TrueFlow®
Air Handler Flow Meter

Operation Manual

Performance Testing Tools
612.827.1117 | www.energyconservatory.com

The Energy Conservatory

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Manual Edition: January 2006

ENERGY CONSERVATORY WARRANTY

EXPRESS LIMITED WARRANTY:

Seller warrants that this product, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for a period of 24 months, or such shorter length of time as may be specified in the operator's manual, from the date of shipment to the Customer.

LIMITATION OF WARRANTY AND LIABILITY:

This limited warranty set forth above is subject to the following exclusions:

- **a)** With respect to any repair services rendered, Seller warrants that the parts repaired or replaced will be free from defects in workmanship and material, under normal use, for a period of 90 days from the date of shipment to the Purchaser.
- **b)** Seller does not provide any warranty on finished goods manufactured by others. Only the original manufacturer's warranty applies.
- **c)** Unless specifically authorized in a separate writing, Seller makes no warranty with respect to, and shall have no liability in connection with, any goods which are incorporated into other products or equipment by the Purchaser.
- **d)** All products returned under warranty shall be at the Purchaser's risk of loss. The Purchaser is responsible for all shipping charges to return the product to The Energy Conservatory. The Energy Conservatory will be responsible for return standard ground shipping charges. The Customer may request and pay for the added cost of expedited return shipping.

The foregoing warranty is in lieu of all other warranties and is subject to the conditions and limitations stated herein. No other express or implied warranty IS PROVIDED, AND THE SELLER DISCLAIMS ANY IMPLIED WARRANTY OF FITNESS for particular purpose or merchantability.

The exclusive remedy of the purchaser FOR ANY BREACH OF WARRANTY shall be the return of the product to the factory or designated location for repair or replacement, or, at the option of The Energy Conservatory, refund of the purchase price.

The Energy Conservatory's maximum liability for any and all losses, injuries or damages (regardless of whether such claims are based on contract, negligence, strict liability or other tort) shall be the purchase price paid for the products. In no event shall the Seller be liable for any special, incidental or consequential damages. The Energy Conservatory shall not be responsible for installation, dismantling, reassembly or reinstallation costs or charges. No action, regardless of form, may be brought against the Seller more than one year after the cause of action has accrued.

The Customer is deemed to have accepted the terms of this Limitation of Warranty and Liability, which contains the complete and exclusive limited warranty of the Seller. This Limitation of Warranty and Liability may not be amended or modified, nor may any of its terms be waived except by a writing signed by an authorized representative of the Seller.

TO ARRANGE A REPAIR: Please call The Energy Conservatory at 612-827-1117 before sending any product back for repair or to inquire about warranty coverage. All products returned for repair should include a return shipping address, name and phone number of a contact person concerning this repair, and the purchase date of the equipment.

Table of Contents

Chapter 1 Introduction

The air flow rate through residential air handlers is an important variable in estimating and optimizing the performance of heat pumps, air conditioners and furnaces. Numerous field studies of installed heating and cooling systems around the United States have found that insufficient air flow across the indoor coil is an extremely common problem. Low air flow can lead to decreased heating and cooling system capacity, increased energy use and comfort problems.

The most widely used methods for estimating the air handler flow rate, (the temperature rise method, static pressure and fan curve method, and the Duct Blaster® isolated return method) have been found to be either problematic or time-consuming to perform. The Energy Conservatory's TrueFlow® Air Handler Flow Meter is designed to provide a simple and accurate measurement of air flow through residential air handlers rated from 1 to 5 tons. The TrueFlow Meter temporarily replaces the filter in a typical air handler system during the airflow measurement procedure. If the filter location is directly adjacent to the air handler, the TrueFlow Meter will measure the total air handler flow. If the filter is located remotely at a single central return, the TrueFlow Meter will measure the airflow through the central return.

Note: If the return duct system is very airtight, the air flow through the single central return will be very close to the total air handler flow.

Extensive field testing of the TrueFlow Meter has shown that it:

- Is easy and fast to use in the field. The TrueFlow Meter provides direct CFM readings in approximately 2 to 4 minutes without extensive calculations or setup. The TrueFlow Meter requires about the same time as the single-point temperature rise method, when including the time required in the temperature method to measure the output capacity.

- Can be used in a wide range of return plenums and air handler fan configurations. Adjustable sizing of the TrueFlow Meter allows it to fit most standard filter slots. Custom adjustments for unusual filter sizes can be easily made by the operator.

- Has a flow accuracy of +/ 7% for most applications when used with a pressure gauge having an accuracy of 1% of reading. The TrueFlow Meter is approximately 4 times more accurate than the single-point temperature rise method, and of comparable accuracy to the Duct Blaster isolated return method.

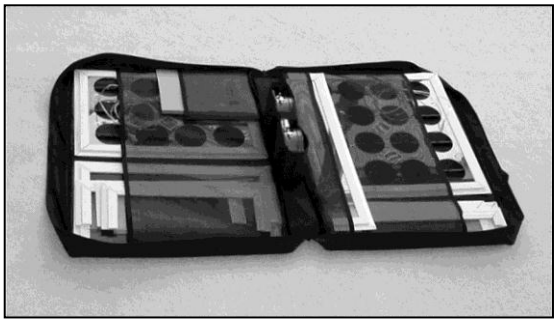
- Is applicable to many systems for which the temperature rise method cannot be used due to inadequate or absent supply plenum temperature measurement points.

- Can be used with any manometer which has a resolution of 1 Pascal or 0.005 In H_2O.

Chapter 2 System Components

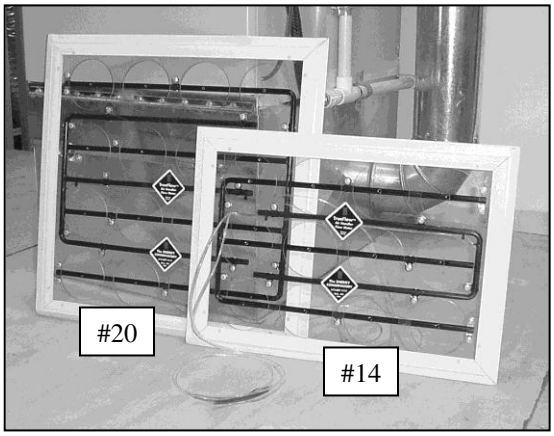
The TrueFlow Air Handler Flow Meter consists of the following components:

- 2 calibrated Metering Plates.
- 8 spacers which attach to the Metering Plates to provide for sizing adjustments.
- 1 static pressure probe.
- Flow conversion tables used to convert Metering Plate pressure measurements to flow in Cubic Feet per Minute.
- 10 feet of blue tubing and 30 feet of clear tubing.
- Operation manual.
- Carrying case.



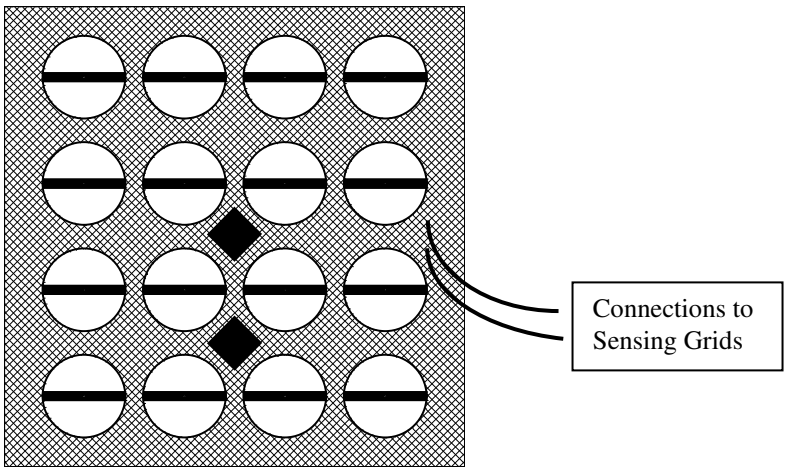
2.1 Metering Plates

The TrueFlow Meter includes 2 Metering Plates (#14 and #20), each comprised of a clear plastic plate with a series of round metering holes and black pressure sensing grids. Each plate has H-channel gasket attached to all 4 sides. The H-channel gasket provides a seal around the Metering Plate when it is installed in a filter slot, and also provides an attachment channel to attach spacers to the plate. Two Metering Plates are provided due to the large range of filter sizes possible in residential air handling systems.



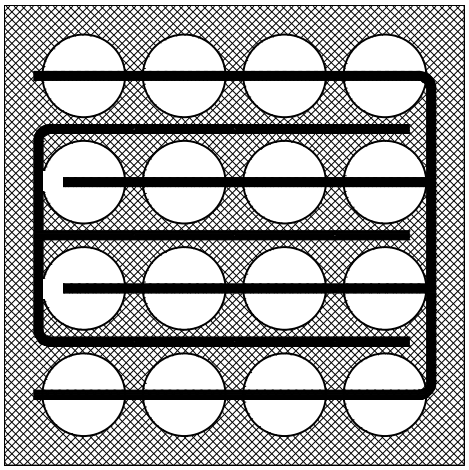
The Metering Plates are installed in place of the system air filter, which is always located in the return side of the duct system. The front side of the Metering Plate, as shown in Figure 1, should be facing "upstream" into the airflow (i.e. away from the air handler fan). The 2 tubing connections to the plate's pressure sensing grids are located on the front side of the plate.

Figure 1: Front Side of Metering Plate (should face into air flow)



The rear side of the Metering Plate, as shown in Figure 2, should be facing "downstream" away from the air flow (i.e. toward the air handler fan). The plate's pressure sensing grids are attached to the rear side of the plate.

Figure 2: Rear View of Metering Plate (should face away from air flow)



Air flow through the Metering Plate is determined by measuring the pressure difference between the two sensing grids on the plate. The measured pressure difference is converted to air flow in Cubic Feet per Minute using a flow conversion table (see **Appendix A**). Each metering plate contains two tubing connections to the pressure sensing grids. The **Red** tubing connection provides a pressure signal from the plate's "total pressure" grid. The **Green** tubing connection provides a pressure signal from the plate's "static pressure" grid.

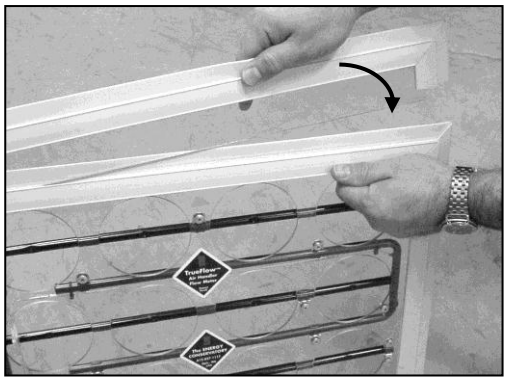
2.2 Spacers

The TrueFlow Meter comes with 8 spacers which are used to adjust the size of the Metering Plates. The 2 Metering Plates and 8 spacers are compatible with the following 12 standard filter sizes :

Table 1: Standard Filter Sizes Compatible with the TrueFlow Meter

Plate #14:	14 x 20	14 x 25	16 x 20	16 x 24	16 x 25	18 x20
Plate #20:	20 x 20	20 x 22	20 x 24	20 x 25	20 x 30	24 x 24

Each spacer consists of a clear plastic plate with H-channel gasket attached to three sides. Spacers are attached to the Metering Plate by pushing the open side of the spacer into the attachment channel found on the Metering Plate H-channel. Install the spacer so that the outside edge of the gasket on the spacer and the Metering Plate line up with each other.



It is sometimes necessary to attach two spacers to a Metering Plate at the same time. Attaching the second spacer is done in the same manner as the first spacer - push the open side of the second spacer into the attachment channels found on the Metering Plate and first spacer. Install the second spacer so that the outside edge of the gasket on the spacer and the Metering Plate line up with each other.

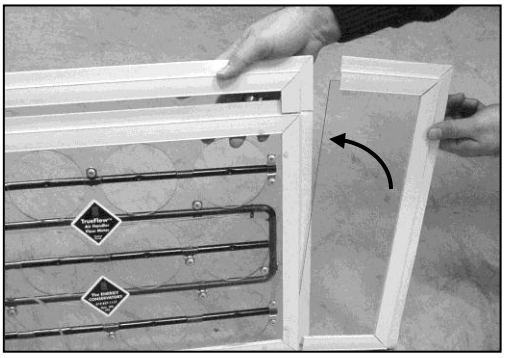


Table 2 below lists the combination of Metering Plates and spacers needed to adjust the TrueFlow Meter to the 12 most commonly found filter sizes.

Table 2: Metering Plate and Spacer Selection Guide

Filter Size (in. x in.)	Flow Metering Plate	Spacer Dimension (in. x In.)	
		Spacer 1	Spacer 2
14 x 20	#14	------	------
14 x 25	#14	5 x 14	------
16 x 20	#14	2 x 20	------
16 x 24	#14	2 x 20	4 x 16
16 x 25	#14	2 x 20	5 x16
18 x 20	#14	4 x 20	------
20 x 20	#20	------	------
20 x 22	#20	2 x 20	------
20 x 24	#20	4 x 20	------
20 x 25	#20	5 x 20	------
20 x 30	#20	10 x 20	------
24 x 24	#20	4 x 20	4 x 24

To use the Selection Guide, locate the filter slot size in the “Filter Slot” column. Determine the TrueFlow Metering Plate and spacers needed by referring to the “Flow Metering Plate” and “Spacer Dimension” columns. For example, a 16” x 25” filter slot requires the #14 Metering Plate, along with the 2” x 20” and 5” x 16” spacers.

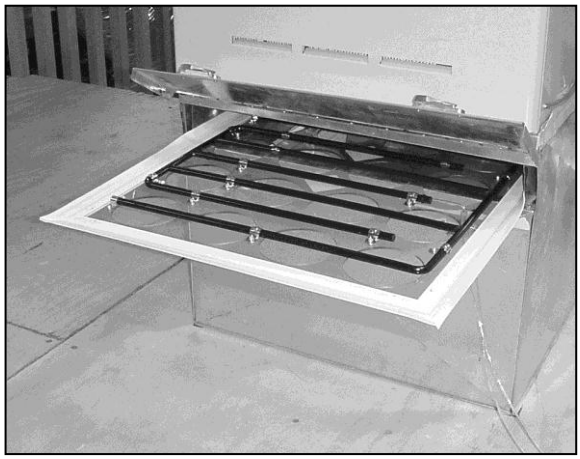
Note: If you need to match a filter slot size that is not listed in the Selection Guide, custom sized spacers can be cut from any 3/32” or 1/8” thick material (e.g. plastic sheet or cardboard). These custom spacers can be attached to the Metering Plates in the same manner as the standard spacers, or they can be taped to the edge of the Metering Plate. In addition, the H-channel gasket can be temporarily removed (by removing the gasket fastener plugs) to reduce the size of the Metering Plates or spacers.

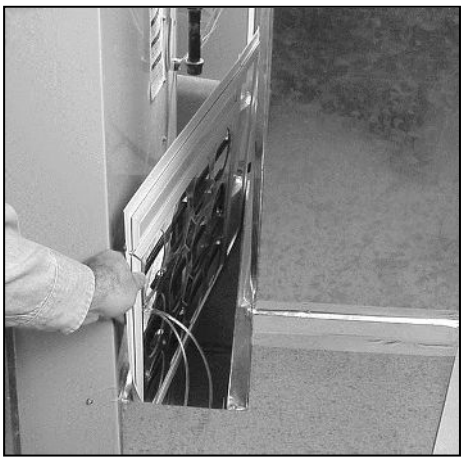
2.3 Installing the Metering Plates

2.3.a Installing at a Filter Slot:

Remove the existing filter and slide the TrueFlow Metering Plate completely into the empty filter slot. Install the Metering Plate so that the front side of the plate is facing into the air flow (front side has two diamond shaped labels on it). The H-channel gasket should provide a seal around the Metering Plate - all of the air flow should pass through the Metering Plate and not around the plate. Be sure that the ends of the flexible tubing connections attached to the pressure sensing grids remain outside of the filter slot (these will be connected to a pressure gauge). Occasionally, drilling holes into the ductwork may be required as a pathway for the ends of the flexible tubing. The flexible tubing can be passed through one of the plate's metering holes if this helps in getting the tubing ends outside of the filter slot.

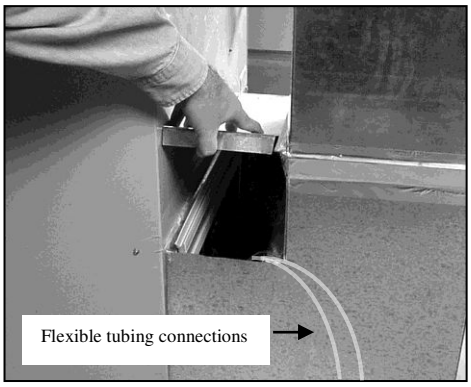
Sliding the TrueFlow Metering Plates Into a Filter Slot





If you wish to install the Metering Plate in a blower compartment and there is no filter slot built into the compartment, it is sometimes possible to temporarily tape the Metering Plate into the compartment for the test procedure. In this case, be sure that the tape is not blocking any of the metering holes in the plate.

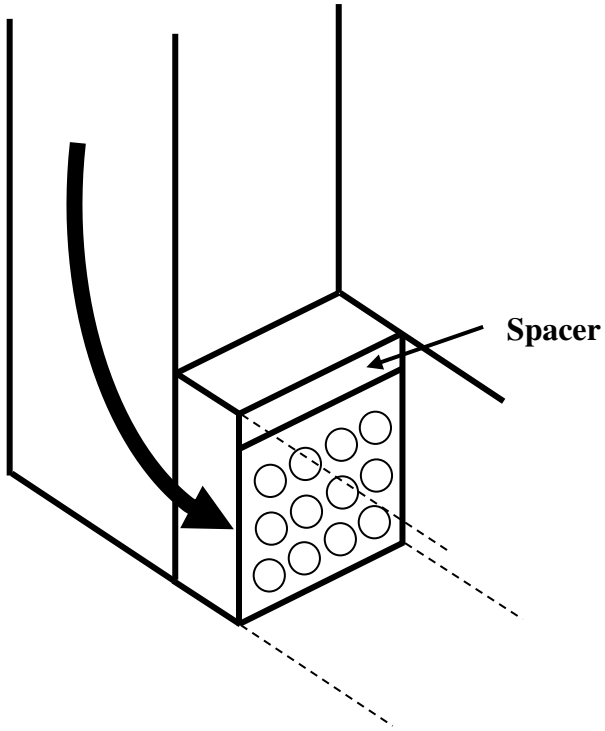
Close the filter access opening. If the flexible tubing connections are coming through the filter slot opening, be careful NOT to pinch-off the flexible tubing with the filter slot cover. Temporarily seal around the filter slot cover with masking tape to prevent air leakage and to direct all air flow through the Metering Plate.



Installation Notes

- Obstructions within 6 inches upstream or 2 inches downstream of the Metering Plate that are blocking air flow through any of the metering holes may reduce the accuracy of the device.
- If there is an obstruction, and there is a spacer attached to the Metering Plate, try to install the Metering Plate so that the spacer is directly in front of the obstruction (this will minimize the effect of the obstruction on the flow measurement).
- If the Metering Plate is installed directly downstream of a 90 degree bend in the duct system, and there is a spacer attached to the plate, install the Metering Plate so that the spacer is on the inside corner of the bend (see Figure 3 below).

Figure 3: Installing Spacer on Inside Corner of 90 Degree Bend



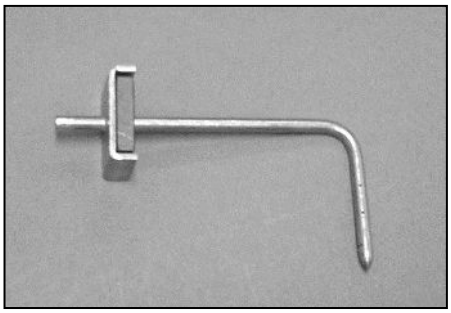
2.3.b Installing at a Single Central Return:

If you are installing the TrueFlow Metering Plate at the filter grille of a single return duct system, simply push the plate into the empty filter rack. Make sure that the front of the plate is facing out (into the air flow). The H-channel gasket should provide an airtight seal around the Metering Plate - all of the air flow should pass through the Metering Plate and not around the plate. Keep the filter grille door open during the remainder of the test.

Note: If there are multiple returns in the duct system, the only way to use the TrueFlow Meter is to simultaneously install a TrueFlow Metering Plate at each of the returns.

2.4 Static Pressure Probe

The TrueFlow Meter comes with one static pressure probe. During the air flow measurement procedure, the operator will need to measure the operating pressure in the duct system, both with the existing filter in place and with the TrueFlow Meter in place. These two operating pressure measurements are used to adjust the measured air flow through the Metering Plate for differences in resistance between the existing filter and the TrueFlow Meter.



2.5 Gauge Options

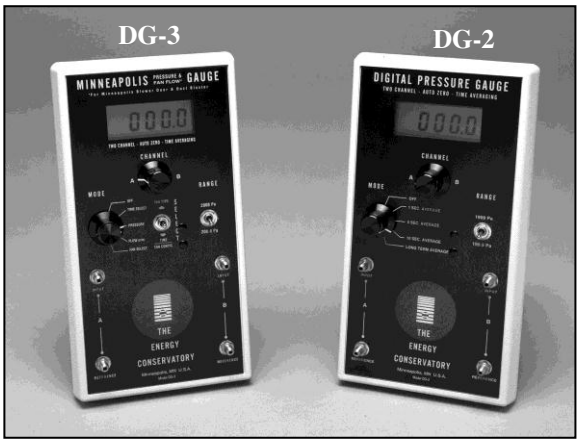
To use the TrueFlow Meter, you will need a pressure gauge with a resolution of 1 Pascal (or 0.005 In. H_2O). The TrueFlow Meter can be purchased with any of The Energy Conservatory's Digital Pressure Gauges (Models DG-700, DG-3 and DG-2), with a set of two Magnehelic® gauges (60 Pa and 250 Pa), or purchased alone for use with an existing pressure gauge.

2.5.a DG-700 Digital Pressure Gauge:

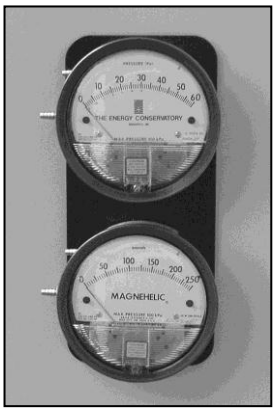
The DG-700's two independent pressure sensors and built-in Air Handler Flow measurement mode make it extremely easy to directly measure and display air handler flow (in CFM) with the TrueFlow system. The DG-700 is shipped in a separate padded case and can be purchased with a gauge board that can be easily mounted on any metallic surface. The DG-700 gauge provides an air flow measurement accuracy of +/- 7% when used with the TrueFlow Metering Plates.

2.5.b DG-2 and DG-3 Digital Pressure Gauges:

The DG-2 and DG-3 pressure gauges each have a single pressure sensor with two switchable measurement channels which allows you to monitor both the operating pressure in the duct system, as well as the pressure signal from the TrueFlow Metering Plate. The DG-3 also has the capability to display the measured airflow through the TrueFlow Metering Plate directly in cubic feet per minute (CFM). The digital gauges are shipped in a separate padded case and can be purchased with a gauge board that can be easily mounted on any metallic surface. Both the DG-3 and DG-2 gauges provide an air flow measurement accuracy of +/- 7% when used with the TrueFlow Metering Plates.



2.5.c Magnehelic Gauges:



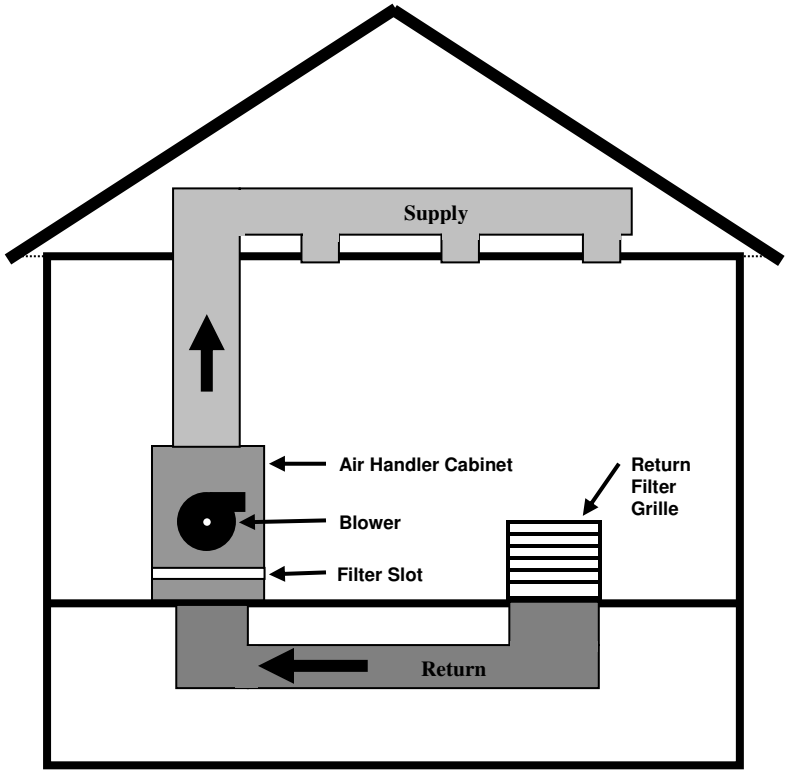
The Magnehelic gauges come mounted on a gauge board that can be easily mounted on any metallic surface. Two gauges are provided (60 Pascal and 250 Pascal) to provide the necessary measurement accuracy over a wide range of pressures. When using the Magnehelic gauges, air flow measurement accuracy of the TrueFlow Meter is +/- 9%.

Chapter 3 TrueFlow Meter Test Procedure

In order to measure total air flow through the air handler, it is best to install the TrueFlow Metering Plate in a filter slot as close to the air handler blower as possible. Many duct systems have a filter slot built into the return plenum ductwork. In addition, most air handler cabinets have a filter slot built into the blower compartment directly upstream of the blower. Install the TrueFlow Metering Plate in these filter slot locations whenever possible.

A TrueFlow Metering Plate can also be installed at the filter grille of a single return duct system. In this case, the TrueFlow Meter will be measuring the air flow through the single return. If the return duct system is very airtight, the air flow through the single return will be very close to the total system air flow. If the duct system has multiple returns, the only way to use the TrueFlow Meter is to simultaneously install a TrueFlow Metering Plate at each of the returns.

Figure 4: Example Duct System



The basic test procedure for using the TrueFlow Meter involves the following six steps (test procedure **Quick Guides** are located in **Appendix E** at the end of this manual):

1. With the air handler "on" and the existing filter in place, measure the Normal System Operating Pressure (**NSOP**) using a static pressure probe.
2. Replace the existing filter with one of the TrueFlow Metering Plates.
3. Measure the system operating pressure with the TrueFlow Metering Plate in place (TrueFlow System Operating Pressure or **TFSOP**) using a static pressure probe.
4. Measure the air flow through the TrueFlow Metering Plate using the pressure signal from the Metering Plate.
5. Calculate a Flow Resistance Correction Factor using the 2 operating pressure measurements (Steps 1 & 3).
6. Multiply the measured air flow through the Metering Plate by the Flow Resistance Correction Factor for the final adjusted air flow result.

Note: The DG-700's built-in Air Handler Flow Mode automatically calculates and applies the Flow Resistance Correction Factor (#5 & #6 above).

3.1 Set-Up to Measure the Normal System Operating Pressure

a) Locate the air handler system filter and replace if dirty,

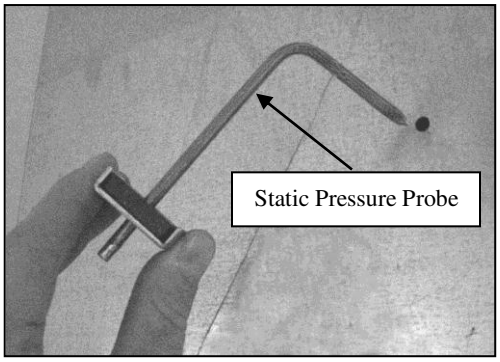
Locate the air handling system filter and if it is dirty, replace with a new one. A dirty filter can significantly reduce air flow through the air handling system. **Note:** If you wish to measure the air flow with the dirty filter, leave the dirty filter in place.

b) Open all registers and outside window.

Make sure all supply and return registers are open. Open a window or door between the building and outside to prevent pressure changes in the building during the test. If the air handler fan is installed in an unconditioned zone (e.g. crawlspace, attic), open any vents or access doors connecting that zone to the outside (or to the building) to prevent pressure changes in the zone during the test.

c) Install the static pressure probe.

Install the static pressure probe into the ductwork at any one of the three locations listed below (the operator will typically need to drill or punch a small hole in the ductwork in order to insert the static pressure probe):



- Insert the static pressure probe into the side surface of the supply plenum. The side of the supply plenum chosen should **not** have a trunk line, distribution duct or supply register connected to it. The static pressure probe should point into the airstream.
- Or, insert the tip of the static pressure probe into a "dead-end" corner of the supply plenum. A "dead-end" corner is simply a corner of the plenum that does not have a trunk line connection, distribution duct connection or supply register within 8 inches of the corner.
- Or, insert the static pressure probe in the side surface of the return plenum. The side of the return plenum chosen should **not** have a trunk line, return duct or return register connected to it. The location chosen should also be at least 24 inches upstream from the TrueFlow Metering Plate, and at least 24 inches downstream from any 90 degree corners or return trunk line connections. The static pressure probe should point into the airstream. **Note:** If the Metering Plate will be installed at a remote filter grille, the static pressure probe may not be installed in the return plenum (i.e. install it in the supply plenum).

These three duct locations typically provide a very stable static pressure reading and are readily available in most applications. If one of the three locations listed above is not available, see **Appendix D** for other location options.

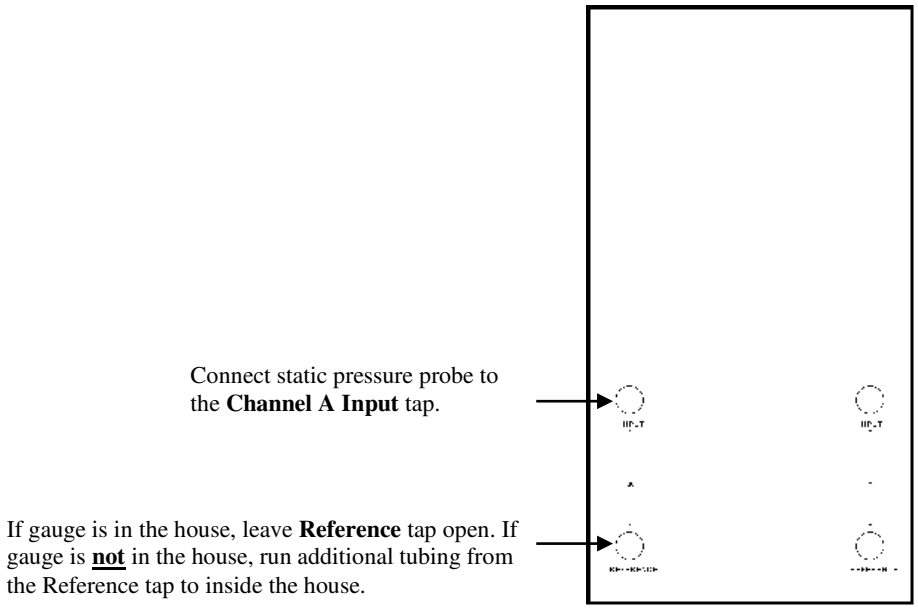
d) Connect the static pressure probe to a pressure gauge.

Connect one end of the static pressure probe to the 10 foot length of blue tubing. Now connect the remaining end of the tubing to a pressure gauge. **Note:** If you are using the "dead-end" corner location, you may simply insert the end of the tubing into the "dead-end" corner and not use a static pressure probe.

- **DG-700, DG-3 or DG-2 Pressure Gauge**

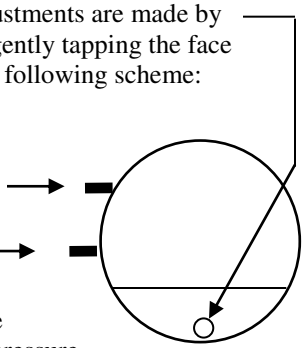
If using a DG-700, DG-3 or DG-2 digital pressure gauge, connect the end of the blue tubing to the **Channel A** Input pressure tap. If the pressure gauge is located inside the house, leave the **Channel A Reference** tap on the gauge open (we want to measure the system operating pressure with reference to the house). If the pressure gauge is not located in the house (e.g. it is in the crawlspace, garage, or attic), run the 30 foot piece of clear tubing from the **Channel A Reference** tap to inside the house

Figure 5: Connecting the Static Pressure Probe to a DG-700, DG-3 or DG-2 Gauge



- **Magnehelic Gauges**

If using the Magnehelic gauges, first mount the magnetic gauge board on a vertical metal surface (e.g. the air handler cabinet or supply plenum). Adjust both gauges to read zero. Magnehelic gauge adjustments are made by turning the adjustment screw near the bottom of the gauge with a small screwdriver while gently tapping the face plate of the gauge. Now connect the end of the blue tubing to the 60 Pascal gauge using the following scheme:



- If the static pressure probe is inserted into the supply plenum, connect the blue tubing to the top tap on the 60 Pascal gauge.
- If the static pressure probe is inserted into the return plenum, connect the blue tubing to the bottom tap on the 60 Pascal gauge.
- If the pressure gauge is located inside the house, leave the remaining pressure tap on the gauge open. If the pressure gauge is not located in the house (e.g. it is in the crawlspace, garage, or attic), run the 30' piece of clear tubing from the remaining pressure tap to inside the house.

- **Using Your Own Pressure Gauge**

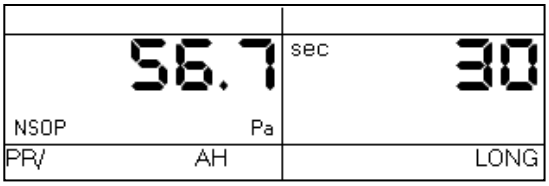
Adjust your pressure gauge to read zero if it has a manual zero adjustment. Now connect the end of the blue tubing to your gauge using the following scheme:

- If the static pressure probe is inserted into the supply plenum, connect the blue tubing to the positive (or high) pressure tap on your gauge.
- If the static pressure probe is inserted into the return plenum, connect the blue tubing to the negative (or low) pressure tap on your gauge.
- If the pressure gauge is located inside the house, leave the remaining pressure tap on the gauge open. If the pressure gauge is not located in the house (e.g. it is in the crawlspace, garage, or attic), run the 30' piece of clear tubing from the remaining pressure tap to inside the house.

3.2 TrueFlow Measurement Procedure Using the DG-700 Gauge

Step 1: Measure the Normal System Operating Pressure (NSOP)

- Turn on the air handler fan to the desired speed (typically using the thermostat).
- Turn on the gauge and put it the **PR/ AH** mode by pressing the **MODE** button 4 times. The icon "**NSOP**" will begin to flash in the **Channel A** display. At this point, the gauge is monitoring the real-time **Channel A NSOP** pressure, but is not recording the reading. The **Channel B** display is not active at this time.
- Press the **START** button to begin the **NSOP** measurement procedure on **Channel A**. Once the **START** button is pressed, the **NSOP** icon stops flashing and the gauge begins recording a long-term average **NSOP** pressure reading on **Channel A**. During the measurement procedure, the **Channel B** display is used as a timer to let the user know how long (in seconds) the **NSOP** measurement has been active. The longer the measurement time, generally the more stable the reading typically becomes. In the screen to the right, the measured **NSOP** pressure is 56.7 Pascals (measured over the past 30 seconds).

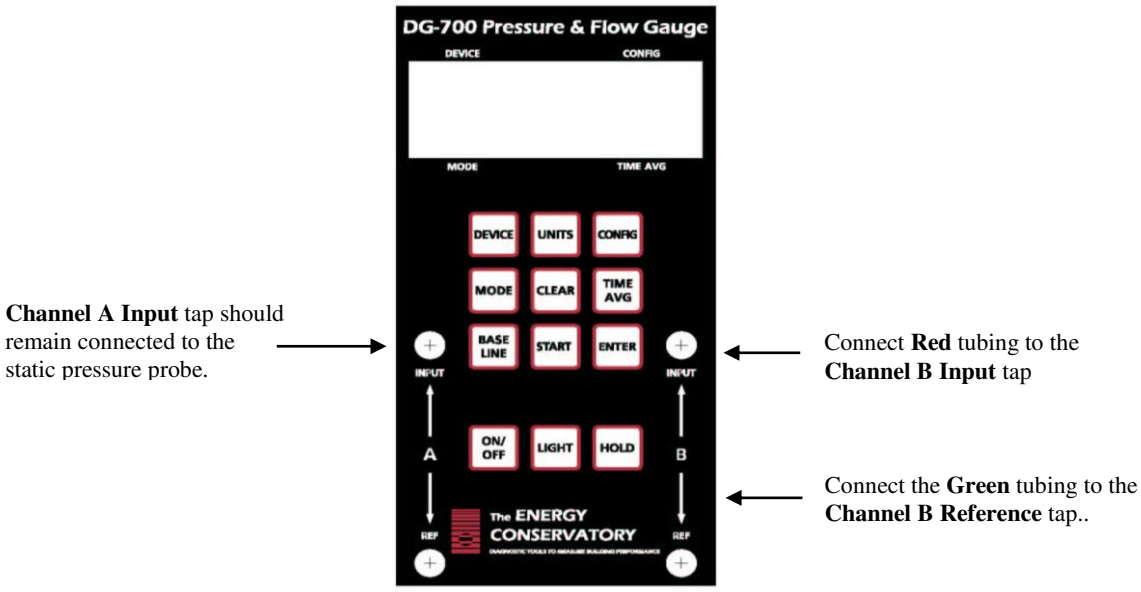


- Once you are satisfied with the **NSOP** reading, press the **ENTER** key to accept and enter the reading into the gauge. Turn off the air handler fan, and leave the static pressure probe in place and connected to the gauge on **Channel A**.
- **Note:** If the **NSOP** reading is very low (less than 10 Pascals), or the reading is fluctuating significantly, try to find a different location for the static pressure probe (see **Appendix D**).

Step 2: Install the Metering Plate

- Remove the existing filter and install the appropriate Metering Plate in place of the filter as described in **Chapter 2**. **Note:** If the Metering Plate is to be installed in a location that is different from the existing filter (e.g. installing the Metering Plate in a filter slot built into the air handler blower compartment, while the existing filter is located at a single return filter grille), the existing filter should still be removed.
- Connect the tubing from the installed Metering Plate to the DG-700. Connect the **Red** ("total pressure grid") tubing connection to the **Channel B Input** pressure tap. Connect the **Green** ("static pressure grid") tubing connection to the **Channel B Reference** pressure tap.

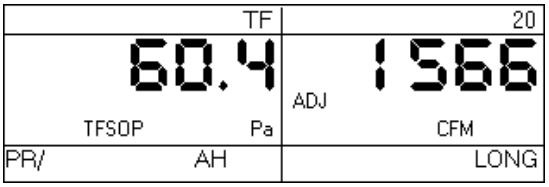
Figure 6: Connecting the Metering Plate to the DG-700



Note: With the DG-700 don't worry if you reverse the Red and Green tubing connections because the absolute pressure difference between the tubing connections is used to determine air flow.

Step 3: Measure the TrueFlow System Operating Pressure (TFSOP) and Adjusted Total Air Handler Flow

- Check and adjust if necessary the selected test Device and Configuration shown in the upper part of the gauge display to match the Metering Plate installed in **Step 2** above. When using the TrueFlow Metering Plates, the Device icon should always be set to **TF**, and the Configuration icon should be set to **14** or **20** depending on which Metering Plate is installed. Changes to the selected Device and Configuration are made by pressing the **DEVICE** and **CONFIG** buttons.



- Turn the air handler fan back on to the same speed as used in **Step 1** above. **Channel A** will now display the **TFSOP** reading from the static pressure probe, and **Channel B** will display adjusted air handler flow. The static pressure probe should be in exactly the same position as it was in **Step 1** above. The air handler flow rate estimate shown on **Channel B** is determined by continuously adjusting the measured air flow from the TrueFlow Metering Plate using a flow resistance correction factor calculated from the **NSOP** and **TFSOP** pressure readings. If the readings are fluctuating, change the time averaging setting to ***5 second***, ***10 second***, *or* ***Long-Term*** average using the **TIME AVG** button.
- Record the adjusted air flow reading from **Channel B**. This result is the estimated air flow at the measurement location with the existing filter in place. Turn off the air handler fan.

Note: When the TrueFlow Air Handler Flow Meter is installed at a remote filter grille, it is possible to make a correction to the measured flow through the Metering Plate which increases the accuracy of the flow measurement. See **Appendix C** for more details.

3.3 TrueFlow Measurement Procedure Using a DG-3, DG-2 or Other Gauge

Step 1: Measure the Normal System Operating Pressure (NSOP)

- Turn on the air handler fan to the desired speed (typically using the thermostat).
- If using a DG-3 or DG-2 gauge, set-up the gauge to measure pressure on **Channel A** and turn the **RANGE** switch to ***Low (200.0)***. You may want to use the ***5 second***, ***10 second*** or ***Long-Term*** time-average setting if the pressure reading is fluctuating.
- Measure and record the **NSOP** reading from the static pressure probe. Turn off the air handler fan, and leave the static pressure probe in place and connected to the gauge.
- If the **NSOP** reading is very low (less than 10 Pascals), or the reading is fluctuating significantly, try to find a different location for the static pressure probe (see **Appendix D**).
- When using the Magnehelic gauges and the **NSOP** reading is greater than 60 Pascals, switch the tubing connection(s) from the 60 Pascal gauge to the 250 Pascal gauge and record the reading.

Step 2: Install the Metering Plate

- Remove the existing filter and install the appropriate Metering Plate in place of the filter as described in **Chapter 2**. **Note:** If the Metering Plate is to be installed in a location that is different from the existing filter (e.g. installing the Metering Plate in a filter slot built into the air handler blower compartment, while the existing filter is located at a single return filter grille), the existing filter should still be removed.

Step 3: Measure the TrueFlow System Operating Pressure (TFSOP)

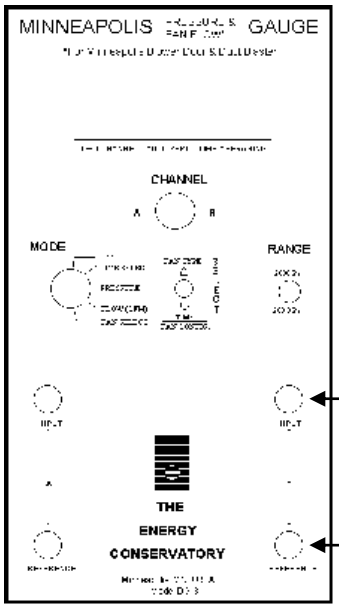
- Turn the air handler fan back on to the same speed as used in **Step 1** above.
- Measure and record the TrueFlow system operating pressure (**TFSOP**) using the static pressure probe. The static pressure probe should be in exactly the same position as it was in **Step 1** above.
- If using a DG-3 or DG-2 gauge, this measurement is made on **Channel A**. You may want to use the ***5 second***, ***10 second*** or ***Long-Term*** time-average setting if the pressure reading is fluctuating.
- If using Magnehelic gauges and the **TFSOP** reading is greater than 60 Pascals, switch the tubing connection(s) from the 60 Pascal gauge to the 250 Pascal gauge and record the reading.

Step 4: Connect the Tubing from the Installed Metering Plate to your Pressure Gauge

- **DG-3 or DG-2 Pressure Gauge:**

Connect the **Red** ("total pressure grid") tubing connection to the **Channel B Input** pressure tap. Connect the **Green** ("static pressure grid") tubing connection to the **Channel B Reference** pressure tap.

Figure 7: Connecting the Metering Plate to the DG-3 and DG-2 Gauges

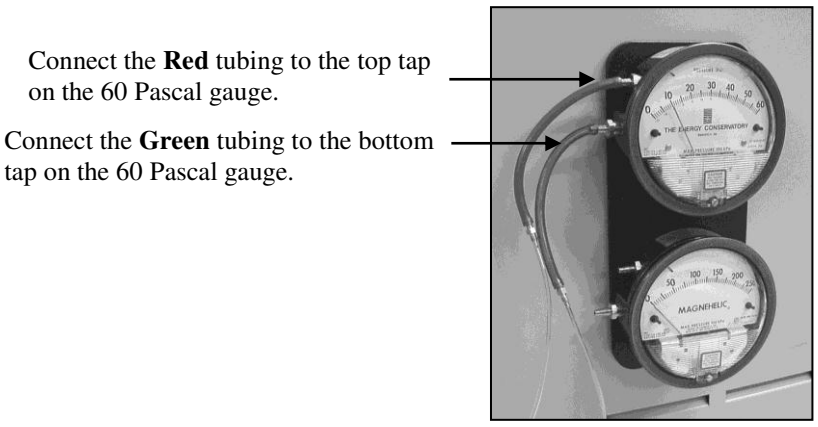


Note: With the DG-3 or DG-2 gauges, don't worry if you reverse the Red and Green tubing connections because the absolute pressure difference between the tubing connections is used to determine air flow.

- **Magnehelic Gauges:**

First disconnect the tubing used to measure the **NSOP** and **TFSOP** readings. Now re-zero the Magnehelic gauges by turning the adjustment screw near the bottom of the gauges with a small screwdriver while gently tapping the faceplate. Connect the **Red** ("total pressure grid") tubing connection to the top tap on the 60 Pascal gauge. Connect the **Green** ("static pressure grid") tubing connection to the bottom tap on the 60 Pascal gauge.

Figure 8: Connecting the Metering Plate to Magnehelic Gauges



- **Using Your Own Pressure Gauge:**

Adjust your pressure gauge to read zero if it has a manual zero adjustment. Now connect tubing to the gauge using the following scheme:

- Connect the **Red** tubing connection to the positive (or high) pressure tap on your gauge.
- Connect the **Green** tubing to the negative (or low) pressure tap on your gauge.

Step 5: Measure and Record the Air Flow Through the Installed Metering Plate

With the air handler fan continuing to run, measure and record the air flow through the Metering Plate.

- **Direct Flow Readings from the DG-3 Gauge**

In order for the DG-3 gauge to directly display air flow in CFM from the Metering Plate, the installed Metering Plate must be selected in the gauge.

To select the Metering Plate being used in your test, first turn the **MODE** knob to the ***Fan Select*** position. The gauge display will show "-SEL" to indicate that a flow measurement device has not yet been selected. The selected flow measurement device is chosen by toggling the **SELECT** Switch up.

If the Display Shows	Description
-SEL	Begin flow measurement device selection by toggling the **SELECT** switch up: - **up 3 times** to select the #14 Metering Plate. - **up 4 times** to select the #20 Metering Plate.
PL 14	This indicates that you have chosen the #14 TrueFlow Metering Plate.
PL 20	This indicates that you have chosen the #20 TrueFlow Metering Plate.

Once the proper plate has been selected, turn the **MODE** switch to ***Flow***. With the **CHANNEL** knob set to **B**, the gauge will now display the air flow through the Metering Plate in CFM. You may want to use the ***5 second***, ***10 second*** or ***Long-Term*** average setting if the flow reading is fluctuating.

Note: DG-3 gauges sold prior to April 2001 may not have the ***PL14*** or ***PL20*** options when selecting a flow measurement device. These gauges can be retrofitted with a new EPROM by The Energy Conservatory (call for more information).

- **Determining Air Flow Using the Flow Conversion Tables (DG-2, Magnehelic or other pressure gauges)**

Measure the pressure signal from the TrueFlow Metering Plate. If using the DG-2, this measurement is made on **Channel B** (you may want to use the ***5 second***, ***10 second*** or ***Long-Term*** time-average setting if the reading is fluctuating.). The Metering Plate pressure can then be converted to airflow in CFM using the appropriate flow conversion table contained in **Appendix A**. Laminated flow conversion tables are also provided with the TrueFlow Manual.

Step 6: Calculate a Flow Resistance Correction Factor

A Flow Resistance Correction Factor can be determined using the two system operating pressure measurements made during the test procedure (**Steps 1** and **3**). The Flow Resistance Correction Factor is used to adjust the measured air flow through the Metering Plate for differences in resistance between the existing filter and the TrueFlow Meter.

A table of Flow Resistance Correction Factors can be found in **Appendix B** and are based on the following formula.

- Flow Resistance Correction Factor = $\sqrt{\textbf{NSOP / TFSOP}}$

  where:

  - **NSOP** equals the normal system operating pressure recorded from **Step 1**.
  - **TFSOP** equals the system operating pressure with the TrueFlow Metering Plate installed recorded from **Step 3**.

Laminated correction factor tables are also provided with the TrueFlow Manual.

Step 7: Calculate the Adjusted Air Flow

Multiply the measured air flow through the TrueFlow Metering Plate (**Step 5**) by the Flow Resistance Correction Factor (**Step 6**) to determine the final adjusted air flow result. This result is the estimated air flow at the measurement location with the existing filter in place. Turn off the air handler fan.

Example: Using the #20 Metering Plate, the three test readings are:

Normal system operating pressure (**NSOP**) = **50 Pa**
TrueFlow system operating pressure (**TFSOP**) = **46 Pa**
Air Flow through the TrueFlow Metering Plate = **1,152 CFM (56 Pa Metering Plate pressure)**

From **Appendix B**, the **Flow Resistance Correction Factor** equals **1.04**.

The **Adjusted Air Flow** equals **1,198 CFM (1,152 CFM x 1.04)**

Note: When the TrueFlow Air Handler Flow Meter is installed at a remote filter grille, it is possible to make a correction to the measured flow through the Metering Plate which increases the accuracy of the flow measurement. See **Appendix C** for more details.

Appendix A Flow Conversion Tables

Table A.1: Flow Conversion Table for TrueFlow Metering Plates (using Pascals)

Plate Pressure	Plate #14	Plate #20
(Pascals)	(CFM)	(CFM)
10	364	487
11	381	511
12	398	533
13	415	555
14	430	576
15	445	596
16	460	616
17	474	635
18	488	653
19	501	671
20	514	689
21	527	706
22	539	722
23	552	739
24	563	754
25	575	770
26	586	785
27	598	800
28	609	815
29	619	829
30	630	843
31	640	857
32	651	871
33	661	885
34	671	898
35	680	911
36	690	924
37	700	937
38	709	949
39	718	962
40	727	974
41	736	986
42	745	998
43	754	1010
44	763	1022
45	771	1033
46	780	1044
47	788	1056
48	797	1067
49	805	1078
50	813	1089
51	821	1100
52	829	1111
53	837	1121
54	845	1132
55	853	1142
56	861	1152
57	868	1163
58	876	1173
59	883	1183
60	891	1193
61	898	1203
62	906	1213
63	913	1222
64	920	1232
65	927	1242
66	934	1251
67	941	1261
68	948	1270
69	955	1279
70	962	1288
71	969	1298
72	976	1307
73	983	1316
74	989	1325
75	996	1334
76	1003	1343
77	1009	1351
78	1016	1360
79	1022	1369
80	1029	1377
81	1035	1386
82	1041	1395
83	1048	1403
84	1054	1411
85	1060	1420
86	1066	1428
87	1073	1436
88	1079	1445
89	1085	1453
90	1091	1461
91	1097	1469
92	1103	1477
93	1109	1485
94	1115	1493
95	1121	1501
96	1127	1509
97	1133	1517
98	1138	1525
99	1144	1532
100	1150	1540
101	1156	1548
102	1161	1555
103	1167	1563
104	1173	1570
105	1178	1578
106	1184	1586
107	1190	1593
108	1195	1600
109	1201	1608
110	1206	1615
111	1212	1622
112	1217	1630
113	1222	1637
114	1228	1644
115	1233	1651
116	1239	1659
117	1244	1666
118	1249	1673
119	1255	1680
120	1260	1687
121	1265	1694
122	1270	1701
123	1275	1708
124	1281	1715
125	1286	1722
126	1291	1729
127	1296	1735
128	1301	1742
129	1306	1749
130	1311	1756
131	1316	1763
132	1321	1769
133	1326	1776
134	1331	1783
135	1336	1789
136	1341	1796
137	1346	1803
138	1351	1809
139	1356	1816
140	1361	1822
141	1366	1829
142	1370	1835
143	1375	1842
144	1380	1848
145	1385	1854
146	1390	1861
147	1394	1867
148	1399	1873
149	1404	1880
150	1408	1886
151	1413	1892
152	1418	1899
153	1422	1905
154	1427	1911
155	1432	1917
156	1436	1923
157	1441	1930
158	1446	1936
159	1450	1942
160	1455	1948
161	1459	1954
162	1464	1960
163	1468	1966
164	1473	1972
165	1477	1978
166	1482	1984
167	1486	1990
168	1491	1996
169	1495	2002
170	1499	2008
171	1504	2014
172	1508	2020
173	1513	2026
174	1517	2031
175	1521	2037
176	1526	2043
177	1530	2049
178	1534	2055
179	1539	2060
180	1543	2066
181	1547	2072
182	1551	2078
183	1556	2083
184	1560	2089
185	1564	2095

Table A.2: Flow Conversion Table for TrueFlow Metering Plates (using In. H_2O)

Plate Pressure	Plate #14	Plate #20
(In. H_20)	(CFM)	(CFM)
0.040	362	485
0.045	384	515
0.050	405	543
0.055	425	569
0.060	444	594
0.065	462	619
0.070	479	642
0.075	496	665
0.080	513	686
0.085	528	708
0.090	544	728
0.095	559	748
0.100	573	767
0.105	587	786
0.110	601	805
0.115	615	823
0.120	628	841
0.125	641	858
0.130	653	875
0.135	666	892
0.140	678	908
0.145	690	924
0.150	702	940
0.155	713	955
0.160	725	971
0.165	736	986
0.170	747	1001
0.175	758	1015
0.180	769	1030
0.185	779	1044
0.190	790	1058
0.195	800	1072
0.200	810	1085
0.172	752	1007
0.176	760	1018
0.180	769	1030
0.184	777	1041
0.188	786	1052
0.192	794	1063
0.196	802	1074
0.200	810	1085
0.205	821	1099
0.210	830	1112
0.215	840	1125
0.220	850	1138
0.225	860	1151
0.230	869	1164
0.235	879	1176
0.240	888	1189
0.245	897	1201
0.250	906	1213
0.255	915	1226
0.260	924	1237
0.265	933	1249
0.270	942	1261
0.275	950	1273
0.280	959	1284
0.285	967	1296
0.290	976	1307
0.295	984	1318
0.300	993	1329
0.305	1001	1340
0.310	1009	1351
0.315	1017	1362
0.320	1025	1373
0.325	1033	1384
0.330	1041	1394
0.335	1049	1405
0.340	1057	1415
0.345	1064	1425
0.350	1072	1436
0.355	1080	1446
0.360	1087	1456
0.365	1095	1466
0.370	1102	1476
0.375	1110	1486
0.380	1117	1496
0.385	1124	1506
0.390	1132	1516
0.395	1139	1525
0.400	1146	1535
0.405	1153	1544
0.410	1160	1554
0.415	1167	1563
0.420	1174	1573
0.425	1181	1582
0.430	1188	1591
0.435	1195	1601
0.440	1202	1610
0.445	1209	1619
0.450	1216	1628
0.455	1222	1637
0.460	1229	1646
0.465	1236	1655
0.470	1242	1664
0.475	1249	1673
0.480	1256	1681
0.485	1262	1690
0.490	1269	1699
0.495	1275	1707
0.500	1281	1716
0.505	1288	1725
0.510	1294	1733
0.515	1301	1742
0.520	1307	1750
0.525	1313	1758
0.530	1319	1767
0.535	1326	1775
0.540	1332	1783
0.545	1338	1792
0.550	1344	1800
0.555	1350	1808
0.560	1356	1816
0.565	1362	1824
0.570	1368	1832
0.575	1374	1840
0.580	1380	1848
0.585	1386	1856
0.590	1392	1864
0.595	1398	1872
0.600	1404	1880
0.605	1410	1888
0.610	1415	1895
0.615	1421	1903
0.620	1427	1911
0.625	1433	1919
0.630	1438	1926
0.635	1444	1934
0.640	1450	1942
0.645	1455	1949
0.650	1461	1957
0.655	1467	1964
0.660	1472	1972
0.665	1478	1979
0.670	1483	1986
0.675	1489	1994
0.680	1494	2001
0.685	1500	2009
0.690	1505	2016
0.695	1511	2023
0.700	1516	2030
0.705	1522	2038
0.710	1527	2045
0.715	1532	2052
0.720	1538	2059
0.725	1543	2066
0.730	1548	2074
0.735	1554	2081
0.740	1559	2088
0.745	1564	2095
0.750	1569	2102

Appendix B Flow Resistance Correction Factors

Table B.1: Flow Resistance Correction Factors (using Pascals)

Normal System Operating Pressure in Pascals (NSOP)

TrueFlow System Operating Pressure in Pascals. (TF SOP)

	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
10	1.00	1.10	1.18	1.26	1.34	1.41	1.48	1.55	1.61	1.67	1.73	1.79	1.84	1.90	1.95	2.00	2.05	2.10	2.14	2.19	2.24
12	0.91	1.00	1.08	1.15	1.22	1.29	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83	1.87	1.91	1.96	2.00	2.04
14	0.85	0.93	1.00	1.07	1.13	1.20	1.25	1.31	1.36	1.41	1.46	1.51	1.56	1.60	1.65	1.69	1.73	1.77	1.81	1.85	1.89
16	0.79	0.87	0.94	1.00	1.06	1.12	1.17	1.22	1.27	1.32	1.37	1.41	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.73	1.77
18	0.75	0.82	0.88	0.94	1.00	1.05	1.11	1.15	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49	1.53	1.56	1.60	1.63	1.67
20	0.71	0.77	0.84	0.89	0.95	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58
22	0.67	0.74	0.80	0.85	0.90	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51
24	0.65	0.71	0.76	0.82	0.87	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44
26	0.62	0.68	0.73	0.78	0.83	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39
28	0.60	0.65	0.71	0.76	0.80	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34
30	0.58	0.63	0.68	0.73	0.77	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29
32	0.56	0.61	0.66	0.71	0.75	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25
34	0.54	0.59	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21
36	0.53	0.58	0.62	0.67	0.71	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18
38	0.51	0.56	0.61	0.65	0.69	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15
40	0.50	0.55	0.59	0.63	0.67	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12
42	0.49	0.53	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09
44	0.48	0.52	0.56	0.60	0.64	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07
46	0.47	0.51	0.55	0.59	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04
48	0.46	0.50	0.54	0.58	0.61	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00	1.02
50	0.45	0.49	0.53	0.57	0.60	0.63	0.66	0.69	0.72	0.75	0.77	0.80	0.82	0.85	0.87	0.89	0.92	0.94	0.96	0.98	1.00

Normal System Operating Pressure in Pascals (NSOP)

TrueFlow System Operating Pressure in Pascals. (TF SOP)

	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150
50	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58	1.61	1.64	1.67	1.70	1.73
55	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51	1.54	1.57	1.60	1.62	1.65
60	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.55	1.58
65	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.41	1.44	1.47	1.49	1.52
70	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34	1.36	1.39	1.41	1.44	1.46
75	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29	1.32	1.34	1.37	1.39	1.41
80	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.37
85	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21	1.24	1.26	1.28	1.31	1.33
90	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18	1.20	1.22	1.25	1.27	1.29
95	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15	1.17	1.19	1.21	1.24	1.26
100	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12	1.14	1.16	1.18	1.20	1.22
105	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09	1.11	1.13	1.15	1.18	1.20
110	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07	1.09	1.11	1.13	1.15	1.17
115	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14
120	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12
125	0.63	0.66	0.69	0.72	0.75	0.77	0.80	0.82	0.85	0.87	0.89	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10
130	0.62	0.65	0.68	0.71	0.73	0.76	0.78	0.81	0.83	0.85	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.07
135	0.61	0.64	0.67	0.69	0.72	0.75	0.77	0.79	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.05
140	0.60	0.63	0.65	0.68	0.71	0.73	0.76	0.78	0.80	0.82	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.98	1.00	1.02	1.04
145	0.59	0.62	0.64	0.67	0.69	0.72	0.74	0.77	0.79	0.81	0.83	0.85	0.87	0.89	0.91	0.93	0.95	0.96	0.98	1.00	1.02
150	0.58	0.61	0.63	0.66	0.68	0.71	0.73	0.75	0.77	0.80	0.82	0.84	0.86	0.88	0.89	0.91	0.93	0.95	0.97	0.98	1.00

Flow Resistance Correction Factor = $\sqrt{\text{NSOP / TF SOP}}$

Table B.2: Flow Resistance Correction Factors (using In. H_2O)

Normal System Operating Pressure in In. H_2O (NSOP)

TrueFlow System Operating Pressure in In. H_20 (TF SOP)

	0.04	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**	**0.10**	**0.11**	**0.12**	**0.13**	**0.14**	**0.15**	**0.16**	**0.17**	**0.18**	**0.19**	**0.20**	**0.21**	**0.22**	**0.23**	**0.24**
0.04	1.00	1.12	1.22	1.32	1.41	1.50	1.58	1.66	1.73	1.80	1.87	1.94	2.00	2.06	2.12	2.18	2.24	2.29	2.35	2.40	2.45
0.05	0.89	1.00	1.10	1.18	1.26	1.34	1.41	1.48	1.55	1.61	1.67	1.73	1.79	1.84	1.90	1.95	2.00	2.05	2.10	2.14	2.19
0.06	0.82	0.91	1.00	1.08	1.15	1.22	1.29	1.35	1.41	1.47	1.53	1.58	1.63	1.68	1.73	1.78	1.83	1.87	1.91	1.96	2.00
0.07	0.76	0.85	0.93	1.00	1.07	1.13	1.20	1.25	1.31	1.36	1.41	1.46	1.51	1.56	1.60	1.65	1.69	1.73	1.77	1.81	1.85
0.08	0.71	0.79	0.87	0.94	1.00	1.06	1.12	1.17	1.22	1.27	1.32	1.37	1.41	1.46	1.50	1.54	1.58	1.62	1.66	1.70	1.73
0.09	0.67	0.75	0.82	0.88	0.94	1.00	1.05	1.11	1.15	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49	1.53	1.56	1.60	1.63
0.10	0.63	0.71	0.77	0.84	0.89	0.95	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55
0.11	0.60	0.67	0.74	0.80	0.85	0.90	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48
0.12	0.58	0.65	0.71	0.76	0.82	0.87	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41
0.13	0.55	0.62	0.68	0.73	0.78	0.83	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36
0.14	0.53	0.60	0.65	0.71	0.76	0.80	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31
0.15	0.52	0.58	0.63	0.68	0.73	0.77	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26
0.16	0.50	0.56	0.61	0.66	0.71	0.75	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22
0.17	0.49	0.54	0.59	0.64	0.69	0.73	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19
0.18	0.47	0.53	0.58	0.62	0.67	0.71	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15
0.19	0.46	0.51	0.56	0.61	0.65	0.69	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12
0.20	0.45	0.50	0.55	0.59	0.63	0.67	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10
0.21	0.44	0.49	0.53	0.58	0.62	0.65	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07
0.22	0.43	0.48	0.52	0.56	0.60	0.64	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04
0.23	0.42	0.47	0.51	0.55	0.59	0.63	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02
0.24	0.41	0.46	0.50	0.54	0.58	0.61	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00

Normal System Operating Pressure in In. H_2O (NSOP)

TrueFlow System Operating Pressure in In. H_20 (TF SOP)

	0.20	**0.22**	**0.24**	**0.26**	**0.28**	**0.30**	**0.32**	**0.34**	**0.36**	**0.38**	**0.40**	**0.42**	**0.44**	**0.46**	**0.48**	**0.50**	**0.52**	**0.54**	**0.56**	**0.58**	**0.60**
0.20	1.00	1.05	1.10	1.14	1.18	1.22	1.26	1.30	1.34	1.38	1.41	1.45	1.48	1.52	1.55	1.58	1.61	1.64	1.67	1.70	1.73
0.22	0.95	1.00	1.04	1.09	1.13	1.17	1.21	1.24	1.28	1.31	1.35	1.38	1.41	1.45	1.48	1.51	1.54	1.57	1.60	1.62	1.65
0.24	0.91	0.96	1.00	1.04	1.08	1.12	1.15	1.19	1.22	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.53	1.55	1.58
0.26	0.88	0.92	0.96	1.00	1.04	1.07	1.11	1.14	1.18	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.41	1.44	1.47	1.49	1.52
0.28	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.10	1.13	1.16	1.20	1.22	1.25	1.28	1.31	1.34	1.36	1.39	1.41	1.44	1.46
0.30	0.82	0.86	0.89	0.93	0.97	1.00	1.03	1.06	1.10	1.13	1.15	1.18	1.21	1.24	1.26	1.29	1.32	1.34	1.37	1.39	1.41
0.32	0.79	0.83	0.87	0.90	0.94	0.97	1.00	1.03	1.06	1.09	1.12	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.37
0.34	0.77	0.80	0.84	0.87	0.91	0.94	0.97	1.00	1.03	1.06	1.08	1.11	1.14	1.16	1.19	1.21	1.24	1.26	1.28	1.31	1.33
0.36	0.75	0.78	0.82	0.85	0.88	0.91	0.94	0.97	1.00	1.03	1.05	1.08	1.11	1.13	1.15	1.18	1.20	1.22	1.25	1.27	1.29
0.38	0.73	0.76	0.79	0.83	0.86	0.89	0.92	0.95	0.97	1.00	1.03	1.05	1.08	1.10	1.12	1.15	1.17	1.19	1.21	1.24	1.26
0.40	0.71	0.74	0.77	0.81	0.84	0.87	0.89	0.92	0.95	0.97	1.00	1.02	1.05	1.07	1.10	1.12	1.14	1.16	1.18	1.20	1.22
0.42	0.69	0.72	0.76	0.79	0.82	0.85	0.87	0.90	0.93	0.95	0.98	1.00	1.02	1.05	1.07	1.09	1.11	1.13	1.15	1.18	1.20
0.44	0.67	0.71	0.74	0.77	0.80	0.83	0.85	0.88	0.90	0.93	0.95	0.98	1.00	1.02	1.04	1.07	1.09	1.11	1.13	1.15	1.17
0.46	0.66	0.69	0.72	0.75	0.78	0.81	0.83	0.86	0.88	0.91	0.93	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14
0.48	0.65	0.68	0.71	0.74	0.76	0.79	0.82	0.84	0.87	0.89	0.91	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10	1.12
0.50	0.63	0.66	0.69	0.72	0.75	0.77	0.80	0.82	0.85	0.87	0.89	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.08	1.10
0.52	0.62	0.65	0.68	0.71	0.73	0.76	0.78	0.81	0.83	0.85	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.06	1.07
0.54	0.61	0.64	0.67	0.69	0.72	0.75	0.77	0.79	0.82	0.84	0.86	0.88	0.90	0.92	0.94	0.96	0.98	1.00	1.02	1.04	1.05
0.56	0.60	0.63	0.65	0.68	0.71	0.73	0.76	0.78	0.80	0.82	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.98	1.00	1.02	1.04
0.58	0.59	0.62	0.64	0.67	0.69	0.72	0.74	0.77	0.79	0.81	0.83	0.85	0.87	0.89	0.91	0.93	0.95	0.96	0.98	1.00	1.02
0.60	0.58	0.61	0.63	0.66	0.68	0.71	0.73	0.75	0.77	0.80	0.82	0.84	0.86	0.88	0.89	0.91	0.93	0.95	0.97	0.98	1.00

Flow Resistance Correction Factor = $\sqrt{\text{NSOP / TF SOP}}$

Appendix C Calibration and Measurement Accuracy

C.1 TrueFlow Metering Plate Calibration Formula

C.1.a Using Pascals

Metering Plate	Formula
#14	Flow (CFM) = 115 x (TrueFlow Plate Pressure in Pascals)$^{0.5}$
#20	Flow (CFM) = 154 x (TrueFlow Plate Pressure in Pascals)$^{0.5}$

C.1.b Using IN H_2O

Metering Plate	Formula
#14	Flow (CFM) = 1,812 x (TrueFlow Plate Pressure in In H_2O)$^{0.5}$
#20	Flow (CFM) = 2,427 x (TrueFlow Plate Pressure in In H_2O)$^{0.5}$

Note: All Energy Conservatory air flow measuring devices are calibrated to a standard air density of 0.075 lbs/ft^3 (1.204 kg/m^3). If the density of air going through the Metering Plates differs from this standard air density, the air flow indicated on an Energy Conservatory gauge or Flow Table will not be the actual volumetric air flow. If the volumetric flow rate, or the standard flow rate (SCFM) going through the Metering Plate is desired, multiply the indicated air flow by the air density factors listed in Tables C.1.c and C.1.d on the next page.

C.2 Correction for Filter Grille Measurements

When the TrueFlow Air Handler Flow Meter is installed at a remote filter grille, it is possible to make a correction to the measured flow through the Metering Plate which increases the accuracy of the flow measurement. A correction is possible with remote filter grilles because the installation conditions and air flow characteristics of this application are highly predictable and repeatable.

- **Correction Factor for Filter Grilles: Multiply the final adjusted air flow reading by 1.04.**

C.3 Specifications

Flow Accuracy: +/- 7% for most applications when used with a 1% pressure gauge (DG-700, DG-3 etc). *
+/- 9% for most applications when used with Magnehelic gauges. *

Flow Range: #14 Metering Plate: 365 cfm to 1,565 cfm.
#20 Metering Plate: 485 cfm to 2,100 cfm.

Nominal Size of Metering Plates: #14 Metering Plate: 14.5 in. by 20.5 in. (with gasket material).
#20 Metering Plate: 20.5 in. by 20.5 in (with gasket material).

System Weight: 13 lbs. (2 Metering Plates, 8 spacers, carrying case, tubing, static pressure probe, manual.)

* The accuracy of the TrueFlow Air Handler Flow Meter is installation dependent. The stated flow accuracy covers 95% of the typical installations documented during both the field and laboratory testing of the device. Obstructions within 6 inches upstream or 2 inches downstream of the Metering Plate that are blocking air flow through any of the metering holes may reduce the flow accuracy beyond the specifications listed here. Always follow the installation and operation instructions listed in **Chapters 2** and **3** of this manual.

Table C.1.c: **Air Density Factors to Convert from *Indicated* Flow to *Volumetric* Flow.**

Temp. of air through the Metering Plate (F)	Elevation (feet)										
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
0	0.933	0.950	0.968	0.986	1.005	1.023	1.043	1.062	1.083	1.104	1.125
10	0.943	0.961	0.978	0.996	1.016	1.034	1.054	1.074	1.095	1.116	1.138
20	0.953	0.971	0.989	1.007	1.026	1.045	1.065	1.085	1.106	1.128	1.150
30	0.963	0.981	0.999	1.017	1.037	1.056	1.076	1.097	1.118	1.139	1.162
40	0.973	0.991	1.009	1.028	1.048	1.067	1.087	1.108	1.129	1.151	1.173
50	0.983	1.001	1.019	1.038	1.058	1.077	1.098	1.119	1.140	1.162	1.185
60	0.992	1.010	1.029	1.048	1.068	1.088	1.108	1.130	1.152	1.174	1.197
70	1.002	1.020	1.039	1.058	1.078	1.098	1.119	1.140	1.163	1.185	1.208
80	1.011	1.030	1.049	1.068	1.089	1.109	1.130	1.151	1.174	1.196	1.219
90	1.021	1.039	1.058	1.078	1.099	1.119	1.140	1.162	1.184	1.207	1.231
100	1.030	1.049	1.068	1.088	1.109	1.129	1.150	1.172	1.195	1.218	1.242
110	1.039	1.058	1.078	1.097	1.118	1.139	1.161	1.183	1.206	1.229	1.253
120	1.048	1.067	1.087	1.107	1.128	1.149	1.171	1.193	1.216	1.240	1.264
130	1.057	1.076	1.096	1.117	1.138	1.159	1.181	1.203	1.227	1.250	1.275
140	1.066	1.085	1.106	1.126	1.148	1.169	1.191	1.213	1.237	1.261	1.285
150	1.075	1.094	1.115	1.135	1.157	1.178	1.201	1.224	1.247	1.271	1.296

Volumetric Flow = Indicated Flow x Sqrt (0.075/air density) where air density is the density of air, in lbs/ft^3, going through the Metering Plate.

Table C.1.d: **Air Density Factors to Convert from *Indicated* Flow to *SCFM.***

Temp. of air through the Metering Plate (F)	Elevation (feet)										
	0	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
0	1.071	1.052	1.033	1.014	0.995	0.977	0.959	0.941	0.923	0.906	0.889
10	1.060	1.041	1.022	1.004	0.985	0.967	0.949	0.931	0.913	0.896	0.879
20	1.049	1.030	1.011	0.993	0.974	0.957	0.939	0.921	0.904	0.887	0.870
30	1.038	1.020	1.001	0.983	0.964	0.947	0.929	0.912	0.895	0.878	0.861
40	1.028	1.009	0.991	0.973	0.955	0.937	0.920	0.903	0.886	0.869	0.852
50	1.018	0.999	0.981	0.963	0.945	0.928	0.911	0.894	0.877	0.860	0.844
60	1.008	0.990	0.972	0.954	0.936	0.919	0.902	0.885	0.868	0.852	0.836
70	0.998	0.980	0.962	0.945	0.927	0.911	0.894	0.877	0.860	0.844	0.828
80	0.989	0.971	0.954	0.936	0.919	0.902	0.885	0.869	0.852	0.836	0.820
90	0.980	0.962	0.945	0.928	0.910	0.894	0.877	0.861	0.844	0.828	0.813
100	0.971	0.954	0.936	0.919	0.902	0.886	0.869	0.853	0.837	0.821	0.805
110	0.962	0.945	0.928	0.911	0.894	0.878	0.862	0.845	0.829	0.814	0.798
120	0.954	0.937	0.920	0.903	0.886	0.870	0.854	0.838	0.822	0.807	0.791
130	0.946	0.929	0.912	0.896	0.879	0.863	0.847	0.831	0.815	0.800	0.785
140	0.938	0.921	0.905	0.888	0.871	0.856	0.840	0.824	0.808	0.793	0.778
150	0.930	0.914	0.897	0.881	0.864	0.849	0.833	0.817	0.802	0.787	0.772

SCFM = Indicated Flow x Sqrt (air density/0.075) where air density is the density of air, in lbs/ft^3, going through the Metering Plate.

Appendix D System Pressure Measurement Location

Due to the nature of air flows within the duct system, certain locations for measuring the "system operating pressures" are more stable, lower in fluctuations and greater in magnitude than other locations. The following three duct locations typically provide a very stable static pressure reading and should be used whenever possible.

D.1 Best Locations for Measuring System Operating Pressures

- Insert the static pressure probe into the side surface of the supply plenum. The side of the supply plenum chosen should **not** have a trunk line, distribution duct or supply register connected to it. The static pressure probe should point into the airstream.

- Or, insert the tip of the static pressure probe into a "dead-end" corner of the supply plenum. A "dead-end" corner is simply a corner of the plenum that does not have a trunk line connection, distribution duct connection or supply register within 8 inches of the corner.

- Or, insert the static pressure probe in the side surface of the return plenum. The side of the return plenum chosen should **not** have a trunk line, return duct or return register connected to it. The location chosen should also be at least 24 inches upstream from the TrueFlow Metering Plate, and 24 inches away from any 90 degree corners or return trunk line connections. The static pressure probe should point into the airstream. **Note:** If the Metering Plate will be installed at a remote filter grille, the static pressure probe may not be installed in the return plenum (i.e. install it in the supply plenum).

D.2 Secondary Locations for Measuring System Operating Pressures

If one of the above three "Best" locations is not available, choose from one of the Secondary locations below:

- Insert the end of the tubing being used to measure system operating pressure into a supply register, without the static pressure probe attached. Place the tubing so that the end of the tubing is facing into the air flow stream exiting the register. This location typically, provides a small pressure signal and requires a high resolution manometer on the order of 1/10th Pascal. **Note:** Using the supply register is common in mobile homes where there is no return ductwork and the supply ducts are inaccessible.

  When measuring system operating pressure at a supply register, it is also possible to attach a "total pressure probe" to the end of the tubing. Total pressure probes can be purchased at most HVAC supply stores, or one can be made by simply cutting off the end of a static pressure probe.

- Insert the static pressure probe into the side surface of a supply trunk or branch duct. The location should be at least 2 feet away from any elbow, ducting junctions or transitions. The static pressure probe should point into the airstream.

Appendix E Quick Guides

E.1 Quick Guide 1 – TrueFlow Air Handler Flow Meter and the DG-3 Gauge

1. Measure the Normal System Operating Pressure (NSOP) with the existing filter in place.

a) Locate the air handler system filter and replace if it is dirty.

b) Install a static pressure probe into the ductwork at one of the 3 locations listed below:

- Insert the static pressure probe into the side surface of the supply plenum. The side of the supply plenum chosen should not have a trunk line, distribution duct or supply register connected to it. The static pressure probe should point into the airstream.
- Or, insert the tip of the static pressure probe into a "dead-end" corner of the supply plenum. A "dead-end" corner is a corner of the plenum that does not have a trunk line connection, distribution duct connection or supply register within 8 inches of the corner.
- Or, insert the static pressure probe in the side surface of the return plenum. The side of the return plenum chosen should not have a trunk line, return duct or return register connected to it. The location chosen should also be at least 24 inches upstream from the TrueFlow Metering Plate, and at least 24 inches downstream from any 90 degree corners or return trunk line connections. The static pressure probe should point into the airstream. **Note:** if the Metering Plate will be installed at a remote filter grille, the static pressure probe may not be installed in the return plenum (i.e. install it in the supply plenum).

c) Connect a piece of tubing between the static pressure probe and the **Channel A Input** tap. If the gauge is in the house during the test procedure, leave the **Reference** tap on **Channel A** open. If the gauge is not in the house during the test procedure (e.g. attic, crawlspace), run additional tubing from the **Channel A Reference** tap to inside the house.

d) Turn the **CHANNEL** knob to **"A"**, the **RANGE** switch to ***Low (200.0 Pa)*** and the **MODE** switch to ***Pressure***.

e) Turn on the air handler fan to the desired speed and record the normal system operating pressure (**NSOP**) from the gauge. You may want to use the ***5 second***, ***10 second*** or ***long-term*** time-average setting if the reading is fluctuating.

f) After recording the **NSOP**, turn off the air handler fan. Leave the static pressure probe in place and connected to the gauge.

2. Install the TrueFlow Metering Plate in an Existing Filter Slot.

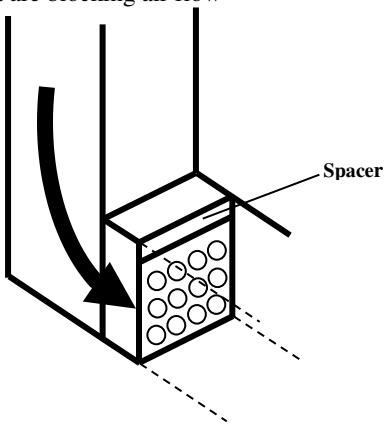
a) Remove the existing filter and set it aside.

b) Choose and assemble the metering plate and spacers needed to match the filter slot size.

Filter Slot (in. x in.)	Flow Metering Plate	Spacer Dimension (in. x in.)	
		Spacer 1	Spacer 2
14 x 20	#14	------	------
14 x 25	#14	5 x 14	------
16 x 20	#14	2 x 20	------
16 x 24	#14	2 x 20	4 x 16
16 x 25	#14	2 x 20	5 x16
18 x 20	#14	4 x 20	------
20 x 20	#20	------	------
20 x 22	#20	2 x 20	------
20 x 24	#20	4 x 20	------
20 x 25	#20	5 x 20	------
20 x 30	#20	10 x 20	------
24 x 24	#20	4 x 20	4 x 24

c) Install the assembled metering plate into the filter slot. Be sure the front side of the metering plate is facing into the air flow (front side has two diamond shaped labels on it). The H-channel gasket should provide a seal around the metering plate - all of the air flow should pass through the metering plate and not around it. Be sure that the ends of the flexible tubing connections attached to the plate's pressure sensing grids remain out of the filter slot. Occasionally, drilling holes into the ductwork may be required as a pathway for the ends of the flexible tubing. The flexible tubing can be passed through one of the plate's metering holes if this helps in getting the tubing ends outside of the filter slot.

- Obstructions within 6 inches upstream or 2 inches downstream of the metering plate that are blocking air flow through any of the metering holes may reduce the accuracy of the device.
- If there is an obstruction and there is a spacer attached to the metering plate, try to install the metering plate so that the spacer is directly in front of the obstruction (this will minimize the effect of the obstruction on the flow measurement).
- If the metering plate is installed directly downstream of a 90 degree bend in the duct system, and there is a spacer attached to the plate, install the metering plate so that the spacer is on the inside corner of the bend (see diagram to right).



d) Close the filter access opening. Be careful not to pinch off the flexible tubing connections. Temporarily seal around the filter slot cover with masking tape to prevent air leakage.

Note: If you are installing the metering plate at the filter grille of a single return duct system, simply push the plate into the empty filter rack. Make sure that the front of the metering plate is facing out (into the air flow). Keep the filter grille door open for the remainder of the test.

3. Re-Measure the System Operating Pressure (TrueFlow Plate Installed).

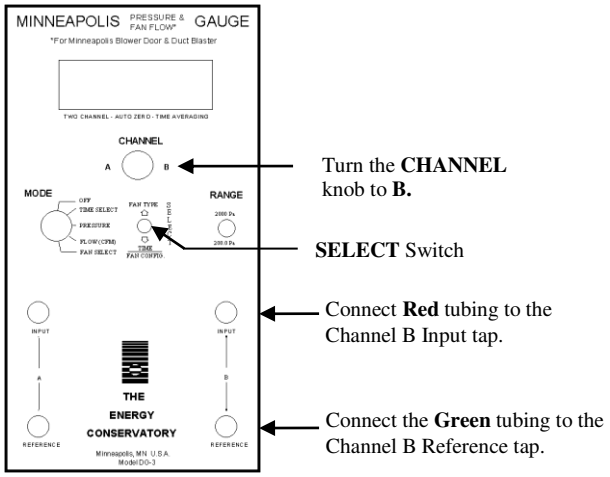
a) Turn the air handler fan back on to the same speed as **Step 1** above.

b) Measure and record the new system operating pressure (**TFSOP**) using the static pressure probe and **Channel A** of the DG-3. The static pressure probe should be in the exact same position as **Step 1** above.

4. Measure the Air Flow Through the TrueFlow Metering Plate

a) Connect the flexible tubing connections from the metering plate to **Channel B** as shown in the diagram.

b) In order for the DG-3 gauge to directly display air flow in CFM from the metering plate, the installed metering plate must be selected in the gauge. To select the metering plate being used in your test, first turn the **MODE** knob to the ***Fan Select*** position. The gauge display will show "-SEL" to indicate that a flow measurement device has not been selected. The selected flow measurement device is chosen by toggling **up** the **SELECT** Switch.



Toggle up 3 times to select the **#14** Metering Plate.
Toggle up 4 times to select the **#20** Metering Plate.

PL 14	This indicates that you have chosen the #14 TrueFlow Metering Plate.
PL 20	This indicates that you have chosen the #20 TrueFlow Metering Plate.

Once the proper plate has been selected, turn the **MODE** switch to ***Flow***. With the **CHANNEL** knob set to **B**, the gauge will now display the air flow through the metering plate in CFM. You may want to use the ***5 second***, ***10 second*** or ***long-term*** time-average setting if the flow reading is fluctuating.

Note: DG-3 gauges sold prior to March 2001 do not have the ***PL14*** or ***PL20*** options when selecting a flow measurement device. These gauges can be retrofitted with a new EPROM by The Energy Conservatory (call for more information). Flow can also be determined by measuring the pressure signal from the metering plate, and using the Flow Conversion Table

5. Look up the Flow Resistance Correction Factor

a) The Flow Resistance Correction Factor can be determined using the correction factor table provided with the manual, and the two system operating pressure measurements (**Step 1** and **Step 3**). The Flow Resistance Correction Factor is used to adjust the measured air flow through the metering plate for differences in resistance between the existing filter and the TrueFlow Meter.

6. Calculate the Adjusted Air Flow

a) Multiply the measured air flow through the metering plate (**Step 4**) by the Flow Resistance Correction Factor (**Step 5**) to determine the final adjusted air flow amount. This result is the estimated air flow at the measurement location with the existing filter in place. Turn off the air handler fan.

Note: When the TrueFlow Air Handler Flow Meter is installed at a remote filter grille, it is possible to make a correction to the measured flow through the metering plate which increases the accuracy of the flow measurement. See **Appendix C** of the TrueFlow manual for more details.

E.2 Quick Guide 2 – TrueFlow Air Handler Flow Meter and the DG-700 Gauge

1. Measure the Normal System Operating Pressure (NSOP) with the existing filter in place.

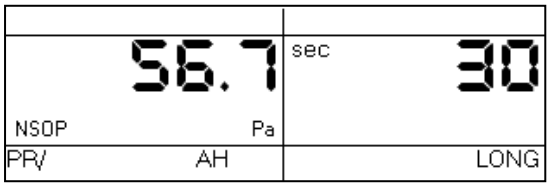
a) Locate the air handler system filter and replace if it is dirty.

b) Install a static pressure probe into the ductwork at one of the 3 locations listed below:

- Insert the static pressure probe into the side surface of the supply plenum. The side of the supply plenum chosen should not have a trunk line, distribution duct or supply register connected to it. The static pressure probe should point into the airstream.
- Or, insert the tip of the static pressure probe into a "dead-end" corner of the supply plenum. A "dead-end" corner is a corner of the plenum that does not have a trunk line connection, distribution duct connection or supply register within 8 inches of the corner.
- Or, insert the static pressure probe in the side surface of the return plenum. The side of the return plenum chosen should not have a trunk line, return duct or return register connected to it. The location chosen should also be at least 24 inches upstream from the TrueFlow Metering Plate, and at least 24 inches downstream from any 90 degree corners or return trunk line connections. The static pressure probe should point into the airstream. **Note:** if the Metering Plate will be installed at a remote filter grille, the static pressure probe may not be installed in the return plenum (i.e. install it in the supply plenum).

c) Connect a piece of tubing between the static pressure probe and the **Channel A Input** tap. If the gauge is in the house during the test procedure, leave the **Reference** tap on **Channel A** open. If the gauge is not in the house during the test procedure (e.g. attic, crawlspace), run additional tubing from the **Channel A Reference** tap to inside the house.

d) Turn on the air handler fan to the desired speed. Now turn on the gauge and put it the **PR/ AH** mode by pressing the **MODE** button 4 times. The icon "**NSOP**" will begin to flash in the **Channel A** display. At this point, the gauge is monitoring the real-time **Channel A NSOP** pressure, but is not recording the reading. The **Channel B** display is not active at this time.



e) Press the **START** button to begin the **NSOP** measurement procedure on **Channel A**. Once the **START** button is pressed, the **NSOP** icon stops flashing and the gauge begins recording a long term average **NSOP** pressure reading on **Channel A**. During the measurement procedure, the **Channel B** display is used as a timer to let the user know how long (in seconds) the **NSOP** measurement has been active. The longer the measurement time, generally the more stable the reading typically becomes. In the screen to the right, the measured **NSOP** pressure is 56.7 Pascals (measured over the past 30 seconds).

f) Once you are satisfied with the **NSOP** reading, press the **ENTER** key to accept and enter the reading into the gauge. Turn off the air handler fan, and leave the static pressure probe in place and connected to the gauge on **Channel A**.

2. Install the TrueFlow Metering Plate in an Existing Filter Slot.

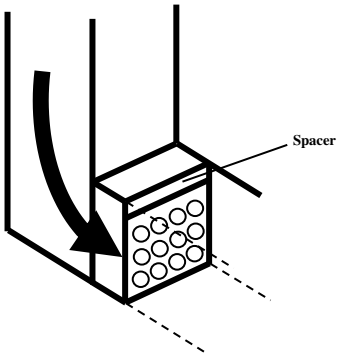
a) Remove the existing filter and set it aside.

b) Choose and assemble the metering plate and spacers needed to match the filter slot size.

Filter Slot (in. x in.)	Flow Metering Plate	Spacer Dimension (in. x in.)	
		Spacer 1	Spacer 2
14 x 20	#14	------	------
14 x 25	#14	5 x 14	------
16 x 20	#14	2 x 20	------
16 x 24	#14	2 x 20	4 x 16
16 x 25	#14	2 x 20	5 x16
18 x 20	#14	4 x 20	------
20 x 20	#20	------	------
20 x 22	#20	2 x 20	------
20 x 24	#20	4 x 20	------
20 x 25	#20	5 x 20	------
20 x 30	#20	10 x 20	------
24 x 24	#20	4 x 20	4 x 24

c) Install the assembled metering plate into the filter slot. Be sure the front side of the metering plate is facing into the air flow (front side has two diamond shaped labels on it). The H-channel gasket should provide a seal around the metering plate - all of the air flow should pass through the metering plate and not around it. Be sure that the ends of the flexible tubing connections attached to the plate's pressure sensing grids remain out of the filter slot. Occasionally, drilling holes into the ductwork may be required as a pathway for the ends of the flexible tubing. The flexible tubing can be passed through one of the plate's metering holes if this helps in getting the tubing ends outside of the filter slot.

- Obstructions within 6 inches upstream or 2 inches downstream of the metering plate that are blocking air flow through any of the metering holes may reduce the accuracy of the device.
- If there is an obstruction and there is a spacer attached to the metering plate, try to install the metering plate so that the spacer is directly in front of the obstruction (this will minimize the effect of the obstruction on the flow measurement).
- If the metering plate is installed directly downstream of a 90 degree bend in the duct system, and there is a spacer attached to the plate, install the metering plate so that the spacer is on the inside corner of the bend (see diagram to right).

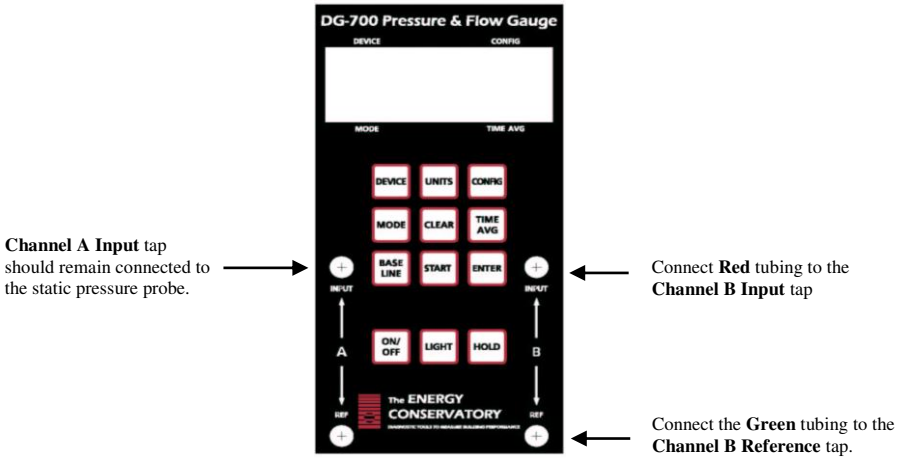


d) Close the filter access opening. Be careful not to pinch off the flexible tubing connections. Temporarily seal around the filter slot cover with masking tape to prevent air leakage.

Note: If you are installing the metering plate at the filter grille of a single return duct system, simply push the plate into the empty filter rack. Make sure that the front of the metering plate is facing out (into the air flow). Keep the filter grille door open for the remainder of the test.

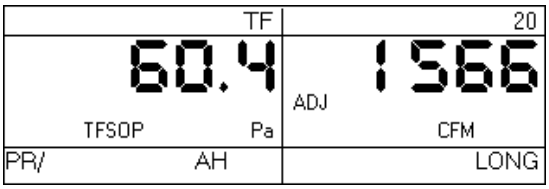
3. Connect the Metering Plate to the DG-700.

a) Connect the tubing from the installed metering plate to the DG-700. Connect the Red ("total pressure grid") tubing connection to the **Channel B Input** pressure tap. Connect the Green ("static pressure grid") tubing connection to the **Channel B Reference** pressure tap.



4. Measure the TrueFlow System Operating Pressure (TFSOP) and Adjusted Total Air Handler Flow.

a) Check and adjust if necessary the selected test Device and Configuration shown in the upper part of the gauge display to match the metering plate installed in **Step 2** above. When using the TrueFlow Metering Plates, the Device icon should always be set to **TF**, and the Configuration icon should be set to **14** or **20** depending on which metering plate is installed. Changes to the selected Device and Configuration are made by pressing the **DEVICE** and **CONFIG** buttons.



b) Turn the air handler fan back on to the same speed as used in **Step 1** above. **Channel A** will now display the **TFSOP** reading from the static pressure probe, and **Channel B** will display adjusted air handler flow. The static pressure probe should be in exactly the same position as it was in **Step 1** above. The air handler flow rate estimate shown on **Channel B** is determined by continuously adjusting the measured air flow from the TrueFlow Metering Plate using a flow resistance correction factor calculated from the **NSOP** and **TFSOP** pressure readings. If the readings are fluctuating, change the time averaging setting to ***5 second***, ***10 second***, *or* ***Long-Term*** average using the **TIME AVG** button.

c) Record the adjusted air flow reading from **Channel B**. In the screen to the right, the adjusted air flow reading is 1,566 CFM. This result is the estimated air flow at the measurement location with the existing filter in place. Turn off the air handler fan.

Note: When the TrueFlow Air Handler Flow Meter is installed at a remote filter grille, it is possible to make a correction to the measured flow through the metering plate which increases the accuracy of the flow measurement. See **Appendix C** of the TrueFlow manual for more details.

Appendix F References

D. Parker, 2000, "Summary of Impacts of Refrigerant Charge, Air Flow and Maintenance Issues for Residential Air Conditioning Systems", Proceedings of the ACEEE 2000 Summer Study on Energy Efficiency in Buildings.

D. Parker et al., 1997, "Impact of Evaporator Coil Airflow in Residential Air Conditioning Systems", ASHRAE Transactions, Vol. 103, Pt.2.

M. Blasnik et al., 1996. "Assessment of HVAC Installations in New Homes in APS Service Territory", Proctor Engineering Group.

M. Blasnik et al., 1995. "Assessment of HVAC Installation in New Homes in Nevada Power Company's Service Territory", Proctor Engineering Group.

J. Proctor, 1990, "Pacific Gas and Electric Appliance Doctor Pilot Project", Proctor Engineering Group.