USING DPR SERIES AND APB2 SERIES BOARD MOUNT PRESSURE SENSORS TO HELP DETERMINE OPTIMAL HVAC AIR FILTER REPLACEMENT

Application Note

These days of spending more and more of our daily lives indoors has led to an increased awareness of the importance of indoor air quality. This Application Note addresses using the DPR Series and the ABP2 Series board mount pressure sensors to help with HVAC air filtering, a critical component to achieving clean, indoor air.

There are a number of factors that need to be considered when looking at HVAC filtering including health concerns, equipment being used to filter such as forced air furnace, or standalone room filters. Other concerns include equipment life and cost to replace the filters. The more dirt is present the higher the back pressure on the fan that can reduce the efficiency, as well as reliability, of the fan. If the resistance of the filter becomes too high, it can also result in the furnace not properly operating and can lead to short cycling wherein the furnace shuts off due to the safety sensors believing that the system is clogged.

Many health concerns can arise due to poor indoor air quality, with global pollution causing significant health concerns. Indoor air quality is getting more attention since we spend most of our daily lives indoors either at work or home Poor air quality is a particular concern when it comes to individuals who have preexisting conditions such as asthma, COPD, emphysema, etc., and can lead to poor health in general if the air quality isn't taken into account. This increase in awareness of air quality is becoming more of a concern to consumers and employers working to keep everyone healthy. This is driving many when looking at HVAC systems to ask greater in-depth questions about filtering, filter replacement intervals, and in some cases, helps makes the sale. So, what once was just a change interval recommendation on the filter is becoming more of filter type and percent clog recommendation, when to change the filter based on airflow, filter rating and the allowable pressure drop of the filter and system.

The "three months and change" rule has been replaced by EPA guidelines which reflect the particle size being filtered, efficiency rating, and amount of air delivery required for the enclosed space. Because a higher efficiency filter costs more than a standard filter, and, in many cases, doesn't last as long, it becomes imperative to know when a filter needs to be changed. Instead of guessing or visually inspecting a filter to determine its useful life, using a pressure sensor to measure pressure drop across a filter provides the data needed to help determine not only if immediate filter replacement is required, but also provides advanced indication of reduced airflow through the filter due to increased clogging. This information allows a new filter to be purchased and its installation scheduled to occur when convenient, instead of requiring immediate attention. A home owner may then combine a filter purchase with a planned trip to the hardware store or a maintenance worker may schedule filter installation to take place in conjunction with a regular plant visit, instead of requiring a separate trip or service call. Using a pressure sensor to monitor when a filter needs changing may also be used in conjunction with a Bluetooth® and a phone app to provide the user with filter status updates.

Although the use of a pressure sensor to measure pressure drop across a filter should be straight forward, choosing a specific pressure sensor becomes complicated due to manufacturer-specific differences in the filters themselves. Varying filter factors such as pore size, webbing type, relative thickness, and efficiency ratings, i.e., HEPA, all affect pressure sensor choice.

According to the EPA's guide to clean air, particle sizes, and other publications, the greatest concern is for particle removal of 2.5 µm and smaller. These are the particles that tend to enter the lung and

Honeywell

stay there. The larger particles and debris in air may be a nuisance but don't tend to stay airborne in the room and settle out.

The EPA recommends that a filter of MERV 13 (Minimum Efficiency Reporting Value) be used which removes 50% or greater of the particles entering the filter. This, along with the Clean Air Delivery Rate (CADR), that should be maintained to provide the required removal rate of small particles, means the filter needs to be maintained and changed immediately when it is becoming clogged. So, having a pressure sensor provide this monitoring is critical to maintain the system's MERV rating.

The issue in doing this is every filter manufacturer has their own initial pressure drop as well as final recommended pressure drop that needs to be known. As an example, Manufacturer "A" has an initial pressure drop at 250 FPM of 0.1 inH$_2$O, and at 500 FPM a drop of approximately 0.3 inH$_2$O, and a final pressure drop when they recommend changing the filter of 0.5 inH$_2$O on their 1-inch thick filter. (See Figures 1 and 2.) This isn't a lot of difference between clean and dirty in terms of pressure drop. This is why a pressure sensor that has a low Total Error Band and high resolution are important to be able to detect accurately the difference between a clean and dirty filter. If it doesn't do this, then either a filter can be changed more frequently than is required, resulting in a higher system cost, or not often enough and the efficiency rating isn't maintained, resulting in poor indoor air quality.

The difference between a clean and dirty filter is only 0.2 inH$_2$O for this filter requiring a sensor with enough resolution to resolve this small change in pressure. As per Figure 3, the DPR or ABP2.0 Series pressure range 2 inH$_2$O sensor would still provide a very useful signal of 0.6 Vdc.

Another concern is even if the manufacturer recommends a certain filter be used, it can not be guaranteed that the user will use the exact same filter as recommended. If it fits in the furnace it can, and probably will be, used.

FIGURE 1: FILTER PRESSURE DROP VERSUS AIRFLOW

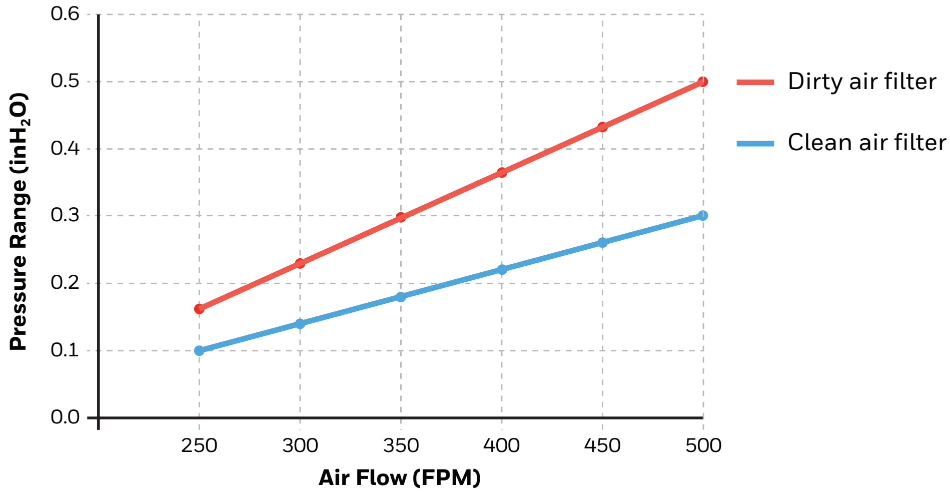


FIGURE 2: DPR SERIES AND ABP2 SERIES IN A TYPICAL HVAC SYSTEM

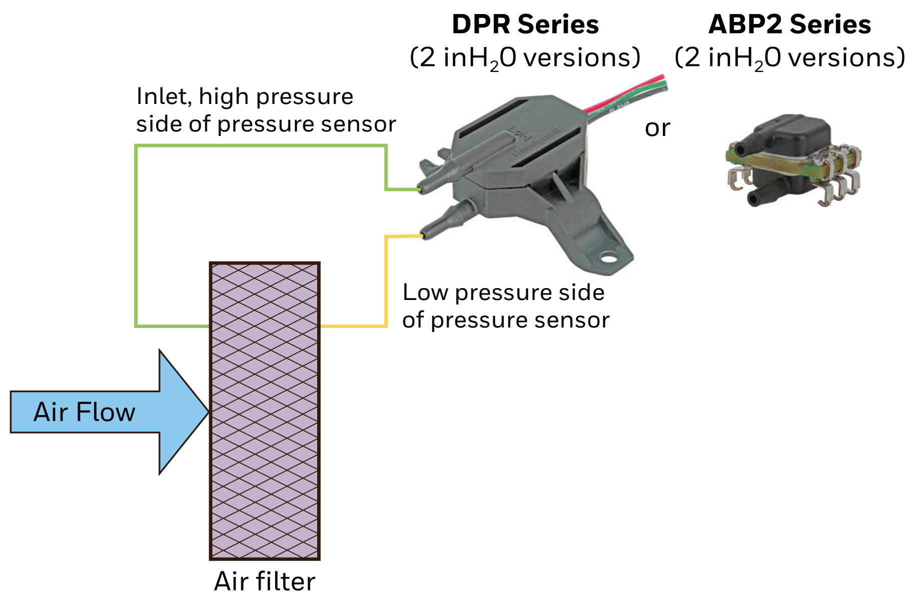
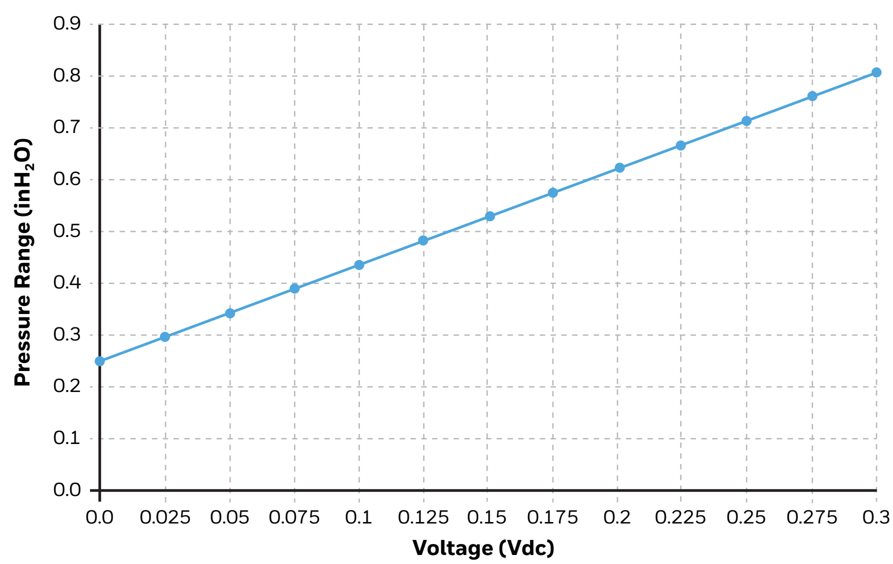


FIGURE 3: DPR SERIES AND ABP2 SERIES OUTPUT VOLTAGE



The problem with this is other filter manufacturers, such as Manufacturer "B", have a different initial and final pressure drop of 0.45 inH_2O starting and 1.5 inH_2O final. This can be a big issue unless the pressure sensor is sized for the biggest drop that can be observed in the application. Although this is probably the largest drop most furnaces can handle, since the plenum pressure sensors used in the furnace are in the range 2 inH_2O to 5 inH_2O, this means that the filter pressure sensor used must be sized to this range for this reason.

The 2 inH_2O range pressure sensor, though, still needs to be accurate down at the lower ranges of 0.1 inH_2O to 0.5 inH_2O to be still able to be used with the lower pressure drop filters. So, this means that a stable sensor with a good resolution and TEB needs to be specified. The DPR and ABP2.0 Series pressure sensors have an output resolution of 0.033 %FSS, which would be 0.0006 inH_2O when using a 2 inH_2O device such as the DPRCAN0002NG0000A5 or ABP2MRRN002ND2A3XX with a resolution of 14 bits 0.00024 in$H_2$0. This means that very small pressure changes can be detected even when using a 2 inH_2O pressure range device. This allows the system to still use a higher range sensor to be able to be used with a wider range of filters and still detect small pressure changes caused by particles. The TEB of 3 %FSS for the DPR Series sensor on the 0 inH_2O to 2 inH_2O device would mean that it could be accurately measured as well 0.06 inH_2O over all operating conditions of temperature and pressure. For the ABP2MRRN002ND2A3 device the 2 %FSS TEB over the 0°C to 50°C range would have a Total Error of less than 0.08 inH_2O.

An even greater accuracy can be achieved in this type of application by performing an autozero correction of the sensor when the system is first turned on, but prior to, starting the fan. Using a system level autozero will improve these errors by 50% or more since most of the sensor error is with the sensor offset. See the Technical Note on our website for autozero of pressure sensors for additional details. This may be significant in applications where the unit is installed on the roof top in industrial applications or in the attic in warmer climates. Having a sensor with a low TEB means that with the temperature changes the sensor is less affected, and therefore more accurate, in knowing what the level of filtering clogging is versus just sensor error.

The other common filtration method becoming very popular is the standalone room purifier. These filter the air typically with a higher-end filter since they tend to be designed for a higher pressure drop type filter such as a HEPA filter.

According to the EPA, the initial pressure drop for these types of filters tends to be approximately 1 inH_2O and the filter needs to be replaced at approximately 2 inH_2O to 4 inH_2O pressure drop. The trend though is to use filters with higher pressure drop such as an initial drop of 6 inH_2O and final at 8 inH_2O pressure drop. So, if a system needs to accommodate a wide range of pressure drops, the pressure sensor must be sized for the largest drop and still be able to detect the changes that occur due to particle accumulation and clogging. This means that this type of application requires a pressure sensor with a good turn down ratio such as the DPR Series.

A suitable pressure range for this type of filter would be a 10 inH_2O full scale device such as the DPR or ABP2.0 Series DPRCAN0010NG0000A5 or ABP2MRRN010NG2A3XX inH_2O to 10 inH_2O range device. Since the flow, and therefore pressure drop, only occurs in one direction, the unidirectional gage pressure range device should be chosen.

Other considerations when purchasing a pressure sensor for filter monitoring applications are the drift of the sensor and sensor life, i.e. MTTF, of the sensor. The DPR Series is constructed using the proven TruStability® HSC/SSC Series as the building block used inside the device and has been in HVAC applications since 2009. The reliability of the building block is as much as 1.7 million hours when used 10ºC to 30ºC based on HSCDRRN002NDAA3, which is 194 years of continuous use, which is well beyond the expected life of the product it is going into! The drift of the DPR Series varies from 0.25 %FSS per 1000 hours to 0.35 %FSS per 1000 hours, which as a percentage of the range being sensed, is small. The drift that is present can be eliminated by implementing an auto zero in the software being used to monitor the filter. Simply put, a new zero reading can be taken by the software when no flow is present, such as start-up, and used as the new zero reading for the sensor. In this way, the long term error of the sensor can be eliminated. See our Auto Zero technical note on our website for details.

Some attempts have been made to use lower-cost Baro sensors, which are embedded in the filter and thrown away with the filter instead, of using a differential pressure sensor that is part of the system. The lower-cost Baro sensors, which are intended for use in cell phones for GPS location and smart watches to determine altitude/location, do not provide the needed resolution to be able to determine when the filter is clogged. A 15 PSIA sensor which corresponds to an approximate pressure range of 415 inH_2O and has the same resolution as our DPRCAN0010NG0000A5 or ABPMRRN010NGAA5 0 inH_2O to 10 inH_2O range device. So, the effective pressure difference the DPR Series delivers is 10/4096=0.0025 inH_2O pressure increments versus the Baro sensor's 0.1 inH_2O pressure increments (415/4096). Since you are trying to accurately discern the difference between a new and dirty filter, it becomes impractical to use this approach.

The only accurate measurement really being provided using the Baro sensor approach, then, is the run time of the fan, which is only somewhat useful, and becomes more of a time-based approach to filter replacement versus the actual filter life. This leads to either replacing a filter that still has a useful life yet, which costs the user, or leaving in a dirty filter that requires replacement resulting in poor indoor air quality.

WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship during the applicable warranty period. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgement or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items that Honeywell, in its sole discretion, finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

While Honeywell may provide application assistance personally, through our literature and the Honeywell web site, it is buyer's sole responsibility to determine the suitability of the product in the application.

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this writing. However, Honeywell assumes no responsibility for its use.

FOR MORE INFORMATION

Honeywell Advanced Sensing Technologies services its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing or the nearest Authorized Distributor, visit our website or call:

USA/Canada	+1 302 613 4491
Latin America	+1 305 805 8188
Europe	+44 1344 238258
Japan	+81 (0) 3-6730-7152
Singapore	+65 6355 2828
Greater China	+86 4006396841

Honeywell
Advanced Sensing Technologies
830 East Arapaho Road
Richardson, TX 75081
sps.honeywell.com/ast

Honeywell