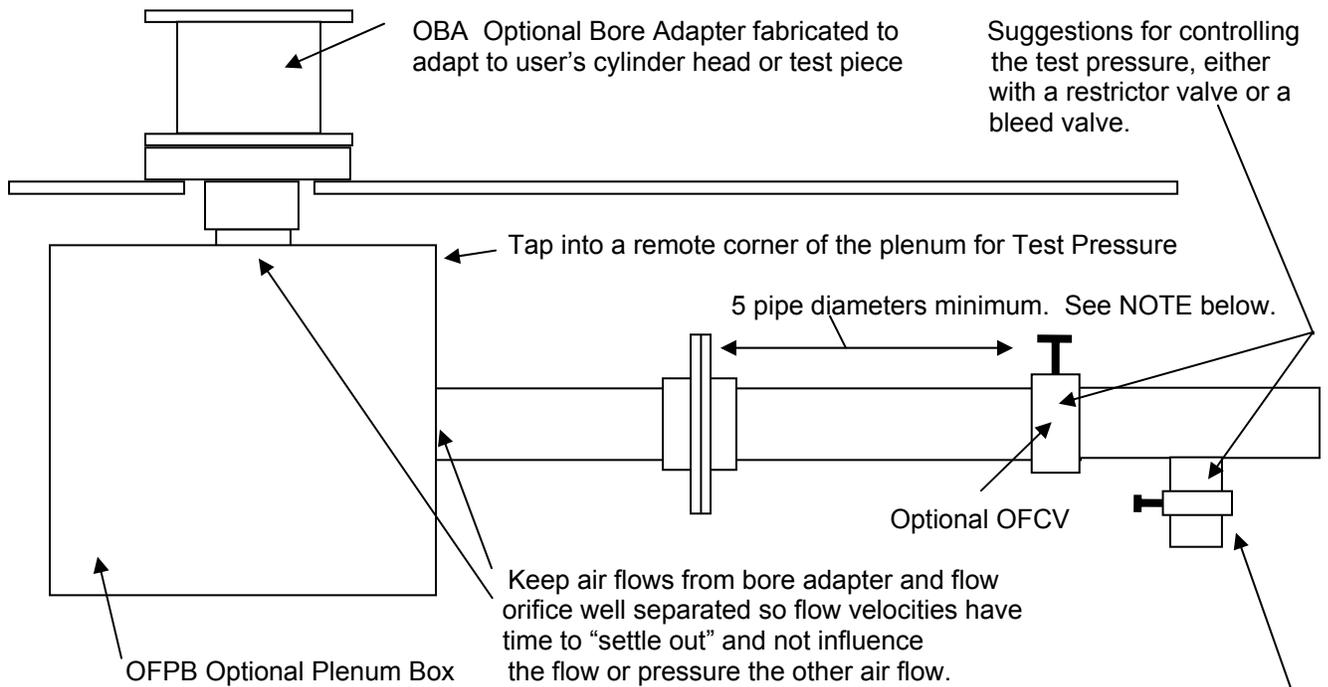
NOTE: Orifice plates must be no larger than half the inside diameter of the PVC tubing it is mounted in. For example, a 2" orifice is the maximum size for a 4" PVC tube.



# EZ Flow System Build Diagram



- \* Keep the PFAEZPP.125 as close as practical to the orifice plate, to ensure the pressure seen is out of the air flow
- \*\* You can use this pressure as both a flow pressure and as the test pressure for the Black Box via a Tee fitting
- \*\*\* The length from the top of the PFAEZBA to the PFAEZ90-4 (90 deg elbow) should be 10" min., longer is better



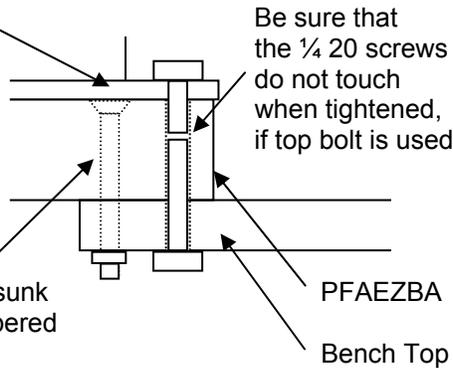
NOTE: If you want to control test pressure with either a restrictor valve (like the OFCV), or with a "bleed" valve, these should be placed 5 pipe diameter away from flow orifice (30" for 6" pipe). You can also reduce pipe size at this point for easier building.

The OFCV valve will restrict flow. You can also use a "bleed" valve to control pressure. This valve can typically be smaller than the pipe size, say, 2-3" valve for 6" main pipe.

### Notes on Mounting PFAEZBA Bore Adapter

Piece mounted on top, like a bore adapter for different cylinder size, or a calibration orifice

Optional Mounting:  
Use 4 10x32 countersunk flathead screws in tapered holes.

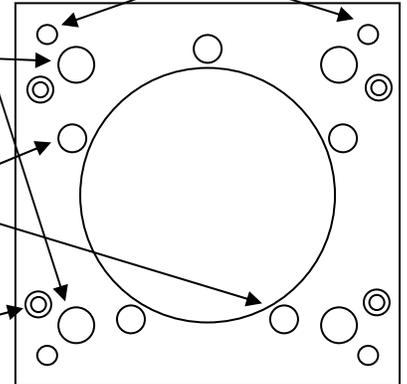


1/4 20 Threaded mounting holes

Small Block Ford Bolt pattern

Small Block Chevy bolt pattern

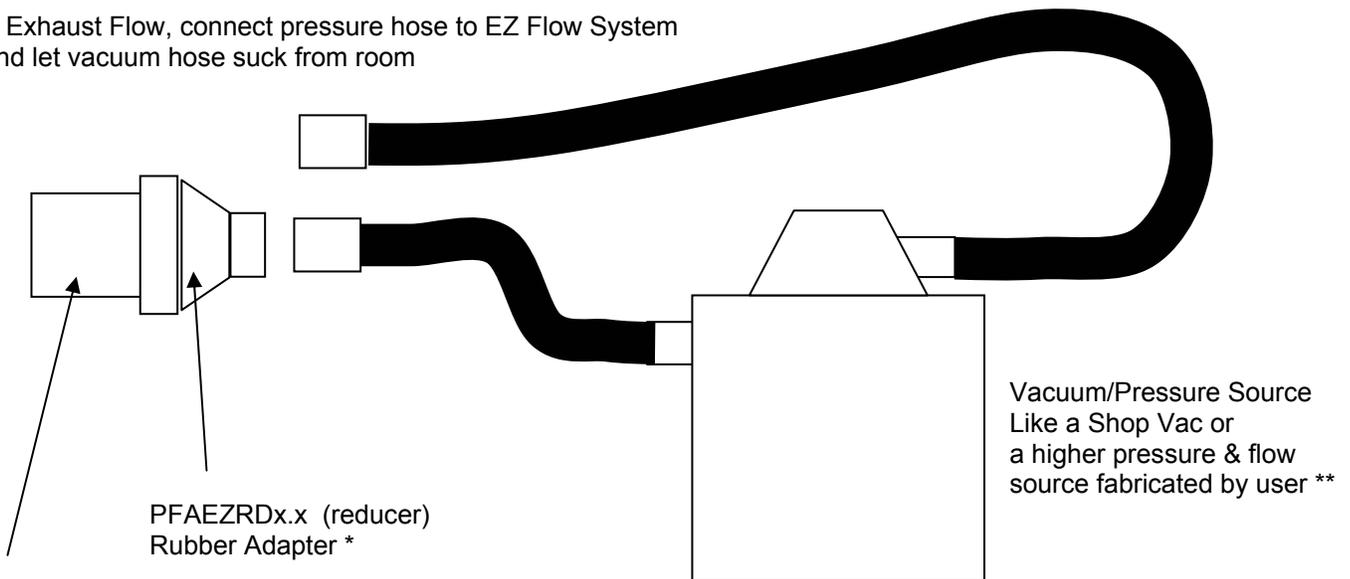
Tapered holes for 10x32 mounting screws



### Vacuum Source Tips

For Intake Flow, connect vacuum hose to EZ Flow System and let pressure hose blow into room

For Exhaust Flow, connect pressure hose to EZ Flow System and let vacuum hose suck from room



PFAEZPVC4-19  
from EZ Flow System

\* Home Depot™ or Ace Hardware™ have a wide array of rubber adapters in the plumbing department, one brand being PIPECONX by UniSeal™

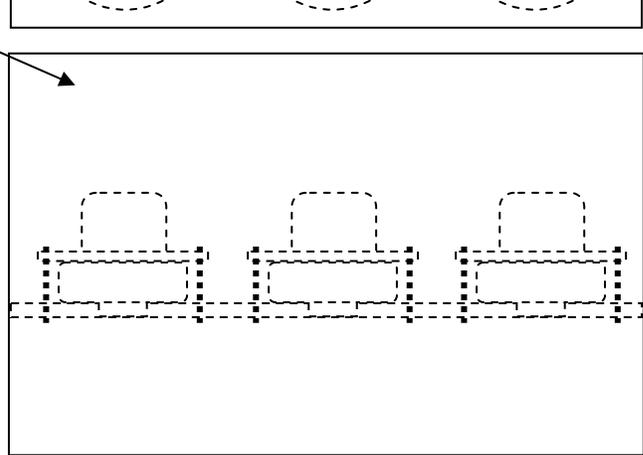
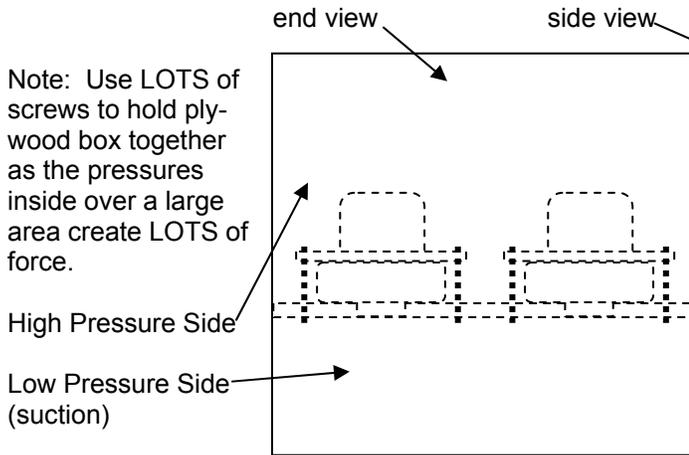
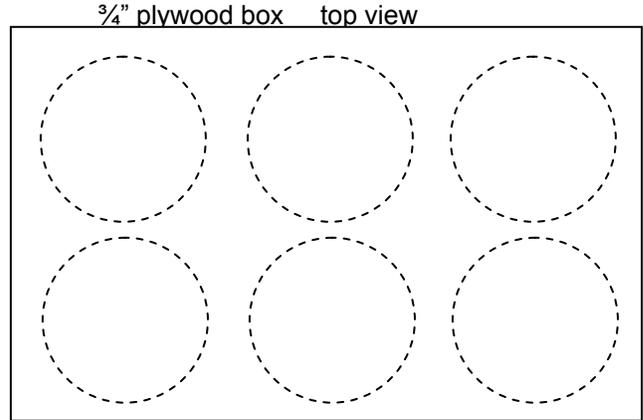
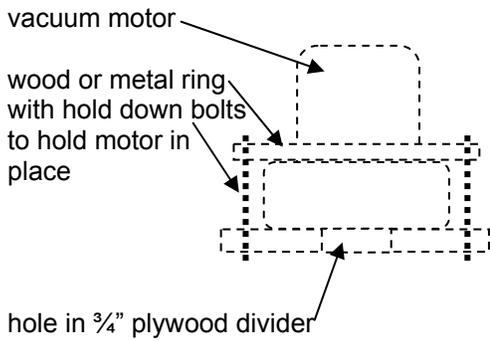
\*\* Grainger and McMaster Carr have both vacuum motors and large diameter vacuum hose where you can fabricate a high capacity vacuum/pressure source

To produce more than 20" water test pressure, you will most likely need 2 stage vacuum motors. To produce more than 30" water test pressure, you will most likely need 3 stage vacuum motors.

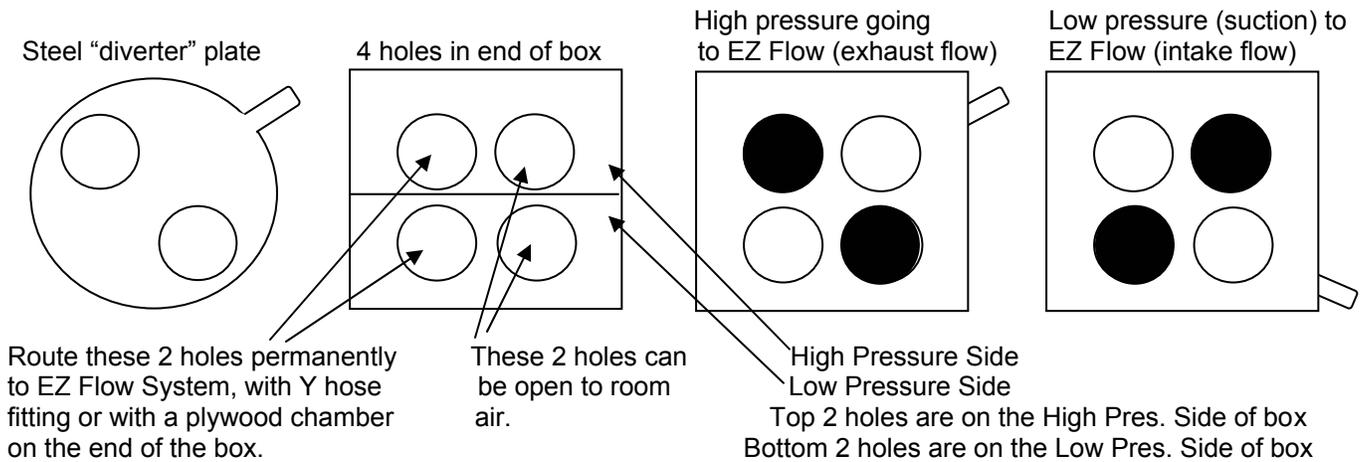
To build a high capacity flow bench, you need several vacuum motors, about 1 for each 70 CFM of flow you want at 28" water. This will require a lot of electrical power (amps), and most likely 220 VAC and a good, knowledgeable electrician. You must also reduce all flow restrictions to a minimum, so all the pressure/vacuum can be used to produce a pressure drop across the head (test piece). This also means the flow orifice must be sized quite large, so it does not become too restrictive.

# Vacuum Source, Custom Build "Shop Vacuum"

If you want more flow capability than a large Shop Vacuum, you can build one following the basic outline below. Contact us for typical part numbers for good vacuum motors. Each motor requires about 10 amps 110 VAC and provides 50 to 80 CFM at 28", depending on EZ Flow details.



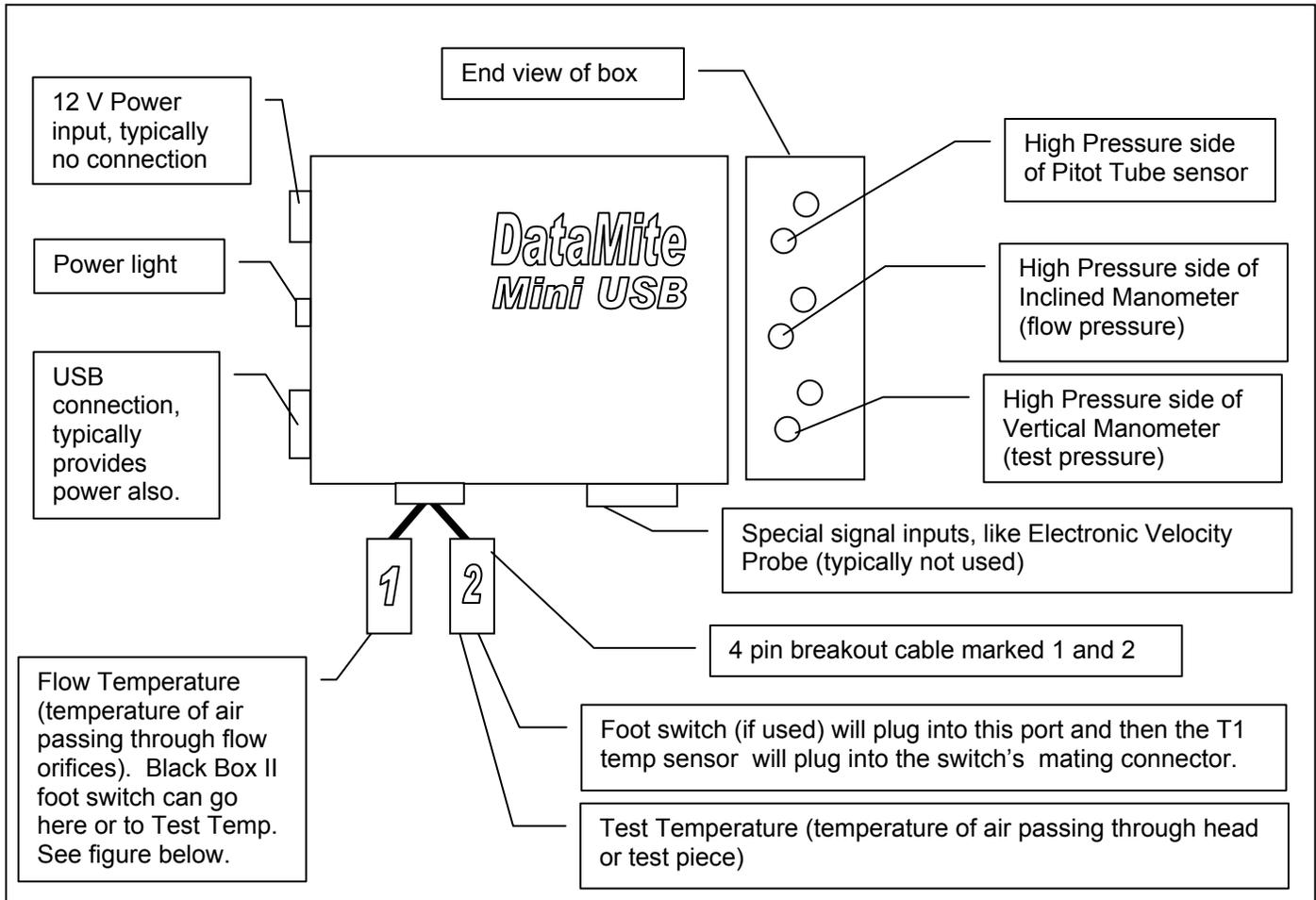
Routing of air: The easiest method is to attach 2 large hoses, one to the top high pressure side and one to the bottom low pressure side. Then you can route the air as shown in the previous Figure of the shop vacuum. A more permanent air routing/diverting method is outlined below.



Tips: It is easiest to have 2 wooden end panels, each with 4 holes, with the diverter plate sandwiched between them. Space the 2 panels apart with washers for a tight clearance. Fasten together with bolts. Use one large bolt as the pivot for the diverter plate. You can get fancy with bearings or bushings if you want. Leaks here in this box do not affect accuracy, just the efficiency of how much total CFM you can generate.

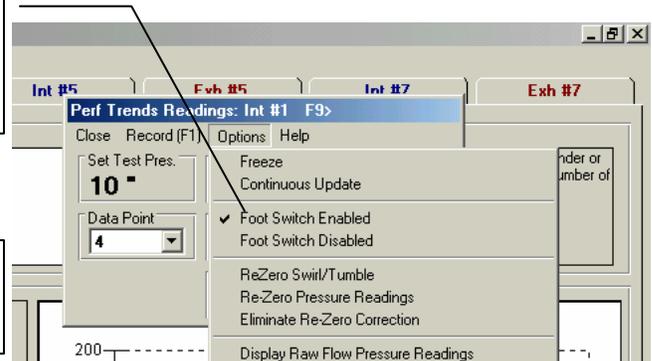
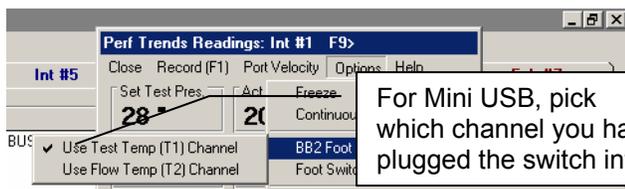
# Instructions for Black Box Hookup to Flow Bench

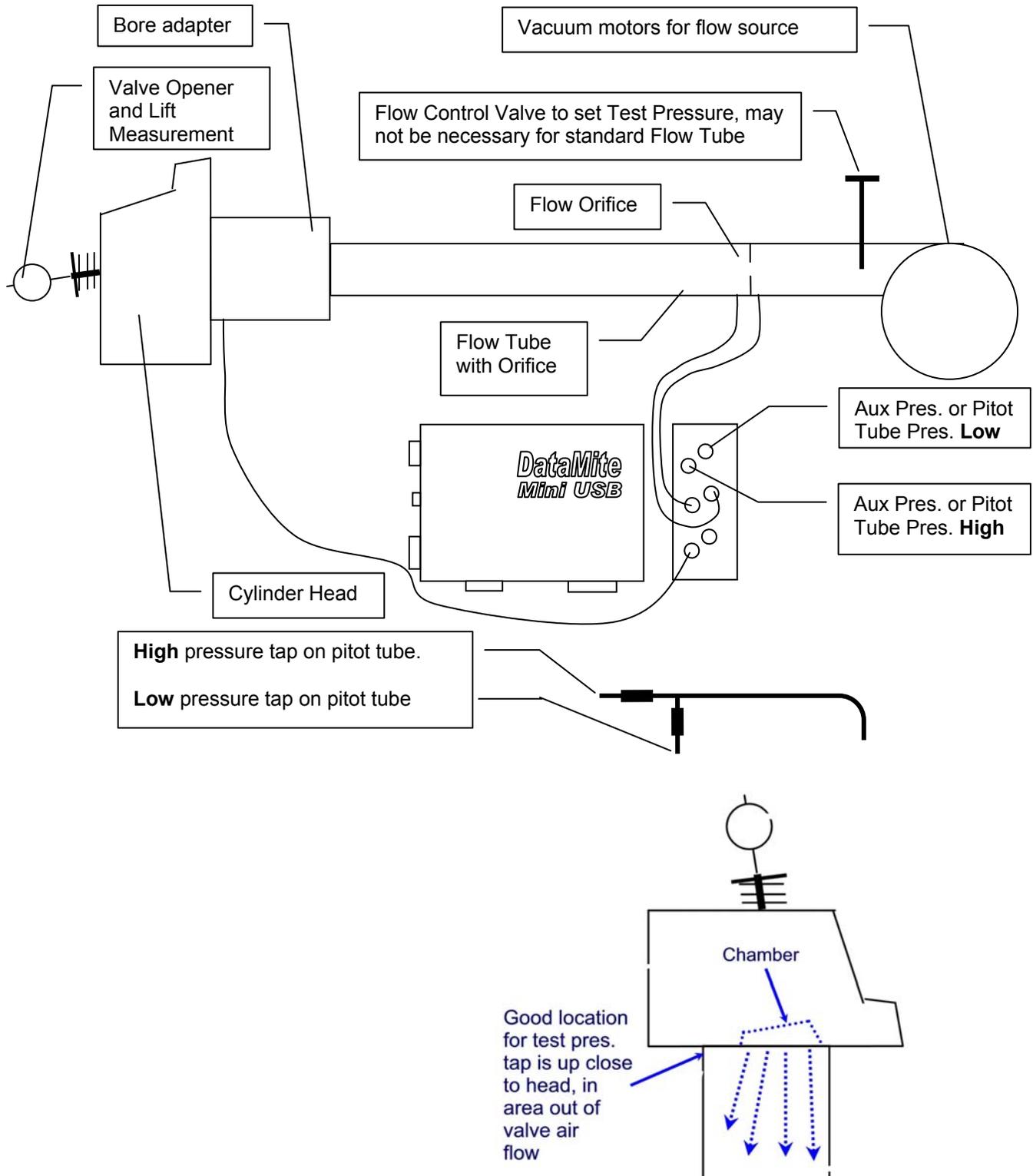
Once you've built your EZ Flow flow bench, you will connect the Black Box. Performance Trends' "Black Box" data logger will record data from your EZ Flow flow bench to greatly enhance your flow bench testing. The 2 figures below give an explanation of the various connections to the Black Box.



## Enable Foot Switch

To enable the use of a foot or hand switch for recording data with the Mini USB, you must enable the switch. Do this by clicking on Options in the Electronics Reading screen, then clicking on Foot Switch Enabled.





The pressure tap for test pressure (measuring pressure under the head) should be placed in a “dead” flow area, and not in a location where air is rushing by it. This produces a Bernoulli “suction” pressure which is not correct. You can also Tee into the pressure tap on the head side of the flow orifice pressure taps, as shown in picture on page 2. However, due to flow losses, flow straighteners, etc, this pressure is not exactly the same as the pressure directly under the head.

# Software Setup

With the Black Box connected, you will want to setup the software. Follow the process outlined in Examples 4.1 and 4.2 in the manual. When doing the Flow Bench Specs setup, follow the instructions outlined below.

**NOTE: There are demo movie files on our website which can help you get “up to speed” quickly. On our website, click on Support, then Movie Demo Files, then find the Port Flow Analyzer movies.**

**First, open up the example test called “EZ Flow Example”.** Click on File at upper left corner of main screen, then “Open (from all saved tests)”.

Then in this Open Test File screen, choose (click on) “Examples” in the lower right corner for the folder, then choose (click on) “EZ Flow Example” in the upper left corner, then Open in the lower left corner.

This will load several test and flow bench settings to get you up and running quickly.

Open the “EZ Flow Example” File

Click on File, then Open (from all saved tests)

Choose the EZ Flow Example test file, then click on Open in the lower left corner.

Choose Examples for the Folder

Tip: Click on a different Folder name to display all the tests saved under that Folder Name

Right click in list above for more Folder Options

Port Flow Analyzer v3.5 Performance

File Edit Graph Report Test Options Head

EZ Start Wizard  
New (start new test) Ctrl+N  
Open (from all saved tests) Ctrl+O  
Open from History Log  
Save Ctrl+S  
Save As Ctrl+A  
Open from Floppy/CD (E:\ Drive)  
Save to Floppy/CD (E:\ Drive)

Open Test File

11 Tests in Library

Black Box II on SF600  
BRODIX.10X  
CHEV-18.DEG  
Example SB Chevy on SF 300  
Example SB Chevy on SF 600  
Example SB Chevy Stock  
Example SB Ford SF 110 w Port Velocity  
**EZ Flow Example**  
Harley Davidson  
SPRTSMAN.II  
Typical SF1020

Chosen File: EZ Flow Example

Preview (max CFMs corrected to 28")  
Head #:  
Intake: Exhaust:  
# Vlvs: 1 # Vlvs: 1  
Vlv Dia: 2.02 Vlv Dia: 1.6  
CFM:252.0 @ .7 CFM:180.2 @ .7  
10:00 am 03/12/2004

Example of EZ Flow test.  
This was 4 runs of the same intake and  
to show the outstanding repeatability of  
This EZ Flow did not have a flow contr  
let the test pressure vary with flow. As  
this method still gives very good repeat

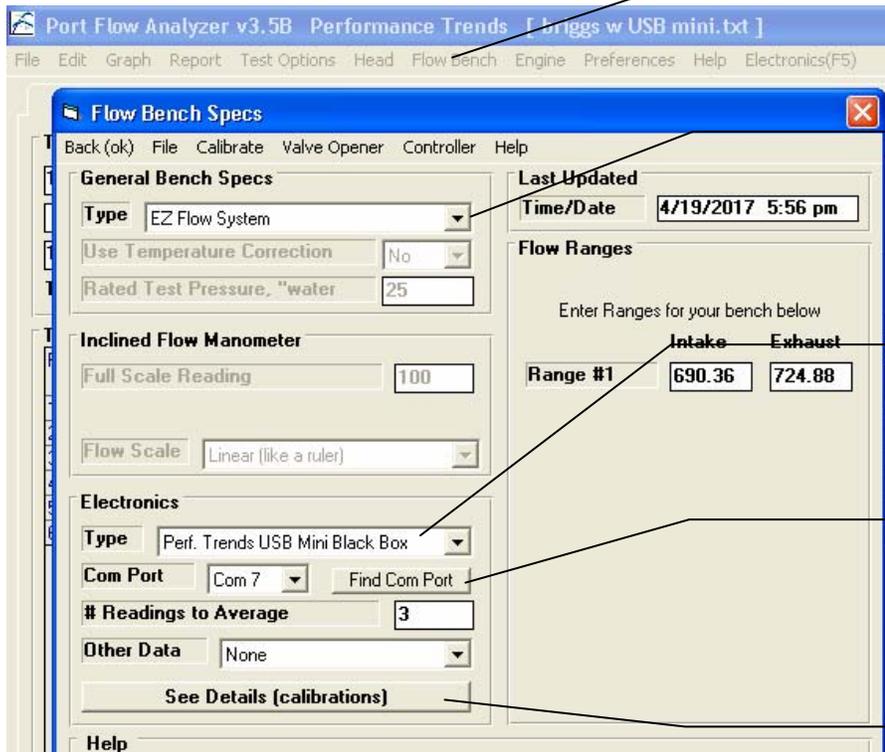
Folders

**EXAMPLES**  
experiment  
My-Tests  
warren

Open Filter (find) Advanced  
Cancel Help Delete

Confirm that these critical specs are correctly set in this EZ Flow Example test file, as shown below.

### EZ Flow System Setup in Port Flow Analyzer Software



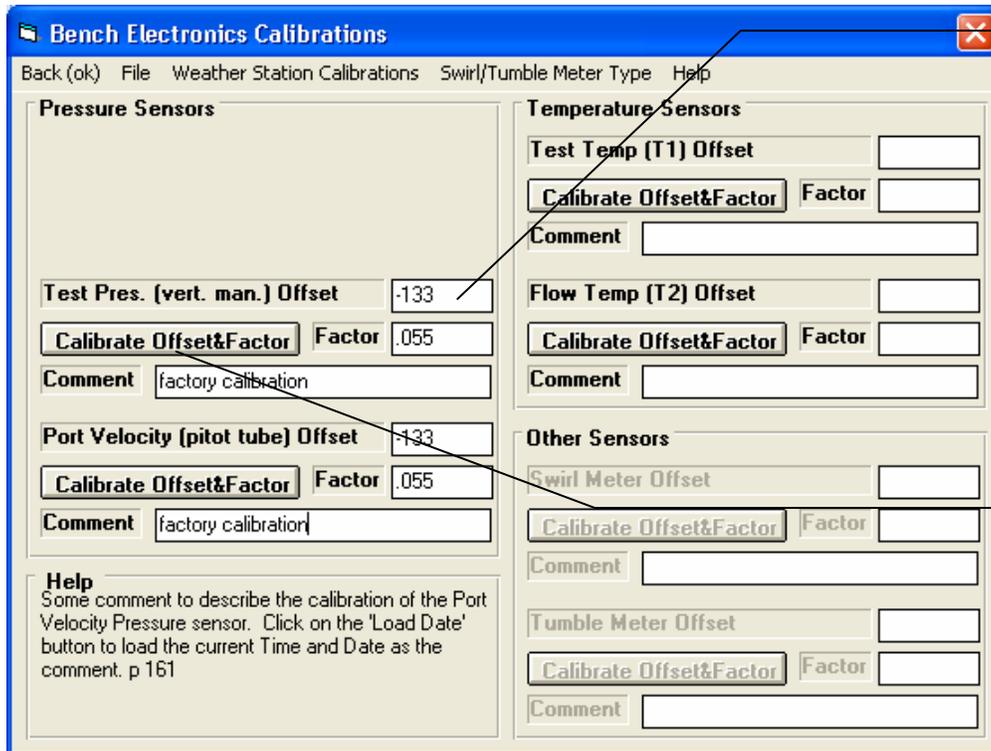
Click on Flow Bench at top of Main Screen to bring up Flow Bench specs screen shown here.

Select EZ Flow System for the Flow Bench Type. Most specs in this screen are now disabled and are being set automatically by the software.

Choose the Type of Electronics. For newer USB systems, choose "USB Mini Black Box" as shown here.

Click on Find Com Port button to have the program look for your Black Box II. Even if you are using a USB adapter, it will still show up as a Com Port.

Click on See Details button to bring up screen shown below.

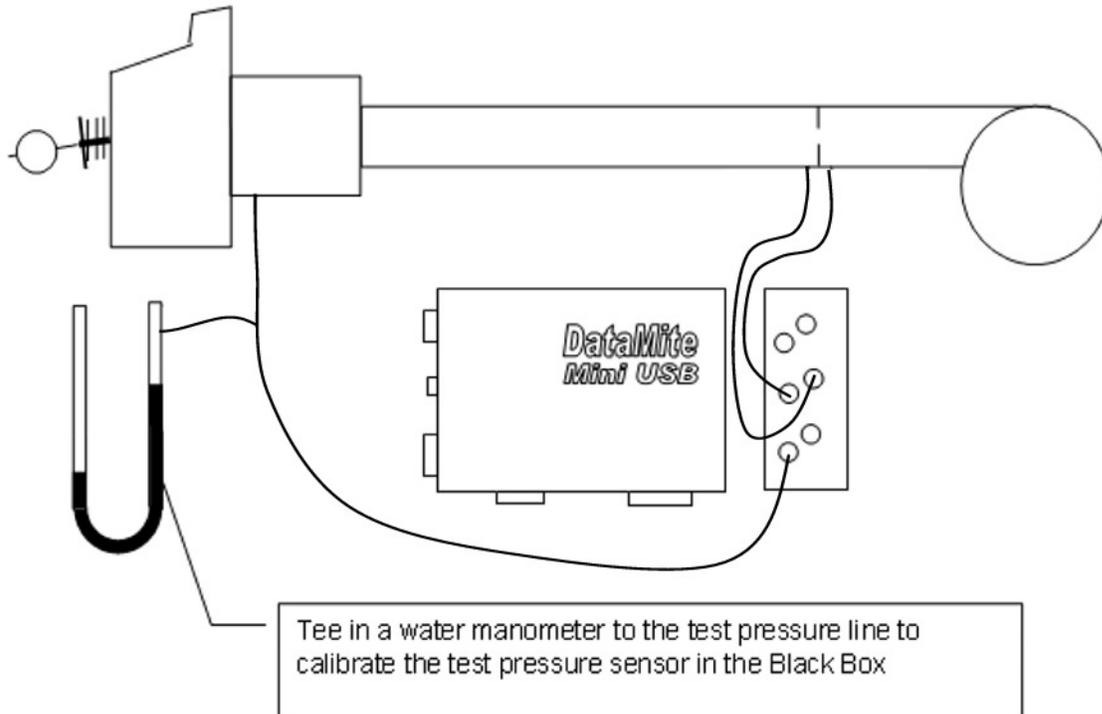


Enter both the Offset and Factor for Test Pres. sensors as shown here. These numbers (-133 and .055) are approximate, but work very well for most situations.

For OLDER boxes with ASCX sensors (plastic pressure taps extend above top of box), these numbers change to -80.5 and .038 respectively.

For added accuracy, you can also click on this Calibrate button and follow the program instructions to calibrate the sensor to a water manometer. See Figure on next page.

### Calibrating the Test Pressure Sensor with a Water Manometer



A water manometer can be as simple as a loop of clear plastic hose with colored water filling a little over half of the hose. It is much easier to work with a "tall" manometer, where the total height of the loop is 40 inches or more. The pressure you record is the total difference in height of the water levels. See Appendix 2 in the Port Flow Analyzer's user manual.

Once the Test Pressure (vertical manometer) sensor has been calibrated, or you have entered the "factory calibration" numbers from the previous page, you can calibrate the entire EZ Flow Flow Bench following the procedure outlined in the figures on the next page.

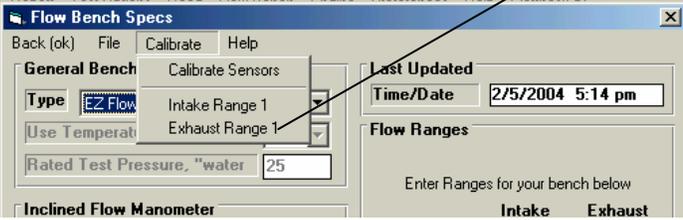
#### NOTES:

If you are not familiar with the term "calibrating" or do not understand water manometers, it is easier and probably MUCH BETTER to:

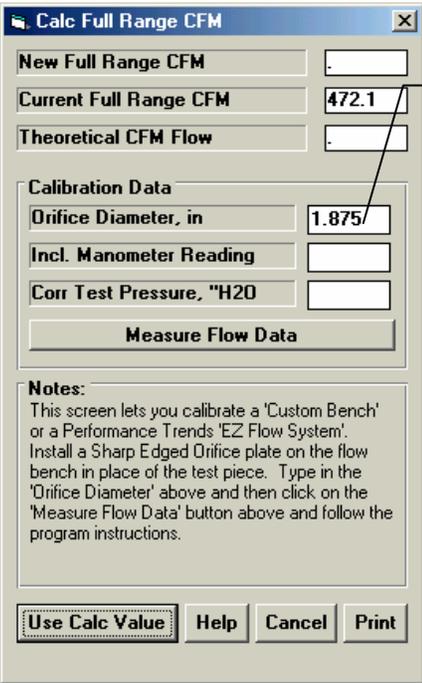
Use (type into the program) the factory calibration numbers for the Test Pres and Port Velocity sensors given on the previous page.

Do not "Calibrate the EZ Flow System" as described on the next page, but just calculate the Intake and Exhaust Flow Ranges from the equation on next page based on the flow orifice diameter (orifice in the PVC tubing).

# Calibrating the EZ Flow System



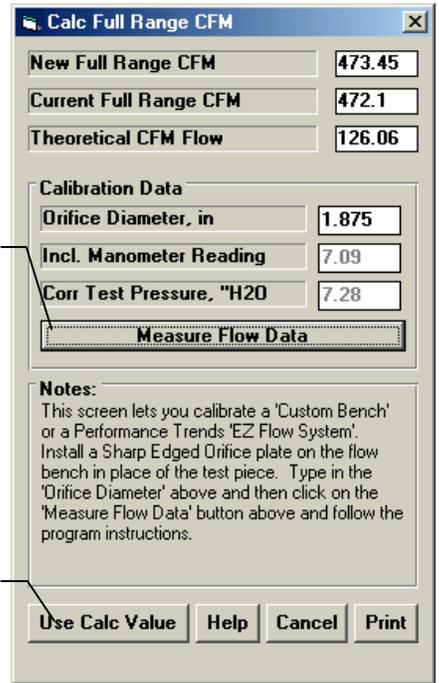
Click on Calibrate, then select either Intake or Exhaust for the flow direction to calibrate.



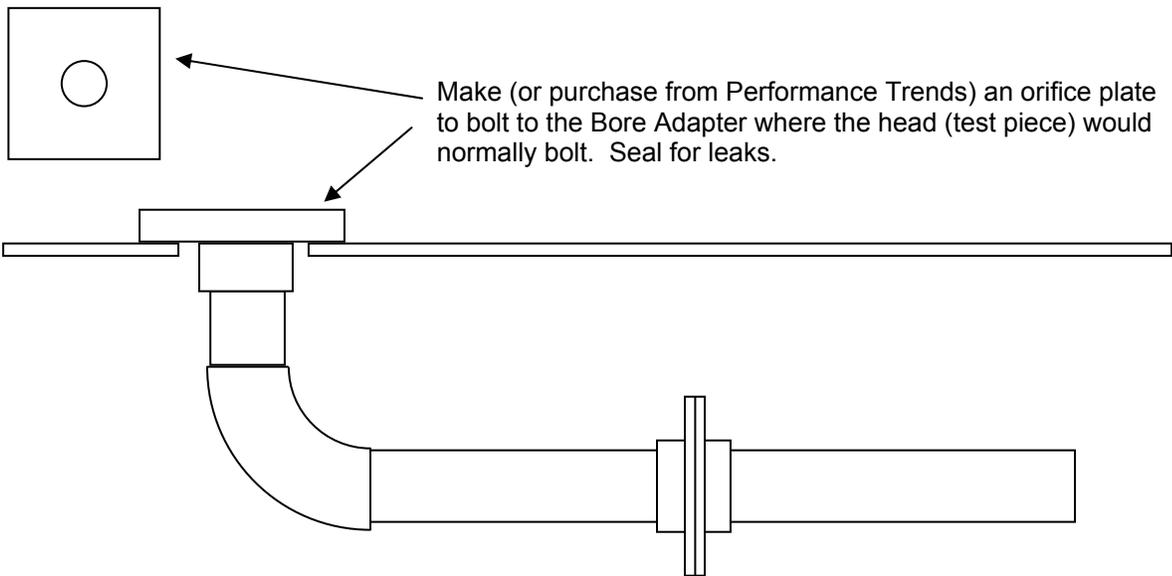
Enter the diameter of the orifice you have installed on the EZ Flow system as pictured below.

Click on Measure Flow Data and follow the program instructions. You will first let the program record zero pressures (with no flow, bench off). Then you will turn on the bench and record pressures for this known orifice size. The results will be shown at the top as "New Full Range CFM".

Click on the Use Calc Value to keep this new calibration.



**IMPORTANT:** You can estimate the New Full Range CFM you should get from this calibration by squaring the diameter of the flow orifice in the tube and then multiplying by 50. For example, for a 2.5" orifice, it should be approximately  $2.5 \times 2.5 \times 50 = 312.5$  CFM. If your calibration does not come close to this (within 10%), double check what you are doing.

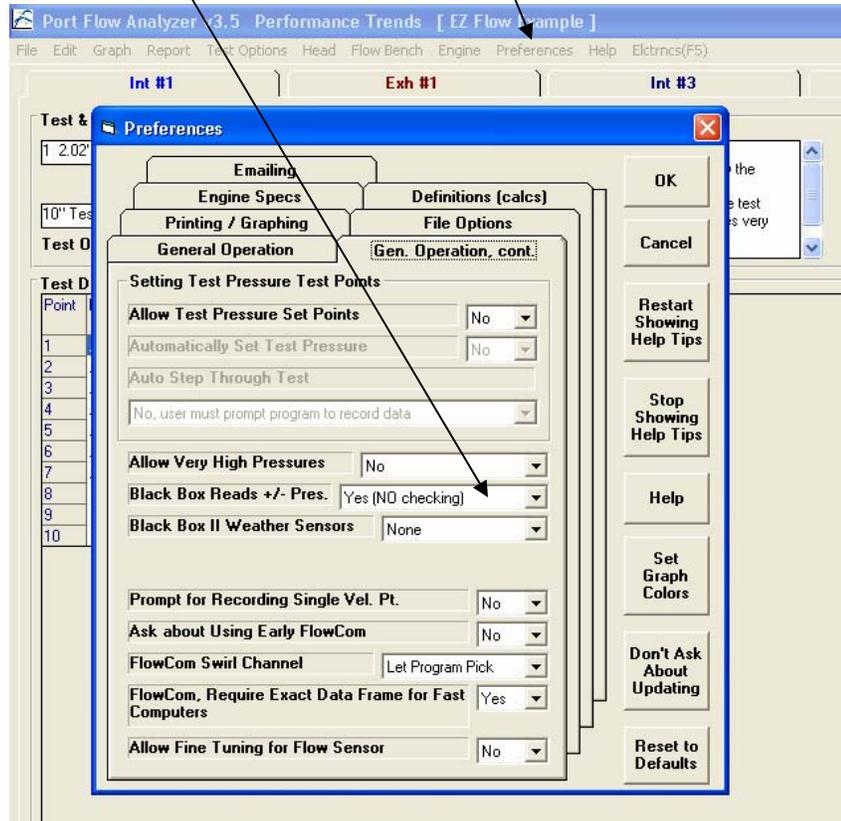


Depending on various combinations of settings, it may be necessary to set the Preference under the “Gen. Operation, cont.” tab of “Black Box Reads +/- Pres.” to “Yes (NO checking)”. See Figure below.

## Preference Settings

Then set Black Box Reads +/- Pres. to “Yes (NO checking)”

Click on Preferences



# 6" EZ Flow System's Bore Adapter and Assembly



