

APPLIANCE & HVAC

REPORT

Reaching Design Engineers at the OEM Level

April 2023

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The Next Step in Home Appliance Control

MOVE OVER ITO— MEET PEDOT

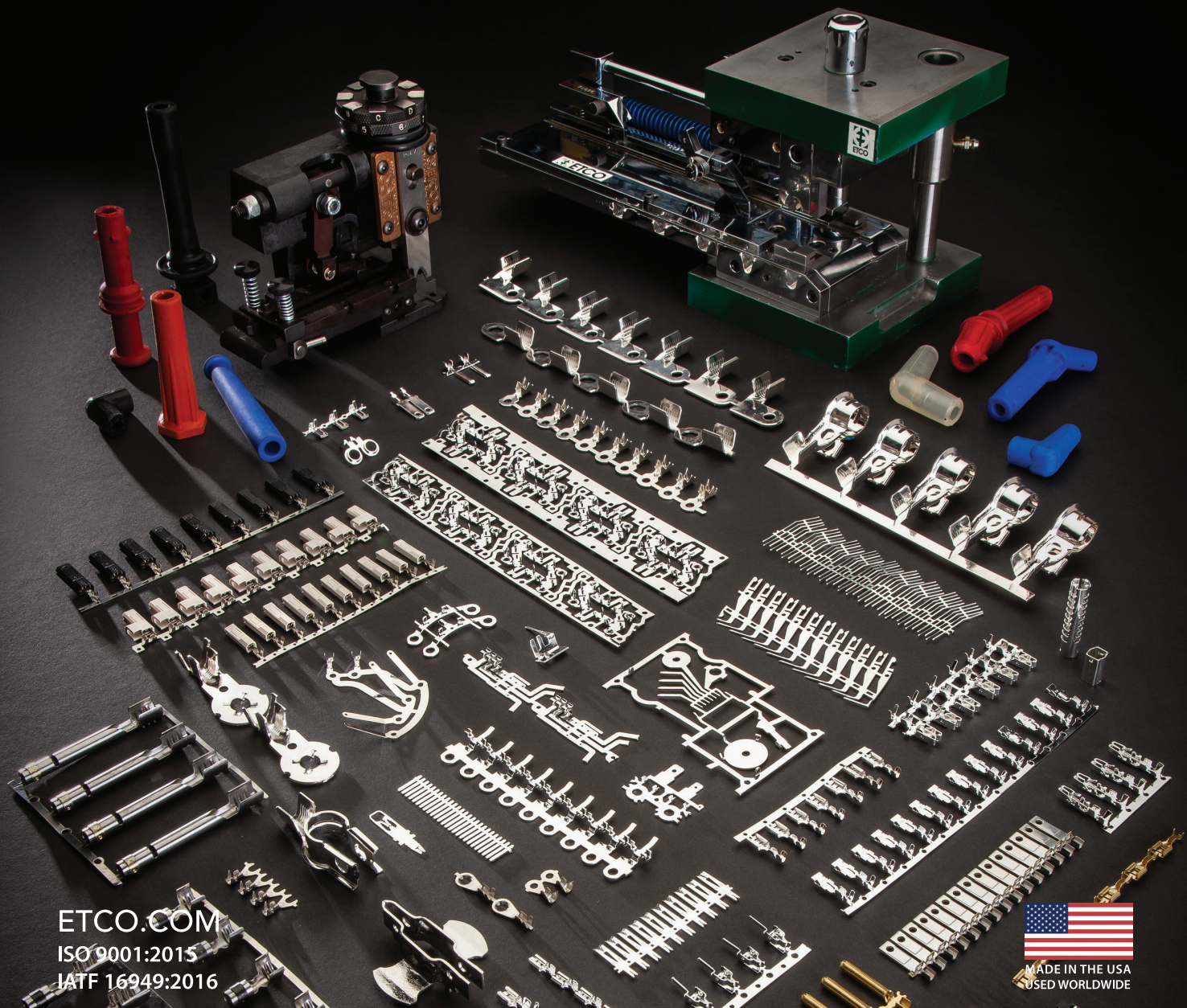
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CERTIFICATION
PEDOT
AIR QUALITY
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Welcome to Our Second Issue of 2023!



For those of you who attended AHR this year, I hope you will agree it was a tremendous show. I have been attending tradeshows since Ronald Regan was president and I can't remember coming away with it with as many conversations and business cards as I did this year.

Here are the numbers: Total attendance 42,794; exhibitors 1,779 (of which 425, 24%, were international) and square footage was almost ½ million.

Ok, so there were a few bumps in the road. The main one being I was almost ejected on Day 3 (if you are going to be tossed, the last day is when you should be). I was going around taking pics with my cell, to use to prepare an article on the event. A rather loud voiced security guard told me "No Pictures" and threatened to throw me out, even if I was an exhibitor (we were) if I didn't stop. So I did.

Come on AHR...loosen things up a bit...how about it? And also is it really necessary to ask me to sign up, and pay a deposit for the 2024 show before 2023 has even started?

Another thing that is bothering me AHR (and other trade associations whose shows I attend, especially but not limited to AAPEX). At this year's show there was a presentation about getting women more involved in the world of HVAC. Sounds good and glad the association is trying to make this happen.

But this is why to me it rings hollow. As I walk around the show, most of the bigger companies with bigger booths have a desk where a visitor will come to, if they have a pre-arranged appointment. At that desk they will ask for the person who they are supposed to meet. Sort of like a receptionist position. And unfortunately in my view, almost every single time that desk will be "manned" by a woman. I have to say to AHR if you are trying to help women get a better place in our industry perhaps you should start with this unfortunate situation.

And there were other humorous moments. One company's booth never arrived. So trying to make the best out of a bad situation, they created a sign in its place. To paraphrase it "Fed Ex loved our booth so much, they decided to keep it". Now that's taking a negative and trying to turn it into a positive!

At the end of the day, after walking and walking and walking some more, I was tempted to ask the folks at Honeywell for a beer. They had some stocked in a cooler in their booth... Heineken and Budweiser as I recall. It was to promote their Solstice product lines. Anyway I resisted temptation, unusual for me.

AHR was in Atlanta this year, and to show how the taxi biz is not near what it used to be, there was hardly one to be seen coming and going. But lots and lots and lots again of Ubers and Lyft's. We used them too. Next year back in The Windy City.

On to other things: For those who follow such things, a debate has begun, regarding the use of gas vs. electric stoves. This is something that we will try to cover in the future. Hopefully in our third quarter issue.

A Startup at Case Western Reserve University, in Cleveland, OH (I reside in the area) caught my attention by inventing a filter for microplastics that are found in washing machines. Here is the article from www.cleveland.com

Startup at Case Western Reserve developing microplastics filter for washing machines - cleveland.com

Kudos to them...let's hope it works.

Thanks to the following who contributed editorially in this issue (as of this writing): Beckett Corp., Certifi Group, Littelfuse, Nostromo Energy, Molex, Superior Sensor Technology and a piece by our consulting friend Hemant Kale.

As always, thanks for reading, including reading our new monthly enewsletter, which debuted back in January. It deploys to our entire database of 24,000 and we have received a lot of favorable comments on it.

We will be at EWPTE soon. Hope to see you there. If not, feel free to contact us anytime at brad@appliancehvacreport.com

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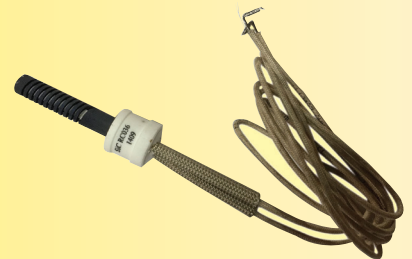
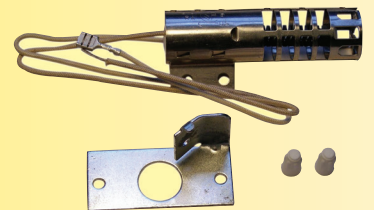
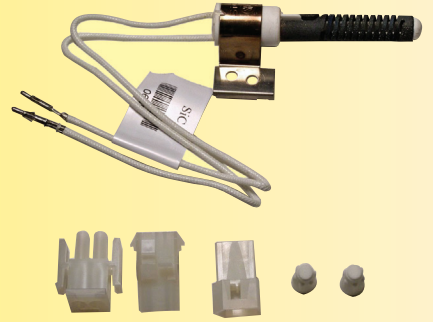
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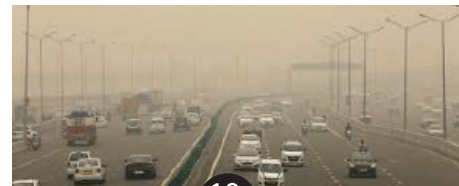


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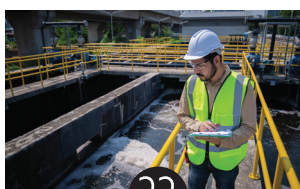


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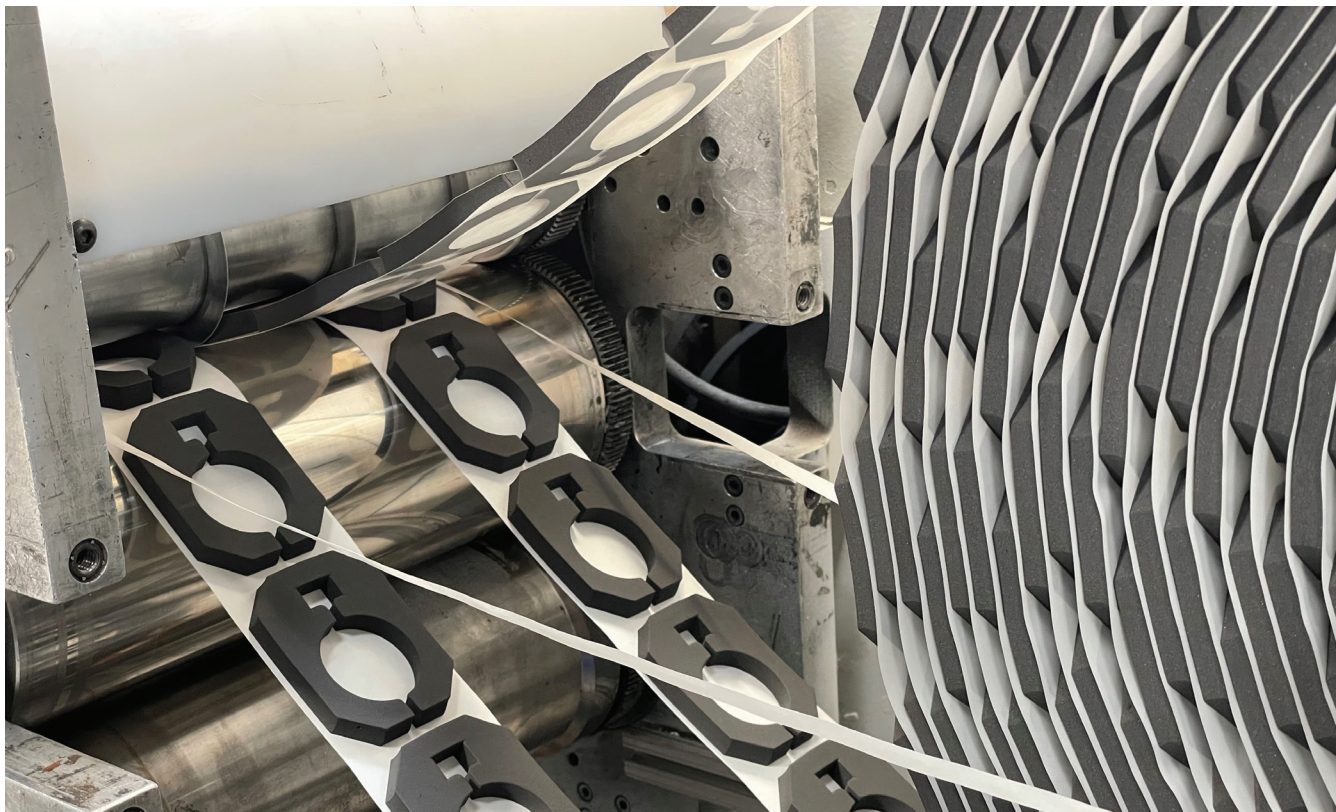
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UL-Certification and Custom Die-Cut Components

BY BOB LESHER

Appliances and HVAC systems contain numerous custom die-cut components, and both applications depend upon UL Certification and testing for competitive and compliance advantages. But does UL Certification matter when it comes to just the die-cut parts?

The short answer is – it depends.

The importance of UL Certification of custom die-cut parts depends on many factors, including the application, the market, and regulatory requirements, all of which can play a role in helping to determine the potential benefits and relevance of UL certification for the

parts themselves.

In this article, we'll look at UL certification in general and what it means for custom die-cut parts. We'll examine the many benefits of obtaining UL Certification, the questions surrounding the certification process, and how JBC Technologies can help you navigate UL certification if it applies to your custom die-cut parts.

What UL Certification Isn't

Before we dive into the details of UL Certification, let's first talk about what UL Certification isn't. The term **UL Approved** isn't a recognized UL (UL Solutions) certification and whenever

you see it, you should be wary of its use.

Some marketers may use the term **UL Approved** to gain a competitive advantage where there isn't one, so it's best to be wary whenever you see it used. UL doesn't use the term **UL Approved** in their certification process and products can't be certified as **UL Approved**.

What UL Certification IS

When dealing with something as potentially complicated as UL Certification, it helps to start at the beginning. UL Certification is a safety rating. It's awarded to a product by an independent safety certification company called UL Solutions (formerly Underwriters Laboratories).

UL Certification assures end-users that a third party has verified the use and performance claims behind the finished product or component and that it's safe to use.

The UL Certification process usually begins with a manufacturer

submitting a representative sample to UL Solutions or a UL-approved testing laboratory. The UL testing lab then assigns the sample to a specific category based on its intended use. From there, it defines the appropriate UL test standards the product must meet to become UL Certified and then continues with the rest of the certification process.

What About UL Standards vs. UL Certification

UL Certification can be an overwhelming proposition. It uses a unique language that, to the uninitiated, can seem filled with confusing, contradictory terms and complicated definitions. No wonder we're so easily confused by UL Certification and often find ourselves heading in the wrong direction.

One of the most common areas of UL Certification confusion we see with our customers is in the use of the terms *UL Standards* and *UL Certification*. Simply put, UL Certification includes UL Standards as a part of the overall evaluation process.

UL develops various standards (i.e., Marking and Labeling Systems, Fire Dampers) to measure and validate product performance, safety, environmental health, and sustainability. UL designs each of these UL Standards — over 1,500 and counting — to cover a wide range of products and industries, each to ensure they meet specific safety and performance requirements.

On the other hand, UL Certification is when a testing lab evaluates the safety and performance of a product based on its intended end-use. A particular UL Certification may require that the product meet the test conditions of multiple UL Standards, each with numerous tests, to ensure it meets the safety requirements outlined in those standards.

Different Types of UL Certification

When a product has obtained UL certification, UL or a UL-approved testing lab has evaluated it and found it meets the safety requirements outlined in the appropriate UL standards based on its end-use and application.

UL Certification is a blanket term encompassing several distinct types of certification, each with its own unique set of test standards and requirements. The flavor of UL Certification you'll require will depend on the type of component, where and how it'll be used, and the particular needs of your end-use customer.

Here are the three main types of UL Certification and what they can mean for your custom die-cut parts:

UL-Listed applies to complete and finished products only. This means

that the evaluated item is in its final form and ready to be used. A UL-Certified Lab has tested the product, ensuring it works as intended and performs its job safely. Examples of UL-Listed products are things like appliances, extension cords, and fire extinguishers.

UL-Recognized applies to products intended to be used as a part of something

else — think components and even barrier materials. This level of UL Certification denotes that a UL-Certified lab has tested the product and that it is safe to use as a component that is part of something else.



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UL-Classified means that the product has been tested for specific things against a limited number of hazards and is

safe for limited use. UL Classification typically means that UL Solutions has only tested and evaluated a product concerning particular properties. UL classifies products to applicable requirements and standards of other organizations.

Important UL Testing Standards for Die-Cut Parts

Here are a few of the most common UL Standards that you're likely to encounter while working with JBC Technologies on your custom die-cutting project:

- **UL 94** – One of the most popular and often-cited UL standards in gasketing and sealing. UL-94 provides a method for rating the ignition characteristics of plastic materials.
- **UL 50E** – Applies to the seals and gaskets used in electrical equipment enclosures. UL 50E measures the ability of a compressible material to prevent air and moisture from entering the enclosure.
- **UL 181A/B** – A pair of HVAC standards covering closure systems for factory-made rigid air ducts or air connectors consisting of pressure-sensitive adhesive (PSA) and heat-activated tapes, and mastics.
- **UL 510A** – Covers the safety of adhesive tapes used for insulating and protecting electrical connections and components and securing electrical components.
- **UL 723** – Testing and evaluation methods for determining the fire-resistance ratings of building materials like wall and floor assemblies and fire-stopping systems.

- **UL 746C** — A set of tests and evaluation procedures to determine the performance of materials — solids and liquids — used to construct electrical and electronic equipment.

- **UL 969** – Guidelines for product markings and labeling of electrical and electronic products, including information such as product certifications, labeling requirements, and marking requirements.

Do UL Certified Materials Make UL Certified Parts?

This is one of the most common questions we get when it comes to custom die-cut parts and UL certification. After all, it makes sense that if you use UL Certified materials exclusively to create your custom die-cut parts, the finished die-cut pieces are UL Certified. Right?

It's not quite that simple.

- **UL Certified Materials ≠ UL-Certified Die-Cut Parts:** UL Certification does not necessarily transfer from a material to a finished component, especially in the case of multi-material parts. For example, if the adhesive and the foam we use to make your custom gaskets are UL Certified, it should follow that the gaskets themselves are UL Certified. The reality is, this isn't the case.

- **Non-UL Certified Materials Can Make a UL Certified Part:** For a die-cut component to meet UL certification, it must be tested as a complete construction, regardless of the UL ratings of its constituent materials. A foam gasket with adhesive backing can be UL Certified even if the foam and PSA (Pressure Sensitive Adhesive) are not themselves.

Once we use UL-certified materials as part of the complete construction of your custom die-cut part, their certification status no longer carries the same weight. It's critical to understand what UL Certification

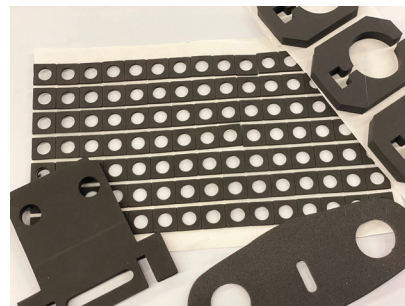
means when it comes to the success of your custom die-cut parts.

UL Certification and Performance Materials

Suppose UL certification is an essential part of the success of your custom die-cut components. In that case, it may be worth seeking materials that meet or have been tested to the UL standards you're interested in rather than those with full UL Certification.

Finding specialty materials like PSA tapes and XLPE foams with the UL mark on them is challenging, but they are out there. Instead, you may find that materials with these phrases may fit the bill:

- This material has been tested against [UL standard]





- Meets [UL standard]

UL Certified materials are available, and we can use them to make your custom die-cut parts. Still, oftentimes it can be just as advantageous and even more economical to use materials that may meet UL requirements but without the certification.

Examples of UL-Certified Performance Materials for Custom Die-Cutting

- 3M™ 3340 Foil Tape (UL181A-P and UL181B-FX Listed)
- 3M™ VHB™ Acrylic Foam Tapes (UL 746C Recognized)
- Avery Dennison FASSON® 0827 (UL 723 Classified)
- Tesa 51408 High-Temperature Polyimide Tape (UL 510 Recognized)
- Armacell Ensolute® IV2 NBR/PVC/CR Foam (UL 94 V-0 Recognized)
- Rogers BISCO® HT-820 Firm Silicone Foam (UL 94 V-0 HF-1 Recognized)
- ITW Formex™ Electrical Insulation (UL 94 VTM-0/V-0, 746A/B Recognized)

Narrowing Your UL Options for Custom Die Cutting

As a custom converter and die-cutting manufacturer, we're used to being approached by individuals in the appliance manufacturing and HVAC industries with questions about UL certification. The answers

to these questions can often impact the designs and performance of their custom die-cut parts.

The challenge for us is ensuring that we're on the same page as our customers. We want to provide the clarity they seek regarding UL Certification and how it may impact their custom components.

We recommend you come to your JBC Technologies project consultation prepared to answer a few basic UL Certification questions like these:

- What is the application of your custom die-cut component?
- What is the UL standard or

standards you require for your components?

- Does the finished part need to be UL Certified or the materials only?
- If the part is composed of multiple layers of dissimilar materials, do all of them need to be UL Certified, or only some of them?

Armed with this information, our team will work with you to determine how UL applies to your custom die-cutting project, whether or not UL Certification is needed, and even which materials we can consider for your parts. ●



Bob Lesher is a content development specialist and the social media manager for JBC Technologies. Bob has over 20 years of B2B technical marketing and product management

experience and is responsible for growing the company's online presence, driving lead generation, and increasing brand awareness. Bob also supports product marketing and sales efforts across key markets through targeted segment engagement and creative digital marketing programs. Bob holds a BS in chemical engineering from Ohio University and MBA from Tiffin University.



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Move Over ITO – Meet PEDOT

The Next Step in Home Appliance Control

BY JEFF NAGY

The widespread adoption of smartphones over the past 15 years has established a new norm in consumer expectations. From the car to the wristwatch, the smart of the smartphone is expected in seemingly every device as users strive for constant connectivity and on-demand access, monitoring and control. Home appliances are no exception. Statista currently projects that over 57% of U.S. residences will include at least one smart home device by 2024 (Statista Research Department, 2021), and Grand View Research expects the global smart home appliance market to expand at an 8.6% compound annual growth rate from 2022 to 2030 (Grand View Research, 2022). Yet the progress of the smart home is marked not just by internet connectivity, but an ever-

increasing emphasis on the physical interaction between the user and the device itself.

In the past, home appliances have primarily been controlled using a mix of mechanical buttons, switches and knobs. The emergence of today's smartphones has since driven Human-Machine Interfaces (HMI) to adopt touch as the primary means of control, relying on capacitive switches and conductive sensors to both quickly and accurately react to a user's intent. The slightest touch or swipe of a finger is now expected to do everything from turning devices on and off to precisely controlling temperature on a thermostat or oven.

Because home appliances vary significantly in size, shape and performance requirements, their unique needs have stressed the capabilities and adaptability of traditional methods for,

and materials used in, touch control. Now, advancements in materials like PEDOT (which stands for polystyrene sulfonate or poly (3,4-ethylenedioxythiophene) – have opened the door to game-changing innovation in intelligent appliance design.

The Journey from Resistive to Capacitive

To meet the user experience popularized by the smartphone, capacitive touch switches have emerged as a replacement for traditional, mechanical and membrane switch technology. Traditional technologies, known as resistive, require a user to push into a switch or touchscreen so that two layers of conductive traces meet and close an electrical circuit. Although relatively durable, resistive technologies have significant limitations such as only detecting one simultaneous touch, reflecting more ambient light and being less adaptable to unique shapes.

In capacitive technology, such as a smartphone's touchscreen, a switch stores an electrical charge — capacitance — and reacts to the presence of conductive material, such as human skin. When an ungloved hand makes even the slightest contact with a capacitive touch switch, a small electrical charge is transferred from the switch to the finger and forms an electrical circuit, thereby informing the switch of the location(s) of the touch. Note the emphasis on “ungloved”: unless fitted with specific materials, a glove is not conductive and will prevent the circuit from forming, thereby causing the switch to not detect the touch. The same applies to why only a stylus specifically designed for capacitive interfaces can generate a touch response.

In addition to featuring superior image quality and supporting multi-

touch functionality, capacitive touch switches have several other benefits to resistive technologies:

- Lack of moving parts minimizes the risk of wear from repeated use.
- Increased sensitivity and responsiveness make for more accurate inputs.
- Smoother surfaces make them easier to clean, ideal for home appliances like ovens and stoves that are prone to splatter from grease.

- They can be manufactured using several different techniques and substrates, either on a conventional Printed Circuit Board (PCB) or a Flexible Printed Circuit (FPC) like those made of polyimide or polyester. This provides flexibility in performance and cost.

Yet even capacitive technologies have faced limitations due to the demanding needs of home appliances.

Where ITO Falters, PEDOT Excels

For years, capacitive touch switches have used Indium Tin Oxide (ITO) as its capacitive material. Because ITO deposits as a transparent film, it remains the gold standard on touchscreens where ultra-clear visibility is paramount (Clegg, 2015). Although suitable for many other applications, ITO's brittle nature and expensive subtractive production process — where the layer of ITO is etched to create the necessary switch circuits — has limited its use in today's home appliances that often feature complex shapes and consumer price sensitivity.

The limits of ITO open a window of opportunity for PEDOT. This printable, liquid organic polymer has emerged as the frontrunner for capacitive HMI in smart appliance design where conductivity, transparency, flexibility, and cost-sensitivity are required.

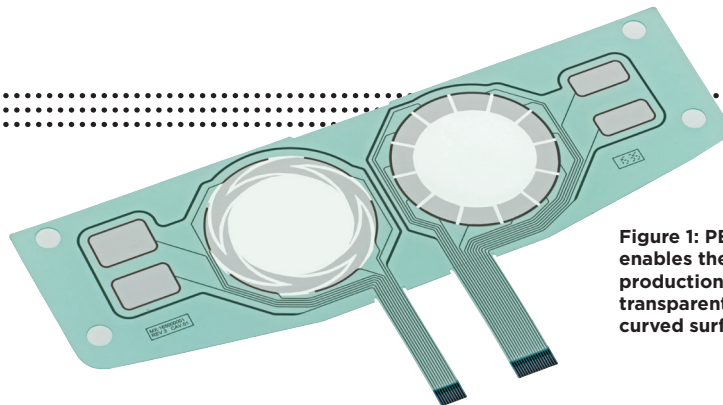


Figure 1: PEDOT enables the inexpensive production of flexible, transparent sensors on curved surfaces.

Why PEDOT?

Superior Design Flexibility:

Because PEDOT switches and sensors do not require pressure to force two conductive layers to touch, such as in resistive technology, and are not brittle as in the case of ITO, PEDOT can be adapted to a near endless array of product shapes and surfaces (Figure 1).

Cost Sensitivity and Production

Efficiency: As mentioned, ITO's subtractive production process, where the ink is selectively added to the substrate only where it needs to be, thus reducing ink usage.

Optical Transparency and

Seamlessness: PEDOT is nearly colorless and produces translucent circuits, ideal for backlit applications. Additionally, PEDOT can be applied to transparent areas of a substrate providing a seamless, integrated appearance.

High Heat Resistance: Although a home appliance may not typically be considered a harsh environment application, and require the same resistance to extreme temperatures, fluids and vibrations you might expect from an industrial application. PEDOT is capable of withstanding high

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temperatures, such as close proximity to a kitchen range cooktop, which is necessary for ensuring switch or sensor functionality.

Excellent Conductivity: While PEDOT is highly conductive, it lags the conductivity of metals like silver. But when PEDOT is combined with silver ink, the resulting material can be used to create complete circuits, and features the flexibility, transparency and heat resistance of PEDOT with the high conductivity of silver (Nair, 2020).

Enabling Tomorrow's Home Appliances

The benefits and capabilities of PEDOT provide home appliance designers with a plethora of capabilities previously challenging to implement or unattainable using ITO and other technologies. PEDOT provides today's home appliance designers with:

- The option to design curved appliance surfaces, enabling everything from more modern appearances to more compact or unique footprints and shapes.
- The ability to incorporate space-saving backlighting techniques that can fit the designer's vision, rather than building the vision to the limitations of the technology.
- Keypad designs that can accommodate increasingly tight space constraints while preserving signal integrity.
- The versatility to withstand repeated and heavy interaction from

the consumer and the potentially harsh functions of the appliance itself.

There isn't a room in the modern home that doesn't provide opportunity for integrating smart appliances. In the kitchen, laundry room and elsewhere, PEDOT is demonstrating its performance as the premier choice for appliance manufacturers that want to provide their customers with sleek-yet-functional and cost-effective human machine interfaces. The future of PEDOT even extends beyond the home; from automotive to medical devices are incorporating PEDOT for its flexibility, durability, conductivity, optical transparency and cost-effectiveness.

Home appliance manufacturers need to meet consumer expectations that are constantly being elevated due to the precedence set heavily by smartphone manufacturers and advancements in connectivity such as 5G. Today's consumers expect clean user experiences defined by ease of use and immediate responsiveness. Using a website as an example, the probability of someone leaving the website increases by 32% if the page takes 3 seconds to load versus 1 second (Google/SOASTA Research, 2017). As smartphones and cellular networks evolve, the need for immediacy only increases as the consumers' digital expectations become even faster.

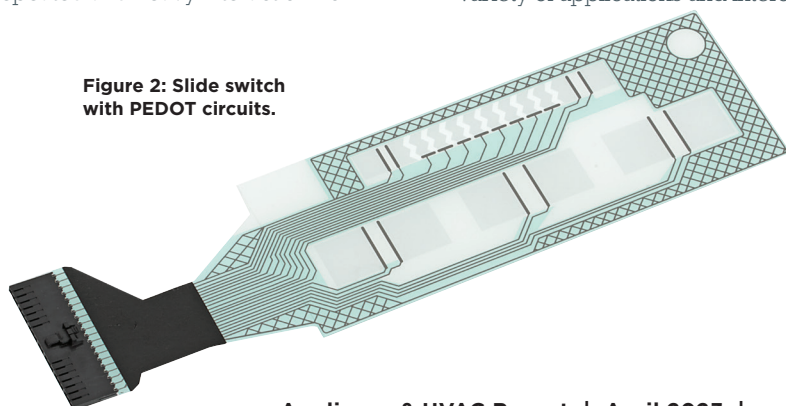
Customers must demand dependable and versatile offerings and expert design resources that can be mixed and matched to meet a variety of applications and interconnect

architectures. PEDOT capacitive switch technologies (Figure 2) must enable today's appliance manufacturers and design engineers to bring their innovation to the marketplace and to set their own standards for meeting and exceeding consumer expectations. ●

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Figure 2: Slide switch with PEDOT circuits.



Jeff Nagy started working for Molex in May 1999. He has a degree in Electrical Engineering and started as a Quality Engineer for Printed Circuit Solutions in the Naperville, IL facility. In 2005 he changed positions to a Senior Quality Engineer and worked until 2007 when he changed positions to a Manufacturing Engineer. In 2010 he transitioned to the sales side and became an Account Manager responsible for all things User Interface. Since then, he has held the titles of Program Manager, Product Manager and his current role of Business Development Manager responsible for North and South America.



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At Pivot Point, we take pride in being a leader in Non-Threaded Fastener innovation. We produce both standard and custom fastening solutions for a variety of industries. Kenyon Grill is one such customer that we had the opportunity to help.

Developing Customized, Quick-Release Fasteners

The Pivot Point team can produce a variety of custom engineered fastening solutions. This case study is one example of how we took a standard solution, and customized it for a specialized application.

- Industry: Manufacturing
- Processes: Manufacturing of grills and glass cooktops
- Company Background: Kenyon® electric grills boast features like being super-portable, safe for indoor use, and exceed the requirements of fire codes in places where open

flame grilling would ordinarily be prohibited.

- Challenge: Developing an easily removable grill lid that solved the issue of providing easy clean-up in a standard kitchen sink or dishwasher.
- Assessment: After reviewing the components required, it was determined that the design needed to allow for quick and easy removal and reinstallation of the lid. Secondary retainers (cotters or clips) were to be avoided, as they could get lost in the grill, sink or dishwasher. Also, the assembly must withstand the high heat produced by the grill.

The Pivot Point Solution – A Stainless Steel Quick-Release Hinge Pin

Kenyon Grills needed a solution to quickly remove/re-attach grill lids. The solution had to be easy to clean, rust resistant, heat resistant, low-profile and a single-piece design with no

components to get lost. Pivot Point delivered with a fully stainless steel quick-release detent pin.

1. The pin features a one-piece bent handle for robustness and ease of removal.
2. The self-retained spring-loaded ball holds the pin in the hinge while allowing for easy removal. No secondary cotter or clip needed.
3. Once the lid is clean, our pin reinstalls just as easily as it was removed.
4. While this application subjects the ball detent pin to extreme heat exposure, the spring underneath the detent ball is not cycled often enough at high temperatures to compromise the spring force.
5. The 300 series stainless steel pin body, ball, and spring withstand exposure to water, grease, and food particles while providing easy clean-up and without rusting.
6. The hinge is a well-designed mating piece for this ball detent pin. It provides a close fit to the pin diameter and a proper bearing surface against the spring-loaded ball, which promotes the desired removal strength in the application.

The Final Result – High-Quality Parts for Fast, Easy Lid Removal

As an effective solution, providing the end-user a secure cover during grilling and easy clean-up afterward, Pivot Point is proud to have manufactured thousands of these hinge pins for various Kenyon® models over the years, and we look forward to our next challenge! ●



What's Happening

Haviv Ilan replaced long-time CEO Rich Templeton, who has overseen a construction boom at **Texas Instruments** in recent years.

Haviv Ilan, chief operating officer of Texas Instruments, was named its next president and CEO. He assumed the position the helm of the analog chip manufacturer on April 1.

He succeeded current president and CEO Rich Templeton, who served in the role for more than 18 years. Templeton will transition out of these roles in the coming months but will remain the chairman of TI's board.

Ilan has been at TI for 24 years, where he arrived after achieving bachelor's and master's degrees in electrical engineering from Tel Aviv University. He's risen through the ranks over the last decade, holding a number of leadership roles. In 2014, he was promoted to senior vice president of TI's analog signal chain business, which is one of its largest. He also was head of TI's high-performance analog unit and vice president in TI's embedded processing business, leading its wireless connectivity efforts.

Ilan was promoted to executive vice president and chief operating officer in 2020, where he's been responsible for overseeing the company's business and sales units as well as its technology and manufacturing operations. He was elected to the board of directors back in 2021.

Challenges lay ahead for the new CEO. He's taking over as the chip sector grapples with a slump in demand due to the weakening state of the global economy, and its customers struggle to get through a glut of inventory. The situation could get worse in 2023 before it gets better.

"Haviv is an inspiring leader who is widely respected amongst our customers, employees and shareholders," said Templeton in a press release. "He has a proven track record of delivering results, an intense focus on innovation and a passion to win, all of which make him an exceptional leader. The board and I are confident that Haviv is the right person to serve as TI's next CEO and further strengthen the company for the long-term."



LG Electronics' appliance assembly plant here has been named as a world-leading "**Lighthouse Factory**" by the World Economic Forum (WEF).

The million-square-foot factory, which makes washers and dryers, is the first appliance assembly plant in the U.S. to earn such a designation. It also is the company's second Lighthouse Factory. LG's Smart Park factory in Changwon, South Korea, was selected by the WEF last year.

A "Lighthouse Factory" is recognized by the WEF for its role in shaping the future of manufacturing through the integration of Internet of Things (IoT), big data, artificial intelligence (AI), robots and other Fourth Industrial Revolution technologies. The WEF began the Lighthouse program in 2018.

LG's factory in Tennessee utilizes a variety of advanced technologies, including AI, big data, IoT and robots. Completed at the end of 2018, the facility now operates three production lines for front-load and top-load washing machines and dryers. With an annual production capacity of 1.2 million washers and 600,000 dryers, the plant proactively responds to changing North American demand through local production. More than 900 people work at the factory.

Each line carries out the entire manufacturing process, from making the parts to assembly and packaging. The factory boasts a fully autonomous logistics system with 166 automated guided vehicles (AGVs) that transport parts around the plant—three times more AGVs than LG's Smart Park factory.

By integrating parts production processes, such as stamping, molding and painting, the company has increased productivity by 21 percent.



Systemair North America,

a leading manufacturer of commercial ventilation products, has appointed **Jeff Bredeson** as its President. In this new role, Bredeson will lead all aspects of Systemair's activities in North America, including the sales organization and the company's three factories, located in Lenexa, Kansas, Bouctouche, New Brunswick, and Tillsonburg, Ontario, as well as Systemair's Fantech and Greentek residential ventilation divisions.

Bredeson's lengthy career in building products includes diverse leadership experience in the HVAC and pump industries, most recently serving as President of fan manufacturer S&P USA Ventilation Systems. Prior positions include President of Hydroflo Pumps, Vice President of Sales at Taco Comfort Solutions, and Senior Vice President and General Manager of Hunter Fans' Industrial Division.

"Jeff is a disciplined leader with a strong focus on market and commercialization, extensive analytical skills, and expertise in lean manufacturing and Six Sigma," said Roland Kasper, CEO for Systemair. "His proven track record of leading companies to achieve aggressive, profitable growth will not only help Systemair grow our North American business, but also increase capacity to help scale the business and individual departments to meet future demand."

Among Bredeson's first initiatives with Systemair will be conducting growth evaluation and analysis and setting short- and long-term goals based on the current product portfolio, production capacities/capabilities, and target market segments.





Robertshaw has developed an innovative and comprehensive sustainability solution that drastically reduces greenhouse gas emissions from gas stoves in the off state.

Robertshaw's patent pending **Master Gas Regulator** addresses a major environmental concern for both manufacturers of appliances including gas ovens, cooktops and ranges, and the public.

All gas ovens and ranges in the United States are subject to gas leakage limits established for the industry by the American National Standards Institute (ANSI). Robertshaw's Master Gas Regulator reduces appliance gas leakage by 90 percent compared to the ANSI standard.

The Master Gas Regulator also detects pressure at the gas inlet and shuts down the appliance to limit gas leakage into the home environment.

In addition to its leak detection and shutdown capabilities, the Robertshaw solution includes two redundant shutoff valves, for a third layer of leak protection.

In addition to the Master Gas Regulator, Robertshaw can address indoor air quality by reducing nitrogen dioxide (NO₂) emissions in appliances. NO₂ can trigger inflammation in the airway and irritate the lungs, worsening respiratory illnesses such as asthma. A patented Robertshaw ultra-low NOx burner technology could be applied to top burners on gas ovens, cooktops, and ranges.

"The kitchen is where families gather. It's the center of our home. We believe consumers are looking for sustainability in their life choices, and Robertshaw is committed to helping our customers deliver on their expectation of innovation, environmental quality, and safety for a sustainable future," said John Hewitt, Robertshaw CEO.

"The Master Gas Regulator is the latest of countless Robertshaw innovations that are designed to improve gas appliance performance, safety, and indoor air quality for the families for whom the kitchen is the heartbeat of the home."

NRG Energy Inc. has entered into an agreement to acquire **Vivint Smart Home Inc.** in an all-cash transaction valued at \$2.8 billion.

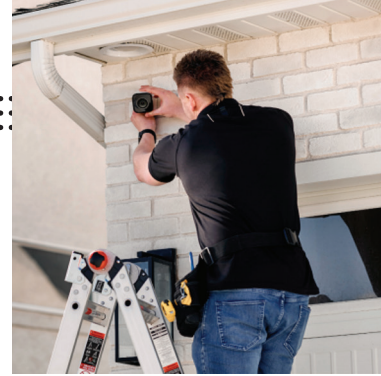
It is an interesting deal considering NRG Energy is a dealer of electricity and natural gas in the U.S. and Canada and Vivint is a smart home device maker.

According to NRG, the deal will accelerate its consumer-focused growth strategy to create home services fueled by leading brands. NRG said it has adopted a strategy to become a provider of services for homes and businesses including those based on consumer trends.

Vivint Smart Home is one of the largest smart home vendors specializing in home security but also has a deep range of doorbell cameras, smart locks, smart thermostats, smart lighting, garage door controls and indoor and outdoor cameras.

Acquisitions are not new in the smart home market. They happen quite frequently in fact. This was after a period of major consolidation in 2019 and 2020 where companies were buying up smaller firms to complete solutions so homeowners could have an all-in-one solution that would be specially tailored to fit their needs.

The most interesting aspect to the deal is that an energy vendor wants to enter into the smart home market. NRG Energy said it sees the sector as a potential opportunity to expand not just in revenue but in its reliance to homeowners with intelligent automated devices.



UL 60335-2-40 RECERTIFICATION

The biggest change coming to the HVAC industry is recertification to UL 60335-2-40. Intertek can help manufacturers during the transition period.

FOR MORE INFORMATION

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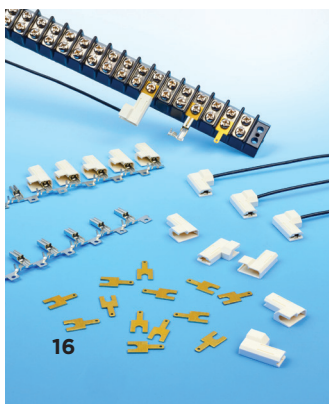


Honeywell announced that its ultra low-global-warming-potential (GWP) refrigerant technology is supporting a new cooling system at the Eiffel Tower. The installation, which uses **Honeywell's Solstice® ze (R-1234ze) refrigerant**, provides the tower's west pillar with an energy efficient and cost-effective solution that reduces greenhouse gas emissions. The pillar is home to the Eiffel Tower Visitor Information Center as well as a souvenir shop and a hydraulic lift that ascends 300 meters to sweeping views over the city of Paris.

The Société d'Exploitation de la Tour Eiffel (SETE), which operates the tower, replaced its aging system run with higher-GWP refrigerant R-407C with a contemporary system incorporating Honeywell's solution and equipment provided by component manufacturer AF Energy and French refrigeration specialist ALM Froid. The solution met SETE's strict criteria to transition to a high-performing, sustainable system with increased reliability, energy efficiency and improved safety to meet EU regulations and reduce its carbon footprint.

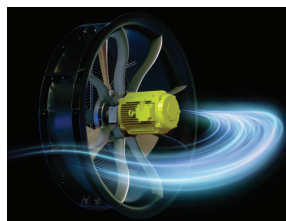
A new line of fully insulated thermal disconnects and terminals that require less metal than standard .250" x .032" NEMA products for smaller applications is being introduced by **ETCO Incorporated** of Bradenton, FL.

ETCO Insulated Connectors and .110" Tabs are available in straight and flag styles and feature fire-retardant, self-extinguishing nylon insulators that are V-0 rated per UL 94. Ideal for low voltage and low AMP applications, these terminals and .110" tabs require less metal and come in strip form for application by bench top and fully automated wire processing equipment.



For the seventh consecutive year, **D.L.S. Electronic Systems**, a Wheeling, IL based global compliance organization specializing in EMI/EMC, Environmental, Wireless and Product Safety testing received the **Customer Quality Service Award** for 2022-23 from the Washington, DC based American Council of Independent Laboratories (ACIL).

This award sets D.L.S.'s laboratory apart from other laboratories by demonstrating their continued commitment to quality testing and customer service. This continuous improvement program was developed to address industry quality issues and recognize those individual testing laboratories with exemplary quality performance. It provides companies and industry with a comprehensive mechanism to evaluate testing laboratories. Participants commit to ensuring data integrity, meeting customers' quality needs and setting performance standards for the testing laboratory industry. No other evaluation program ranks customer satisfaction with laboratory services and requires laboratory management to commit to a data integrity program. To become a participant, testing laboratories must distribute satisfaction surveys to customers, commit to an ethics program and submit a signed code of ethics.



Multi-Wing Group, a leader in designing and manufacturing flexible and modular axial fans, has acquired its long-term partner **Fabrika Special Motors**, which until now has been part of the electric motors company Fabrika.

Multi-Wing Group is a plus 400 employee business headquartered in Vedbæk, Denmark with 20+ worldwide locations. The integration of Fabrika Special Motors will be an important lever in the build-up of a strong electrical motor competency centre to the benefit of both future customers and legacy Fabrika Special Motors and Multi-Wing customers.



Formed this year, the **International Network for Women in Cooling** (INWIC) has appointed its first president and president-elect. **Colleen Keyworth** was voted in by the board as president to serve as of January 1, 2023, with **Dr. Ina Colombo-Youla** as president-elect to succeed her in 2024.

The official appointments were made after a unanimous vote during the recent quarterly INWIC board meeting. Representatives from 12 of the 13 founding partners attended the virtual meeting, despite the vast time zone differences, and voted on the nominations that had been previously submitted.



Johnson Controls, the global leader for smart, healthy and sustainable buildings, has named **Lei Schlitz** as vice president and president, Global Products effective today. In this role, Schlitz will lead the Global Products business, succeeding Jeff Williams who retired earlier this year. She will be based in Milwaukee, Wisconsin.

"There is a multibillion-dollar addressable market in front of us, with unconstrained growth opportunities to deliver increased customer value through a wide range of building portfolio products," said George Oliver, Chairman and CEO, Johnson Controls. "Lei brings a wealth of experience and knowledge to the role, and she will be an asset to Johnson Controls as we accelerate our solution offerings and leverage our scale to capture this incredible market opportunity."





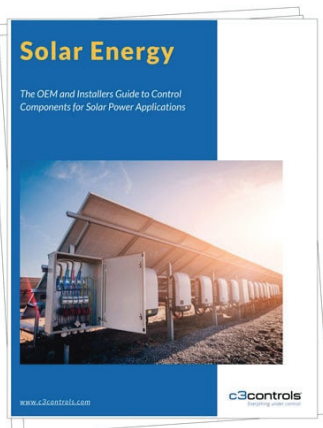
The Chemours Company (“Chemours”) (NYSE: CC), a global chemistry company with leading market positions in Titanium Technologies, Thermal & Specialized Solutions, and Advanced Performance Materials, began taking orders from North American customers in December for its **Opteon™ XL41 (R-454B) hydrofluoroolefin (HFO) refrigerant**, which the company will start fulfilling by the end of Q1

2023. Opteon™ XL41 is an R-410A replacement in new air conditioning and heat pump applications, offering zero ozone depletion potential (ODP) and an approximate 78% reduction in global warming potential (GWP) when compared to R-410A (AR4 GWP). One of the latest next-generation solutions in the Chemours Opteon™ portfolio, in addition to being the lowest GWP replacement for R-410A alternatives on the market today, Opteon™ XL41 offers the optimal balance of performance, sustainability, and cost, and is

classified as a low-flammability (A2L) refrigerant.

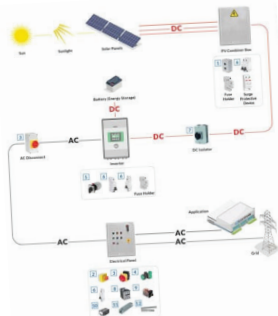
The availability of Opteon™ XL41 refrigerant comes approximately one year ahead of the next major scheduled step-down outlined in the American Innovation and Manufacturing (AIM) Act. Starting January 1, 2024, regulations will require an additional 30% reduction in hydrofluorocarbon (HFC) production and consumption. Amidst this regulatory landscape, Opteon™ XL41 will offer customers product longevity.

“As the industry prepares for the next HFC phasedown, Chemours is fully committed to supporting a diverse group of HVACR applications in making a successful transition to sustainable refrigeration solutions,” said Alisha Bellezza, President of Thermal & Specialized Solutions at Chemours. “We are excited that so many of the major players in equipment manufacturing recognize the environmental and performance efficacy of Opteon™ XL41. Together, we are ensuring the refrigerant and equipment are readily available to support an industrywide move to the lowest possible GWP operation without sacrificing performance.”



The Solar Energy Industries Association (SEIA) is aiming for solar power to account for 30% of ALL electricity by 2030 — and 40% by 2035. Fueling this growth are major technological advancements which have made solar an effective, efficient, and economical solution for applications ranging from residential homes to industrial manufacturing facilities. A hot topic, solar can provide great opportunities for both you and your business...

That's why c3controls created a Solar Brochure to help you capitalize on these opportunities! This guide provides the industry information you need while detailing components and finished solutions for combiner boxes, inverters, control panels, and more.



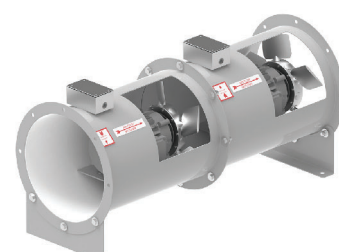


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Figure 2: Air Pollution and Impact on Health

Accurate Air Quality Measurements

BV SUPERIOR SENSOR TECHNOLOGY

Air quality is a serious topic these days. From airborne viruses to pollution, allergens and gas leaks, accurately ensuring the safety of the air we breathe is paramount. To do so, organizations use air quality measurement devices to measure particles and other contaminants in the air, like the one shown in Figure 1.

• Air quality embodies a host of applications including:

- 1) Air filtration systems that monitor not just the flow rate of air, but the quality as well
- 2) Carbon monoxide detectors to ensure carbon monoxide levels do not exceed safety levels
- 3) Fume hood monitors to limit exposure to hazardous or toxic fumes, vapors or dust
- 4) Clean room environments to

ensure dust or other particles do not contaminate the laboratory or manufacturing facility

- 5) Radon detectors to determine levels of radon in the environment
- 6) Air purifiers to ensure the air flow meets the air quality requirements
- 7) Smoke detectors to help provide early detection of a potential fire
- 8) Carbon dioxide detectors to indicate levels of carbon dioxide in the air
- 9) Smog detectors to measure pollution coming from an automobile exhaust
- 10) Outdoor air monitoring to measure levels of pollutants in the air (see Figure 2)

The Role of Differential Pressure Sensors in Measuring Air Quality

Differential pressure sensors measure the difference in air flow and play a critical role in measuring air quality where determining exposure to potential contaminants is important. There are many airborne particles that if they exceed a certain amount can be hazardous: airborne viruses, carbon monoxide, radiation, toxic fumes, etc. – the number of potential

contaminants is endless.

The system works as follows: through a flow element, such as a Venturi, the differential pressure sensor measures air flow between its two ports. This enables the air monitoring system to calculate the particle density in the air for which it is measuring. Based on the result, the system may generate an alarm or other warning if the density exceeds a predetermined value.

However, as with most electromechanical devices differential pressure sensors are sensitive to many external factors including noise, humidity, temperature and physical positioning. Differential pressure sensors that reduce the impact of external factors will provide the most accurate differential readings for computed airflows and thus air quality measurements.

Superior's System-in-a-Sensor: Better Performance & Lower System Cost

Superior Sensors' proprietary NimbleSense™ architecture is the industry's first System-in-a-Sensor integrated platform. Incorporating a highly differentiated advanced pressure sensing system with the ability to integrate optional building blocks, enables us to combine the highest accuracy and reliability with lower overall system cost. For air quality applications, we have developed our HV Series of differential pressure sensors.

• Highest Levels of Accuracy

The HV Series was designed to provide the highest levels of accuracy and greatest reliability for air quality and other HVAC applications. The HV Series provides accuracy within 0.10% of the selected pressure range with long-term stability as low as 0.10% and Total Error Band (TEB) within

Figure 1: Air Quality Measuring Device from Particles Plus



0.15% FSS. These market leading figures ensure the highest accuracy when monitoring air quality levels.

• Lowest Noise Floor

The HV Series offers our integrated advanced digital filtering technology – a multi-order filter that utilizes advanced filtering capabilities on the front-end of the sub-system to eliminate critical noise created by fans, blowers or other dry air/gas sources prior to reaching the pressure sensor. This reduces system noise levels by 10x or more, and allows the sensor to make extremely accurate readings.

• Integrated Closed Loop Control

The NimbleSense architecture's integrated closed loop control can be applied to improve the reliability and speed/responsiveness of the air quality monitoring device. This capability can significantly reduce loop delays and ensures accurate readings by directly controlling motors, valves and actuators. This integrated capability also simplifies product design, reduces system power/heat and provides an improvement in accuracy.

• Multi-Range™ Technology

One of the most innovative NimbleSense architecture features found in all of our differential pressure sensors is our unique Multi-Range technology that allows one sensor to replace several different sensors. On the HV Series, Multi-Range can support up to 8 different pressure ranges with each pressure range factory calibrated and optimized to ensure no degradation in total error band, accuracy or stability regardless of the range selected. Figure 3 shows the difference between a typical differential pressure sensor and the Superior Sensor's HV Series.

With Multi-Range, pressure ranges can be changed 'on the fly' so that

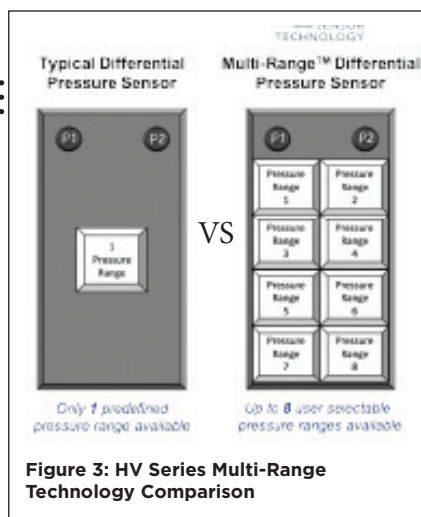


Figure 3: HV Series Multi-Range Technology Comparison

one device in the field can be used to serve multiple purposes. Multi-Range also enables manufacturers to bring product variants to market quickly and reduces inventory costs and product obsolescence since only one SKU needs to be stocked.

• Position Insensitivity

Extremely beneficial for eliminating concerns with sensor orientation and ideal for handheld or portable air quality measuring devices, Superior's unique dual-die implementation with the HV210 maintains consistent and highly accurate readings regardless of physical orientation or movement of the air quality measuring device. Rated with a positional sensitivity to within 0.25 Pa, the HV210 is an industry leaders with respect to position insensitivity.

• Reduction in System Costs

By utilizing a System-in-a-Sensor approach where the sensor module integrates many advanced functions and multiple pressures in one device, Superior Sensors is simplifying product design and helping bring down system costs. In addition to the Multi-Range cost savings mentioned above, the integrated closed loop control and advanced digital filtering provide further system cost savings. With these capabilities directly in the sensor module, there is no longer a need to externally design these functions with discrete components. This reduces BOM cost and PCB footprint, increases reliability and speeds time to market.

Conclusion

There is no question behind the importance of air quality measurement devices. Whether tracking internal or external air quality, the need to accurately detect dust particles, chemicals, viruses and other pollutants will continue to grow. With more air quality devices being deployed, ensuring their reliability is just as important. Removing unnecessary components reduces the number of field failures. Further, allowing the air quality devices to be configured 'on the fly' maximizes flexibility and expands the potential uses of the system.

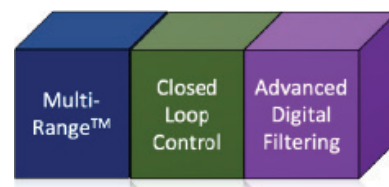


Figure 4: NimbleSense Building Blocks for Air Quality Applications

The NimbleSense architecture has several building blocks (see Figure 4) that are customized specifically for air quality applications:

- Multi-Range
- Closed Loop Control
- Advanced Digital Filtering

Major worldwide manufacturers such as Johnson Controls and Dwyer Instruments have entrusted Superior Sensor Technology for their differential pressure sensors needs. Our unique differential pressure sensor technology, based on our proprietary NimbleSense architecture, provides many differentiating features resulting in the most accurate air quality monitoring devices. For more detailed information about our solutions, please visit our HV Series product page or contact us. ●



Come Wired and Leave Inspired

BY ALICIA BALONEK

We're looking forward to an exceptional event this year, the Electrical Wire Processing Technology Expo (EWPTE), to be held in Milwaukee, Wisconsin, May 16-18. Produced by the Wiring Harness Manufacturer's Association (WHMA), the only trade association exclusively representing the cable and wire harness manufacturing industry and IPC, EWPTE is the wire harness manufacturing industry's premier event for electrical wire harness, wire, coil winding and cable processing. It's where the industry comes together with more than 3,000 attendees and

nearly 200 exhibitors convening to access new technologies find solutions to challenging wire problems through training and education and network with industry leaders and subject matter experts.

Decision-makers who design, specify, purchase, install, sell, maintain, or manufacture electronic cable assemblies, cord sets, wiring harnesses, and other related products for the following industries will benefit from attending EWPTE.

- Aerospace
- Automotive/Transportation (Automobiles, Rail, Buses and Trucks)

- Consumer Technology (Business Equipment and Appliances)
- Defense/Military
- Medical Instruments
- Off Highway (Constructions, Agriculture and Mining)
- Recreational (RV, Marine, OPE & RTV)

Not just an exhibition, EWPTE is a full-scale event featuring a slate of educational and career enhancement opportunities, including professional development courses and technical conference sessions. Subject matter experts will offer learning opportunities on calibration, cleanliness, rework, quality, failure

analysis, troubleshooting, wire harness workforce training, and much more.

Highlights of this year's event include a keynote from Dr. Kenneth F. Harris II, an engineer and advocate for the importance of early STEM exposure and engagement. An elected official for the Board of Education in Prince George's County, Maryland, he is a strong supporter of the mentorship of the next generation and passing along our STEM knowledge to our future colleagues. Acknowledged by NASA leadership and the Project Management Institute (PMI) internationally for his historic leadership on the multi-billion-dollar James Webb Space Telescope, Dr. Harris is amongst the youngest engineers to ever accomplish such integration leadership since NASA's founding in 1958. In his presentation, "Building the Future," Dr. Harris will share his experience as a wire harness engineer on the James Webb Space Telescope and a champion of early STEM exposure.

Education & Training

Professional Development Courses with content designed to deliver new information, skills, and techniques related to the cable and wire harness industry.

Technical Conference Sessions presented by engineers, researchers, academics, technical experts, and industry leaders who will share new technical data, and significant results from experiments and case studies, emphasizing new techniques and discussing trends of interest with appropriate technical test results.

Wire Harness Assembly for Operators workforce training course overview, highlighting the key tools, materials, and processes that wire harness operators need to reliably and repeatably assemble quality harnesses.

Accessing New Technologies and finding new suppliers to find solutions to challenging wire problems on the show floor from nearly 200 exhibitors.

Peer-to-Peer Networking Opportunities during refreshment breaks, breakfasts with exhibitors, and an After-Hours VIP Party providing opportunities for connecting with industry leaders and subject matter experts.

The goal for all attendees, at all career stages, is to enable them to take their ideas and innovations developed on-site and turn them into real-world solutions and business opportunities. EWPTE has something for everyone in the wire harness industry.



In addition, EWPTE will feature IPCSummerCom, IPC's standards development committee meetings, to be held May 13-18. Three standards development task groups will meet to discuss wire harness-related standards: 7-31f: IPC/WHMA-A-620 Task Group; 7-31fiv: IPC/WHMA-A-620 High-Voltage Cable Task Group and 7-31k/7-31h: Joint meeting of Wire Harness Design Task Group and IPC-HDBK-620 Handbook Task Group. ●

EWPTE SCHEDULE AT A GLANCE

Tuesday, May 16

7:00 am	Registration Opens
10:00 am - 5:00 pm	Professional Development Courses

Wednesday, May 17

7:00 am	Registration Opens
8:00 am - 8:45 am	Keynote Session: Building The Future Kenneth F Harris II, Eng.D., The Aerospace Corporation Senior Project Engineer Space Integration and Asset Protection
8:45 am	Ribbon Cutting Ceremony
9:00 am - 10:00 am	Networking Morning Refreshment Break with Mimosa Bar
9:00 am - 5:00 pm	Exhibit Hall is Open
9:30 am - 4:00 pm	Technical Conference Sessions
2:00 pm - 3:00 pm	Networking Afternoon Refreshment Break
5:00 pm - 7:00 pm	Exhibits close at 5 pm for After Hours VIP Party

Thursday, May 18

7:00 am	Registration Opens
7:00 am - 8:30 am	Networking Breakfast with Exhibitors
9:00 am - 10:00 am	Networking Morning Refreshment Break with Bloody Mary Bar
9:00 am - 1:00 pm	Technical Conference Sessions
9:00 am - 3:00 pm	Exhibit Hall is Open
2:00 pm - 3:00 pm	Networking Afternoon Refreshment Break

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Electrical Wire Processing Technology Expo
(electricalwireshow.com)

Interested in exhibiting?

Contact AliciaBalonek@ipc.org



Variable Frequency Drive (VFD)

Direct-On-Line (DOL) Starter

Replacing VFDs with Motor Starters

BY TED WODOSLAWSKY

Can I Use Standard Motor Control in Place of a Variable Frequency Drive?

The chip (Integrated Circuit) shortage, combined with energy and raw material shortages have created the perfect storm of forces that have resulted in a crisis for manufacturers looking to expand, upgrade, or improve their operations.

Programmable Logic Controllers (PLCs), Human Machine Interface (HMI), Drives, and other intelligent devices have become difficult to source. While geopolitical analysts have been talking about de-globalization and the reshoring of high-tech manufacturing, that process will be long and arduous. We should not expect things to get easier anytime soon.

Because of these factors, many companies have been finding themselves in a bind sourcing Variable Frequency Drives (VFDs)

and Soft Starters and therefore are looking to more traditional control means. The question of "Can I use

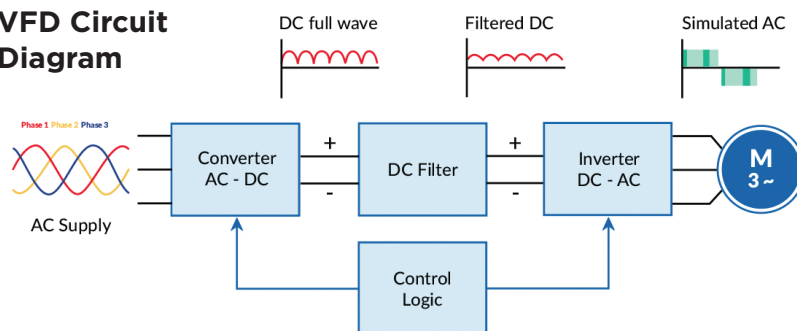
a standard electric motor starter in place of a VFD?" has crossed more than a few minds. The answer is, "Yes, in some cases."

This short paper is not intended to be an exhaustive application guide of VFDs vs Electrical Motor Starters, but is rather to get you thinking about it.

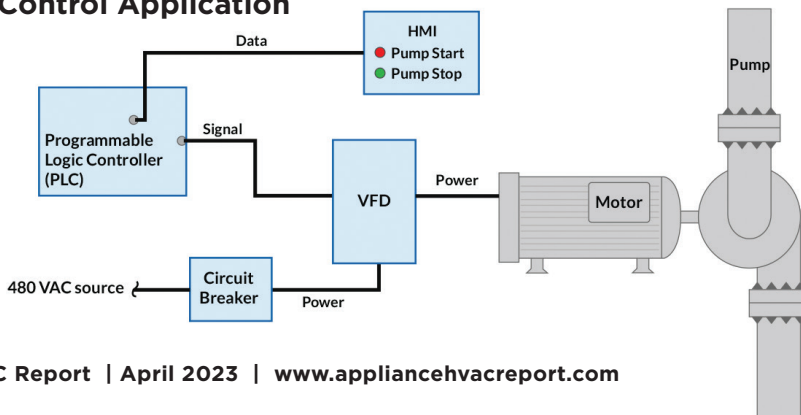
What is a VFD?

A Variable Frequency Drive (VFD) is a type of motor controller that drives an electric motor by varying the frequency and voltage supplied to the electric motor. Other names for a VFD are variable speed drive, adjustable speed drive, adjustable frequency drive, AC drive, microdrive, and inverter.

VFD Circuit Diagram



VFD in a Pump Control Application



Frequency (or hertz) is directly related to the motor's speed or revolutions per minute (RPMs). In other words, the faster the frequency, the greater the RPM. If an application does not require an electric motor to run at full speed, the VFD can be used to ramp down the frequency and voltage to meet the requirements of the electric motor's load. As the applications motor speed requirements change, the VFD can simply turn up or down the motor speed to meet the requirement. - *Source: vfds.com*

What is a Motor Starter?

A motor starter is an electrical device that is used to start and stop a motor safely. Similar to a relay, the motor starter switches the power ON/OFF and unlike a relay, it also provides low voltage and overcurrent protection.

The main function of a motor starter is;

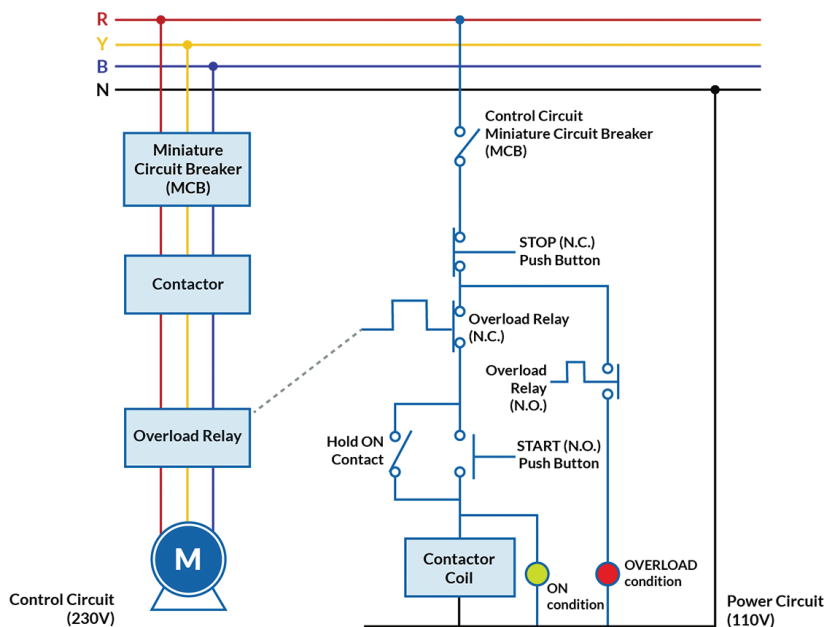
- To safely start a motor
- To safely stop a motor
- To reverse the direction of a motor
- To protect the motor from low voltage and overcurrent

Similarities and Differences of VFDs and Motor Starters

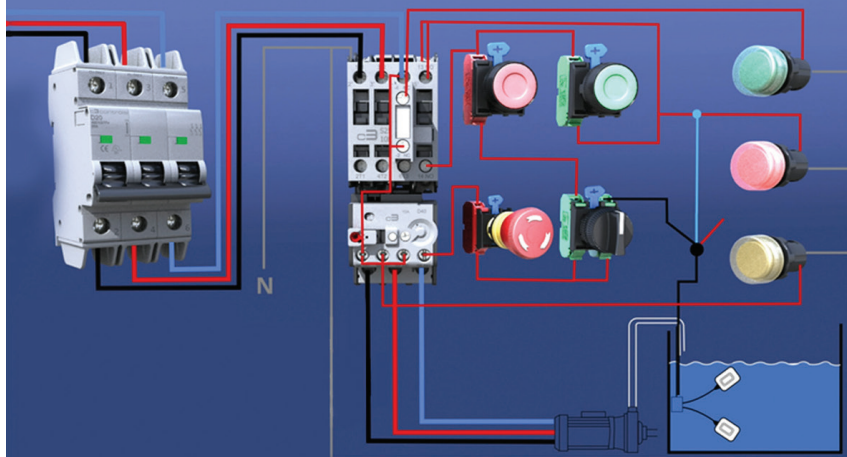
Both VFDs and Motor Starters serve as the control circuit between the HMI (Human Machine Interface) and the motor. Both are also used as a means of controlling and managing the flow of electricity from the power supply and circuit breakers to the physical motor itself.

The main difference between VFDs and Motor Starters is the VFDs ability to be programmable, functioning in a solid state and having a large variety of applications. VFDs also allow for coordinated starting, stopping and speed of multiple electric motors, such as those found in a paper mill.

Direct-On-Line (DOL) Starter Circuit Diagram



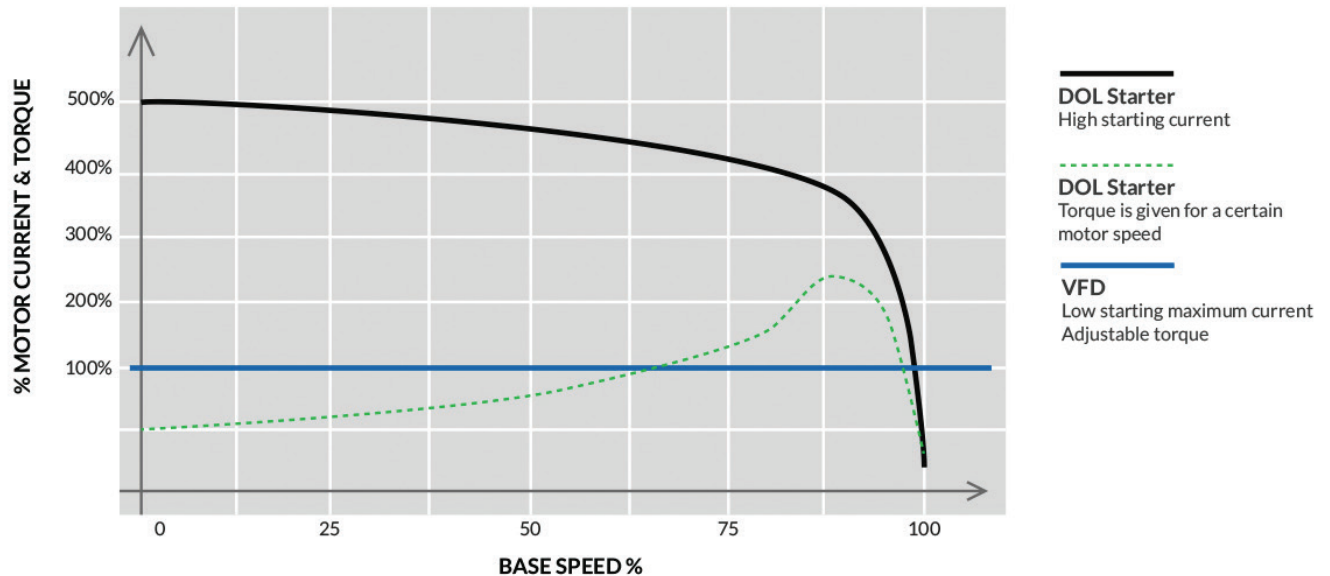
Direct-On-Line (DOL) Pump Control Application



Indication Wiring

- Terminal 1 NC on auxilliary contact to Green indicating light
- Terminal 2 (NC) on auxilliary contact to 5L3 wire
- Wire connecting Terminal A2 on contactor to Red indicating light
- Float switch to Wire connecting Terminal A2 on Contactor
- Terminal 98 (NO) on overload relay to Yellow indicating light
- Terminal A1 on contactor to Neutral
- Common side of all indicator lights to Neutral

Motor Starting Current



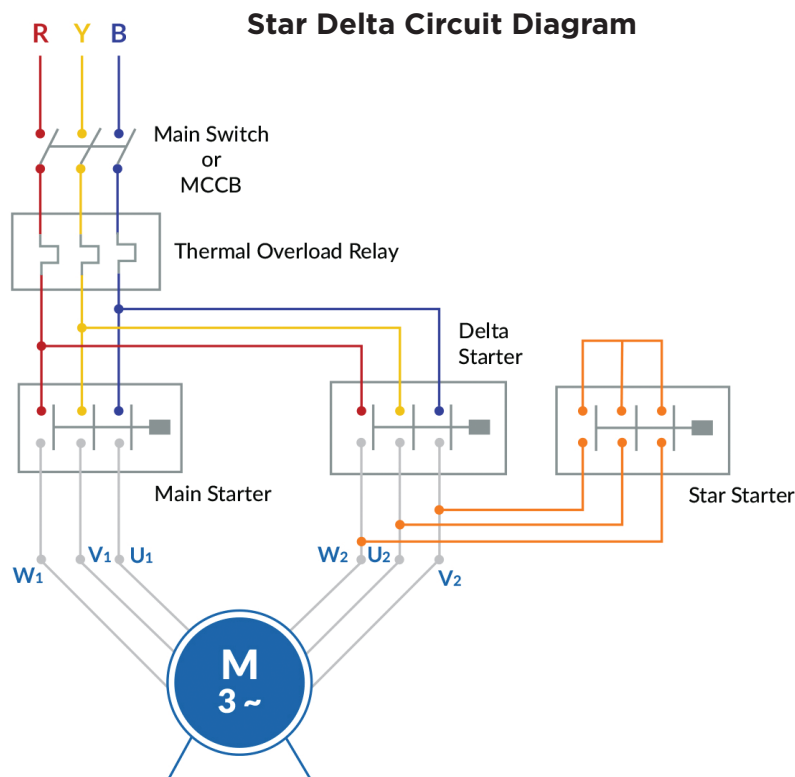
Torque and Current

With a VFD, the torque is constant across the speed range and requires a lower starting current. A DOL starter requires much more current to start

the motor and the torque varies with motor speed.

As you can see in the graph below, the amount of current needed to start the motor (inrush current)

can be 500% or higher than the operating current when using a DOL starter. This is why a DOL starter is typically limited to lower horsepower applications, 5 HP and below.



Star-Delta Motor Starter

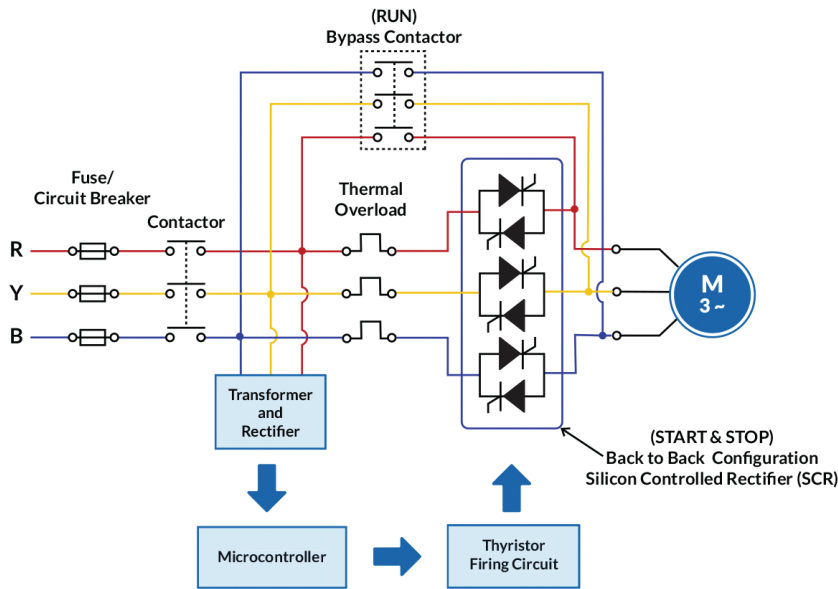
For higher horsepower applications, inrush current can be reduced by using a Star-Delta configuration for a three-phase induction motor. Star-Delta starters are particularly suited for high inertias, where the loads are initiated after full load speed. With Star-Delta, inrush current is reduced by 33%.

Soft Starter Defined

The soft starter is a type of motor starter that uses the voltage reduction technique to reduce the voltage during the starting of the motor.

The soft starter offers a gradual increase in the voltage during the motor startup. This will allow the motor to slowly accelerate and gain speed in a smooth fashion. It prevents any mechanical tear and jerking due to sudden supplying of full voltage.

Soft Starter Circuit Diagram



During motor stopping, the supply voltage is gradually reduced to smoothly decelerate the motor. Once the speed reaches zero, it breaks the input voltage supply to the motor.

Because it is an intelligent device, a soft starter can also allow for connectivity to factory control and communication networks.

Electric Motor Starter Choices

VFDs are used to run an AC Motor at variable speeds, or for smooth start up via slower acceleration. VFDs convert 3 phase AC to DC via diodes, then the DC power gets sent to a capacitor, which is finally converted

back to AC power via transistors (or "switches"). These switches are used to adjust the frequency that the VFD supplies to the motor, which controls the speed (RPM). VFDs are widely used to regulate water flow at a water treatment plant, allowing more control over the flow of the pump.

A Motor Starter is an electro-mechanical system that typically provides the motor switching and thermal overload protection. There are also Combination Motor Controllers that provide additional functions, such as motor disconnecting means, motor branch circuit, short circuit, and ground fault protection, in addition

to the motor switching and thermal protection. A DOL Starter is a good option for smaller motors, typically below 5HP. For larger motors, a Star-Delta configuration should be used.

A Soft Starter is a step above a Star-Delta configuration for applications with frequent stops and starts, larger motors, and applications that need tighter integration with the factory control system. But, sourcing a soft starter can be as difficult as a VFD, so it may not be a solution for you.

Can I Use a Standard Electric Motor Starter in Place of a VFD?

Returning to our question, "Can I use a standard electric motor starter in place of a VFD?" The answer is a definite "Yes," with thoughtful planning and an understanding of the possible limitations. ●



Ted Wodoslawsky joined c3controls in December 2017 as the Director of Commercial Marketing. Since then, he is currently the Vice President of Commercial

Marketing and Customer First. In his role, Ted is responsible for all activities related to conceptualizing and implementing market strategy to generate demand as well as order entry and customer service.

Ted holds a Bachelor's degree in Business Management from Malone University in Canton, Ohio, a Technical Diploma from DeVry University in Electronics Technology, in Columbus and is a member of MENSA International.

Electric Motor Starter Types				
	DOL	Star-Delta	Soft Starter	VFD
HP Rating	≤ 5 HP	≤ 20 HP	≥ 20 HP	≥ 20 HP
Starting Current	500% or more of rated current	Reduce 1/3	Reduced	Will not exceed 110% of rated current
Method	Full Voltage Starting	Start with Star connection, Run with Delta	Start and Stop with gradual speed control	Frequency increase/decrease to control speed
Speed Control	No	No	Start and Stop Speed Control	Start and Stop operating speed control
Cost	\$	\$\$	\$\$\$	\$\$\$\$

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Cooling Global Warming: Reducing HVAC Emissions With Ice-Based Energy Storage Solutions

BY YARON BEN NUN

In the fight against climate change, a scalable, effective decarbonization strategy for commercial real estate will be critical, as building operations account for 37 percent of global annual greenhouse gas emissions. This is due to the large amounts of energy required in their day to day operations, with HVAC accounting for nearly 40 percent of consumption.

Although the energy required for chillers is increasingly being supplied by renewable energy resources, such as solar and wind, these resources are not always available. For example, as the sun goes down, solar power production declines, even though the demand for temperature control remains high. In these instances, many buildings are left to rely on more expensive, higher carbon footprint energy produced by fossil-fuel powered plants.

Ice-Based Energy Storage Can Safely Reduce Costs and Improve Sustainability

Energy storage is an effective way to reduce reliance on the grid during periods of high demand, offering a behind-the-meter source of power for building temperature control. Electricity is pulled and stored from the grid when it is abundant, affordable, and clean, and then utilized at a later point when power from the grid is in short supply, expensive, and produced using fossil fuels. The utilization of stored energy in place of the grid reduces a building's carbon footprint, as well as the financial costs of building operations. However, one of the most common forms of energy storage – lithium-based batteries – expose building operators to safety concerns due to their flammability and toxicity.

Ice-based storage represents a paradigm shift in how buildings can

utilize energy storage to meet their cooling needs. Ice-based systems use stored energy to operate in place of traditional chillers during periods when electricity is most costly and sourced from high-emission sources. During off-peak hours, these systems utilize cheaper, cleaner renewable energy to freeze water by circulating a cold solution of ethylene/propylene glycol from the chiller to the ice-based storage systems. By initiating a change of state from liquid to solid, the solution transfers and stores the energy as ice. This ice is used during peak hours to cool a building's circulated water without relying on the grid, dramatically reducing the building's energy use during these key hours. These systems have been proven to be environmentally friendly, with high performance and negligible degradation.



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Installed on site, this behind-the-meter solution can transform buildings into grid interactive assets, reducing energy consumption when demand is at its highest. Building operators have the ability to shift their energy loads on a daily basis, enabling granular and effective energy management.

Some existing ice-based storage systems offer integration with cloud based control systems, allowing for the adjustment of local control systems to meet discharge and charge requests through external sources. In the appropriate geographies, this technology can be integrated with demand response and load shift programs, forming the foundation of virtual power plants that react to the needs of the grid in order to not only save costs for building owners, but support the reliability and sustainability of the grid itself. By responding in real time to energy market demands, storage systems can help reduce reliance by the grid on fossil fuel powered peaker plants, and ultimately manage emissions and help avoid outages.

Bring Innovative Solutions to Your Clients

For HVAC installers, ice-based energy storage offers an opportunity to establish stronger, more significant connections with the customer. This technology complements pre-existing or new HVAC systems, creating benefits such as increased resilience and reduced emissions. By integrating with HVAC systems, these storage solutions minimize costs and make the existing equipment last longer. By proposing and executing these novel solutions for clients, installers and consultants can establish themselves as leaders in the field, ahead of the curve on not only meeting a customer's

cooling needs, but their desires for savings and sustainability as well.

HVAC professionals who propose ice-based solutions for their clients can find themselves responsible for bringing their customers a myriad of benefits. These systems can help buildings achieve their sustainability goals, and even help meet the requirements for LEED certification. The buildings will also become increasingly resilient, able to continue controlling temperature during grid outages – especially salient for operations that require constant predictability in indoor climate. And of course, clients will appreciate the demand charge reductions that these upgrades bring, supporting their business profitability.

Increasingly Affordable Solutions

As ice-based storage technology has advanced, it has also become increasingly compact and modular, making it ideal for retrofits. Removing the need for expensive and time intensive overhauls, ice-based systems have emerged that can be unincorporated into existing designs, requiring minimal real estate. With the increased flexibility in terms of installation location and requirements, ice-based systems enable adopters to use their precious space strategically and profitably.

Ice-based systems have recently become even more affordable, thanks in part to the incentives offered in the Inflation Reduction Act (IRA). The IRA provides a 30% investment tax credit for such storage systems, incentivising their incorporation through an accelerated payback period. With their low degradation rates, ice-based storage systems present an opportunity to secure long term peace of mind for building managers and HVAC installers alike.

The Technology Needed and Available NOW!

Ice-based energy storage technology is already proven, installed, and operational, actively contributing to the decarbonization of the building sector. As it spreads, more buildings will become energy assets, contributing to building profitability, sustainability, and overall decarbonization. Energy storage has been hindered by the limitations of batteries until now, but ice-based storage represents a game changer for commercial and industrial real estate customers. With no time to waste in the fight against climate change, these technologies have become available at the perfect time.

Sources

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Yaron Ben Nun is Founder and Chief Technology Officer at Nostromo Energy, where his vision for reducing carbon emissions by decarbonizing buildings led to the

development of Nostromo's novel IceBrick® energy storage technology. Yaron has led the company through its pre-seed capital funding, to winning a \$500,000 grant and two-year product development sponsorship from Shell Plc's GameChanger Clean-Energy Accelerator, to the company's first commercial deployment of its IceBrick® technology at med tech company Medinol's Jerusalem headquarters, to building a pipeline of projects in the U.S. and globally. As CTO, Yaron leads the overall vision and strategic development of Nostromo's technology and product development, with the goal of making the IceBrick® an industry standard and playing a key role in the emerging behind-the-meter energy storage arena.



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The Ultimate Guide to HVAC Condensate

BY JOSE LEON AND RUSSELL NELSON

Unless you're an experienced HVACR professional, most people don't realize that air conditioning, refrigeration, and other HVACR equipment can produce condensate during normal operation.

This article is intended to help provide a basic understanding of condensate, condensate removal, and condensate-related problems in HVAC systems. Ready to learn more, let's dive in!

Key Takeaways

- All air conditioning systems produce condensate during normal operation
- Condensate must be drained or pumped from systems to avoid costly damage
- Condensate pumps, drain pans, and drain lines require routine maintenance
- Condensate overflow and leaks can cause water damage, mold growth, and unpleasant odors
- Some condensate is corrosive and requires treatment

What is Condensate?

Condensate is created during a change in the state of water from a gas or vapor form into a liquid form. It generally occurs when vapor in warm air encounters a cool surface, which normally occurs in air conditioning systems, refrigeration equipment, and other types of cooling and heating equipment.

To prevent the unwanted collection of condensate water, it should be drained away by gravity through a drain pipe or hose. If gravity drainage is not possible, a condensate pump is used to automatically pump the

condensate water to a drainage point or sewer drain.

Other types of equipment that produce condensate include condensing boilers, high-efficiency furnaces, dehumidifiers, ice machines, grocery store refrigeration/freezer display cases (dairy, meat, produce, etc.), convenience store refrigerated beverage display cases, walk-in refrigerators and freezers, steam humidifiers, industrial air dryers, and tankless/instant water heaters.

Where Does Condensate Naturally Occur?

In addition to the variety of equipment that produces condensate, condensate also occurs naturally in our daily lives:

- Morning dew in our garden/lawn
- Early morning moisture beads on car windows
- Sweaty droplets on your can or bottle containing a cold beverage
- Water droplets or steamy bathroom mirrors
- Visible breath in cold winter conditions
- Clouds in the sky or fog in the air
- Fog or moisture on glasses and goggles

How Does Condensation Relate to Evaporation?

The two terms are related, but they have opposite meanings. While condensation occurs when a gas or vapor changes into liquid form, evaporation happens when a liquid substance changes to a gaseous form. For example, when the morning dew burns off, it does so through the process of evaporation.

- Process of ironing damp clothes
- Process of sweating by the human body
- Line drying clothes
- Whistling steam from a stovetop kettle
- Puddles drying up
- Melting of a glass of ice

Is it Normal For HVAC Systems to Produce Condensate?

Yes. The same process that causes a cold glass of iced tea to form water droplets on its exterior in the summer causes condensation in your air conditioner and other similar equipment.

During normal operation, the evaporator coils of your air conditioning system cools the warm air that passes over it, absorbing heat and moisture from the air, and condensation naturally forms. As the condensation drips off the evaporator coil it then collects in your system's drain pan and eventually drains through the condensate drain line via gravity or to a condensate pump (assuming it's properly maintained and not clogged).

Common Issues With Condensate Water in HVAC Systems?

Condensate-related issues can range from high humidity levels that lead to mold and mildew proliferation and structural damage from drainage water that accumulates and puddles in areas where it does not belong. These issues are typically caused by one of the following problems.

Condensate Drain Pan Problems

- Under normal operation, your A/C drain pan collects condensate from the



evaporator and sends it to an external drain. However, after years of use, condensate drain pans can corrode or crack leading to water leaks into the A/C unit and excess condensate below the drain pan causing damage to the A/C unit and your home or commercial building.

Clogged or Dislodged Drain Line

- If bacteria and fungus build up in the drain line, it can become clogged. It is also common for drain lines to become dislodged or outdoor drain lines to become obstructed. When this happens, your condensation pan is plugged and can overflow, causing damage.

Broken Condensate Pump - In homes and commercials building with basements or attics, an automatic condensate pump assists in the removal of condensate water from the system. If the pump is not properly maintained, becomes plugged or fails, condensate water can overflow or leak causing damage.

Dirty Air Filter Leading to a Frozen Evaporator Coil - Dirty HVAC system air filters restrict adequate airflow over the evaporator coil. Without proper airflow, the coil can get too cold and freeze. When this ice melts, dripping into the condensation pan, it can overflow due to the excess volume.

In Simple Terms, What is a Condensate Pump?

Condensate pumps are designed to move the condensate water produced by moisture-prone equipment (e.g. air conditioner, furnace, refrigerator, ice machine, etc.) to a holding tank before removing it to a drain or sewer. The holding tank collects the condensate liquid until it rises to a level that raises an internal float switch which automatically activates the pump until the liquid level in the tank is lowered.

How Do Condensate Pumps Work?

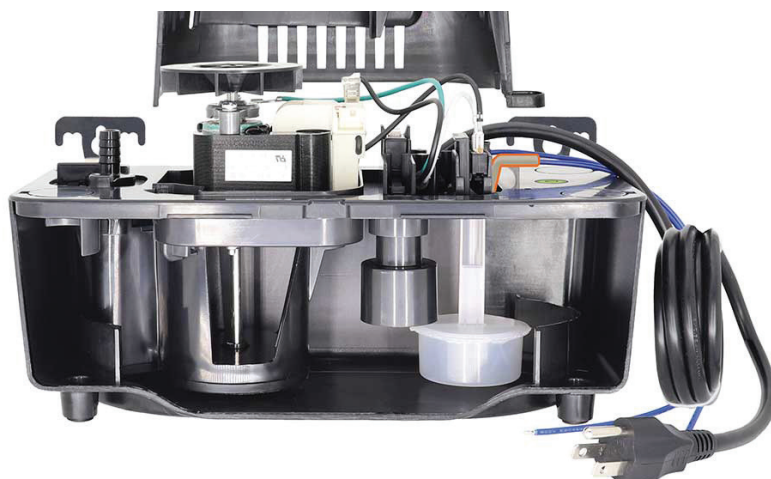
Most condensate pumps have a main float switch to automatically start/stop the pump when the water reaches preset levels inside the pump reservoir. The pump will automatically turn on/off when the water level

increases/decreases in the reservoir or tank. Some pumps also feature a safety switch that can be wired to the condensate source (air conditioner, furnace, refrigerator, freezer, ice machine, etc.) to automatically shut off the source equipment in case of a blocked discharge line or pump failure.

Choosing a Condensate Pump

The first step in choosing the right condensate pump is to determine if your application is subject to local condensate handling and disposal regulations. Select a model that operates within these guidelines.

Next, determine the lift required for the pump by identifying where the pump will be mounted and where the discharge or drain point will be. Condensate flow will decrease in



accordance with the height it must travel until the maximum lift, or “shut-off” lift is reached. Select a pump with a maximum lift rating that is suitable for your application.

Check your equipment service manual to determine the condensate output and choose a pump with sufficient capacity. As a general rule, the output flow of the pump should be at least double the input rate from the appliance.

Ascertain your voltage requirements. Most pumps are available in 120V or 230V models. Some commercial-grade pumps are available in 230V and 460V.

If property damage or personal injury can result from an inoperative or leaking pump, choose a condensate pump with an overflow shutoff switch or install one with your pump.

Unless you're replacing an existing condensate pump, it is strongly recommended that you contact an HVAC professional to properly size and select a condensate pump for any new application.

What Are The Risks of Not Properly Disposing of Condensate in HVAC Systems and Other Equipment?

When condensate water is not properly removed from a system it can overflow or leak, causing a range of problems and damage.

- Water damage due to overflowing condensate pans or plugged drain lines
- Damage to HVAC equipment and surrounding structures
- Mold, algae or scale buildup leading to foul odors and plugged drain lines

- Mold and mildew growth due to excessive moisture and leaks
- Equipment and pipe corrosion related to untreated corrosive condensate

How Much Condensate Does an Air Conditioner, Furnace or Other Cooling Equipment Produce?

It depends on the application, size, and type of equipment. Normally, the amount of condensate that drains from an A/C system can range from 5-20 gallons per day, depending on its size, how long the unit runs and how much moisture is in the air.

Properly designed and maintained systems should easily drain the condensate via a gravity drain line or an automatic condensate removal pump. However, problems and damage can occur when condensate overflows or leaks occur due to lack of maintenance or equipment failure.

What Type of Condensate Can be Corrosive?

Conventional furnaces and A/C systems do not produce corrosive condensate because the combustion gases are sent directly to the flue from the combustion chamber. However, in high-efficiency condensing furnaces, the exhaust gases are passed through a second heat exchanger which in turn

produces a corrosive condensate.

These hot gases get a chance to cool down within the condensing furnace system so no heat goes to waste (e.g. high-efficiency). When the temperature of the combustion gases drops, they condense and form a condensate that is usually corrosive, requiring treatment or neutralization before being passed into a drain or sewer line. ●

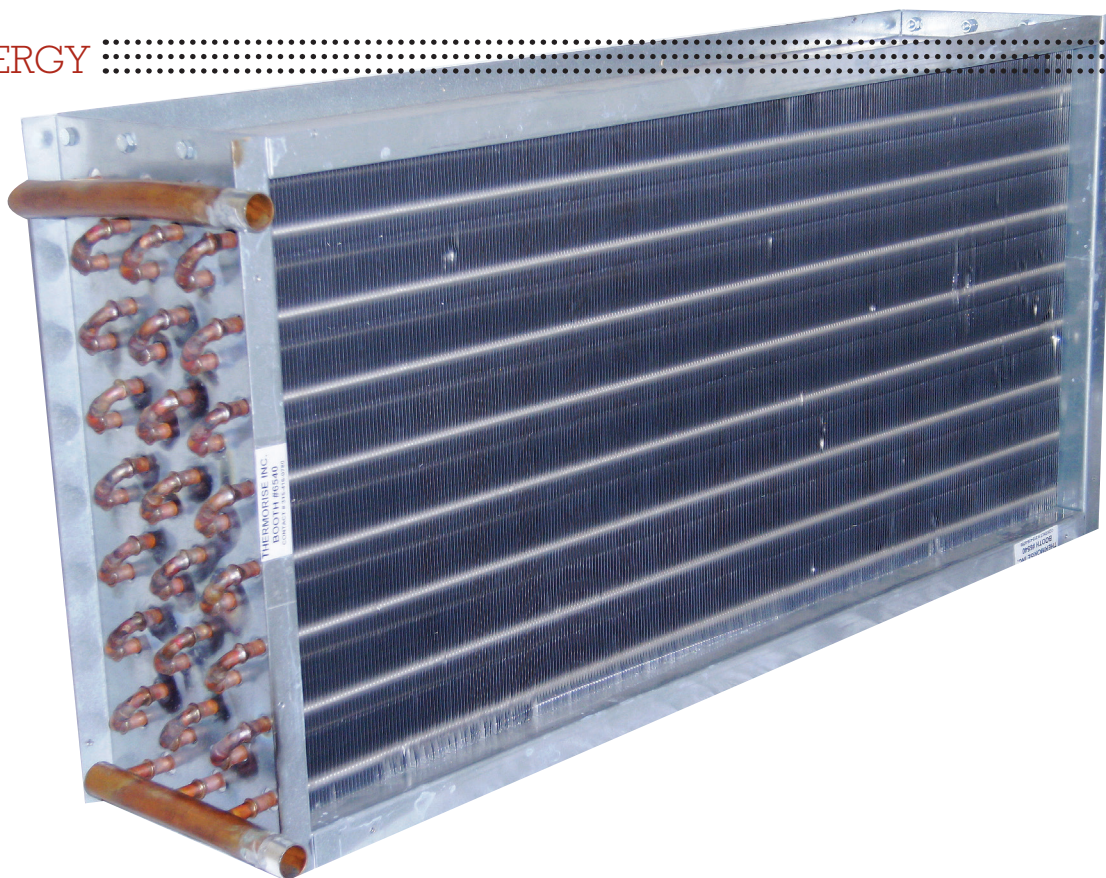


Jose Leon is a Senior Project Manager of Engineering at Beckett Corporation. Jose has a B.S. Degree in Mechanical Engineering from the University of Texas and extensive training in ISO 9000 Quality Management. For over 23 years, Jose has worked with Beckett's product management, product engineering, and manufacturing teams.



Russell Nelson is the OEM HVAC Product Manager at Beckett Corporation. For over 30 years, Russell has worked in the water pump industry in various capacities, including 15 years in product management specializing in new product development. His expertise and tenure within Beckett's engineering department provides an invaluable resource to the company and its customers.

NEED HELP SELECTING A BECKETT HVAC PUMP?		Condensate Management Solutions. Driven by Innovation Since 1948.			
1 What is the Application or Job Type?	CONDENSATE REMOVAL PUMPS	LOW PROFILE CONDENSATE PUMPS	MID-SIZE CONDENSATE PUMPS	PLENUM & HIGH TEMPERATURE PUMPS	IN-PIPE CONDENSATE PUMPS
Common Equipment and Installation Examples	Air conditioners, condensing furnaces, boilers, and dehumidifiers	Air conditioners and condensing furnaces with limited space for pump installation	Wall mounts and ductless mini-split air conditioners	Attic-mounted and below-floor plenum applications; commercial refrigeration systems; dehumidifiers	Air conditioners and dehumidifiers with limited space for pump installation
Shut Off (Max Lift) Range	12.7 to 65'	140-155 GPH	1200 to 2000	1200 to 2000 or 4000	12"
Flow @ 1 ft. Range	57-476 GPH	1200 to 2000	N/A	25 to 100 GPM (500 to 1000)	1200
Flow @ 1 ft. Range	1200, 2000 or 4000	25 to 100 GPM	1000 to 2000	1000 to 2000	300'
Water Volume	25 to 100 GPM (500 to 1000)	1000 to 2000	1000 to 2000	1000 to 2000	300'
Collection Tank Size	100 to 200 L	100 to 200 L	100 to 200 L	100 to 200 L	100 to 200 L
Maximum Water Temp	100 to 120°F	100 to 120°F	100 to 120°F	100 to 120°F	100 to 120°F
Discharge/Check Valve	3/8" to 1/2"	3/8"	3/8"	3/8"	3/8"
2 Other Considerations					
Power Supply	120V or 230V for BK17, BK22, BK23, BK24, BK25, BK26, BK27, BK28, BK29, BK30, BK31, BK32, BK33, BK34, BK35, BK36, BK37, BK38, BK39, BK40, BK41, BK42, BK43, BK44, BK45, BK46, BK47, BK48, BK49, BK50, BK51, BK52, BK53, BK54, BK55, BK56, BK57, BK58, BK59, BK60, BK61, BK62, BK63, BK64, BK65, BK66, BK67, BK68, BK69, BK70, BK71, BK72, BK73, BK74, BK75, BK76, BK77, BK78, BK79, BK80, BK81, BK82, BK83, BK84, BK85, BK86, BK87, BK88, BK89, BK90, BK91, BK92, BK93, BK94, BK95, BK96, BK97, BK98, BK99, BK100	120V or 230V	120V or 230V	120V or 230V	120V or 230V
Safety Switch	Included on Certain Models	Included on Certain Models	Included on Certain Models	Included on Certain Models	Included on Certain Models
PVC Tubing	Included on Certain Models	Included on Certain Models	Included on Certain Models	Included on Certain Models	Included on Certain Models
UL/CSA Listed	No	No	No	No	No
UL/CSA - Plenum Rated	No	No	No	No	No
Standard Warranty	1-3 Year Warranty	1-3 Year Warranty	1-3 Year Warranty	1-3 Year Warranty	1-3 Year Warranty
3 Beckett Pump Models	BK17, BK22, BK23, BK24, BK25, BK26, BK27, BK28, BK29, BK30, BK31, BK32, BK33, BK34, BK35, BK36, BK37, BK38, BK39, BK40, BK41, BK42, BK43, BK44, BK45, BK46, BK47, BK48, BK49, BK50, BK51, BK52, BK53, BK54, BK55, BK56, BK57, BK58, BK59, BK60, BK61, BK62, BK63, BK64, BK65, BK66, BK67, BK68, BK69, BK70, BK71, BK72, BK73, BK74, BK75, BK76, BK77, BK78, BK79, BK80, BK81, BK82, BK83, BK84, BK85, BK86, BK87, BK88, BK89, BK90, BK91, BK92, BK93, BK94, BK95, BK96, BK97, BK98, BK99, BK100	BK17, BK22, BK23, BK24, BK25, BK26, BK27, BK28, BK29, BK30, BK31, BK32, BK33, BK34, BK35, BK36, BK37, BK38, BK39, BK40, BK41, BK42, BK43, BK44, BK45, BK46, BK47, BK48, BK49, BK50, BK51, BK52, BK53, BK54, BK55, BK56, BK57, BK58, BK59, BK60, BK61, BK62, BK63, BK64, BK65, BK66, BK67, BK68, BK69, BK70, BK71, BK72, BK73, BK74, BK75, BK76, BK77, BK78, BK79, BK80, BK81, BK82, BK83, BK84, BK85, BK86, BK87, BK88, BK89, BK90, BK91, BK92, BK93, BK94, BK95, BK96, BK97, BK98, BK99, BK100	BK17, BK22, BK23, BK24, BK25, BK26, BK27, BK28, BK29, BK30, BK31, BK32, BK33, BK34, BK35, BK36, BK37, BK38, BK39, BK40, BK41, BK42, BK43, BK44, BK45, BK46, BK47, BK48, BK49, BK50, BK51, BK52, BK53, BK54, BK55, BK56, BK57, BK58, BK59, BK60, BK61, BK62, BK63, BK64, BK65, BK66, BK67, BK68, BK69, BK70, BK71, BK72, BK73, BK74, BK75, BK76, BK77, BK78, BK79, BK80, BK81, BK82, BK83, BK84, BK85, BK86, BK87, BK88, BK89, BK90, BK91, BK92, BK93, BK94, BK95, BK96, BK97, BK98, BK99, BK100	BK17, BK22, BK23, BK24, BK25, BK26, BK27, BK28, BK29, BK30, BK31, BK32, BK33, BK34, BK35, BK36, BK37, BK38, BK39, BK40, BK41, BK42, BK43, BK44, BK45, BK46, BK47, BK48, BK49, BK50, BK51, BK52, BK53, BK54, BK55, BK56, BK57, BK58, BK59, BK60, BK61, BK62, BK63, BK64, BK65, BK66, BK67, BK68, BK69, BK70, BK71, BK72, BK73, BK74, BK75, BK76, BK77, BK78, BK79, BK80, BK81, BK82, BK83, BK84, BK85, BK86, BK87, BK88, BK89, BK90, BK91, BK92, BK93, BK94, BK95, BK96, BK97, BK98, BK99, BK100	BK17, BK22, BK23, BK24, BK25, BK26, BK27, BK28, BK29, BK30, BK31, BK32, BK33, BK34, BK35, BK36, BK37, BK38, BK39, BK40, BK41, BK42, BK43, BK44, BK45, BK46, BK47, BK48, BK49, BK50, BK51, BK52, BK53, BK54, BK55, BK56, BK57, BK58, BK59, BK60, BK61, BK62, BK63, BK64, BK65, BK66, BK67, BK68, BK69, BK70, BK71, BK72, BK73, BK74, BK75, BK76, BK77, BK78, BK79, BK80, BK81, BK82, BK83, BK84, BK85, BK86, BK87, BK88, BK89, BK90, BK91, BK92, BK93, BK94, BK95, BK96, BK97, BK98, BK99, BK100



DEEP Coil with Guaranteed 50% Energy/ Cost Improvement in HVAC/R Appliances

BY HEMANT D. KALE

Basic Vapor Compression Cycle

From heat transfer point of view, for this cycle to be fully efficient, it needs to reject all heat absorbed in the evaporator -- and compressor-- to the atmosphere through the condenser. And, do it with minimum air. Complete heat transfer will only occur if the condensed liquid leaving the condenser is at the same temperature as the temperature of air entering the heat exchanger, which is outdoor air temperature. However, this is almost never the case in air-cooled air conditioning, refrigeration units. Achieving the leaving refrigerant temperature same as outdoor air temperature, with minimum air movement, is not practical and/or economical in current design fin-tube coil. It is only possible if you have

significant counter flow. Achieving counter flow in current-design 1, 2, 3 row coil (Sample A, see below, "Thin Coil") is inherently impractical, expensive and ineffective compared to **equivalent** 9 row design "**DEEP Coil**" (Sample B) coil. By not rejecting all the heat available to reject, perhaps up to a third of the refrigerant in the system remains **dormant**, without any utility. Though, this dormant "**un-utilized**" refrigerant entails larger compressor, larger condenser, larger evaporator, larger indoor/outdoor motors, larger receiver and **larger amount of energy** to continuously circulate this "unutilized" refrigerant in the system. The complete heat rejection achieved in Sample B **DEEP coil** due to counter flow, will trigger smaller compressor, smaller condenser, smaller outdoor

motor(s) and smaller amount of energy. The **whole system will shrink**, lowering the product cost/energy, or, conversely, will have considerably higher cooling capacity.

There are many variables in this subject matter. As such, the figures mentioned in this paper are considered to be more representative.

Condenser Fan Motor Power Reduction

The basic formula for heat transfer to air is:

$BTU (sensible) = \Delta t \times CFM \times 1.08$,
where Δt is the temperature difference between air entering and air leaving the condenser coil.

Fan power reduces along formula:

$$BHP2 = BHP1 \times (sp2/sp1)^{1.5}$$

Where "**sp**" is static pressure and

BHP is fan h.p.

The reconfigured coil B (DEEP Coil) provides for **long counter flow relative to Coil A**. The advantage of counter flow is that it allows the air entering the condenser to reach maximum temperature rise possible with minimum air. Alternately stated, counter flow allows the condensed liquid to reach same temperature as the air entering the condenser, which is optimum sub-cooling of the refrigerant, which is optimum heat transfer. Concurrently, the reconfigured coil B (DEEP Coil) offers much reduced air resistance ("sp" static pressure) due its low fin density (5 fpi vs 15 fpi) and its open tube spacing (3"x0.866" vs 1"x0.866"). Combined effect is to **reduce fan BHP by up to 75%**.

Both coils – Coil A and Coil B – use same amount of copper tubing and fin material as well as same face area.

Following is a graphical illustration based on laboratory tests on 4 sq.ft. face area conventional ("T1" Thin) coil and its equivalent transformation into ("D1" DEEP) coil. Equivalent coil has same face area and utilizes same amount of copper and aluminum material, both type and quantity. At 800fpm, the fan BHP required is reduced to 25% for essentially same BTU heat transfer under identical conditions. For example, with the DEEP (D1) coil, a 1 HP motor can be

reduced to ¼ HP. The coil samples used in these tests were deficient in some respects due to lack of proper tooling. With more representative test samples, the performance difference can be better. S P is static pressure in inches of water column.

Compressor Power Reduction

Compressor needs energy to compress the gas and then to push it through elaborate tube formation which includes multiple, tight 180° return bends. Specific data is not available regarding how much of the compressor energy goes in compressing the gas and how much goes in pushing this gas through the resistance created by tube length and tube bends.

In Sample A Thin Coil, assume, each tube is 36" (3') long. Each tube has one (1), 180°, 1" dia. return bend. From fluid resistance consideration, a 3/8" tube, 1" dia., 180° return bend is equivalent to approx. 2' of straight tubing. So, each tube is 3'+2'=5' long. In sample B DEEP Coil, each tube is same 36" (3') long with one (1), 1.73" dia. 180° return bend (). Return bend of 1.73" dia. 180° will be proportionately equivalent to 2 x (1/1.73) = 1.15' of straight tube. The total equivalent straight tube length in Sample B DEEP Coil will be 3'+1.15= 4.15'. This is 4.15/5 = 0.83,

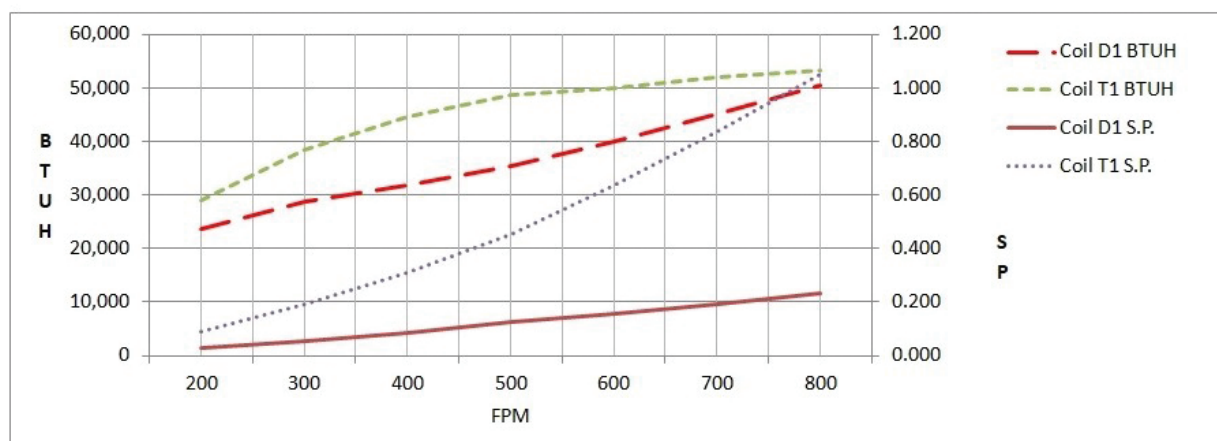
which is 17% reduction in equivalent tube length. This reduction becomes substantially larger in smaller units like window a.c. and smaller in larger units, though 36" is taken as fairly representative of most of heat exchangers. This 17% reduction in "equivalent" tube length will reduce compressor power by 8.5%, half of 17%, though it can only be determined by lab tests.

Maximum sub cooling is absolutely essential in these rising temperature, climate change scene. Only counter flow can provide maximum sub cooling at minimum airflow. With higher condensing temperatures of newer refrigerants, this issue becomes still more critical. Further, a multispeed fan motor can be used to adjust air cfm to achieve optimum sub cooling in wide outdoor temperature range, alleviating complex inverter hardware.

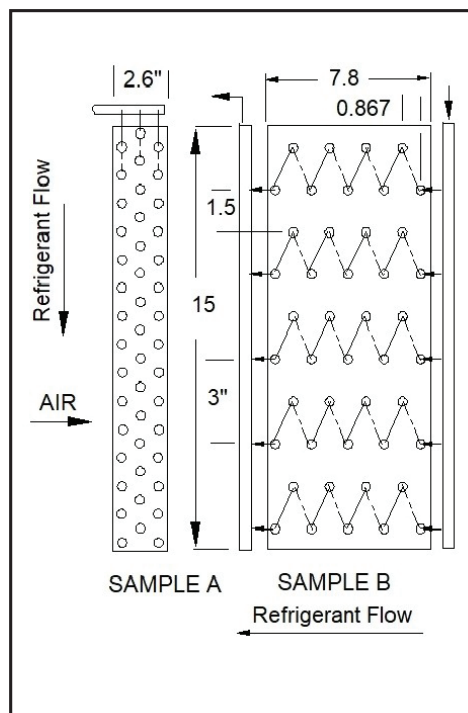
DEEP coil in indoor (evaporator) application, given its larger diameter return bends contribute to reduced fluid side resistance allowing reduction in compressor power

Indoor (Evaporator) Motor Power Reduction

DEEP Coil provides much lower air resistance which will allow downsizing of motor h.p. DEEP coil also provides for long counter flow which enhances heat transfer.



Following is a Comparison of Performance Differences Based on Laboratory Tests



SAMPLE SPECIFICATIONS USED

BOTH SAMPLES USE COPPER 3/8 INCH TUBES AND ALUMINUM FINS

	SAMPLE A THIN COIL	SAMPLE B DEEP COIL
Face Area H x W x D"	15 x 36 x 2.6	15 x 36 x 7.8
Fin Density fpi	15	5
Tube Spacing "	1 x 0.866	3 x 0.866
Tube Rows	3	9
No. of Return Bends/Dia."	45/1	45/1.73
Actual Total Tubing, ft, includes Return Bends	141	145
Equivalent Total Tubing, ft	231	197
Total fin surface sq.ft.	146	146

PROJECTED NEW PERFORMANCE

BOTH SAMPLES USE COPPER 3/8 INCH TUBES AND ALUMINUM FINS

	SAMPLE A THIN COIL	SAMPLE B DEEP COIL
BTU Output	x	x1.2
Static Pressure, "w.c.	x	x0.2
Fluid Pressure	x	x0.9 to x0.75
Fan BHP	x	x0.5
Fan BHP/10k BTUH	x	x0.29
Compressor HP	x	x0.95-x0.75

$$FanBHP = \frac{(scfm \times sp \times sp.gr.)}{(6356 \times fan \cdot eff.)}$$

sp(specific gravity) =1, fan fan effi. =0.7, SCFM (standard CFM=approx 0.88 x Actual cfm)

Case For Combined Energy and Cost Reduction of 50%

- 20%+ power reduction (or, increased cooling/heat transfer) resulting from substantial/complete sub-cooling due to counter flow
- 15%+/- compressor power reduction from reduced fluid-side resistance due to larger tube return bends (higher for small-face window units, smaller for large-face larger units)
- 50%+/- reduction in fan BHP, which

can amount to 15%+/- reduction in overall unit power needs

- Unit cost reduction commensurate with smaller compressor, smaller motors and other.

Emerging Focus on Heat Pump to Combat Climate Change

Many governments have pledged their support for heat pumps to wean away from fossil fuels due to world-wide 'climate change' movement. The

energy/cost reduction solution revealed here is of particular significance to heat pumps. ●



Hemant Kale, P E has life-long experience in HVAC/R field, in various fields like safety/performance compliance, product design, product manufacturing, working for prominent companies like Lennox, Intertek Testing Services (ETL) and others. He holds several heat transfer related patents.



Keep Your Smoke and Heat Detector Designs From Going Up in Smoke

BY RYAN SHEAHEN

Smoke and heat detectors provide early warning to save lives and protect properties from damage. The National Fire Protection Association (NFPA), in NFPA 101 Life Safety Code, contains guidelines for smoke detectors in various types of facilities, including residential facilities. Many government entities mandate smoke detectors in facilities such as multi-family residential and commercial buildings, and smoke detectors are recommended or required in all bedrooms of a residential building.

Both rising awareness of the importance of fire protection and regulation drive the global growth of the smoke and heat detector market. As a result of increased regulation, population growth, and growth in cities, unit shipments of smoke detectors are expected to grow from 98 million units in 2020 to 150

million units in 2025, representing a significant compound annual growth rate of around 8.8%. Currently, the Americas and Europe have the largest markets for smoke and heat detectors, but the Asia Pacific region is growing at the highest rate.¹

The latest smoke detector designs incorporate more features, including wireless communication interfaces, that enable the devices to integrate into a smart home or building, providing automated warning capability. Thus, a house or building can have continuous, smart monitoring.

The design engineer's challenge is including all the new capabilities and maintaining maximum safety-critical device reliability. Secondary challenges require maximizing energy efficiency and minimizing the detector's size. This article will help designers overcome these challenges by providing techniques

and recommended components for protection from electrical hazards, long-life reliability, and energy efficiency of new smoke and heat detector designs. The article will conclude with recommendations on resources for designers that will not only assist with component selection but can also help with compliance with the applicable safety standards.

Overview of a Smoke and Heat Detector Design

The example smoke and heat detector version in Figure 1 is a line-powered model with a battery backup. The diagram recommends components for protecting the detector from overcurrent, transient overvoltage, and electrostatic discharge (ESD). In addition, the text blocks list recommendations for sensing, control, and energy efficiency. Designers only need a few components to protect the smoke and heat detector, with the added advantages of robust control and efficient operation.

The block diagram in Figure 2 details the circuit blocks in a high-performance smoke and heat detector. Microcontroller (MCU)-based intelligence with digital signal processing and wireless communication enables the device to have more functionality than conventional smoke and heat detectors. With this capability, the detector can collect a wide range of data and transmit the data and detector status to a monitoring station. A universal asynchronous receiver/transmitter (UART) allows the programming of the MCU so that the detector can perform additional functions. Greater functionality challenges the designer to ensure a reliable and robust product that remains operational on a 24/7 basis.

Electronics engineers must overcome

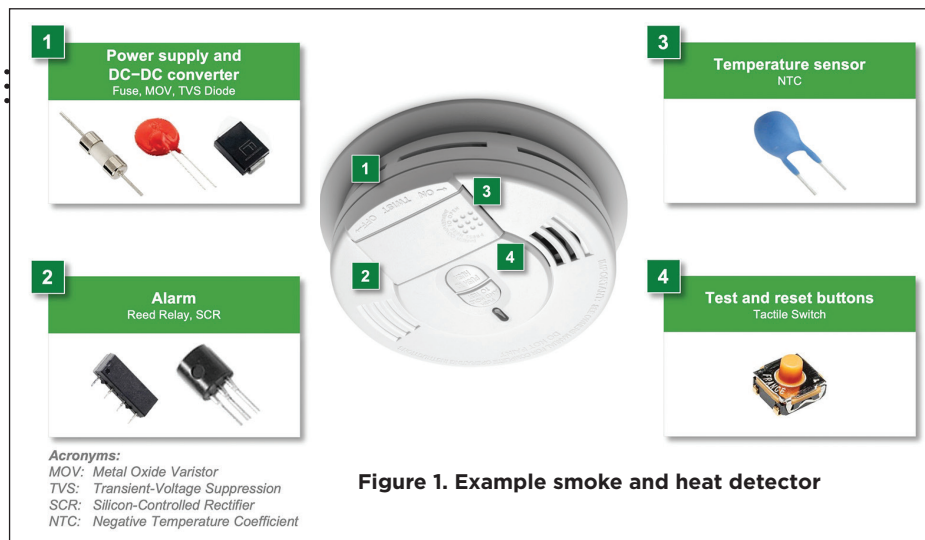


Figure 1. Example smoke and heat detector

multiple design challenges, including:

- protecting the smoke and heat detector from electrical hazards
- incorporating reliable sensing and control
- accommodating space limitations, and achieving operating energy efficiency.

Continue reading to learn about the recommended solutions to these challenges.

Protecting a Line-Powered Smoke and Heat Detector From Overcurrent, Overvoltage, and ESD

The AC power line, a high-power delivery source, can supply an undesirable, very high current if a short circuit occurs in the detector. Protect the AC/DC Power Stage and the whole detector with a fast-acting fuse to interrupt an overcurrent. Look for a fuse element with a low resistance under

10 Ω to minimize energy loss during normal operation. To avoid a potential arc in the fuse during an overcurrent condition, always select a fuse with a voltage rating higher than the maximum rated voltage of the AC power line. Of most importance, use a fuse that has nationally recognized testing lab (NRTL) certification. Certified or component-recognized components reduce compliance testing time and costs.

Transients can induce on the AC line from phenomena such as lightning strikes and large motors connected to the line that are turning on and off. All electronic products, including smoke and heat detectors connected to the AC line, are subject to these potentially high-voltage transients. A metal oxide varistor (MOV) can protect the AC/DC Power Stage from voltage transients. Look for a MOV with a high surge voltage rating and current absorption

of at least 1 kV and 500 A, respectively. Also, select a MOV that can safely operate at temperatures up to 125° C to ensure robust operation. As with the fuse, save certification time by choosing an NRTL-recognized component.

Some portion of a voltage transient will get through the AC/DC Power Stage and impinge upon the DC-DC Converter. A transient voltage suppressor (TVS) diode can respond quickly and clamp the transient to a safe voltage to protect the semiconductors in the DC-DC Converter stage and downstream circuitry. Consider the following properties that make TVS diodes excellent for both secondary transient protection and ESD protection:

- Ultra-fast response times of under 1 ps
- Capacity for at least 1500 W of peak power absorption
- ESD protection up to 30 kV
- Low clamping voltages
- Space-saving surface mount packages as small as the 0402 configuration.

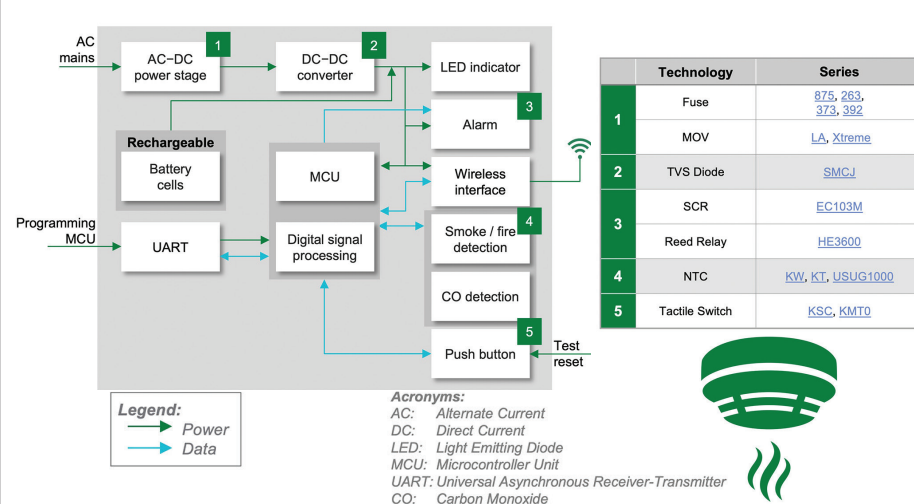
TVS diodes can be uni-directional or bi-directional, as shown in Figure 3. A bi-directional TVS diode has two diodes connected cathode-to-cathode, and its I-V curve is symmetric for positive and negative polarity voltages and currents. The bi-directional TVS diode clamps positive and negative voltage transients.

It only takes a few components to protect a smoke and heat detector from electrical hazards. Judicious selection of the protection components can contribute to a robust, reliable device.

Providing Reliable, Energy-Saving Control and Sensing

The Alarm, Smoke/Fire Detection, and Pushbutton circuit blocks equip the smoke and fire detector with the audio indication of a potentially hazardous condition, monitor the surrounding temperature, and initiate a test or a

Figure 2. Smoke and heat detector block diagram



reset state. These circuit blocks need to be robust and energy efficient.

Consider a silicon-controlled rectifier (SCR) or a reed relay to activate the audio alarm in the Alarm circuit. An SCR offers a low-power drive for the alarm. Energy-efficient SCRs can have gate currents under 500 μA . Another advantage of SCRs is that versions are available in surface mount packages for PC board (PCB) space savings.

If the design requires isolation between the audio alarm load and the other circuit blocks, use a reed relay. Reed relays have:

- Minimum coil power consumption for energy savings
- Hermetically sealed contacts for both maximum reliability and maximum operating life
- Sub-miniature, single-in-line packaging for conserving PCB space
- Coil suppression diodes to protect coil drive circuits from coil back EMF
- Optional magnetic shielding to minimize EMI generation.

Temperature monitoring is a critical function of the smoke and heat detector.

In the Smoke/Fire Detection circuit, use a negative temperature coefficient (NTC) thermistor. A vital feature of a thermistor to consider is accuracy. Look for a rated accuracy of $\pm 0.5^\circ\text{C}$ or better. Investigate the thermistor's thermal response. Consider thermal time constants in air of under 10 s. Ensure a reliable, long life with epoxy encapsulation. For space savings, thermistors are available with diameters under 0.1 inch.

Select a high-reliability tactile switch for use in the Push Button circuit, which tests and resets the smoke/heat detector. Consider:

- Using a small, compact switch that can meet the design requirements for operating force.
- Selecting a sealed switch with an environmental rating of at least IP67, indicating the switch is waterproof and protected from dust.
- Specifying contact materials with high corrosion resistance.
- Selecting a long-life switch rating of 1 million operations.

Using components with the above characteristics will ensure reliable, energy-efficient control and sensing.

Consuming minimal power will maximize battery operating life in the event of a lengthy power outage.

Taking Advantage of a Component Manufacturer's Services to Achieve Design Goals

It is extremely difficult to have expertise in all aspects of product design and be aware of all the components that serve specific purposes. Designers can help themselves while saving development time and costs by taking advantage of the knowledge and expertise of the component manufacturer's application engineers. They can help with cost-effective component selection. In addition, the application engineers can assist developers with guidance on the requirements of applicable national and international standards that a specific product, such as a smoke and heat detector, must meet. Furthermore, some component manufacturers can perform pre-compliance testing on a product to help avoid costly, multiple test cycles at a nationally recognized testing lab due to non-compliance to a standard.

By partnering with a component manufacturer, designers can develop a high-reliability product and reduce time-to-market, contributing to maximized revenue. ●

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- Integrated Circuits Selection Guide
- C&K Switches Product Guide



Ryan Sheahen is the Global Strategic Marketing Manager for the Electronics Business Unit. Ryan joined Littelfuse in 2011 as an inside sales specialist. He was previously the Global

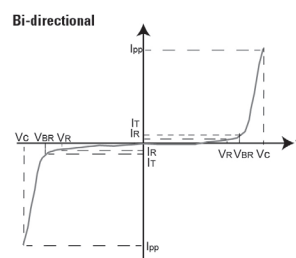
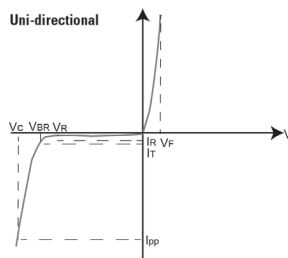
Product Manager for the magnetic sensing product portfolio.

Figure 3. Uni-directional and bi-directional TVS diode functional diagram

Functional Diagram: Uni-directional and Bi-directional TVS Diodes



I-V Curve Characteristics



P_{ppm} Peak Pulse Power Dissipation – Max power dissipation
V_c Stand-off Voltage – Maximum voltage that can be applied to the TVS without operation
V_{BR} Breakdown Voltage – Maximum voltage that flows through the TVS at a specified test current (I_t)
V_c Clamping Voltage – Peak voltage measured across the TVS at a specified I_{ppm} (peak impulse current)
I_r Reverse Leakage Current – Current measured at V_r
V_r Forward Voltage Drop for Uni-directional

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