airflow systems since 1980 www.retrotec.com

Retrotec Inc.

DM-2 Operation Manual

rev-2012-01-09

Table of Contents

List of Tables

List of Figures

1 Understanding the Pressure Gauge

A high-performance digital differential pressure gauge offers a number of advantages over analog counterparts:

- Easy to read
- Pressure sensors with greater sensitivity
- Performs calculations that would otherwise need to be done manually

A digital gauge, therefore, can save a lot of testing time with proper use of its functions.

Note: Before beginning a test, it is absolutely critical to enable and select the proper Device and Range in order to obtain the correct results. Refer to section 3 for instructions on how to enable, select the proper Device, and select the proper Range.

Differential Pressure

Each gauge consists of two pressure transducers, which each measure the difference in pressure between two Input ports. The most common units of measurement are Pascals (Pa), but inches of water column (in WC) and pounds per square foot (PSF) are also available. Inches of water column is the easiest to visualize because one inch water column (1 in WC) is the amount of pressure required to suck water up a straw to a height of one inch.

One inch of water column (in WC) = 249 Pa = 5.2 PSF [pounds per square foot]

To measure a pressure

1. Connect a pressure tube to the blue port of the DM-2.
2. Press **[On]**.
3. Place the end of the tube into a glass of water, slightly more than 1 inch below the surface. The gauge will display around 1.00 in WC, or 250 Pa or 5.2 PSF depending on the units being displayed. (Units can be easily changed using the Setup Menu).

Figure 1. Gauge displaying 249.5 Pa (or 1 in WC).

Positive vs. Negative Pressure

The DM-2 gauge will display pressures from -1250 Pa to + 1250 Pa.

A higher pressure on the positive (“Input”) port than on the negative (“Reference”) port displays a positive pressure on the gauge. Alternatively, a higher pressure on the negative (“Reference”) port than on the positive (“Input”) port displays a negative pressure.

Measure a negative pressure

1. Connect a pressure tube to the red (negative, “Reference”) port of the DM-2.
2. Place the end of the tube into a glass of water, about 1 inch below the surface.
3. The gauge will display around -1.00 in WC, or -250 Pa or -5.2 PSF. Notice the negative sign.

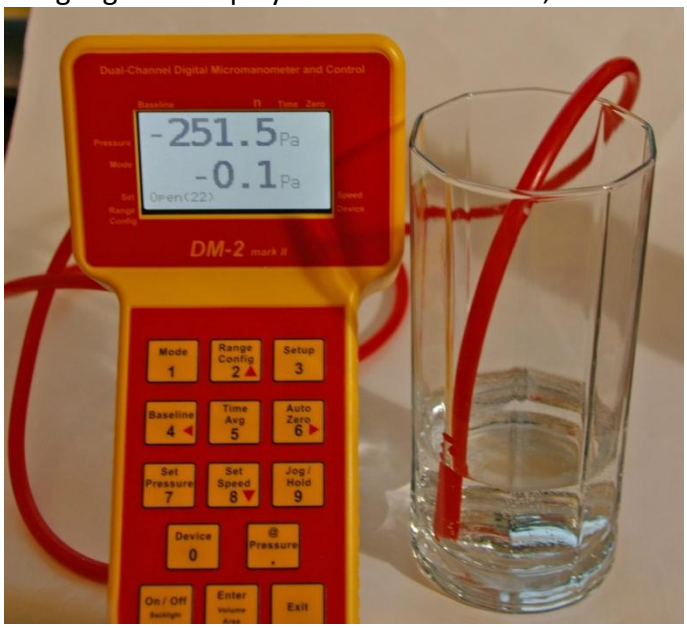


Figure 2. The gauge displays a negative pressure (-1 in WC, or -0.1 Pa) on the DM-2.

Analog Gauges

Retrotec no longer manufactures or sells analog gauges. It is recommended that Door Fan systems using analog gauges be upgraded with a digital gauge.

Retrotec manufactured three types of analog gauges:

- A 60 Pa gauge, which displays two ranges, 0 Pa to 60 Pa and 20 Pa to 40 Pa
- A 250 Pa gauge
- A 500 Pa gauge

The E43 Door Fan system included an analog gauge clip which contains two 60 Pa Gauges and a 500 Pa gauge as shown on the second image in Figure 3. All Retrotec Door Fan systems can be connected to an analog gauge.

Reading the pressure on an analog gauge is simply a matter of determining where the needle is pointing on the gauge. The needle indicates the pressure differential between the two pick-up points on the gauge. Note that it's important to zero the gauge before use, as readings will be incorrect if the gauge does not read zero before any tubes are attached.

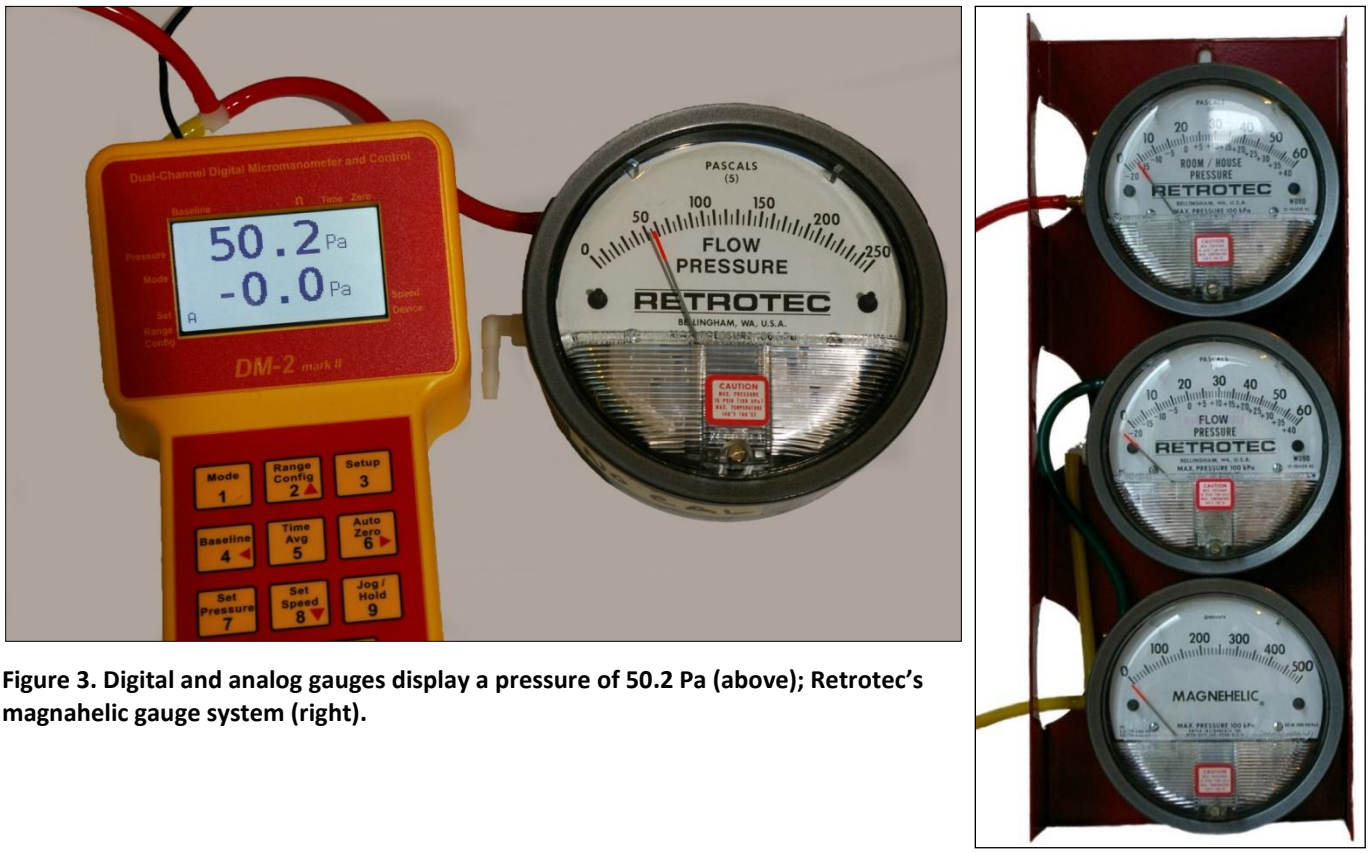


Figure 3. Digital and analog gauges display a pressure of 50.2 Pa (above); Retrotec's magnahelic gauge system (right).

2 DM-2 Digital Gauge Basics

The DM-2 is Retrotec's digital micromanometer. It combines simple but comprehensive functionality, with intuitive controls and setup. The DM-2 is a dual channel digital micromanometer that always displays a pressure on Channel A, but will display pressure, flow, velocity, or leakage area on Channel B (depending on the Mode selected). To ensure accurate results, the DM-2 takes up to four pressure readings per second on each channel, and updates the information displayed on the screen every second.

2.1 Batteries

The DM-2 can draw power from an AC power supply through the fan, directly from the wall outlet, or from four AA batteries. It is recommended that the gauge be used on battery power when possible. When battery power is insufficient to power the gauge, the warning message "Battery Too Low" will appear on the screen.

The DM-2 includes the ability to recharge the batteries inside the gauge. The batteries will not start charging if the DM-2 is not turned on first (i.e. you must turn on the DM-2 first, and then plug in the AC power supply to charge the batteries).

To prolong battery life, recharge the batteries only when they reach ¼ power (displayed on the battery status indicator). Do not operate the DM-2 with the AC power adapter or the Umbilical power cord attached after they are fully charged; this will significantly shorten the lifespan of rechargeable batteries. If the DM-2 must be operated with AC power, remove the batteries to prevent the shortening of the battery lifespan. The batteries are fully charged when the battery indicator is solid black. Allow the batteries to occasionally discharge completely to improve battery life.

Install batteries

The DM-2 comes with four AA NiMH rechargeable batteries. The batteries can be charged in the DM-2 with the AC power adapter, or in a compatible battery charger. The batteries should be charged for at least 8 hours each time. To completely charge the batteries, prior to using the gauge for the first time, 24 hours may be required.

To install batteries for the first time

1. Using a small Phillips screwdriver, open the lower back panel of the DM-2.
2. Install the four AA rechargeable NiMH batteries, making sure to align them correctly, and ensuring that the contacts are secure against both the positive and negative ends of each battery.
3. Replace the battery compartment panel and securely tighten the screw.
4. Plug the AC power adapter into a wall outlet and into the DM-2 DC power receptacle.
5. Turn the gauge on.
6. Allow the batteries to charge until the charging is complete (according to the battery status indicator). This may take up to 24 hours.

Figure 4 Battery cage and four rechargeable batteries for the DM-2.

Caution: Do not open the panel labeled “No User Serviceable Parts Inside. Do Not Open.” Doing so will void the calibration and warranty.

Rechargeable or non-rechargeable (alkaline) batteries

The standard NiMH batteries that are included with the DM-2 should last for two years of constant use. Every six months, it is worthwhile to remove the batteries and place them in a quality charger. This reconditions them and extends their life. Non-rechargeable batteries can also be used, but the charging circuit should be disabled to prevent accidental charging. Charging an alkaline battery may cause it to explode or leak.

To replace the current batteries

1. Using a small Phillips screwdriver, open the lower back panel of the DM-2.
2. Remove the four old AA batteries and recycle them at a participating collection center.
3. Install four new AA batteries, making sure to align them correctly, and ensuring that the contacts are secure against both the positive and negative ends of each battery. The DM-2 can use either rechargeable NiMH batteries, or standard alkaline batteries.
4. Replace the battery compartment panel and securely tighten the screw.

If a different type of battery is used (i.e. change from rechargeable to non-rechargeable), make sure to change the battery type in the Setup Menu of the DM-2. When "Not Rechargeable" is selected, the batteries, regardless of type, will not be charged. Attempting to charge non-rechargeable batteries can cause the batteries to leak, permanently damaging the DM-2.

To select proper battery type

1. Press **[Setup]**.
2. Scroll to "Battery Type" and select "Rechargeable" or "Not Rechargeable" as needed.
3. Press **[Exit].**

To view the remaining battery power:

The DM-2 features a battery health indicator, displaying the current status of the battery on the main screen. The indicator is located in the upper-left corner of the display.

1. Turn the gauge on by pressing **[On/Off]**.
2. The splash screen is displayed.
3. Press **[Exit]** to view the main screen. The battery power indicator is in the top left.

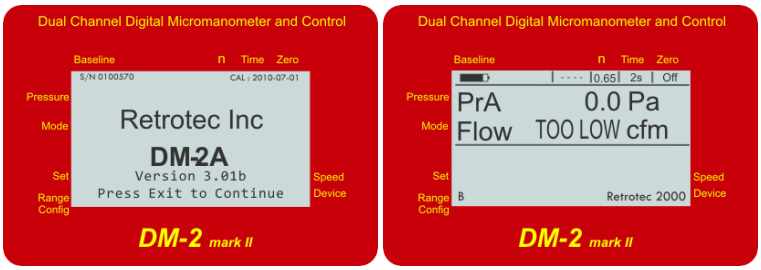


Figure 5. Splash screen and the main screen with battery life indication in the top left.

Batteries will last longer if the backlight and auto-zero features are turned off, and if the gauge is manually turned off when not in use.

2.2 Gauge Overview

The Retrotec DM-2 mark II gauge has: a connections panel, a display screen, and a keypad. The connections panel on the back of the gauge is where all external devices are connected to the DM-2. The display provides information on the current test mode and/or setup, as well as the device status and measurement values. The keypad is where the user inputs data to the DM-2, and controls the DM-2 functions.

The Connections Panel

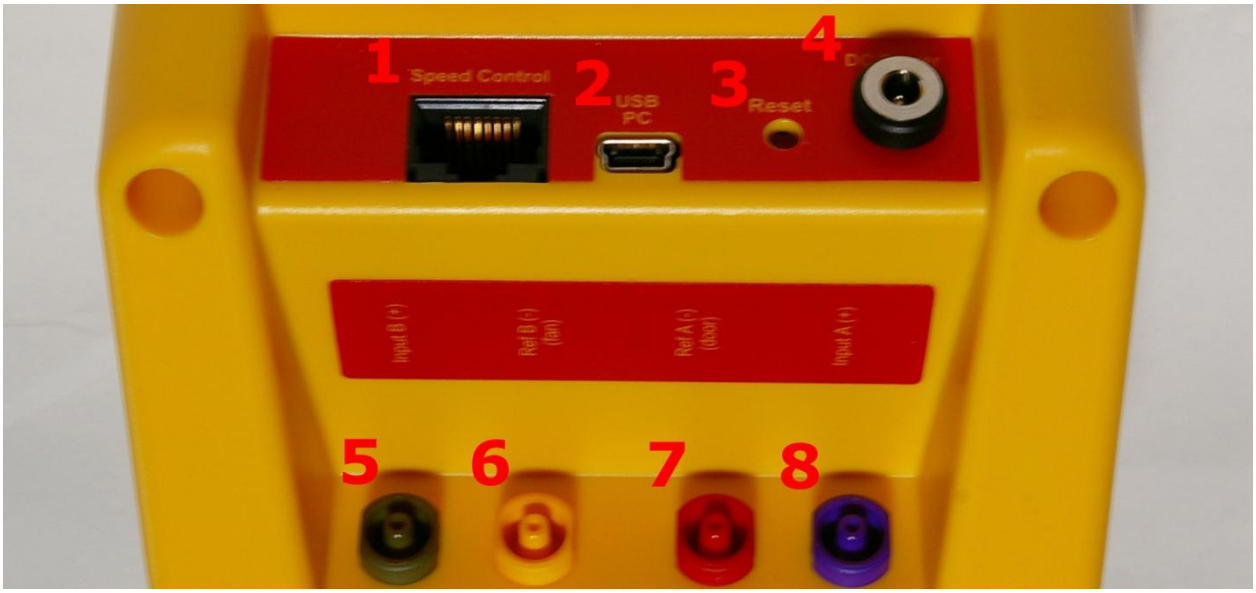


Figure 6. DM-2 back panel with pressure ports and electrical connections.

The connections panel has the following:

1. Control port
2. USB input
3. Reset button
4. Power input

Pressure Ports:

5. Input B (+)
6. Reference B (-)
7. Reference A (-)
8. Input A (+)

The DM-2 Screen

The Display Screen is where all measurement values are shown, as well as the current status of the device, and test configuration.

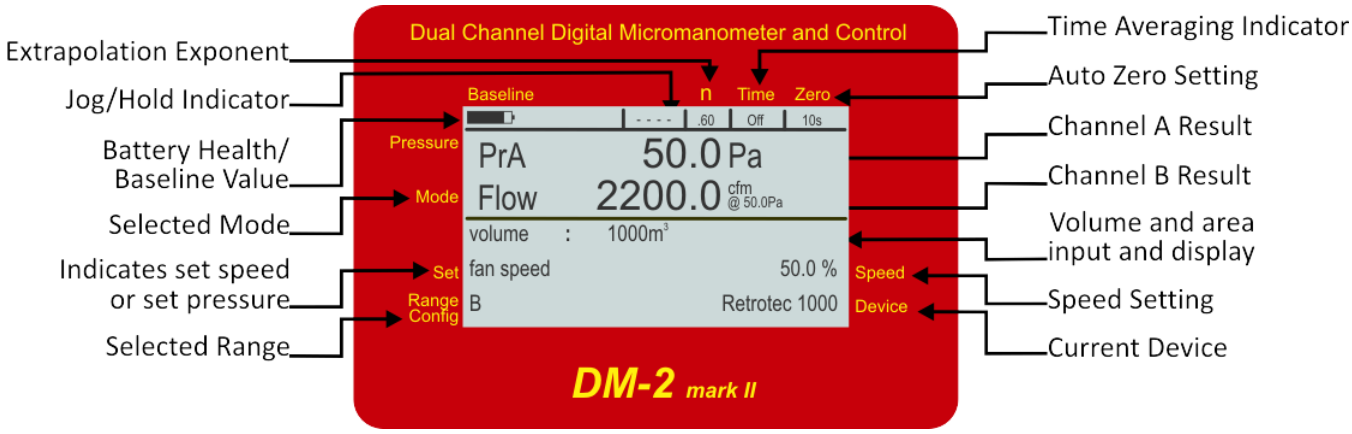
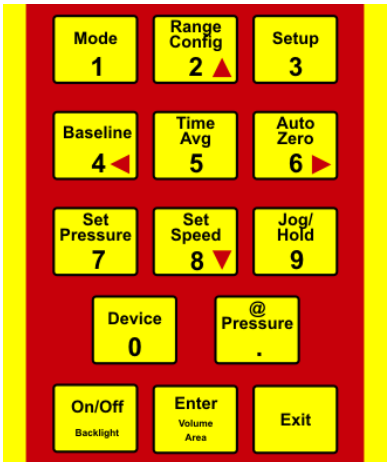


Table 1. DM-2 Gauge keys and functions.

Key	Description	Page for more information
Battery Health /Baseline	Displays the battery health (degree of charge) for rechargeable batteries only. If Baseline has been activated, a pressure will appear that is deducted from the PrA value.	17
Jog/Hold	Cycles between inactive as indicated by "- - - - " and "Hold" which will hold the display and control functions until “Hold” is turned off. Jog can be enabled when in Set Speed or Set Pressure mode.	19
n	Displays the current value of the slope of the line along which @Pressure measurements are extrapolated. Can be set between 0.50 and 1.00. A value of 0.65 is suggested for houses, 0.60 for ducts and 0.55 for leaky buildings with large holes and for large buildings.	27
Time	Displays the current Time Averaging setting: Off, 1s, 2s, 4s, 8s, 10s, 20s, 1m, 2m.	18
Zero	Displays the current Auto Zero status, On or Off.	18
Volume/Area Input	Displays the current surface area, or enclosure volume setting, used for calculations involving per unit area.	15
Speed	Displays the current fan speed as a percentage.	19
Device	Displays the current fan (also known as the Device). This must match the fan that is in use.	15
Range Config	Displays the full Range configuration. The range selected must match the Flow Range that is in use.	16
Set	Displays either the Set Pressure for Channel A or the Set Speed for the fan that the gauge will attempt to reach.	18 19
Mode	Displays the current results being calculated by the gauge.	16

The Keypad

The DM-2 keypad provides access to all DM-2 settings and controls.



Some keys have multiple functions. Keys labeled with an arrow **[▼]**, **[▲]**, **[◀]**, and **[▶]** can be used to navigate around the menus, or to change the current selection. Pressing and holding a key automatically repeats the keystroke, and can be used to scroll through menus more quickly.

2.3 Resetting the Gauge

If the DM-2 ever becomes frozen, or stops responding, it can be reset. Depending on the age of the gauge, there are two ways to reset a gauge.

To reset a DM-2 with the Reset button

1. Press the Reset button. (The Reset button is located at the back of the gauge)
2. The gauge should turn on.
3. If pressing the Reset button on the DM-2 fails to reset the gauge, the batteries may need to be replaced or plugged into DC supply

To reset a DM-2 without using the Reset button

1. Remove the back panel labeled "Battery Compartment".
2. Remove the batteries, and disconnect all other tubes or cords.
3. Wait five minutes.
4. Re-install the batteries.

2.4 Screen Contrast

Older model DM-2s include the ability to change the screen contrast in order to improve visibility in different light conditions. Newer models have the voltage to the screen regulated so the contrast adjustment is not necessary.

To change the screen contrast

1. If required, insert a small Phillips head screwdriver into the hole on the back marked "LCD Contrast".
2. Adjust the dial until the desired screen contrast is achieved.

3 DM-2 Keypad Functions

The DM-2 Keypad has 14 keys which control all of the DM-2 functions.

On/Off (Backlight)

The On/Off (Backlight) key turns the gauge on and off, and allows the user to turn on the backlight, or preserve battery life and turn it off.

Press **[On/Off]** to turn the DM-2 on. The key needs to be held down for two seconds to turn the gauge off. The DM-2 is equipped with a backlight to improve visibility. The backlight turns on for a brief time when any key is pressed. When the DM-2 is on, pressing **[On/Off]** briefly will turn the backlight on permanently. Pressing it quickly again will turn the backlight off.

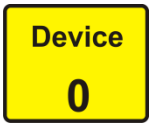
Exit

The Exit key allows the user to exit from certain screens, stop the fan, and clear entries. Press **[Exit]** after turning the gauge on, in order to clear the splash screen. When in a Setup Menu, press **[Exit]** to back out of the current menu screen, or to cancel a menu selection. While in Set Pressure or Set Speed mode, press **[Exit]** to immediately turn off the fan (the fan can also be stopped by setting the speed to zero). Pressing **[Exit]** at any time while in the main screen will cancel the Baseline as well.

Enter (Volume/Area)

Enter is a multi-application key that applies to several functions. Press **[Enter]** to select menu items, or to save input values. Depending on the Mode in use, a volume or area value may be required (Volume for Air Changes per hour, Area for any of the "per Area" results). Press **[Enter]** while the volume or area result is selected, to activate data entry for volume or area. Enter the appropriate value and press **[Enter]** again to save.

Device



Device refers to the fan or pressure measuring device being used to conduct the current test. It is important to make sure that the correct device is selected; the calculations for each of the results are based on system flow equations that are different for each device.

Press **[Device]** to switch between the devices that have been enabled on the DM-2. Only the devices that have been enabled in the Setup Menu can be selected with the Device key. The currently selected device is displayed on the bottom right corner of the screen. The devices that can be selected for use with the DM-2 are listed in Table 4.

When numerical input is required, the Device key is used to input the number zero.

Mode

The DM-2 mark II can display measurements and calculate results in a variety of units. The top result line ("Pressure") always displays Channel A pressure in Pascals. The second result line("Mode") displays the user's selected units. (For information on selecting units, see "Mode Setup" in section 5.3). Table 2 lists all the Modes, its units, and the results that are available on the DM-2 (note that some units are not available on all DM-2 models).

Table 2. Possible results and selectable units for the DM-2 gauge.

Mode	Measures	Units
Pressure	Fan Pressure through the fan	Pa, inches H_2O, lb/ft^2
Flow	Air flow through the fan	CFM, l/s, m^3/s, m^3/h
EfLA	Effective Leakage Area – calculated size of the total hole in the Envelope. Usually taken at 4Pa in the US	cm^2, in^2, ft^2
EqLA	Equivalent Leakage Area – calculated size of the total hole in the Envelope. Usually taken at 10Pa in Canada	cm^2, in^2, ft^2
Air Change	Number of air changes per hour	/h
Flow/Area	Air flow divided by the area of the enclosure	CFM/ft^2, $l/s/m^2$, $CFM/100ft^2$, $m^3/h/m^2$
EfLA/Area	Effective Leakage Area divided by enclosure area	$in^2/100ft^2$, cm^2/m^2
EqLA/Area	Equivalent Leakage Area divided by enclosure area	$in^2/100ft^2$, cm^2/m^2
Hole Flow	The flow across a hole – to be used to measure flow through a known hole size (like exhaust fan or register)	CFM, l/s, m^3/s, m^3/h
Velocity	Air velocity (requires pitot tube)	m/s, km/h, ft/s, ft/min, mph
Velocity Flow	Flow from velocity and area of duct	CFM, l/s m^3/s, m^3/h

Press **[Mode]** to scroll through the measurements that have been activated in the Setup menu. If all modes are activated then they will cycle through the results in the following order:

Pressure → Flow → EqLA → EfLA → Air Changes → Flow/Area → EqLA/Area

→ Hole Flow → Velocity →Velocity Flow

When numerical input is required, the Mode key functions to input the number one.

Range Config (fan Flow Ranges)

Flow Ranges, are used to limit the air flow through a fan, so that the fan can achieve a measurable Fan Pressure, even when moving only a small amount of air (for more information, see *Door Fan Operations Manual*). Every fan that the DM-2 is compatible with, has a set of associated Flow Ranges. Select the correct Flow Range to ensure that the DM-2 performs accurate calculations, and displays correct results. Press **[Range Config]** to cycle through the Flow Ranges that are available for the currently selected device. Available Flow Ranges that are not used, can be removed from the menu. (See "Enable and Disable Range Configurations" in section 5.2)

When numerical input is required, the Range Config key functions to input the number two.

Setup

The Setup key allows access to the Setup Menu, where the gauge is customized. For more information about navigating the menu and the options available, see Advanced DM-2 Options.

Setup is used to enable or disable each of the various modes and devices, to configure the units of measurement for each mode, and to configure the operation of the DM-2. To navigate around the setup menu, use the up or down arrows **[▼]**and **[▲]** to scroll through the menu. Use the left or right arrows **[◀]** and **[▶]** to choose between the different options. The configuration is saved in non-volatile memory so the DM-2 will have the same configuration each time it is turned on.

The Setup menu provides access to the following settings:

- Full Screen Timeout – specify the time before the screen changes to the full screen format
- Restore Settings – used to restore the DM-2 to factory settings
- Language – choose a language for the DM-2 menus and results
- Battery Type – choose between rechargeable and non-rechargeable (alkaline)
- Display Version Info – view the system version information
- n – the slope of the line that the DM-2 will use to extrapolate results, when using the @Pressure function
- Power Down Hour – the DM-2 will automatically turn off after the set number of hours
- Surface Area Unit – specify the units that will be used for enclosure area
- Building Volume Unit – specify the units that will be used for enclosure volume
- European , Separator – specify whether to use a comma in place of a period in the numbers displayed
- Sig Figs – Select either 2.5, 3.0, or 3.5 significant figures (e.g. 1134 is displayed as 1135 for 3.5, 1130 for 3.0, and 1150 for 2.5)
- Device Setup – enable or disable the use of compatible devices and associated Flow Ranges
- Mode Setup – disable or specify the units for available modes

When numerical input is required, the Setup key functions to input the number three.

Baseline

The Baseline function allows the user to measure the bias pressure, or Baseline pressure, under the current test conditions. Once measured, the DM-2 will automatically subtract the baseline pressure from all subsequently measured pressure readings, and will display only the adjusted pressures on the screen. Some buildings have an initial pressure imbalance between the indoors and outdoors, prior to any testing. The DM-2 averages the background pressure for the duration of the acquisition period. A 60 second baseline reading is typically enough to establish an accurate baseline measurement. If the building conditions change during the test, the baseline should be cleared, and a new measurement should be taken. Remember, if **[Exit]** is pressed to stop the fan, the baseline measurement will also be cleared, and will need to be re-taken.

To establish a baseline pressure

1. Press **[Baseline]** to begin acquiring the background pressure. The gauge displays “acquiring” and begins to sample the background pressure. While acquiring the pressure value, the gauge will continuously display the updated average pressure, and the sampling duration on the screen. The more the pressure is fluctuating, the longer the baseline samples for.
2. Press **[Enter]** to accept the current measurement, usually after approximately 60 seconds. If there is a lot of fluctuation, let the baseline acquire for longer than 60 seconds. The current baseline measurement, and the time taken to acquire it, is displayed at the bottom of the Main Screen.
3. Pressing **[Exit]** will clear the measurement.

When numerical input is required, the Baseline key functions to input the number four.

Time Avg

When Time Averaging is active, the DM-2 will display results and pressures that are averaged over the time period selected, on both channels. Regardless of the averaging value, the display will update with a new value every second. This can provide significantly more accurate results.

The DM-2 includes nine time averaging settings. Press **[Time Avg]** to scroll through the following time averaging settings: Off, 1s, 2s, 4s, 8s, 10s, 20s, 1m, and 2m.

Caution: When changing the fan speed, set pressure, or taking a reading after making any other changes, wait for twice the time averaging period to elapse before taking a reading. Taking a reading too quickly can lead to recording incorrect results.

Notice that the **[Time Avg]** key is located in the middle of all the arrow keys on the keypad. As a user friendly feature, while in the Setup Menu, the **[Time Avg]** key can be used to select menu items, just as you would using the **[Enter]** key.

When numerical input is required, the Time Avg key functions to input the number five.

Auto Zero

Over time, the reading on Channel A and Channel B will start to drift away from zero. The longer the gauge is turned on, the larger this error can become. With Auto Zero on, the gauge will automatically zero the gauge every 8 seconds. In general, the DM-2 should be used with auto zero feature on. However, the function does consume extra battery power. Turning auto zero on, only at the start of each data acquisition cycle, will maximize gauge performance and data transfer rates.

Press **[Auto Zero]** to turn Auto Zero on/off.

When numerical input is required, the Auto Zero key functions to input the number six.

Set Pressure

The DM-2 can automatically control the fan speed on 'Q' model systems to achieve a user set building pressure. This is the easiest method to achieve a specific test pressure.

To use the Set Pressure function

1. Press **[Set Pressure]** to activate the automatic control. Input the desired building pressure using the DM-2 keypad and press **[Enter]** to start the fan.
2. The fan will accelerate until the input pressure has been reached, or the fan reaches 100% speed. The fan will continue to hold at that pressure, regardless of changes to the enclosure or room (i.e. opening/closing windows and doors, HVAC on/off, sealing, etc.).
3. Press **[Exit]** to stop the fan, and cancel the Set Pressure.

If the pressure is set to "0" Pa, the DM-2 will adjust the fan speed to bring the existing pressure to zero. This can be used to normalize pressures during specific tests. See the Retrotec *DucTester Operation & Testing* manual for an example.

When numerical input is required, the Set Pressure key functions to input the number seven.

Set Speed

The DM-2 can automatically control the fan speed on a 'Q' model system to achieve a specific user-defined fan speed.

To use the Set Speed function

1. Press **[Set Speed]** to activate the automatic control.
2. Input the desired speed using the DM-2 keypad. Speed is input as a percentage, and can be any value from 1-100.
3. Press **[Enter]** to start the fan. The fan will accelerate until the desired speed is achieved.
4. Press **[Exit]** to stop the fan and cancel the Set Speed, or press **[Set Speed] [0] [Enter]** to stop the fan.

When numerical input is required, the Set Speed key functions to input the number eight.

Jog/Hold

Jog/Hold functions differently depending on which mode the DM-2 is currently in. The key has two functions:

Hold

- Freezes the display with the data currently displayed on the screen. Nothing will change until the Jog/Hold key is pressed again to clear "Hold".
- Can be activated at any time.
- Allows the recording of instananeous results (eg. Flow, EqLA, PrB at pricisely the same time)

The screen will display either "- - - - " or "Hold".To activate Hold

1. Press **[Jog/Hold]** until "Hold" appears on the screen to freeze the screen and lock the data currently displayed.
2. Press **[Jog/Hold]** again until "----" is displayed to unlock the screen.

Jog

- Enables the keypad arrows **[▼]** or **[▲]**to adjust the Set Speed or Set Pressure up or down much like a traditional remote control.
- The screen will display either "- - - - ", "Jog" or "Hold" (when in Set Speed or Set Pressure mode).
- When not in Set Speed or Set Pressure mode, the DM-2 will not enter Jog mode (but Hold mode can be activated at any time).

In Set Speed mode

1. Press **[Jog/Hold]** until "Jog" appears on screen.
2. Press **[▼]** or **[▲]** to increase or decrease the set speed in 1% increments.
3. Press and hold **[▼]** or **[▲]** to increase or decrease the set speed in 5% increments.
4. Press **[Jog/Hold]** again until "----" is displayed to resume normal operation.

In Set Pressure mode

1. Press **[Jog/Hold]** until "Jog" appears on screen.
2. Press **[▼]** or **[▲]** to increase or decrease the set pressure in increments of 5 Pa, 0.02 in WC, or 0.105 lbs/ft^2.
3. Press and hold **[▼]** or **[▲]** to increase or decrease the set pressure in increments of 10 Pa, 0.04 in WC, or 0.21 lbs/ft^2.
4. Press **[Jog/Hold]** again until "----" is displayed to resume normal operation.

When numerical input is required, the Jog/Hold key functions to input the number nine.

@ Pressure

The @ Pressure key asks the DM-2 to calculate a result that would be achieved, if the desired test pressure were measured. The measured pressure will almost always be at least slightly over, or under, the exact test pressure making it difficult to report results that are standardised for a specific pressure. The @ Pressure function performs a calculation called "extrapolation" which analyzes the currently measured results, and displays the results as if the test pressure was achieved.

Press **[@ Pressure]** to toggle the DM-2 pressure extrapolation function on and off. The test pressure that is being extrapolated to is configured in the Setup Menu.

Note: While the DM-2 is capable of extrapolating to any pressure, it is more accurate when the actual building pressure is closer to the desired extrapolation pressure.

The @ Pressure function provides unique advantages over un-extrapolated results:

- There's no need to achieve an exact test pressure.
- The results on the screen will be very stable since results are extrapolated to a specific pressure.
- Results can be obtained, even if the test pressure cannot be reached.

In Set Speed mode

1. Press **[@ Pressure]** to view the results at a particular pressure, as set in the Setup Menu. The units will change to indicate that @ Pressure is on (e.g. CFM@50.0Pa).
2. Press **[@ Pressure]** again to view the current (non-extrapolated) results. The units will change to indicate that @ Pressure is off (e.g. CFM).

In Set Pressure mode

1. Press **[@ Pressure]** once to view the results at the current Set Pressure value. The units will change to indicate that @ Pressure is on (e.g. CFM@40.0Pa).
2. Press **[@ Pressure]** again to view the results at the @ Pressure, as set in the Setup Menu. The @ Pressure value will change (e.g. CFM@50.0Pa).
3. Press **[@ Pressure]** again to view the current (non-extrapolated) results. The units will change to indicate that @ Pressure is off (e.g. CFM).

It is important to understand how to use this feature properly, as inaccurate results are likely if it is used incorrectly. The extrapolation feature works by estimating a typical leakage constant, and using it to calculate the results at the desired pressure. In general, if the desired test pressure is within +/- 10% of the actual measured pressure, the @ Pressure will be accurate enough to record. This function should only be turned on and made active when in the appropriate situation – do not leave it on for all tests as this may lead to inaccuracies. See below for examples.

Example #1 - Inaccuracy

A 50 Pa building pressure is desired, but only 20 Pa can be reached (due to severe leakiness). In this instance, the extrapolated results for flow '@ 50 Pa' do not represent the reality of the testing conditions and might be highly inaccurate.

In the same situation, a 45 Pa building pressure is achieved. The extrapolated '@ 50 Pa' pressure is now much more accurate, and provides an acceptable result.

Example #2 - Set Speed

With the fan set at 100% speed, a building pressure of 46 Pa is reached. The gauge is setup to calculate flow in CFM, and the @ Pressure setting is @50 Pa.

Press **[@ Pressure]** once. Each time the key is pressed, the results alternate between displaying “CFM” and “CFM @50Pa”.

Example #3 - Set Pressure

The gauge is set up to measure flow in CFM, with the @ Pressure setting @50 Pa.

The DM-2 is set to automatically control the fan speed to reach a test pressure of 75 Pa by using the Set Pressure function.

Press **[@ Pressure]** once. Each time the key is pressed, the results rotate through 'CFM', 'CFM @50Pa', and 'CFM@75Pa'.

When numerical input is required, the @ Pressure key functions to input a decimal point.

4 Using the DM-2 Gauge for Testing

The DM-2 can be used for testing either on its own, or connected to a specialized, calibrated fan. Before it can be used for testing, it's important to know how to connect it properly.

4.1 Making the Connections

The DM-2 mark II can be used with a Retrotec Door Fan and other similar devices. The Retrotec Umbilical cable includes all necessary tubes and cable connections. The pressure tubes, in the Umbilical cable, are color-coded. The pressure and hardware connection ports are also clearly labeled on the top of the gauge.

Pressure port connections

Retrotec has a specially designed connection port that makes a perfect seal and grips the tube well, but releases without tearing the tubing after multiple uses. This exclusive connector was designed by Retrotec to make contact with the both tube internally and externally with a shallow taper. The tube ends should be clean, and not stretched in order to make a proper connection. If the pressure tube is damaged, simply slice a short piece of tube off the end to ensure a clean fit. Tubing can crack in cold weather, but it can be warmed in hot water before being handled. Be careful to dry all water from the tubing prior to connecting.

- Green - Input B (+) - A higher pressure on this port and PrB reads positive.
- Yellow - Ref B (-) (fan) - A higher pressure on this port and PrB reads negative.

- Red - Ref A (-) (door) - A higher pressure on this port and PrA reads positive.
- Blue - Input A (+) - A higher pressure on this port and PrA reads positive.

Figure 7. Pressure ports of the DM-2 gauge.

Hardware connections

- Speed Control – Connects the DM-2 gauge to the fan using an Ethernet style cable.
  CAUTION: Never connect the DM-2 (or the fan) to an internet modem/router.
- USB PC – The USB (Universal Serial Bus) port is used to connect the DM-2 to a computer equipped with Retrotec's FanTestic software. The computer can assume complete control of the gauge for data acquisition and control of advanced automated testing.
- LCD Contrast dial (older models) – Adjust to increase or decrease the contrast of the display screen. Higher contrast settings will increase the display screen legibility in low-light situations, but will reduce battery life.
- Power – Connects the gauge to an external power source using either the AC power adapter or power available from the fan (if available).

To connect the DM-2 to a Retrotec fan or variable speed drive box

1. Locate the end of the Umbilical cable (this is the bundle of pressure tubing and Control Cable) with the shortest length of exposed pressure tubes and Control Cable. Plug the yellow Control Cable into the Speed Control port on the DM-2.
2. Plug colored tubes into the matching color-coded pressure ports on the top side of the DM-2. Ensure the tubes are snugly connected to the ports. Depending on the system, Umbilical cable can contain red, yellow, green, and/or blue tubes.

Note: The Umbilical power cord should not be attached unless the DM-2 batteries are below one quarter power, and require recharging.

3. From the other end of the Umbilical cable, plug the yellow Control Cable into the port labeled Control on the Fan Top.
4. Attach the yellow pressure tube to the yellow bulkhead fitting labeled Ref B (fan) on the Fan Top. If available, the green pressure tube should be attached to the green bulkhead fitting labeled B (+).
5. Attach the Umbilical power cord to the port labeled DM-2 Power on the Fan Top, if the DM-2 requires recharging.

6. Pass the red pressure tube through the Door Panel and lay the end down out of the way of any air flow from the fan.

The Retrotec DM-2 can be connected to Minneapolis's Model 3 and Model 4 fans.

To connect the DM-2 to a Minneapolis Model 3 or Model 4 Fan

1. Using the included Retrotec Umbilical cable, connect the yellow pressure tube from the yellow port of the DM-2 to the open port on the fan.
2. Some newer versions of the Model 3 and 4 contain an additional Reference port. If available, connect the green tube in the Umbilical cable from the green port on the DM-2 to the Reference port on the fan.
3. The power and Control Cables included in a Retrotec umbilical cannot be used when using a 3rd party fan. Make sure the batteries are fully charged, prior to beginning testing.

4.2 Conducting a Basic Test

After making the necessary connections with the DM-2 (to the fan), follow these steps to begin a test.

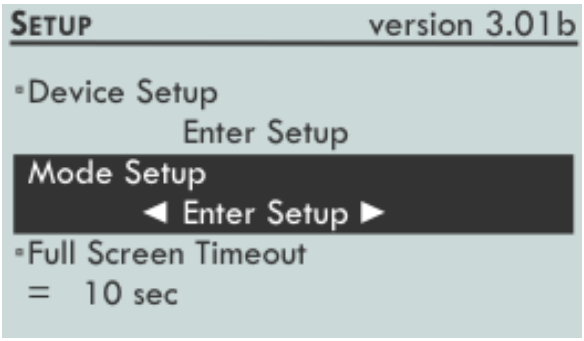
To conduct a test

1. Turn the gauge on by pressing **[On/Off]**.
2. Press **[Exit]** to exit the welcome splash screen.
3. Check the battery power before beginning a test to ensure the gauge has enough power to complete the test. (Plug the gauge in, recharge or replace batteries if needed).
4. Select the appropriate device to which the DM-2 is connected by pressing **[Device]**.
5. Select the appropriate Flow Range configuration for the fan by pressing **[Range Config]**.
6. Press **[Mode]** to select the required results to display. Note that the mode can be changed at any point during the test to view different results.
7. Select an appropriate time averaging value for the test conditions by pressing **[Time Avg]**.
8. Ensure that AutoZero is on.
9. Press **[Baseline]** to begin acquiring a baseline pressure reading. Press **[Enter]** after 60 seconds to set the baseline reading.
10. To view the results at a particular pressure, use the **[@ Pressure]** function.
11. Either press **[Set Speed]** to set the fan speed to a particular percentage,
    OR press **[Set Pressure]** to control the fan to a particular building pressure.
12. Press **[Jog/Hold]** once and use the arrows to increase or decrease the speed/pressure, or push it twice to hold the results on the display.

5 Gauge set up

While the DM-2 can be run using the default settings, configuring the DM-2 for a specific fan system and testing protocol can save time and reduce the chance of making mistakes. Some systems may be ordered with the correct settings for a specific region and for the equipment being used. The Setup Menu provides access to a number of settings, including the Device and Mode Setup screens.

5.1 Setup Menu



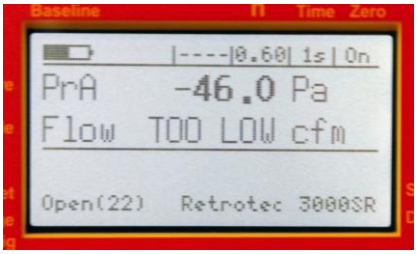
The Setup Menu contains access to two sub-menus and a list of other setup options:

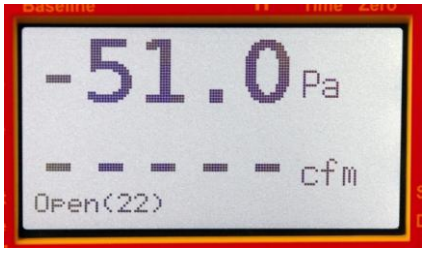
- Full Screen Timeout
- Restore Settings
- Language
- Battery Type
- Display Version Info
- N
- Power Down Hour
- Surface Area Unit
- Building Volume Unit
- European , Separator
- Sig Figs
- Device Setup
- Mode Setup

Notice that the **[Time Avg]** key is located in the middle of all the arrow keys on the keypad. As a user friendly feature, while in the Setup Menu, the **[Time Avg]** key can be used to select menu items, just as you would using the **[Enter]** key.

Full Screen Timeout

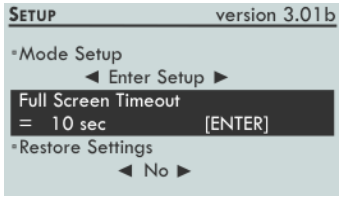
DM-2s that have firmware Version 3.0 or higher, have a large format screen, which automatically appears when no key press is recorded for a period of time. The length of time that must pass is determined by the Full Screen Timeout setting.





To change the Full Screen Timeout time period

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Full Screen Timeout" in the list. Press **[Enter]**.



3. Input a time (in seconds) between 0-120. Press **[Enter]**. Press **[Exit]**.

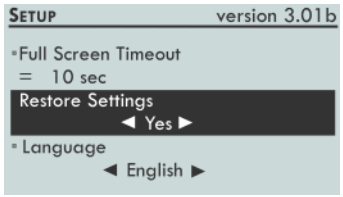
The DM-2 will not display the large format screen if a time period of '0' is used.

Restore Settings

At any time, the factory settings can be restored in the DM-2. This will reset the gauge to have exactly the same settings that the gauge was shipped with.

To restore the factory settings

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Restore Settings" in the list.



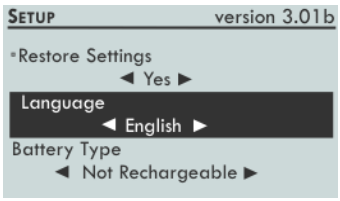
3. Press **[◄]** or **[►]** to select *Yes*.

Language

The DM-2 can display information in the following languages: English, French, German, Norwegian, Swedish, and Latvian.

To change the language

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Language" in the list.



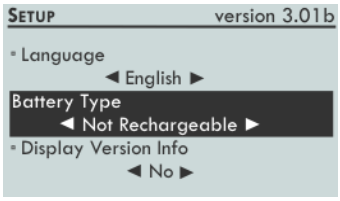
3. Press **[◄]** or **[►]** to select the desired language.

Battery Type

The gauge supports both rechargeable and non-rechargeable (alkaline) batteries. It's important to correctly identify the battery type in the gauge setup, to prevent damage to the gauge.

To select a battery type

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Battery Type" in the list.



3. Select the correct battery type for the installed batteries.

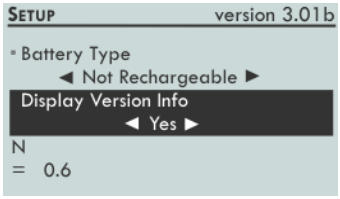
Rechargeable batteries will not be charged when connected to a power supply if *Non-Rechargeable* batteries are selected.

Display Version Info

The current firmware and hardware version information can be found in the Setup Menu.

To view version information

1. Press **[Setup]** to access the Setup Menu.
2. Press **[▼]** or **[▲]** to select "Display Version Info" in the list.



3. Press **[Enter]**. The DM-2 version information is displayed.
4. Press **[Exit]** to return to the Setup Menu.

n

The "*n*" value is typically 0.65 for houses and 0.60 for ductwork. A wide open hole has an *n* of 0.5, meaning that when the pressure is quadrupled, the flow doubles. That is due to completely turbulent flow going through that hole (flow = square root of pressure, a constant for that particular hole).$flow = Pressure^n$

$$flow = Pressure^{0.5}$$

An *n* value of 1.0 represents tiny little holes, so small that the air would not be turbulent but rather would go through the holes as laminar flow. This means that when pressure is quadrupled, so will the flow.

$$flow = Pressure^1$$

$$flow = Pressure$$

$$4 * flow = 4 * Pressure$$

Houses and ducts are composed holes that will have both turbulent and laminar flow going through them. Duct holes tend to be slightly larger, whereas houses have more prevalent long tiny cracks, and therefore tend to have lower *n* values.

These *n* values can be measured simply by doing a multi-point Door Fan or duct test. The result will be an *n* and a *C* (coefficient) so flow at any pressure can be calculated by using the equation:

$$flow = Pressure^n \times C$$

The gauge uses the "*n*" and "*C* "values to extrapolate for flows at other pressures.

For example: If we guess at the n value of a duct as being 0.6 and measure 100 CFM at 20 Pa (by accident or by design), then the DM-2 will complete the following calculation for flow at 25 Pa:

$$flow@25\ Pa = 25^{0.6} \times \frac{flow@20\ Pa}{20^{0.6}}$$

If the test pressure (20 in this case) is close to the desired reference pressure (25 Pa in this case), then the correction is small and the value of *n* does not play as large a role. However, if the test pressure is much higher or lower than the reference pressure, the error could be greater.

The @ Pressure feature is very useful for ensuring that results taken when the pressure was not adjusted perfectly are still accurate.

To continue the above example: The flow at 20 Pa is 100 CFM. Actual *n* is 0.7, but this is unknown. Instead, 0.6 will be used.

The DM-2 would calculate:

$$Flow@25\ Pa = \frac{25^n \times CFM}{20^n}$$

$$Flow@25\ Pa = \frac{25^{0.6} \times 100}{20^{0.6}}$$

$$Flow@25\ Pa = 114\ CFM$$

However, if it was known that n was 0.7, the flow at 25 should have been:

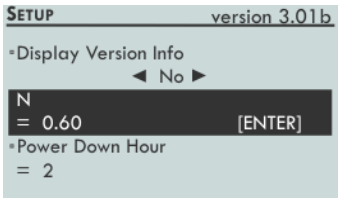
$$Flow@25\ Pa = \frac{25^{0.7} \times 100}{20^{0.7}}$$

$$Flow@25\ Pa = 117\ CFM$$

This value is less than 3% off from what it should be. If the test pressure was within 1 or 2 Pa of the reference pressure of 25 Pa, the @ Pressure reading would be exact.

To change the n value

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "n" in the list. Press **[Enter]**.



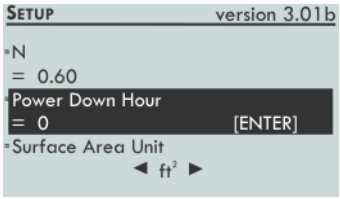
3. Input the new value between 0.5 and 1. Press **[Enter]**.

Power Down Hour

The Power Down Hour helps to maximize battery power by enabling the DM-2 to automatically turn off when it has been inactive for a set time period. The feature can be set to any value between 0 and 255 hours. Applying a 0 value will disable the Power Down feature, and the DM-2 will never automatically shut down.

To change the Power Down Hour

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Power Down Hour" in the list. Press **[Enter]**.



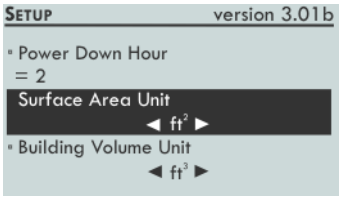
3. Input the new value. Press **[Enter]**.

Surface Area Unit

For some results (e.g. Flow/Area, EqLA/Area, Hole Flow) an area measurement is required to calculate them. The units used for area can be configured. The area units may be set to square feet (ft^2), square meters (m^2), square centimeters (cm^2), or square inches (in^2).

To change the Area units

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Surface Area Unit" in the list.



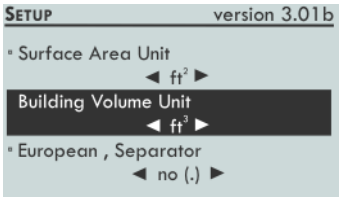
3. Press **[◄]** or **[►]** to select the desired units.

Building Volume Unit

For air change per hour results, volume measurements are required to calculated them. The units used for volume can be configured. The volume units may be set to cubic feet (ft^3) or cubic meters (m^3).

To change the Volume units

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Building Volume Unit" in the list.



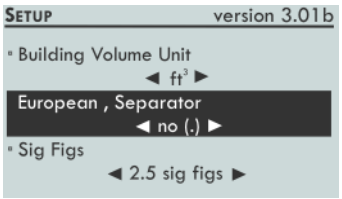
3. Press **[◄]** or **[►]** to select the desired units.

European , Separator

The European decimal convention specifies how whole and fractional values are presented on the display and in captured data. European conventions use a comma (,) rather than a decimal point (.) to separate the integer portion of a number from the fractional portion. The DM-2 gauge supports both conventions. Select 'yes' to represent the decimal as a comma, choose 'no' to use a period.

To change the European Separator units

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "European , Separator" in the list.



3. Press **[◄]** or **[►]** to select yes or no.

Sig Figs

The significant figures feature controls the number of significant digits displayed on the gauge. The available options are:

- 2.5 Two significant figures plus a third figure rounded to either 0 or 5.

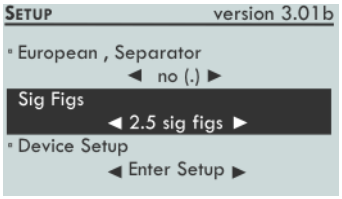
- 3.0 Three significant figures.
- 3.5 Three significant figures plus a fourth figure rounded to either 0 or 5.

Table 3. Example values displayed using each of the three significant figure options.

	Significant Figures		
Base Number	**2.5**	**3.0**	**3.5**
1.034	1.05	1.03	1.035
20.353	20.0	20.4	20.35
147.626	150.	148.	147.5
4326.72	4350.	4330.	4325.

To change the number of Significant Figures

1. Press **[Setup]** to access the Setup menu.
2. Press **[▼]** or **[▲]** to select "Sig Figs" in the list.



3. Press **[◄]** or **[►]** to select 2.5, 3.0, or 3.5.

5.2 Device Setup

The DM-2 mark II supports fan equipment from virtually every other calibrated fan manufacturer on the market.

Table 4. List of compatible devices to be used with the DM-2.

Device Mfr	Device displayed	Description
Retrotec	DU100	Obsolete DucTester
	DU200	Model 200 fan, Q32 DucTester
	600/700	Obsolete fans
	800/900	
	1000	Model 1000 systems with 0.75 hp yellow wheel rim style fans
	2000	Model Q46 and Q56 systems with 0.75 hp yellow foam core fan
	3000	Older Model Q4E, Q5E and QMG systems with 2 hp yellow foam core Door Fan
	3000SR	Model Q4E, Q5E and QMG systems with 2 hp yellow foam core Door Fan – all fans are self-referencing (have green tube)
Minneapolis	DuctBlaster B	Duct testing fan
	Model 3 (120V)	0.75 hp black wheel rim style fan
	Model 3 (240V)	
	Model 4 (240V)	
	Exhaust Fan	Exhaust Fan Flow Meter – measures air flow through residential exhaust fans between 10 and 124 CFM
	True Flow	True Flow Grid – measures flow through a residential air handler
Infiltec	E3	0.75 hp black wheel rim style fan

Model 200 Fan

600 Fan

900 Fan

1000 Fan

2000 Fan

3000 Fan

Mn Duct Blaster B

Mn Model 3/4 Fan

Mn Exhaust Fan Flow Meter

Mn True Flow Grid

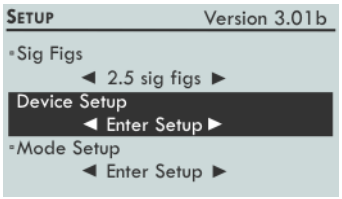
Infiltec E3

Enable and Disable Devices

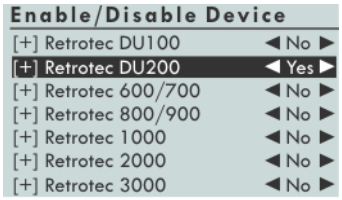
To simplify the device selection process, it's possible to disable devices that will not be used. Disabled devices are saved in system memory, and will remain disabled upon subsequent uses. They can always be enabled if necessary.

To enable/disable Devices

1. From the main gauge screen, press **[Setup]** to access the Setup menu.



2. Press **[▼]** or **[▲]** to select "Device Setup" in the list. Press **[Enter]**.



3. Press **[▼]** or **[▲]** to select a device. Press **[◄]** or **[►]** to toggle between "Yes" or "No" next to each device. Selecting "Yes" for a device enables that device to be selected on the Main Screen.
4. Press **[Exit]** to return to the Setup Menu, press **[Exit]** again to return to the Main Screen.

Enable and Disable Flow Range Configurations

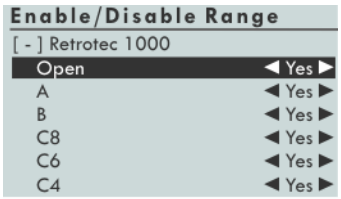
It is also possible to enable and disable Flow Ranges for each of the devices being used. This will eliminate the need to scroll through each Flow Range when it can be determined which ones are the most well-used, cutting down on gauge setup time. Disabled Flow Ranges are saved in system memory, but can always be enabled if necessary.

Table 5. DM-2 compatible devices and associated Flow Range configurations.

Calibrated Fan	Available Flow Ranges
Retrotec 600/700	Open, 12, 8, 6, 2, 1
Retrotec 800/900	18F, 18R, 9, 5, 3, 1.4, 1.3, 1.2, 1.1, 0.1
Retrotec 1000	Open, A, B, C8, C6, C4, C2
Retrotec /2000/3000/3000SR	Open, A, B, C8, C6, C4, C3, C2, C1, L4, L2, L1
Retrotec DU100/DU200	Open, Mid, Low
Minneapolis DuctBlaster B	Open, Ring 1, Ring 2, Ring 3
Minneapolis Model 3/4	Open, A, B, C, D, E
Minneapolis Exhaust Fan	E1, E2, E3
Minneapolis True Flow	#14, #22
Infiltec E3	Open, 7 Holes, 4 Holes, 3 Holes, 2 Holes, 1 Hole

To enable/disable Flow Range configurations in Device [Setup]

1. Enter the Device Setup menu by pressing **[Enter]** on “Device Setup”.



2. Select the device on which Flow Ranges need to be enabled/disabled and press **[Enter]**.
3. Press **[◀]** or **[▶]** arrows to turn the Flow Ranges on ("Yes") or off ("No").

5.3 Mode Setup

The DM-2 gauge is set to use a preset unit measurement configuration for each of the available modes.

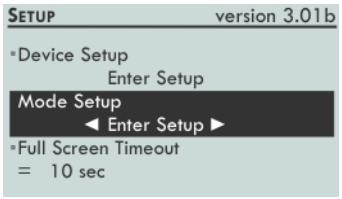
Table 6. Default mode set-up.

Mode	Settings	
Pressure	Pa	n/a
Flow	CFM	@ 50 Pa
EfLA	Off	@ 4 Pa
EqLA	ft^2	@ 10 Pa
Air Changes	/h	@ 50 Pa
Flow per Area	Off	@ 50 Pa
EqLA per Area	Off	@ 50 Pa
EfLa per Area	Off	@ 50 Pa
Hole Flow	Off	n/a
Velocity[1]	Off	n/a
Velocity Flow[1]	Off	n/a

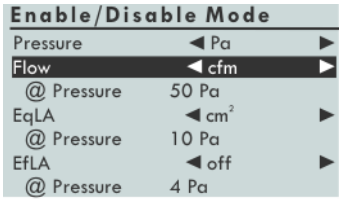
The DM-2 mark II supports a number of calculations which can simplify the testing procedure. Some of these may be useful for specific testing needs. Use Mode Setup to customize the gauge to enable access to only specific results that will be used regularly. The configuration is permanently saved, but can be changed at any time. Once configured, the gauge will cycle through only those modes that are enabled in the Mode Setup menu.

To configure Mode Setup

1. Press **[Setup]** to access the Setup menu.



2. Press **[▼]** or **[▲]** to select "Mode Setup" in the list. Press **[Enter]**.



3. Press **[▼]** or **[▲]** to select a mode. Press **[◄]** or **[►]** to select the units associated with each mode. Select 'off' to disable that mode on the Main Screen.
4. Some modes have an associated @ Pressure. To change it, highlight the associated "@ Pressure", and press **[Enter]**.
5. Input the new value using the number keys on the keypad, and press **[Enter]** again.

[1] Some versions of the Firmware do not support velocity and velocity flow.

5.4 Setting up your DM-2 for a NFPA Enclosure Integrity Test

For a test to comply with the NFPA 2001, test results should be obtained in the units used in NFPA 2001's *Standard on Clean Agent Fire Extinguishing Systems* (2008 edition).The units of results that should be enabled on the Setup Menu of the DM-2 are:

Results	DM-2 label	Unit required for NFPA
Pressure (Target Pressure)	"PrA"	Pa
Flow	"Mode"	m^3/s

For simplicity purposes, the display of units for all other results are unnecessary and can be disabled on the gauge. The following step-by-step instructions can be followed to set up the DM-2 gauge for testing enclosure integrity in accordance to NFPA 2001:

Setting up the units of results for a NFPA Enclosure Integrity test

1. Press **[Setup]**to enter the Setup menu
2. Press **[▼]**or **[▲]**to scroll through the list until "Mode Setup" is highlighted
3. Press **[Enter]** to enter the Mode Setup submenu
4. If Pressure is not highlighted, Press **[▼]**or **[▲]** to scroll until "Pressure" is highlighted.
5. Use **[◀]** or **[▶]** to scroll until "Pa" is displayed
6. Scroll down to highlight "Flow"
7. Press **[◀]** or **[▶]**to scroll until "m^3/s" is displayed (your unit setting)
8. Scroll down to all other results in the Mode Setup menu, and use **[◀]** or **[▶]** to scroll until "Off" is displayed to disable all other results.
9. Press **[Exit]** once to exit from the Mode setup submenu and save the settings.

Your DM-2 is now set up and ready for performing the NFPA 2001 Enclosure Integrity Test.

5.5 Performing an NFPA 2001 Enclosure Integrity Test (single point test as per 2008 edition)

For an Enclosure Integrity test to comply with the NFPA 2001's *Standard on Clean Agent Fire Extinguishing Systems* (2008 edition), Door Fan tests must be performed at four distinct points: two target pressures while depressurizing the enclosure, and two target pressures while pressurizing the enclosure.

Target pressures required for NPFA Enclosure Integrity tests are:

Test direction	**Target Pressure required for NFPA** ("PrA")
Deressurization	-10 Pa
	-50 Pa
Pressurization	+10 Pa
	+50 Pa

The following step-by-step instructions can be followed to test enclosure integrity in accordance to NFPA 2001:

1. Set up your Door Fan system according to the "Door Fan Operation" Quick Guide.
2. Enter test conditions and dimensions into Retrotec's CA2001 software
3. Press **[Mode]** repeatedly until "CFM" appears beside the Mode label on the DM-2
4. Press **[Time Avg]** repeatedly until "4s" appears beside the Time label on the DM-2
5. Press **[Auto Zero]** until "On" appears beneath the Zero label on the DM-2
6. Press **[Device]** until the name of the fan you are using appears beside the Device label on the DM-2
7. Press **[Range]** until the installed range appears beside the Range Config label on the DM-2
8. Press **[Baseline]**, wait for 30 seconds, then press **[Enter]**
9. Press **[Set Pressure]** and enter one of the pressures listed in the table above
10. Achieve the first target pressure (using one of the two methods below), and enter the actual pressure read from the DM-2 gauge into CA2001
11. Repeat steps 8-10 for the remaining Target Pressures from the table above.
12. If retention time is less than 10 minutes, use smoke from a Retrotec Air Current Tester to determine where leaks are, then seal the leaks.
13. Repeat test until retention time is greater than 10 minutes

Achieve the Target Pressure (Method 1) – Using Set Pressure

1. Press **[Set Pressure]** and enter the target pressure. The fan should increase in speed and eventually stabilize with “PrA” approximately matching the input target pressure.
2. Enter “PrA” (pressure reading on Channel A, which is the building pressure or also called room pressure) and “PrB” (pressure reading on Channel B which is the Fan Pressure) from the DM-2 into CA2001.

Achieve the Target Pressure (Method 2) – Using Set Speed

1. Press **[Jog/Hold]** until “Jog” appears in the top center of the DM-2 display
2. Press **[▼]**or **[▲]** to increase/decrease the fan speed until “PrA” approximately matches the input target pressure. (Quickly press and release for increments of 1% speed. Hold and release for increments of 5% speed)
3. Enter the “PrA” (pressure reading on Channel A which is the building pressure or also called room pressure) and the “PrB” (pressure reading on Channel B which is the Fan Pressure) from the DM-2 into CA2001.

5.6 Using the DM-2 to look for the locations of Leaks

If your test does not comply (e.g. the retention time is less than what is required) with the Standard you are testing against (e.g. NFPA 2001), you need to search where the leakage locations are in the enclosure, seal up the leakages, and run the Enclosure Integrity Test again.

The following instructions describe how to measure the total leakage area of the enclosure while sealing up leaks to pass the Enclosure Integrity Test:

1. If you are not already in Set Pressure mode (for example, you used Method 2 to achieve your target pressure) then press **[Set Pressure]** and input the current target pressure.
2. Press **[Mode]** until "EqLA" appears on the display beside the Mode label on the DM-2. (Enable EqLA in the Mode Setup if EqLA does not appear after cycling through **[Mode]**)
3. If the units for EqLA indicate ft^2 or in^2 "@ 50Pa", then press **[@Pressure]** until the @ qualifier disappears. The DM-2 now displays the total leakage area of the enclosure.
4. If the displayed leakage is small, and the units for EqLA are in "ft^2" you might want to switch the units to "in^2" in the Setup menu. If the leakage is large and you are in "in^2", you might want to switch the units to "ft^2".)
5. Search for, locate, and temporarily seal holes in the enclosure. You will hear the fan slow down (less flow is required to achieve the target pressure when the room is tighter).
6. The "retention" tab in Retrotec's CA2001 software indicates the "Maximum AllowableELA". If the EqLA reading on the DM-2 is greater than what is the "Maximum Allowable ELA" on CleanAgent 2001, you must continue sealing leaks in order to get the EqLA reading on the gauge to be less than what is the "Maximum Allowable ELA" is specified for your test on CleanAgent 2001.
7. When the EqLA reading on the DM-2 is less than the "Maximum Allowable ELA" on the CleanAgent 2001, you have passed the Enclosure Integrity Test. (According to NFPA 2001, this translates to what the Maximum Allowable ELA should be to have a retention time of at least 10 minutes)

5.7 Setting up for a test with Alaska's AkWarm software

1. Press **[Setup]** to enter the Setup menu
2. Press **[▲]** or **[▼]** to scroll through the list until "Mode Setup" is highlighted
3. Press **[Enter]** to enter the Mode Setup submenu
4. Press **[▲]** or **[▼]** to scroll until "Pressure" is highlighted.
5. Press **[◀]** or **[▶]** to scroll until "Pa" is displayed
6. Press **[▼]**to highlight "Flow"
7. Press **[◀]** or **[▶]**to scroll until "CFM" is displayed
8. Press **[▼]** once to highlight "EqLA"
9. Use **[◀]** or **[▶]** to scroll until "in^2" or" ft^2" is displayed (this is an optional measurement forAlaska AkWarm)
10. Press **[▼]** once to highlight "Air Change"
11. Use **[◀]** or **[▶]** to scroll until "On" is displayed (this is an optional measurement for Alaska AkWarm)
12. Scroll down to all other results in the Mode Setup menu, and use **[◀]** or **[▶]** to scroll until "Off" is displayed to disable all other results.
13. Press **[Exit]** once to return to the Setup submenu
14. Press **[▼]** to select "n"
15. Press **[Enter]**
16. Use the keyboard to set this value to "0.65"
17. Press **[Enter]** to accept this value
18. Press **[▼]** to select "Power Down Hour"
19. Leave at "2" (hours) or set to "0" to turn auto-power-down off.
20. Press **[▼]** to select "Surface Area Unit"
21. Press **[◀]** or **[▶]** to set to "ft^2" (Note: AKWarm does not require the use of this parameter)
22. Press **[▼]** to select "Building Volume Unit"
23. Press **[◀]** or **[▶]** to set to "ft^3" (Note: when you select Air Changes, you will enter volume in ft^3)
24. Press **[▼]** to select "European , Separator"
25. Press **[◀]** or **[▶]** to set to "No"
26. Press **[▼]** to select "Sig Figs"
27. Press **[◀]** or **[▶]** to set to "3.5"
28. Press **[Exit]** to exit the Setup menu and save these Setup settings.

Your DM-2 is now set up for performing an Air Leakage Test with Alaska's AKWarm Software.

6 Field Calibration

Gauge Calibration

To verify the calibration of a gauge, the easiest method is to compare the readings of one channel with respect to the other channel. If the pressures are equal, then it is likely the gauge is accurate, because the chance of both channels being out of calibration by the same amount is very small.

To perform a cross port check

1. Set both channels to measure pressure in Pascals.
2. Turn Auto-Zero off
3. Connect the Input port of Channel A to the Input port of Channel B using a small piece of tubing. The measured pressure on both channels should be within 1% of each other.
4. Disconnect the tubing, and then connect the Reference ports of both channels using the same piece of tubing. The measured pressure on both channels should be within 1% of each other.

   The same procedure can be followed to compare two gauges. The reading on both gauges should be the same.

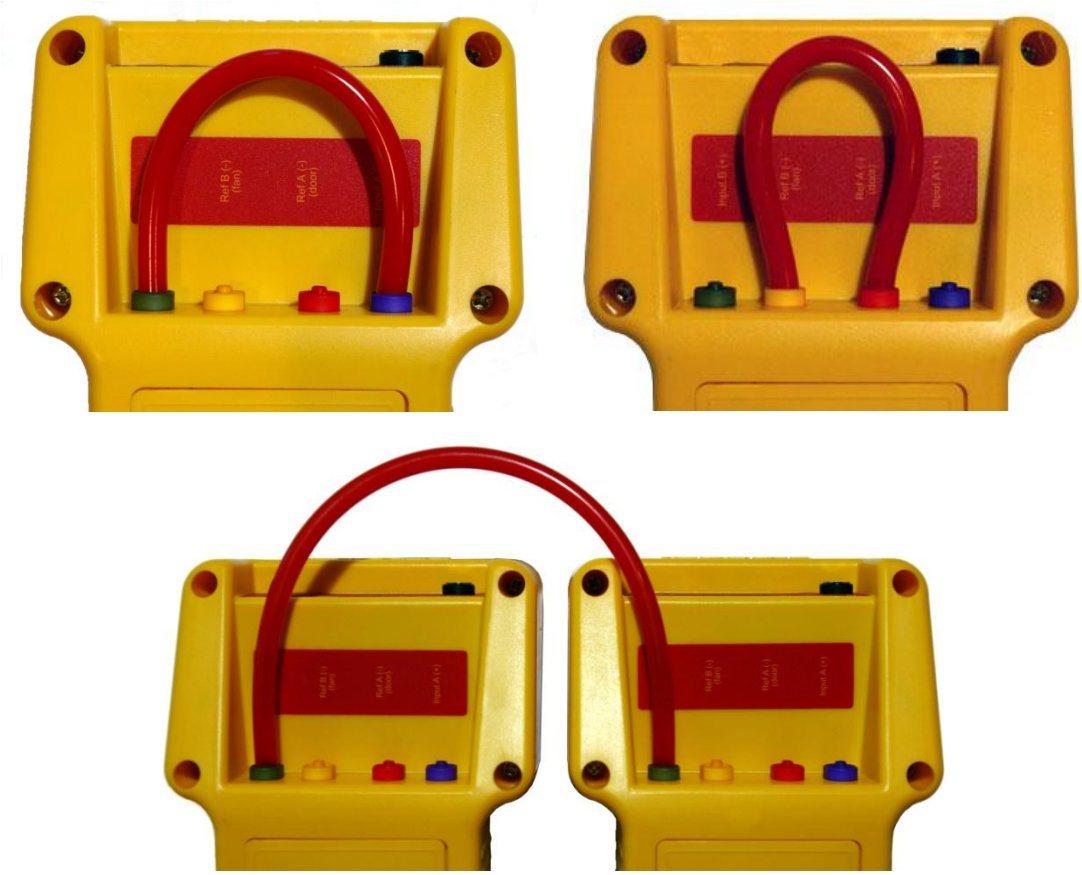


Figure 8. Gauge field check configurations (cross-channel checks (top), cross-gauge checks (bottom)).

When performing a gauge calibration with two gauges, if one gauge is known to be calibrated accurately, it can be used as a reference for the second gauge. In that case, the measured pressure on the tested gauge should be within 1% of the measured pressure on the calibrated gauge.

To perform a T-connection Fan Pressure check

1. Using a T-connection, connect a pressure tube to the Input port of both Channel A and B.
2. Create a Fan Pressure on the end of the pressure tube.
3. Both Channel A and B should display the same measured pressure (or within 1%).

Figure 9. Fan Pressure check using a T-connection check.

A similar procedure can be performed, by using a syringe to create a Fan Pressure. This can be done with either one or multiple gauges.

Although the procedure with a syringe is fairly widely used, it is not recommended by Retrotec for the following reasons:

- Requires equipment that most people don't have (Magnehelic gauge).
- Requires specific syringes (50 and 500 cc).
- It's an awkward procedure.
- Some part of the testing system of tubes and syringe will invariably be leaky and produce inaccurate results.

To perform a syringe check

1. Connect two gauges and a syringe following the set up in Figure 5-1.
2. Connect a Magnehelic gauge as shown.
3. Slowly pull air out of the syringe. Pressure readings on both gauges should increase.
4. Both gauges should display the same measured pressure.
5. Repeat steps 1 - 3 on the Input and Reference ports of both gauges.

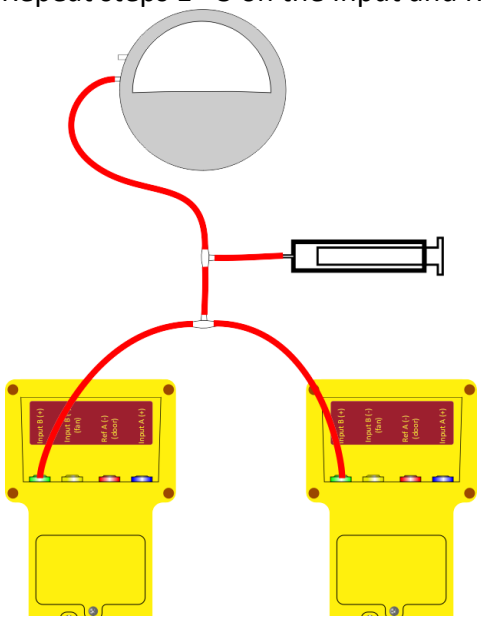


Figure 10. Syringe check setup

7 Troubleshooting

After getting a clear understanding of what pressure is and how it's measured, knowing the common causes of erroneous readings will increase the confidence of the results. It is often assumed the gauge must be regularly calibrated in order to get accurate readings, but this thought obscures the fact that most gauge problems do not result from incorrect calibrations. The following list provides approximate percent probabilities based on our experience for certain types of gauge problems. Notice that gauge calibration is one of the smallest, and even that can usually be eliminated, by following the gauge check procedures in this manual.

Problem caused by	Error frequency	Error range	Comments
Tubing is crimped shut	5%	25 to 90%	Usually noticeable because gauge does not move, but the blockage may be partial, which could cause an erroneous result.
Water in tubing	10%	75-90%	Possible only in wet areas. If gauges sent in to be repaired or calibrated, the water evaporates and the user never discovers the cause.
Improper Device selected	2%	20 to 90%	Not common because the wrong Flow Ranges will appear on the gauge.
Improper Flow Range selected	5 to 25%	50%	Very common unless gauges checked before and after tests to ensure the right Flow Range.
Extrapolation pressure set incorrectly	10%	25%	If the gauge shows a different extrapolation pressure [@ Pressure] then the results will be extrapolated to the wrong pressure
Improper use of reference tube for pressurization.	5%	25%	Pressurization is seldom used, but if the technician is improperly trained, they may not set the equipment up properly for this test.
Time averaging set too high or too low	25%	5 to 10%	If the gauge is fluctuating too much it will be difficult to read. If the time averaging is too high, the pressure may have changed but that change is not reflected in the reading.
Wind	25%	10%	These errors can be eliminated by long-term averaging or by multiple pressure pickups.
Out of calibration	5%	1-50%	Gauges can go out of calibration in a week or may take 10 years. It is impossible to tell unless the readings seem unreasonable.
Out of calibration with regular checks	0.5%	1-2%	Regular gauge checks can eliminate most of the calibration problems, by identifying large errors immediately, and before erroneous test results can be taken. It is unlikely that errors in excess of 2% would occur if the gauges checked before each use.

Proper training can eliminate almost all of the above errors.

7.1 DM-2 Rechargeable Battery Problems

The DM-2 is designed to recharge NiMH batteries in the gauge, eliminating the need to purchase a stand-alone battery charger. The charging cycle is designed to fully discharge batteries before recharging them. This can cause problems if the DM-2 is connected to a power plug for only brief periods of time.

If the gauge exhibits any of the following conditions, it may be a problem with the rechargeable batteries:

- Short battery life
- Will not turn on
- Keys will not respond
- Loss of power during test

The solution is to reset gauge and charge the batteries, or switch to non-rechargeable batteries.

To charge the batteries:

1. Connect the AC power supply if rechargeable NiMH batteries are already installed.
2. Press the reset button on the back of the DM-2. The gauge turns on.

Note: DM-2's that have firmware prior to version 2.28 will not have a reset button. To reset the gauge, remove all power connections, and the batteries, and wait at least 5 minutes. Then re-install the batteries and reconnect the charger.

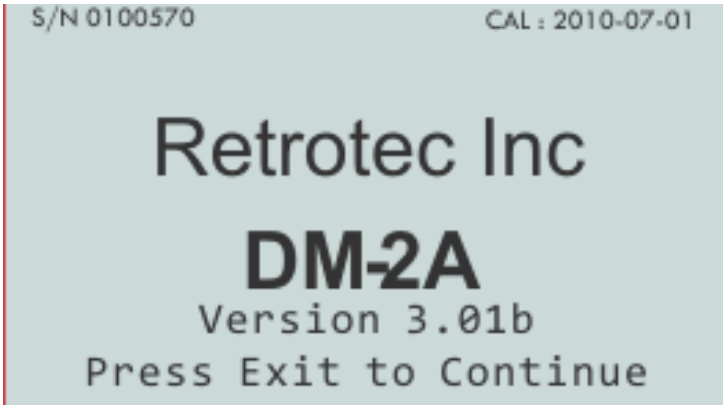
3. Press **[Exit]** to show the main screen.
4. Display indicates batteries are charging.
5. Charge for at least 8 hours, or until battery icon stops moving.

Problems can be avoided by taking a few simple steps.

- Leave DM-2 disconnected from a power supply until the batteries are depleted to one quarter power or less.
- Do not short-charge batteries by interrupting a charge in progress.
- Replace batteries with new AA NiMH batteries after 2 years.

7.2 Serial Number and Calibration Date Check

It's recommended to check the serial number and calibration date on the DM-2 regularly.



If the screen does not display a valid serial number and calibration date, please contact Retrotec tech support since your gauge may have switched over to default calibration values. This can be checked by connected your gauge to another gauge, port to port to ensure they read within 1%.

7.3 Moving Tubes Cause Fluctuating Pressures

If the measured values on Channel A or B are fluctuating back and forth, in a way that doesn't correspond with any of the current testing conditions, it's possible that the pressure tube is moving. A moving tube can cause a significant error. For instance, a tube that is attached both to the gauge and to the fan, but is in the path of the fan's air flow, can swing back and forth. This swinging motion can easily cause fluctuations in the measured pressure.

It's never a good idea to leave a tube hanging in the air, either between two points, or out of a window. The pressure tube should sit securely on the ground and be kept still as much as possible. The effects of a moving tube are very similar to the effects of wind on a tube, which is described below.

To see the effect of a moving tube

1. Connect a pressure tube (10 feet or longer) to the blue port of the DM-2.
2. Set Time Averaging to one second.
3. Wave the end of the tube through the air. Notice the fluctuations.
4. Hold the end of the tube still, and swing the middle of the tube. Notice the fluctuations.

Figure 11. The effect of a moving tube on pressure readings.

7.4 Wind causes a fluctuating pressure

A wind blowing across the tip of a tube can cause significant error, even if the tube is not moving.

One of the first things to notice when the wind is blowing is that it's very difficult to establish the test pressure. For example, when trying to establish 50 Pa, the wind will cause that pressure to go up to 55 Pa and down to 45 Pa, making it very difficult to take a reading.

This type of problem can be rectified by using the @ Pressure key, which will extrapolate the reading to the desired pressure regardless of the actual pressure being experienced at the moment. This does not solve the problem completely, but it does help.

A second option is to increase the time averaging to 20 seconds or more. Be aware that if the fan is increasing or decreasing in speed, it will take 20 seconds at least for the gauge to register its reading. For example, if during the initial 10 seconds there was no building pressure whatsoever, and during the second 10 seconds there was 50 Pa, then the gauge will average that to 25 Pa. The rule of thumb here is to wait for at least double the time average period before a reading is taken.

To learn how Time Averaging can negate the effects of wind

1. Use a fan to create an air stream.
2. Set Time Averaging to one second.
3. Place a tube, connected to the positive port, in the path of the air stream.
4. The gauge will display a pressure that fluctuates. Adjust the "wind" speed until the gauge is reading between 2 and 5 Pa.
5. Adjust Time Averaging to 20 seconds.
6. Notice that after 20 seconds, the gauge reading fluctuates significantly less.

The Baseline feature can also be used to minimize the effects of wind, especially if the wind is relatively constant.

To learn how establishing a Baseline can minimize the effects of wind

1. Use a fan to create an air stream that causes between 2 and 5 Pa pressure.
2. Set Time Averaging to one second.
3. Place a tube, connected to the positive port, in the path of the air stream.
4. Establish a Baseline pressure.
5. Notice that once a Baseline pressure is taken, the measured pressure drops closer to zero, negating the effects of the wind on the actual measured pressure.
6. Stop the fan.
7. Notice now that the measure pressure is negative, even though no pressure is being received by the gauge. With the Baseline feature still active, the gauge is compensating for a pressure that does not exist. Clear the baseline reading to eliminate this error.

Another option is to ensure that the outdoor pressure pickup point is sheltered from the wind. In spite of standards that require tubes be attached to walls, this strategy does not work particularly well for limiting factor wind. What does seem to work is taking the outdoor pressure pickup tube 25 feet away from the building, and setting it in a flat area. Cover the end of the tube with a heavy flat sheet of half-inch plywood, for example, and the wind fluctuations will be reduced.

In extreme cases, wind dampening kits split the main pressure pickup point into either two or four directions, which will average the fluctuation across the building. Recent experience has shown that longer time averaging on a digital gauge is almost as effective as the four tube wind damping kit. When the time taken to set up the kit is taken into account, increasing the time averaging will actually save time.

Overall, what works best is to have one tube running outdoors, where it is T'd into two equal length tubes that are placed as far away from the building as possible.

7.5 Time Averaging User Errors

While the Time Averaging feature is useful to help minimize the effects of wind, it can also cause problems if not used correctly. Whenever Time Averaging is on, it is important to wait at least twice the time averaging period before taking a reading.

To learn how Time Averaging can cause error

1. Create a pressure on the positive port of Channel A (Input).
2. Set Time Averaging to one minute.
3. Wait until the pressure reading becomes stable. After one minute, Channel A should display the created pressure.
4. Remove the tube from Channel A, eliminating the pressure.
5. Notice that the gauge continues to display a pressure on Channel A, which slowly decreases. After one minute, the gauge should display no pressure difference.

If a reading is taken from the gauge before the full time averaging period has passed, then the displayed pressure may not be accurate.

7.6 Large fixed errors

A pinched pressure tube can create a very high reading on the gauge, which is erroneous. In other cases, a pinched tube will prevent the pressure measurement from reaching the gauge at all. In cases where tubes get stepped on, they are seldom sealed off completely, but will still cause the gauge readings to jump around. If the gauge begins to display an unusually high or unexplained pressure, check the tubing to ensure that it has not been compressed in any way.

Figure 12. Errors in pressure reading from a pinched tube.

Water can also cause significant errors if a drop is pulled into the pressure tubes. It is very easy to get a water drop inside the end of a tube. Simply drag it over a shallow puddle of water, and a drop of water will get pulled into the tube by capillary action. Notice in the Figure 13 how one drop of water in the end of the tube is creating 190 Pascal pressure. It is possible to complete a Door Fan test with a water drop in the end of the tube. It will appear as if the fan is creating a pressure in the building, but in fact the results are way off. Particularly unusual behavior in the gauge could mean that there is water in the end of the tube.

- Be careful that no one steps on the tubes, or creates a kink in any of the lines while performing a test. If this happens, wait a few seconds for the effects to subside before taking any readings from the DM-2.
- Whip the end of the tube around to remove excess water. If this doesn't work (in extreme cases), water can be blown out from the other end. Be sure to not have the gauge connected when blowing water from the tube. Water can cause either a positive or a negative pressure, based on which way the drop of water is pulling. If a drop of water is facing downward, it pulls out of the tube, creating a negative pressure (as displayed in Figure 13). Point the tube upward, and the water drop falls back into the tube, creating a positive pressure.

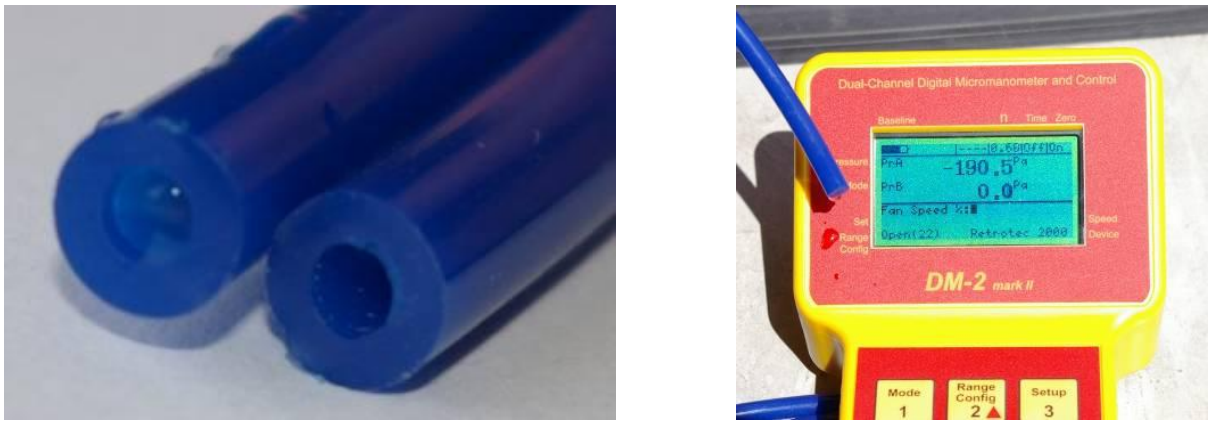


Figure 13. Water in the reference tube (left); high fixed pressure due to water (right).

7.7 Wrong Flow Range or Device selected

If the results just don't make sense, check to make sure the correct Flow Range and device are selected. Each Device and Flow Range configuration has its own individual flow curve that is used to convert fan pressure into flow, and into the results selected under the Mode menu. If a test is completed with the incorrect Device and/or Flow Range selected, it is possible to salvage the data by using the customized flow charts provided in Appendix A.

To determine correct flow if wrong Flow Range/device was selected:

1. Select the fan pressure for which a corrected flow value is needed.
2. Find this fan pressure value in the left column of the flow conversion tables in Appendix A.
3. Move across the row and record the flow value beneath the column heading with the actual Flow Range that was used.

Note: Retrotec 2000 and 3000 series fans have the same flow curves.

7.8 No reference tube while pressurizing

Model 1000, 2000, and 3000 fans are automatically referenced by the gauge, and do not require reference tubing (the green tube) for accurate results. Whenever the DM-2 measures a positive pressure, and knows that the fan flow is towards a greater pressure, it makes the necessary deductions from the Fan Pressure.

Model 3000SR fans are self-referenced, and include a connection point for the green tube, which must be connected.

7.9 Windy conditions

High fluctuations of bias (baseline) pressures on the gauge (greater than 2 Pa) are a good indication that wind may be a large source of error. In windy conditions, the house/room gauge will fluctuate. If the fluctuation is greater than 2 Pa due to wind buffeting, a wind damping system can be used to average out the wind, and get a more stable pressure reading. In addition to a number of suggestions for obtaining better performance from a single tube system (see 7.4), Retrotec offers two wind-damping kits specifically designed to reduce the pressure fluctuations due to wind.

The basic wind-damping kit consists of a dual-tube pressure averaging system and will work in wind conditions up to about 10 mph. The deluxe wind-damping kit (our “Wild Wind Tamer”) consists of a four-tube engineered damping system that will provide damping results in winds up to 20 mph.

Using a wind-damping kit

1. Set up the house/room gauge and red tube as normal.
2. Connect the open end to the T-connection on the basic wind-damping kit; connect the open tube to the output port on the deluxe wind-damping kit.
3. Place the wind-damping tubes away from the building to avoid the pressure pulse that gets created when the wind hits the wall.
4. Cover the end of the tubes with sheet material/a box to stop the wind, if required.

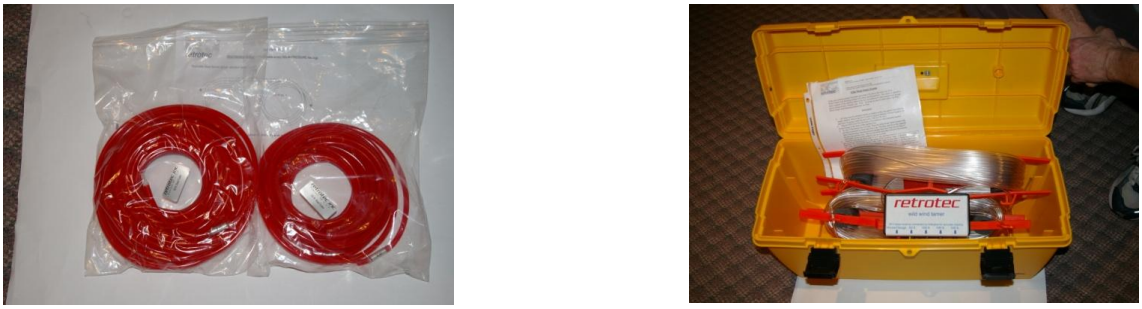


Figure 14. Wind-damping kits; basic (left) and deluxe (right).

7.10 Pressure overshoots when using the Set Pressure key

When Set Pressure is used to establish 60 Pa for example, the pressure will overshoot to 90 Pa for a few seconds before it settles back to the desired 60 Pa. If this is a concern, start the fan on Set Speed or set to a lower pressure and then use the Jog key to increase the set point in smaller steps. The gauge's controller has been optimized to achieve the desired pressure as quickly as possible and to remove the overshoot would force the user to wait much longer.

When using the FanTestic software, set the pressure to go to the lowest pressure first. Eg. Set pressure range from 10 to 60 Pa, NOT 60 to 10 Pa.

To experience the overshoot and understand how to avoid it, perform the following test on the Retrotec simulator or a tight room where the leakage can be adjusted.

Set Device to 1000 for example, range to C1, time averaging to 10 seconds.

Set the leakage area on an enclosure by adjusting the size of the hole. When using the Retrotec simulator, use the slider. Optionally, measure the leakage area with a Door Fan using EqLA which you can access using the Mode key. Watch the gauge carefully to detect the peak pressure reading on Channel A in the peak percent speed on the bottom right-hand of the display.

Device [1000, 2000, 3000]	1000	1000	1000	1000	1000	1000	1000
Range, [C4, C2, C1]	C1	C1	C1	C1	C1	C1	C1
Time averaging, seconds	4	4	4	4	4	4	4
Actual leakage area as measured,	8 in^2	12 in^2	16 in^2	20 in^2	24 in^2	28 in^2	32 in^2
Press [Set Pressure]	60Pa	60Pa	60Pa	60Pa	60Pa	60Pa	60Pa
Read peak pressure from gauge	92Pa	83Pa	71Pa	60Pa	60Pa	60Pa	60Pa
Read peak % speed from gauge	34%	33%	32%	37%	49%	61%	76%
Read final % speed from gauge	15%	18%	27%	37%	49%	61%	76%

Pressures will overshoot when the range is incorrectly set too low. Ranges should always be selected where the fan runs the fastest possible speed in order to achieve the highest desired test pressure.

If you believe you have a problem with overshoot, fill out the table below and send it to tech-support.

Device [1000, 2000, 3000]							
Range, [C4, C2, C1]							
Time averaging, seconds							
Actual leakage area as measured,							
Press [Set Pressure]							
Read peak pressure from gauge							
Read peak % speed from gauge							
Read final % speed from gauge							

Set the correct Device on your gauge because it will respond differently to different Devices.

7.11 The keys on the DM-2 Keypad are not working

If the DM-2 will power on, but one or more keys do not work, the cables may have come dislodged. To rectify the cable problem, follow these steps:

To reconnect the keypad cable

1. Remove AC power adapter and USB cable.
2. Remove battery compartment cover and remove batteries.
3. There are ribbon cables by the battery compartment, at the heal of the gauge.
   With a small screwdriver, ensure that back cable connectors are properly seated (note that there are two ribbon cables back to back).
4. Re-connect the AC power adapter.
5. DM-2 will power on.
6. Press **[Exit]** to display the main operating screen.

Note that there are two physically separate connectors that need to be connected together. The one in the rear can be quite difficult to physically connect, and care should be taken to ensure that both of these connectors are firmly depressed.

7.12 Updating Firmware

If the DM-2 has firmware 3.0 or higher, it will be possible to update the firmware online in the future, by visiting the Retrotec website. For DM-2s with firmware prior to 3.0, the gauge must be returned to Retrotec to be manually updated.

Firmware Changes

Table 7. Firmware changes from versions prior to 2.29 to the current version 3.01.

Mode Setup (units)			
FIRMWARE	**Version <2.29**	**Version 2.31**	**Version 3.01**
Pressure	Pa, in WC, PSF, m^3/h		
Flow	CFM, l/s, m^3/s, m^3/h		
EqLA	in^2, ft^2, cm^2		
EfLA	in^2, ft^2, cm^2		
Air Changes	/h		
Flow per Area	CFM/ft^2, CFM/100ft^2, $m^3/hr/m^2$, L/s/m^2	CFM/ft^2, CFM/100ft^2, $m^3/hr/m^2$, L/s/m^2, CFM/1000ft^2	
EqLA per Area	in^2/100ft^2, cm^2/m^2		
EfLA per Area	in^2/100ft^2, cm^2/m^2	in^2/100ft^2, cm^2/m^2, in^2/in^2	
Hole Flow		CFM, l/s, m^3/s, m^3/h	
Velocity	Mph, fpm, fps, km/h, m/s		
Velocity Flow	CFM, l/s, m^3/s, m^3/h		
Other Setup Menu Features (available options)			
Full Screen Timeout			0-120s
Restore Settings			Yes No
Lanugage			English, Francais, Deutsch, Norske, Svenska, Latvijas
Battery Type			Not rechargeable, Rechargable
Display Version Info			0.5-1.00
n	0.5-1.00		
Power Down Hour	0-255		
Surface Area Unit	ft^2, m^2		
Building Volume Unit	ft^3, m^3		
European , Separator	Yes (,) No (.)		
Sig Figs	3.5 3.0 2.5		
Large Display		YES	
Online Upgrade			YES

Appendix A: System Flow Equations for all Devices

The following equation can be used to determine flow, using the variables listed in the table below. Each fan has a different flow equation, incorporating N and K values related directly to that particular fan.

$$Flow = (FP - CR \times K1)^N \times (K + K3 \times FP)$$

where: FP is the fan pressure, and CR is the corrected room pressure

Note: CR can be determined by subtracting bias pressure from room pressure, by using the “Baseline” feature on the DM-2, or by retrieving corrected pressure from FanTestic.

To determine the fan flow for a particular fan pressure, insert the values for *FP*, *CR*, and the N and K values (based on the type of fan and its Range Plate/Range being used).

The Fan Pressure (FP or "PrB" reading on the DM-2) must be greater than the minimum Fan Pressure, “MF” in the Table 8, and greater than (PrA*K2)

Table 8. N and K coefficients for all DM-2 supported fans.

	Range	N	K	K1	K2	K3	MF
DU220	Open	0.5115	30.7774	0.000	0.2	0.0000	10
	Mid	0.5415	5.9146	0.000	0.5	0.0000	25
	Low	0.6125	1.0056	-0.024	0.5	-0.0002	25
Retrotec 1000 / 2000 / 3000 / 3000SR	Open	0.5214	519.6	-0.070	0.8	-0.1150	8.6
	A	0.5030	265.0	-0.075	1.0	0.0000	12
	B	0.5000	174.8824	0.000	0.3	0.0000	10
	C8	0.5000	78.5000	-0.020	0.5	0.0160	10
	C6	0.5050	61.3000	0.054	0.5	0.0040	10
	C4	0.5140	39.3000	0.080	0.5	0.0005	10
	C2	0.5500	20.0000	0.139	0.5	-0.0027	10
	C1	0.5410	11.9239	0.122	0.4	0.0000	10
	L4	0.4800	4.0995	0.003	1.0	0.0004	10
	L2	0.5020	2.0678	0.000	0.5	0.0001	10
	L1	0.4925	1.1614	0.100	0.5	0.0001	10
Mn DuctBlaster	Open	0.5032	108.7000	0.000	1.0	0.0000	25
	Ring 1	0.5038	40.5000	0.000	1.0	0.0000	25
	Ring 2	0.5064	15.2700	0.000	1.0	0.0000	25
	Ring 3	0.5140	5.8400	0.000	1.0	0.0000	4
Mn Model 3 110 V	Open	0.4879	506.8000	0.000	1.0	0.0000	25
	A	0.4876	190.1000	0.000	1.0	0.0000	25
	B	0.4955	60.6700	0.000	1.0	0.0000	25
	C	0.5132	21.3700	0.000	1.0	0.0000	15
	D	0.4942	7.2160	0.000	1.0	0.0000	15
	E	0.5267	2.7260	0.000	1.0	0.0000	15

	Range	N	K	K1	K2	K3	MF
Mn Model 3 230 V	Open	0.4918	498.9000	0.000	1.0	0.0000	25
	A	0.4889	190.1000	0.000	1.0	0.0000	25
	B	0.4958	60.3500	0.000	1.0	0.0000	25
	C	0.5178	20.4700	0.000	1.0	0.0000	25
	D	0.5022	6.8700	0.000	1.0	0.0000	15
	E	0.5139	2.8170	0.000	1.0	0.0000	15
Mn Model 4 230 V	Open	0.4848	438.7000	0.000	1.0	0.0000	25
	A	0.4952	160.8000	0.000	1.0	0.0000	25
	B	0.4968	48.0800	0.000	1.0	0.0000	20
	C	0.5157	11.3600	0.000	1.0	0.0000	15
	D	0.5032	7.2460	0.000	1.0	0.0000	15
	E	0.5166	2.8020	0.000	1.0	0.0000	15
Infiltec E3	Open	0.5000	103.0000	0.000	1.0	0.0000	10
	7 Holes	0.5000	103.4000	0.000	1.0	0.0000	10
	4 Holes	0.5000	61.1000	0.000	1.0	0.0000	10
	3 Holes	0.5000	44.6000	0.000	1.0	0.0000	10
	2 Holes	0.5000	28.0000	0.000	1.0	0.0000	10
	1 Hole	0.5000	10.8300	0.000	1.0	0.0000	10
Mn Exhaust Fan	E1	0.5000	43.7300	0.000	1.0	0.0000	1.0
	E3	0.5000	20.7200	0.000	1.0	0.0000	1.0
	E3	0.5000	10.0700	0.000	1.0	0.0000	1.0
Mn True Flow	#14	0.5000	115.0000	0.000	1.0	0.0000	10
	#20	0.5000	154.0000	0.000	1.0	0.0000	10

Table 9. N and K coefficients for all DM-2 supported fans, Obsolete.

	Range	N	K	K1	K2	K3	MF
DU100	Open	0.4910	39.4840	0.000	1.0	0.0000	10
	2.75	0.5110	3.0110	0.000	1.0	0.0000	10
	1.23	0.5110	1.1290	0.000	1.0	0.0000	10
Retrotec 600 / 700	Open	0.5280	372.5200	0.000	1.0	0.0000	10
	12	0.5000	104.6800	0.000	1.0	0.0000	10
	8	0.5000	54.0300	0.000	1.0	0.0000	10
	6	0.5000	24.1250	0.000	1.0	0.0000	10
	2	0.5000	8.2400	0.000	1.0	0.0000	10
	1	0.5000	4.0700	0.000	1.0	0.0000	10
Retrotec 800 / 900	18F	0.4690	332.3705	0.000	1.0	0.0000	10
	18R	0.4800	374.4180	0.000	1.0	0.0000	10
	9	0.4920	153.8012	0.000	1.0	0.0000	10
	5	0.4510	102.0857	0.000	1.0	0.0000	10
	3	0.4700	54.3137	0.000	1.0	0.0000	10
	1.4	0.4670	31.8802	0.000	1.0	0.0000	10
	1.3	0.4420	28.3473	0.000	1.0	0.0000	10
	1.2	0.4830	17.7951	0.000	1.0	0.0000	10
	1.1	0.4740	12.5194	0.000	1.0	0.0000	10
	0.1	0.5100	6.0989	0.000	1.0	0.0000	10

Appendix B: Cannot Reach @ Pressure Factors

Cannot Reach 50 Pa Factors

Take CFM reading at pressure achieved and multiply by "Cannot reach 50 factor" to get pressure at 50 Pa. e.g. read 1000 CFM at building pressure of 30 Pa. Factor is 1.36,

1000 x 1.36 = 1360 CFM

Table 10. Factors for when a building pressure of 50 Pa cannot be reached ("n" value of 0.65).

Pressure achieved	Cannot reach 50 factor
50	1.00
49	1.01
48	1.03
47	1.04
46	1.06
45	1.07
44	1.09
43	1.10
42	1.12
41	1.14
40	1.16
39	1.18
38	1.20
37	1.22
36	1.24
35	1.26
34	1.28
33	1.31
32	1.34
31	1.36
30	1.39
29	1.42
28	1.46
27	1.49
26	1.53

Pressure achieved	Cannot reach 50 factor
25	1.57
24	1.61
23	1.66
22	1.71
21	1.76
20	1.81
19	1.88
18	1.94
17	2.02
16	2.10
15	2.19
14	2.29
13	2.40
12	2.53
11	2.68
10	2.85
9	3.05
8	3.29
7	3.59
6	3.97
5	4.47

Cannot Reach 25 Pa Factors

Take CFM reading at pressure achieved and multiply by "Cannot reach 25 Pa factor" to get pressure at 50 Pa. e.g. read 600 CFM at building pressure of 19 Pa. Factor is 1.18,

600 x 1.18 = 708 CFM

Table 11. Factors for when a building pressure of 25 Pa cannot be reached ("n" value of 0.6).

Pressure achieved	Cannot reach 50 factor
25	1.00
24	1.02
23	1.05
22	1.08
21	1.11
20	1.14
19	1.18
18	1.22
17	1.26
16	1.31
15	1.36
14	1.42
13	1.48
12	1.55
11	1.64
10	1.73
9	1.85
8	1.98
7	2.15
6	2.35
5	2.63

Appendix C: Temperature Correction

Temperature correction is only required when there is a temperature difference across the Door Fan.

Table 12. Temperature correction factors for enclosure depressurization.

		Inside Temperature (F)								
		50	**55**	**60**	**65**	**70**	**75**	**80**	**85**	**90**
Outside Temperature (F)	**-20**	0.929	0.924	0.920	0.915	0.911	0.907	0.903	0.898	0.894
	-15	0.934	0.930	0.925	0.921	0.916	0.912	0.908	0.904	0.899
	-10	0.939	0.935	0.930	0.926	0.921	0.917	0.913	0.909	0.904
	-5	0.945	0.940	0.935	0.931	0.927	0.922	0.918	0.914	0.909
	0	0.950	0.945	0.941	0.936	0.932	0.927	0.923	0.919	0.914
	5	0.955	0.950	0.946	0.941	0.937	0.932	0.928	0.924	0.919
	10	0.960	0.955	0.951	0.946	0.942	0.937	0.933	0.929	0.924
	15	0.965	0.960	0.956	0.951	0.947	0.942	0.938	0.934	0.929
	20	0.970	0.965	0.961	0.956	0.952	0.947	0.943	0.938	0.934
	25	0.975	0.970	0.966	0.961	0.957	0.952	0.948	0.943	0.939
	30	0.980	0.975	0.971	0.966	0.962	0.957	0.953	0.948	0.944
	35	0.985	0.980	0.976	0.971	0.966	0.962	0.957	0.953	0.949
	40	0.990	0.985	0.981	0.976	0.971	0.967	0.962	0.958	0.953
	45	0.995	0.990	0.985	0.981	0.976	0.972	0.967	0.963	0.958
	50	1.000	0.995	0.990	0.986	0.981	0.976	0.972	0.967	0.963
	55	1.005	1.000	0.995	0.990	0.986	0.981	0.977	0.972	0.968
	60	1.010	1.005	1.000	0.995	0.991	0.986	0.981	0.977	0.972
	65	1.015	1.010	1.005	1.000	0.995	0.991	0.986	0.981	0.977
	70	1.019	1.014	1.010	1.005	1.000	0.995	0.991	0.986	0.982
	75	1.024	1.019	1.014	1.009	1.005	1.000	0.995	0.991	0.986
	80	1.029	10.24	1.019	1.014	1.009	1.005	1.000	0.995	0.991
	85	1.034	1.029	1.024	1.019	1.014	1.009	1.005	1.000	0.995
	90	1.038	1.033	1.028	1.024	1.019	1.014	1.009	1.005	1.000
	95	1.043	1.038	1.033	1.028	1.023	1.019	1.014	1.009	1.005
	100	1.048	1.043	1.038	1.033	1.028	1.023	1.018	1.014	1.009
	105	1.053	1.047	1.042	1.037	1.033	1.028	1.023	1.018	1.014
	110	1.057	1.052	1.047	1.042	1.037	1.032	1.027	1.023	1.018

Typically, with the door open, the temperature inside the room is the same as outside, so no temperature correction is required. Retrotec's Fantestic software automatically corrects for any

temperature difference. Software sourced from another vendor will need to be checked to verify whether or not this correction is required.

Multiply flow by factor to get the corrected air flow.

Table 13. Temperature correction factors for enclosure pressurization.

	Inside Temperature (F)									
Outside Temperature (F)		50	55	60	65	70	75	80	85	90
	-20	1.077	1.082	1.087	1.092	1.098	1.103	1.108	1.113	1.118
	-15	1.071	1.076	1.081	1.086	1.091	1.097	1.102	1.107	1.112
	-10	1.065	1.070	1.075	1.080	1.085	1.090	1.096	1.101	1.106
	-5	1.059	1.064	1.069	1.074	1.079	1.084	1.089	1.095	1.100
	0	1.053	1.058	1.063	1.068	1.073	1.078	1.084	1.089	1.094
	5	1.047	1.052	1.058	1.063	1.068	1.073	1.078	1.083	1.088
	10	1.042	1.047	1.052	1.057	1.062	1.067	1.072	1.077	1.082
	15	1.036	1.041	1.046	1.051	1.056	1.061	1.066	1.071	1.076
	20	1.031	1.036	1.041	1.046	1.051	1.056	1.061	1.066	1.070
	25	1.025	1.030	1.035	1.040	1.045	1.050	1.055	1.060	1.065
	30	1.020	1.025	1.030	1.035	1.040	1.045	1.050	1.055	1.059
	35	1.015	1.020	1.025	1.030	1.035	1.040	1.044	1.049	1.054
	40	1.010	1.015	1.020	1.025	1.030	1.034	1.039	1.044	1.049
	45	1.005	1.010	1.015	1.020	1.024	1.029	1.034	1.039	1.044
	50	1.000	1.005	1.010	1.015	1.019	1.024	1.029	1.034	1.038
	55	0.995	1.000	1.005	1.010	1.014	1.019	1.024	1.029	1.033
	60	0.990	0.995	1.000	1.005	1.010	1.014	1.019	1.024	1.028
	65	0.986	0.990	0.995	1.000	1.005	1.010	1.014	1.019	1.024
	70	0.981	0.986	0.991	0.995	1.000	1.005	1.009	1.014	1.019
	75	0.976	0.981	0.986	0.991	0.995	1.000	1.005	1.009	1.014
	80	0.972	0.977	0.981	0.986	0.991	0.995	1.000	1.005	1.009
	85	0.967	0.972	0.977	0.981	0.986	0.991	0.995	1.000	1.005
	90	0.963	0.968	0.972	0.977	0.982	0.986	0.991	0.995	1.000
	95	0.959	0.963	0.968	0.973	0.977	0.982	0.986	0.991	0.995
	100	0.954	0.959	0.964	0.968	0.973	0.977	0.982	0.987	0.991
	105	0.950	0.955	0.959	0.964	0.969	0.973	0.978	0.982	0.987
	110	0.946	0.951	0.955	0.960	0.964	0.969	0.973	0.978	0.982

Appendix C: Exponent Errors

If a gauge is set to an exponent value ("n") but the actual exponent (the true exponent value that is supposed to be entered for the building) differs, an error will result. The tables below show the percent error that can result from entering an incorrect exponent value.

Table 14. If the "n" value on the DM-2 is set to 0.65 and the building "n" is different, a small error, as shown in the table, will result.

		Actual Flow Exponent (n) of Building[1]					
		0.50	**0.55**	**0.60**	**0.65**	**0.70**	**0.75**
Achieved Building Pressure (Pa)	10	-21.4%	-14.9%	-7.7%	0.0%	8.4%	17.5%
	15	-16.5%	-11.3%	-5.8%	0.0%	6.2%	12.8%
	20	-12.8%	-8.8%	-4.5%	0.0%	4.7%	9.6%
	25	-9.9%	-6.7%	-3.4%	0.0%	3.5%	7.2%
	30	-7.4%	-5.0%	-2.5%	0.0%	2.6%	5.2%
	35	-5.2%	-3.5%	-1.8%	0.0%	1.8%	3.6%
	40	-3.3%	-2.2%	-1.1%	0.0%	1.1%	2.3%
	45	-1.6%	-1.0%	-0.5%	0.0%	0.5%	1.1%
	50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	55	1.4%	1.0%	0.5%	0.0%	-0.5%	-0.9%
	60	2.8%	1.8%	0.9%	0.0%	-0.9%	-1.8%
	65	4.0%	2.7%	1.3%	0.0%	-1.3%	-2.6%
	70	5.2%	3.4%	1.7%	0.0%	-1.7%	-3.3%

Table 15. If the "n" value on the DM-2 is set to 0.60 and the building "n" is different, a small error, as shown in the table, will result.

		Actual Flow Exponent (n) of Building[1]					
		0.50	**0.55**	**0.60**	**0.65**	**0.70**	**0.75**
Achieved Building Pressure (Pa)	10	-14.9%	-7.7%	0.0%	8.4%	17.5%	27.3%
	15	-11.3%	-5.8%	0.0%	6.2%	12.8%	19.8%
	20	-8.8%	-4.5%	0.0%	4.7%	9.6%	14.7%
	25	-6.7%	-3.4%	0.0%	3.5%	7.2%	11.0%
	30	-5.0%	-2.5%	0.0%	2.6%	5.2%	8.0%
	35	-3.5%	-1.8%	0.0%	1.8%	3.6%	5.5%
	40	-2.2%	-1.1%	0.0%	1.1%	2.3%	3.4%
	45	-1.0%	-0.5%	0.0%	0.5%	1.1%	1.6%
	50	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	55	1.0%	0.5%	0.0%	-0.5%	-0.9%	-1.4%
	60	1.8%	0.9%	0.0%	-0.9%	-1.8%	-2.7%
	65	2.7%	1.3%	0.0%	-1.3%	-2.6%	-3.9%
	70	3.4%	1.7%	0.0%	-1.7%	-3.3%	-4.9%

- Achieved pressure is the actual maximum pressure achievable in the ducts

$$Error = \left(\frac{Pressure\ of\ Interest}{Achieved\ Pressure}\right)^{(Actual\ n - Assumed\ n)}$$

where: Pressure Of Interest = 50Pa (or 25Pa), and Assumed n = 0.65 (or 0.60)

- Actual flow exponent (n) can be calculated by measuring building leakage at multiple pressures from 10 to 50 Pa and determining the slope of the line Flow = K x Pressure^n (must be graphed on a log-log scaled curve)

Glossary

Term	Definition
Air Current Tester	Neutrally buoyant smoke (manufactured by Retrotec Inc.) used to locate leakage locations, and to observe the direction of air flow, or to see if pressure neutralization between two zones is reached.
air leakage	Pertains to how leaky an enclosure may be; The movement/flow of air through the building Envelope, which is driven by either or both positive (infiltration) or negative (exfiltration) pressure differences or test pressures across the building Envelope.
background pressure	See "**Baseline pressure**"
Baseline pressure	Pressure that exists when the enclosure has been prepared for the test, but before the fan is activated. There is always some Baseline pressure due to stack, wind, flues and active HVAC systems. There are two components of Baseline pressure. A fixed Baseline offset (usually due to stack or HVAC) and a fluctuating pressure (usually due to wind or elevator operation). A method determining baseline pressure is by having a digital gauge accumulate readings over an adjustable time period (Note: The terms "**static pressure**", "**bias pressure**," and "**zero Fan Pressure difference**" are used interchangeably with the term baseline pressure in other documents/standards used in the industry.)
CFM	Cubic feet per minute, the units of volumetric flow
Control Cable	An Control Cable used to control Retrotec fans
Control port	Control port on a Retrotec fan, labeled "Control"
Depressurization	The process of creating a negative pressure in the enclosure by blowing air out of it. Air is drawn in from outside to replace it, showing up as "geysers" when checked with an air current tester.
digital gauge	A gauge with an electronic pressure sensor and digital display that is capable of reading in tenths of a Pascal.
Door Fan	A test instrument that fits into an open doorway in order to pressurize or depressurize an enclosure. It is a calibrated fan capable of measuring air-flow, and is used while mounting it into a doorway. A Door Fan is often called a "**Blower Door"** or an "**Infiltrometer™"**. Door fan is more linguistically correct than the common term "blower door." Since it is not a "door," but rather a "fan" and since it does not use a "blower." a more correct term is door fan.
Door Panel	A solid or flexible panel used to temporarily seal off a door way while allowing for the installation of a fan for the purpose of blowing air into the building in order to measure the air leakage rate or to provide a pressure to assist in the location of air leaks.
DucTester	Retrotec's duct testing system is named the DucTester.

Term	Definition
effective leakage area	A common term used to describe air flow at a pressure by equating it to an equivalent size hole in an elliptical nozzle that would pass the same air flow at the same test pressure. It is usually taken at 4 Pa and incorporates a 1.0 discharge coefficient. It is typically about half the size of an equivalent leakage area that describes the same air flow rate. See ASTM E779-10, eq. (5).
enclosure	The surface bounding a volume, which is connected to outdoors directly. For example an apartment whose only access to outdoors was through a doorway that leads directly outdoors. Or, a building with a series of apartments or offices whose only access to the outdoors is through a common hallway then the enclosure would be the volume that bounds all of the apartments or offices.
Envelope	The surfaces composed of floor and walls and floors that separate the test volume from volume surrounding the test volume. Also see" **enclosure"**
Equivalent Leakage Area (ELA or EqLA)	In layman's terms, the ELA is the size of hole we'd have if all the building's cracks and holes could somehow be brought together. Also called: Whole Room Leakage and includes leaks through the ceiling and below the ceiling (BCLA). In CA2001 we measure this in units of ft^2. or m^2. at a reference pressure in Pascals (Pa). In Engineer's terms: the equivalent size of hole required in a flat plate to give the same flow rate having a discharge coefficient of 0.61 and taken at the Reference Pressure. This ELA is sometimes called the EqLA or Canadian ELA because it was first used in the Canadian GSB air leakage standard for houses. This ELA enjoys worldwide acceptance by most testers, even in the US. This ELA should not be confused with another ELA that is often called the EfLA or Effective Leakage Area. It is very unfortunate that both these ELA's have the same acronym of ELA. The EfLA was developed for the US ASTM Standard and is smaller than the EqLA by at least a factor of 0.61 because it uses a discharge coefficient of 1.0. This EfLA is sometimes called the LBL or Lawrence Berkley Labs ELA because it was developed there and is used in the LBL natural airchange model that enjoys wide usage- apart from that usage, the EfLA is not used very much but the existence of both can create huge problems that are totally lost on some users. When it is taken at a reference pressure of 75 Pa, it is often referred to as EqLA75. EqLA is typically about twice the size of an effective leakage area that describes the same air flow rate. See ASTM E779-10, eq. (5).
Fan Pressure	The pressure difference between inside the door fan and the surrounding air. This pressure can be read as "PrB" from Channel B on the DM-2. It is used by the computer to calculate the air flow rate through the Door Fan.
Fan Top	Part on the fan where the fan's tubing, Control Cable, and power connections are.
HVAC	Heating Ventilating and Air conditioning system.
Leakage	A general term used to describe holes or the area of holes in or around an enclosure.
Leakage Area	This is the same as "Leakage" but expressed in ft^2 or m^2.
micromanometer	A digital gauge that is capable of reading in tenths of a Pascal.

Term	Definition
NFPA	National Fire Protection Association
outdoors	Outside the building in the area around the building.
Pascal (Pa)	A very small metric unit of pressure. There are 249 Pascals in 1" Water Column (the pressure required to push water up 1" in a tube). One Pascal = 0.000145 psi.
Pressurization	The process of creating a positive pressure in the house by blowing air into the enclosure. Air is pushed out through all the leaks, causing the smoke to move away from the operator when checked with an air current tester.
Range configuration	The Open Range, the Range Plate or Range Ring that is used on the fan during a Door Fan test. See Retrotec's Fan Range Configuration QuickGuide
Range Plate	The Range attachment on the Retrotec Door, which holds Ranges C8, C6, C4, C3, C2, C1, L4, L2, and L1. See Retrotec's Fan Range Configuration QuickGuide.
Range Ring	The plastic Range attachments on the Retrotec Door, which include Range A and Range B. See Retrotec's Fan Range Configuration QuickGuide.
reading	A set of simultaneous Room Pressure and Fan Pressure readings. Sometimes referred to as a data set or test point because it is plotted as one point on a graph.
reference pressure	The pressure at which the ELA is calculated, usually at the test pressure.
room	See "**Enclosure"**.
room pressure	The pressure difference created by the Door Fan between inside and outside of the enclosure. This pressure is commonly measured by Channel A on the DM-2 gauge.
Speed Control port	Control port on the DM-2 gauge, labeled "Speed Control"
time averaging	Refers to the digital gauge display that must have an adjustable averaging from 1 second to 1 minute for the purpose of averaging fluctuating pressure signals. Averaging can be block averages that will update for the length of the average or rolling (moving) averages that will update continuously by displaying the average over the past time period.