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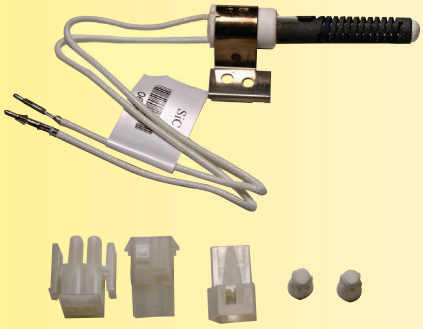
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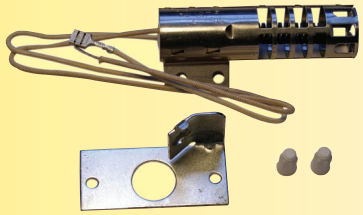
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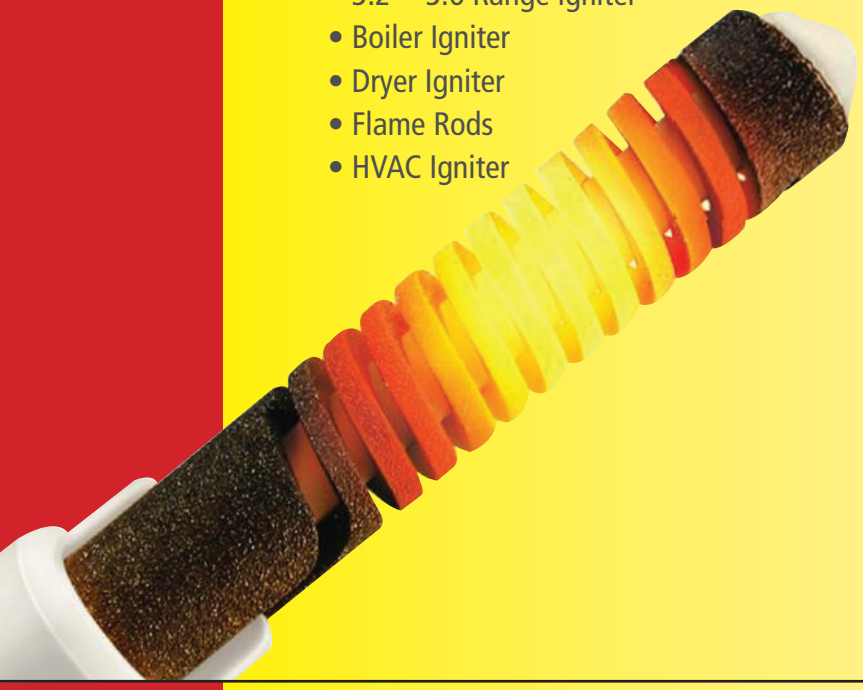
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RECENTLY A PRESS RELEASE CAME TO MY ATTENTION. NOTE THE FIRST PARAGRAPH.

LOUISVILLE, Ky. (AP) — GE Appliances plans to shift production of refrigerators, gas ranges and water heaters out of China and Mexico as part of a more than $3 billion investment to expand its U.S. operations in Kentucky, Georgia, Alabama, Tennessee and South Carolina.

GE Appliances is headquartered in Louisville, Kentucky. As further referenced in the story is the majority of their design work is done in the US (which is why our brand's audience is 90% US too), as is the majority of their manufacturing. Now even more will be done here.

Further in the press release, almost at the bottom is this nugget:

GE Appliances is a subsidiary of the China-based Haier company.

I think it should have been higher up in the story. Anyway. this is an important part of the tariff ''wars''. The goal is to bring more manufacturing back to the US if other countries will not open their borders to our products. Not just appliances, other products and services toom with automotive coming to mind. Will it work? Who know? My crystal ball is filled with clouds so I can't see what the future holds.

In other news we are adding a 5 th issue to our publishing schedule this year. It will be a 40 pager that contains numerous articles by LITTELFUSE we have published over the last 6 years (we were founded in 2019). Like this issue it ''hits the digital streets'' in October. Littelfuse has been the most prolific provider of content for us so what better way to highlight this than by a dedicated issue containing it?

Editorially here are the companies contributing to this issue: AVNAN, Systems, International Copper Association, Littelfuse, Nidec, UL Solutions, and Vitrek.

This issue and the Littelfuse issue conclude our magazine publishing for 2025. But still keep your eyes open for our bi-monthly enewsletters. And for those of you in the ''converting'' business, TSG Resolute is working with Avery Dennison and will be having a webinar on Thursday, November 6. Watch for the links we'll be sending it for it.

Have a great remainder of 2025. The second half of this decade awaits!

Brad Glazer

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APPLIANCE & HVAC REPORT
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Design Engineers
at the
OEM Level

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Mastering High Voltage: The Importance of Accurate Test Equipment

Introduction

Accurate measurement of electrical performance parameters is crucial for the reliability and safety of high-voltage equipment and cabling.

For applications involving tens of thousands of volts, safety risks and demands on test equipment are high. Proper calibration of test instruments is essential to meet strict performance needs and standards, often conducted by certified laboratories with traceability to national standards like NIST.

This article is a synopsis of the full whitepaper available online at Vitrek.com and discusses the importance of high-voltage test equipment calibration and considerations for ensuring measurement accuracy.

HV Measurement Techniques

Various high-voltage measurement techniques have unique advantages and calibration needs:

- Step-Down Transformers: Reduce high voltage to manageable levels.
- Capacitive and Resistive Voltage Dividers: Divide voltage proportionally.
- Series Resistance (Microampere Measurement): Measure current through high resistance in series with voltage source.
- Analog Style Measurement Devices:
  - Sphere Gaps: Measure breakdown voltage between two spheres.
  - Electrostatic Measurement: Quantify electrostatic force between two plates

Why Measure High Voltage?

Measuring high voltage is increasingly important as technology advances. High-voltage systems reduce current carrying requirements and minimize energy loss. Also, in many cases, voltage values determine system performance. This means the voltage sources must be accurate and reliable in order to meet systems specifications. Also, monitoring systems need to be in place to ensure that the systems perform reliably from end-to-end and year-to-year.



Many types of equipment are used for high-voltage measurement.

High-Voltage Applications by Industry

High voltage is used in various fields including:

- Defense/Aerospace
- Manufacturing
- Research
- Power Products
- Inspection
- Medical
- Semiconductor
- And More

Conclusion

As technology advances, the importance of accurate high-voltage measurements will only grow, making it essential for industries to invest in proper calibration practices. Ultimately, mastering high-voltage measurement is about safeguarding both the equipment and the people who rely on it, ensuring a safer and more efficient future for all.

This article is a synopsis of a free whitepaper that provides additional materials including Calibration of High-Voltage Test Equipment and Choosing the right HV Test Equipment for the Application.

View the full article at: https://bit.ly/41XVNSi

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Demand for Variable Speed Motors Kicks Into High Gear

The industry transition to variable speed motors in HVAC is not simply taking off --- it is flying with momentum. The question now is how quickly the motor industry can match up these newer motors to all the industry control systems and methods that exist for single speed and induction variable speed applications in place today. Replicating the spectrum of applications and communications will take time to develop, but there are options now to ease the transition.

Variable speed, and particularly ECM (electronically commutated motor) as a method of driving variable speed applications, is taking over at a faster and faster pace in fan and pump applications in industry sectors around the world including commercial buildings. That transition is justified by energy savings.

Variable speed allows the system to more closely match the demand in an efficient way that can lead to energy savings in most cases between 20% to 40%. Transitioning from fixed speed to variable speed ECM offers the maximum energy savings. A transition from VFD and induction motor to a synchronous motor ECM can also have significant energy savings of up to 10% depending on the application. The energy savings are a very compelling force to implement variable speed and in particular ECM.

For clarity, here are a few definitions:

- Induction variable speed is a fixed speed induction motor that is running in a variable speed mode utilizing either a separately mounted or an integrated variable frequency drive (VFD).
- An ECM is a synchronous motor with an integrated VFD. Within ECM applications, particularly in air moving, there are different software-based control applications that include pure variable speed, constant torque and a constant speed or constant flow. All ECM applications allow for different speeds, but the control of the application varies.

Measurement and Control

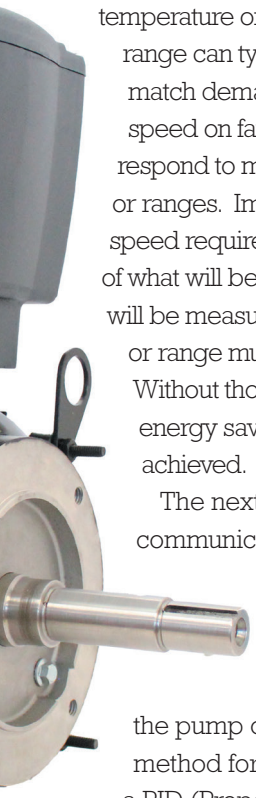
There are some key factors in variable speed implementation, particularly when transitioning into an existing fixed speed installation. Those factors are measurement and control. Most existing fixed speed applications do not include a robust set of measurements that indicate the demand or result of the demand that is occurring. Without that measurement of the demand, or an indication of what that demand means, the true variable speed energy savings cannot be realized.



The SynRA™ synchronous motor from Nidec/U.S. MOTORS runs at variable speed and offers more energy savings than induction or fixed speed motors.

For existing variable speed applications with an induction motor and VFD, the VFD often offers multiple interface options for control. Most ECMs have a much more limited set of interface options. The combination of limited measurements from fixed speed and limited interface options for ECMs leads to limits to how fast and how many options there are for ECMs to replace existing fixed speed and variable speed induction applications to maximize energy savings.

Let's address measurement first. Two of the most commonly used measurements in commercial building applications are temperature and pressure. As demand varies, a



temperature or pressure set point or range can typically be utilized to match demand. The use of variable speed on fans and pumps can then respond to maintain those set points or ranges. Implementing variable speed requires that a plan is in place of what will be measured, where it will be measured and what set point or range must be maintained. Without those criteria, desired energy savings will simply not be achieved.

The next step is how to communicate this set point or the reaction to the change in demand back to the ECM driving the pump or fan. A common method for control is utilizing a PID (Proportional-Integral-Derivative) control process. It sounds complicated, but the idea is to maintain a set point with input on how fast to respond to get back to the set point and how far to either side of the set point is acceptable before it responds. As an analogy, it's like driving in rush hour traffic as if it's a NASCAR race, versus drifting with traffic knowing the gap will shrink eventually.

For fixed speed systems the control methodology is often to turn the system on or off or use a type of throttle or valve. For a variable speed system, a decision must be made about where the PID control will occur. Some existing induction motor systems will have a VFD that is PID capable. In that case, the pump, fan or HVAC system may do the PID work and simply tell the VFD what to do with speed. In other cases, the VFD may do the PID control work and change speed for itself.

Many ECMs do not have onboard PID capabilities. In that case either the building system can perform the PID work, or a controller will need to be added that can do the analysis and then send the speed change information to the ECM driving the pump or fan.

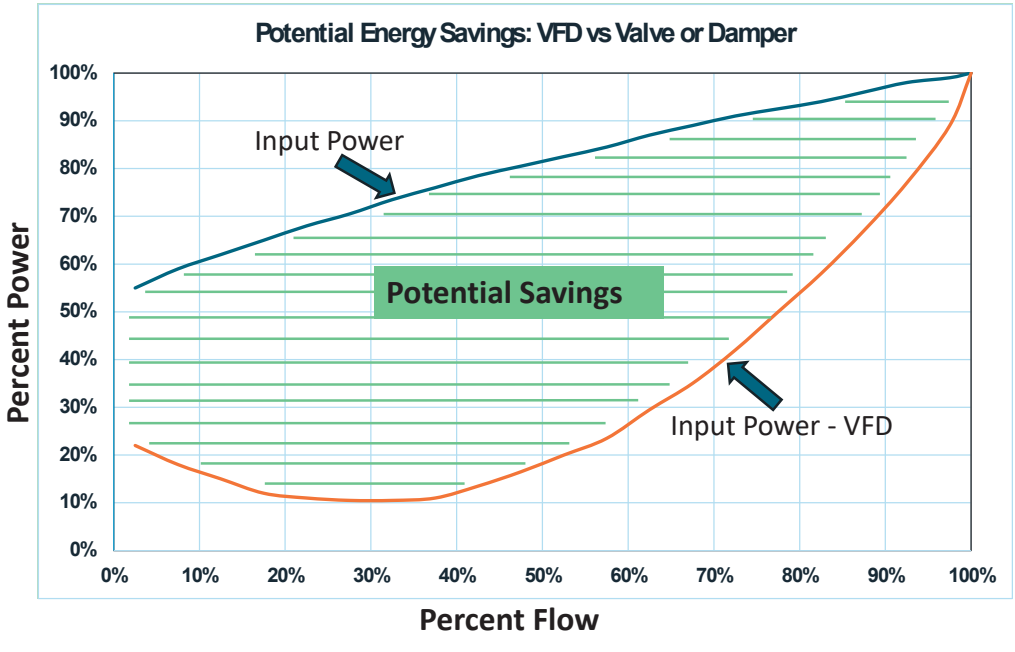
Commercial buildings use many different control communication methods. The most common analog methods are 0–10-volt DC and 4-20 ma. Digital communications methods are more varied but common protocols include Modbus and BACnet. Other control and communication methods may make it more complicated to implement variable speed in the most effective way.

The Need for Small, Compact Replacement Motors

One of the goals for most ECM installations is to ensure the motor is small and compact enough to fit into the space of an existing induction motor. This can be a challenge as the ECM includes both the motor and the drive in a single package. The challenge in size also limits the size that can be dedicated to incremental controls in the drive and, very importantly, the space allocated for connections.

Some of the analog and digital communications mentioned above require a connection to the ECM. In some cases, some of those connections could be shared to some degree but not entirely. That means that the more connections provided, the larger the ECM must

- At 70% flow, 49% input power reduction
- Even larger savings below 70%
- Similar effect for fans and compressors



be to accommodate the connections. That is counter to the goal of a small size and the requirement to fit into the existing induction motor space. The higher the level of environmental protection desired or required due to the VFD integration of the ECM makes it even more of a challenge for the ECM to have multiple connections.

Due to limited space for connections and incremental processors, most ECMs have limited communications options. Also, each additional or change in connection requires an incremental agency approval as the connection and processor are integrated as part of the ECM.

The Drive to Greater Efficiency

Regulatory efficiency increases and a desire to save energy are driving the need for increased system efficiency and reduced power usage. That push is leading the motor and drive industry to race to create new ECM products that cover new power, speed, voltage and envelope ranges with as many communication and control options as possible.

New drive technology utilizing wide-bandgap semiconductors will help in future integration capabilities but most likely will also create some new challenges as well. That said, the existing installations in the commercial building space have been built up over decades. It will take time to develop new communication solutions across the wide range of applications that utilize the older induction technology.

For the OEM and the end user, a decision will have to be made to wait for an ECM that will fit exactly the existing space and communications requirements or consider modifications in communications

to utilize an existing ECM product that may not match the current communications. Doing the latter will allow significant energy savings to start now instead of waiting for future ECM developments.



Tim Albers is Senior Director of Product Management at Nidec Motor Corporation. The U.S. MOTORS brand of Nidec encompasses a complete line of general and special purpose commercial and industrial motors, including HVAC motors for OEMs as well as replacement motors for major OEM equipment. USMotors.com



The PrecisionFlowTM ECM from Nidec/U.S. MOTORS offers up to 85 percent efficiency, an improvement of up to 30 percent over common PSC motors. These energy savings apply to both residential and commercial HVAC applications.





All Roads Lead to China for Cutting Edge Heat Pumping Technology

Over the past decade, the adoption of small diameter copper tubes (SDCT) technology has taken off—especially across Asia, where major OEMs continue to lead the charge in innovation and manufacturing excellence.

It is safe to say that Asian OEMs dominate AC appliance manufacturing. Chinese titans such as Gree, Haier, Hisense and Midea are potent forces. Japanese giants such as Daikin, Mitsubishi, Toshiba, Panasonic and Fujitsu are among the world's largest OEMs in the ACRHP space. OEMs from South Korea including LG and Samsung are also forces to be reckoned with on the global stage. Finally, Bluestar is a rising star in AC manufacturing in South Asia, where the demand for AC is rapidly escalating. Other Asian countries play a role in the manufacturing infrastructure that supports the Asian ACRHP powerhouse.

Asia is the undisputed leader in the manufacture of the whole gamut of ACRHP products. Major brands from China, Japan and South Korea dominate high volume AC manufacturing. These OEMs have broadly adopted SDCT technology to improve the performance of their products. It is noteworthy that the next meeting of the International Conference on Refrigeration (ICR) from the International Institute of Refrigeration (IIR) https://iifiir.org/en/iir-presentation will be held in Seoul, South Korea, in 2027 https://www.icr2027.org/.

Factually, China leads in the implementation of SDCT technology in the design of new products.

In addition to the major brands, scores of smaller companies are designing and manufacturing innovative ACRHP products and testing them in the domestic markets. For more about ACRHP development in China, see the article "Heat Pumps Gain Popularity in China." MGU 12-1

World class ACRHP research laboratories can be found within Chinese Universities such as Shanghai Jiao Tong University (SJTU) and University of Shanghai for Science and Technology (USST). See "In the Spotlight" column "USST Conducts Research on Heat Exchangers for Refrigerated Display Cabinets." MGU 12-1 Spotlight

Major Industry Trade shows in China include the China Refrigeration Expo (CR Expo https://www.cr-expo.com/en/); and the Appliance & Electronics World Expo (AWE, https://www.awe.com.cn/).

Another key conference is the China Heat Pump Forum (CHPF), which is presented annually by the China Heat Pump Alliance (CHPA). CHPF is the only international conference that is 100 percent dedicated to the heat pump sector. It is fast becoming a key annual event, which should be marked on the calendar of every executive, technologist or policy maker in the global heat pump industry.

The 2025 China Heat Pump Forum (CHPF) this year was motivated by the dual themes of "Promoting High-



Quality Development of the Heat Pump Industry'' and ''Assisting in the Green Transformation of Economy and Society,'' reflecting both quality and purpose. This grand event took place in Jinan, China on July 30 and July 31 with a welcome dinner on July 29. It was attended by representatives from member companies of the China Heat Pump Alliance (CHPA) as well as stakeholders in the heat pump industry from around the world.

The CHPF is a unique global venue that is dedicated exclusively to heat pumps. It includes an exhibition with heat pump systems and components on display to encourage conversations with industry stakeholders, including engineering, research and marketing professionals.

Technological advances, heat-pump applications and market developments were shared over the course of two days within seventeen sub-forums and exchange meetings, providing in-depth coverage of a broad scope of topics such as these sub-forums.

- High-Quality Development Forum of the Heat Pump Industry,
- Chief Engineer Forum on Heat Pump Technology Application, Forum on Heat Pumps Assisting in the Construction of Zero-Carbon Factories and Parks,
- Development Forum of Heat Pump Comfort Systems,
- Forum on Heat Pumps Promoting Low-Carbon Development of District Heating,
- Forum on Clean Heating and Channel Growth of Heat Pumps,
- International Policy and Market Development Forum of Heat Pumps,
- Technical Innovation Forum for Improving Heat Pump Energy Efficiency,
- Technical Innovation and Development Forum of High-Temperature Heat Pumps,





- Multi-Energy Complementary Technology Forum of Heat Pumps,
- Industrial Application Development Forum of Heat Pumps.

A keynote address was delivered at the conference by Peixue Jiang, the renowned professor in the field of heat pumps and Vice President of Tsinghua University. He pointed out that promoting the high-quality development of the heat pump industry is conducive to advancing energy conservation and carbon reduction in key areas, as well as fostering new growth points in green and low-carbon industries.

Professor Jiang put forward four hopes for the Heat Pump Professional Committee of the China Heat Pump Alliance and the entire heat pump industry: first, promote collaborative innovation among industry, academia, research, and application; second, strengthen product promotion and technology popularization; third, carry out vocational skills training; and fourth, deepen international cooperation in the heat pump field.

Professional research reports and white papers released during at the CHPF included the following:

1. White Paper on ''Industrial Heat Pump Development'' (2025)
2. Report on ''Global Heat Pump Industry Development'' (2025)
3. Report on ''China Heat Pump Industry Development'' (2025)
4. White Paper on ''Market and Technology Development of Heat Pumps for Air-Conditioning and Floor Heating Systems'' (2025)
5. ''Zero-Carbon Industry,'' and
6. ''Air-Source Heat Pump Heating Technology''

An international workshop on the importance of heat pump data for policy-making and innovation was held at the 2025 CHPF. The purpose of the workshop was to discuss international best practices around heat pump data collection and stimulate cross-learning from the Chinese experience.

Additionally, Part II of a preliminary common heat pump taxonomy was presented and discussed. This updated version was developed in consultation with various stakeholders within the International Energy Agency Technology Collaboration Programme on Heat Pumping Technology (IWA TCP HPT). An important analysis on **"The Future of Heat Pumps in China"** was published in 2024 by the International Energy Agency.

Other activities at the 2025 CHPF were the High-Quality Heat Pump Procurement and Exhibition, the Heat Pump System Application Design Competition, the Excellent Paper Award, the Friendly Football Match, the Photography Competition on Heat Pumps Assisting Green and Low-Carbon Development, and the Industry Dinner.

The success of the 2025 CHPF is playing a vital role in actively promoting the implementation of policies such as the ''Action Plan for Promoting High-Quality Development of the Heat Pump Industry,'' advancing technological progress and quality improvement, and expanding the heat pump industry.

CHPA was established in 2008 and has since become the most influential organization in the heat pump industry in China. Its mission is to promote the use of heat pump technologies for sustainable development. CHPA is a secondary professional committee under the China Energy Conservation Association (CECA). It has more than 500 enterprise members, representing more than 80 percent of China's heat pump product R&D, production, and manufacturing capacity. CHPA has a close relationship with all parties in the heat pump industry, especially heat pump manufacturers, research institutions, and government agencies, and it acts as a bridge between policy makers and manufacturers in terms of policy and standard formulation.

SPECIAL ANNOUNCEMENT

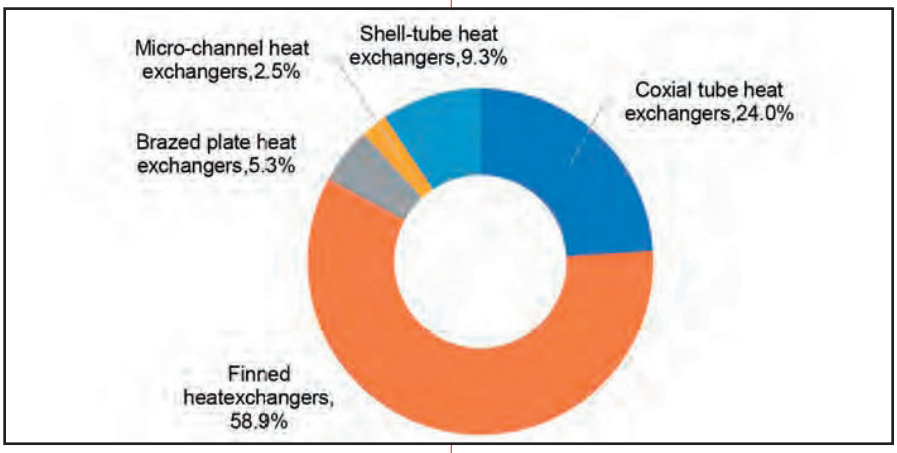
The International Copper Association (ICA) recently launched a new website to provide timely news on Small Diameter Copper Tube (SDCT) Heat Exchanging Technology. The website covers global trends in ACRHP Technology, including updates from ICA Asia, ICA Europe and the Copper Development Association in North America. It includes a Library of legacy Microgroove Update newsletters, white papers, technical articles and slideshows. The first issue of the SDCT Tech newsletter begins a new era for copper in ACRHP. It replaces the MicroGroove Update (MGU) newsletter, which began fifteen years ago when small diameter copper tube technology was just beginning to make waves in the world of heat exchangers. Now, advantaged by hindsight, we're excited to kick off this new chapter by looking at how SDCT has grown into a global game changer throughout the AC, Refrigeration and Heat Pump industries.

Subscribe to SDCT Tech newsletter here and visit www.sdct-tech.com.

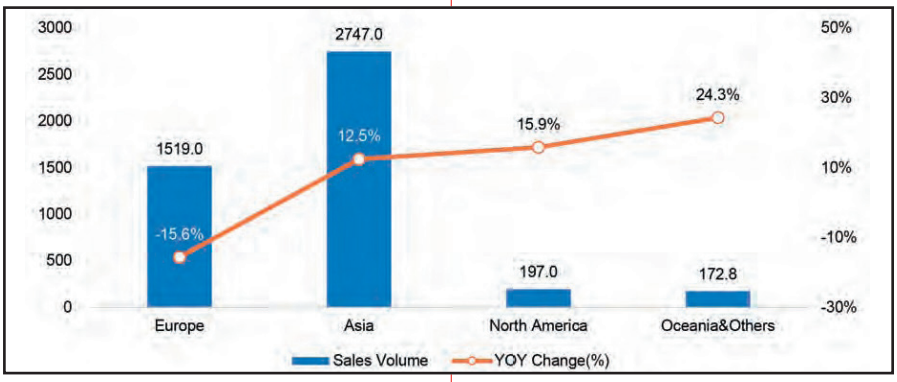
By Harry Schmitz, The Kellen Company, Washington, D.C.



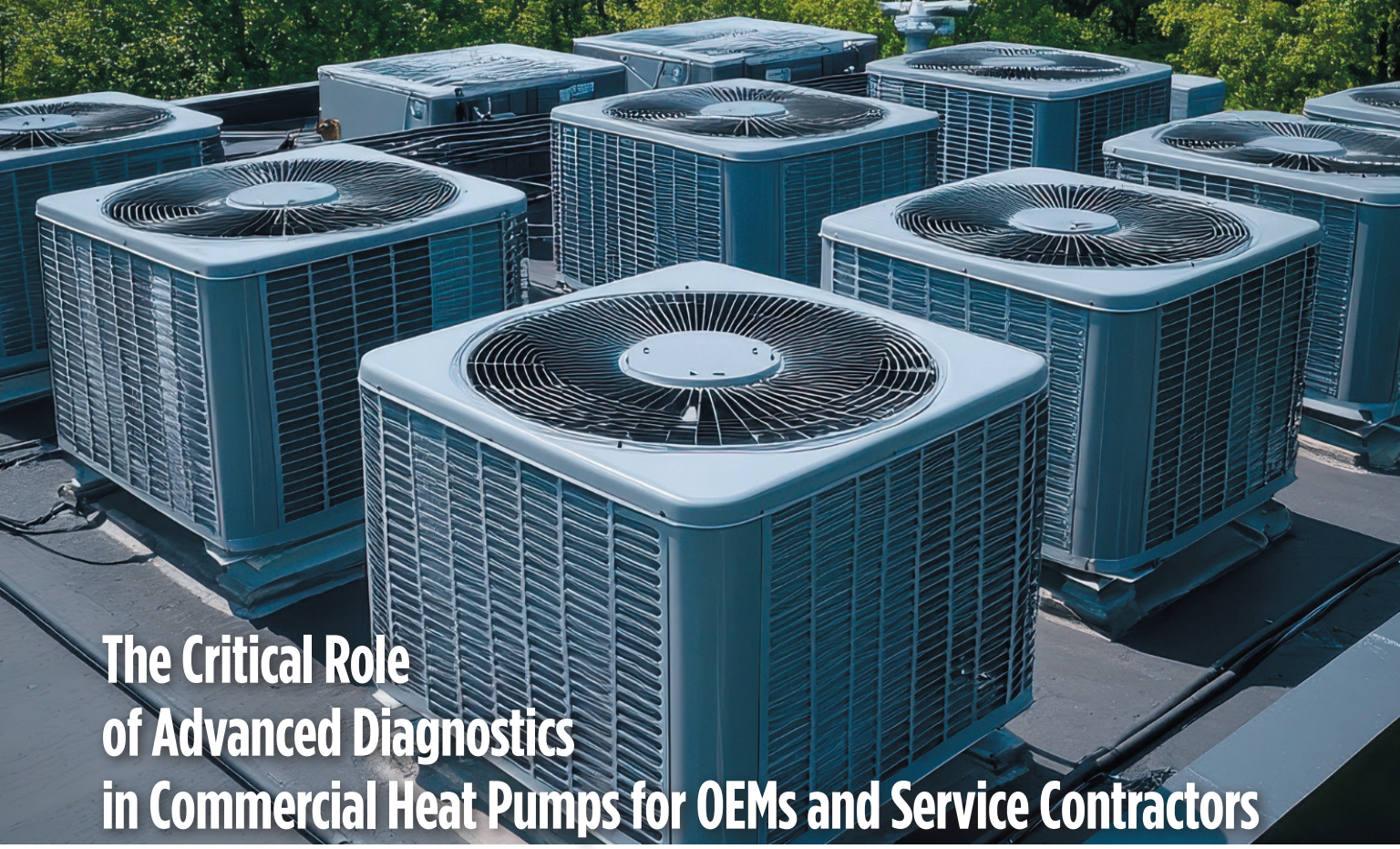
Harry Schmitz is a director of strategic communications at the Kellen Company. He was graduated Stony Brook University with a doctorate in materials science and engineering based on research completed at several national laboratories. Marketing campaigns have focused on small diameter copper tube heat exchanger technology for AC, refrigeration, and heat pumping.



The majority of heat exchangers for heat pumps harness round tubes and plate fins. Courtesy of CHPA and China IOL from "2024 Global Heat Pump Market Report."



China exports heat pumps primarily to Asian and European countries. Courtesy of CHPA and China IOL from "2024 Global Heat Pump Market Report."



The Critical Role of Advanced Diagnostics in Commercial Heat Pumps for OEMs and Service Contractors

With rising temperatures and more intense cooling needs, the heat pump industry is poised for significant growth. The U.S. Energy Information Administration projects that cooling demand will increase by about 30% in commercial buildings and 71% in residential homes by 2050, driven largely by climate warming trends [1]. This surging demand, coupled with electrification incentives, means original equipment manufacturers (OEMs) are racing to design differentiated heat pump products to capture the market.

However, incorporating advanced features like remote connectivity and integrating equipment into complex building automation systems brings new technical challenges. Commercial heat pumps in particular face heightened risks in real-world operation – from capacity overloads to control system failures, that can undermine performance and reliability if not properly addressed. To meet customer expectations for uptime and efficiency, OEMs and service contractors must lean on advanced diagnostic features as a critical tool. These built-in diagnostics can monitor system health, quickly pinpoint faults, and enable proactive maintenance, ensuring that modern heat pump systems deliver the promised efficiency and reliability.

In the following sections, we discuss common failure scenarios in commercial heat pumps and how integrated diagnostics help prevent or mitigate these issues.

System Overloading

One major challenge is system overloading when a heat pump is undersized for its application or when the building's cooling/heating load grows beyond initial design parameters. For example, if a building expands its footprint or significantly increases occupancy, an existing heat pump may struggle to maintain comfortable temperatures. Simply adding more indoor units (air handlers) onto an existing outdoor unit to meet new demand can exceed the system's capacity. The added strain of trying to condition a larger space with an undersized unit often leads to the compressor and other components being overworked. This overexertion can cause premature wear or even system failure.

Modern heat pump designs combat this by including load monitoring and calculation capabilities. These diagnostics continuously compare the system's output capacity to the building's demand. If the load consistently approaches or exceeds the unit's design limit, the system can alert operators or adjust operation to protect itself. For instance, an advanced controller might flag that the compressor is frequently hitting thermal limits or that indoor temperatures aren't being maintained, indicating

the system is undersized for the load. By identifying this condition early, facility managers can take action (such as adding capacity or redistributing loads) before an overload causes a breakdown. In essence, a heat pump with smart load diagnostics ensures it is appropriately sized (or augmented) to handle current and future needs effectively.

Faulty Control Systems



Another common source of failures in commercial heat pumps is faulty control systems, particularly thermostat or sensor malfunctions that lead to erratic operation. For instance, if a programmable thermostat or control board malfunctions, the heat pump may run continuously, cycle on and off unpredictably, or fail to run at all.

These control failures not only impact comfort and energy efficiency but can also strain the equipment. To prevent such issues, advanced diagnostic features are invaluable. A smart control system can detect abnormal operating patterns, for example, if it notices the compressor has been running without a break far beyond normal cycle lengths, or if room temperature isn't responding to HVAC commands, it can infer a thermostat or sensor fault. Some modern thermostats and controllers include self-diagnostic codes for common failures (stuck relays, sensor errors, etc.) and will display an error or send an alert when such conditions occur.

Service contractors greatly benefit from these diagnostics. Instead of a time-consuming trial-and-error approach, a technician can retrieve error codes or trend data from the heat pump's control module.

System Freezing

For commercial heat pumps, especially those in colder climates or those that use water-source loops, system freezing is a significant concern. When operating in heating mode during harsh winter conditions, large outdoor units can accumulate frost or ice. Normally, heat pumps handle this with periodic defrost cycles, temporarily reversing operation to warm the coils and melt any ice. However, in extremely low outdoor temperatures or high humidity, the defrost cycle may struggle to keep up. Ice buildup on the outdoor coil can become excessive, impairing the unit's ability to extract heat from the air or water source.

An advanced diagnostic system can check that sensors are reading correctly and that the reversing valve is switching as commanded. If not, it identifies the likely failure point (for example, "defrost sensor failure" or "outdoor coil temp not rising – possible ice blockage"). This information allows the maintenance team to respond quickly and precisely, targeting the exact issue.

Electrical Failures

Modern heat pumps are complex electro-mechanical systems, and electrical failures represent another category of problems that advanced diagnostics help manage. Issues such as faulty wiring, loose connections, or component failures (e.g. a fan motor, capacitor, or control board fault) can lead to intermittent operation or a complete system shutdown. For instance, a loose wire on a contactor might cause the compressor to randomly cut out, or a surge could trip a circuit breaker. Without diagnostics, an HVAC technician might spend hours hunting for the cause of an intermittent outage.

Heat pumps equipped with advanced electronic diagnostics can pinpoint many issues immediately. Intelligent control boards continuously monitor electrical parameters like voltages, currents, and relay states. Some units include phase and voltage monitoring that will generate an error code as soon as power irregularities occur. In the case of a shorted or open sensor

circuit, the controller flags exactly which sensor failed. All of this diagnostic information dramatically speeds up troubleshooting having the technician read an error report, guiding them directly to the electrical subsystem in question.

Service contractors no longer have to guess whether a shutdown was due to a thermostat issue, a tripped breaker, or a sensor, the system's diagnostics narrow it down automatically. This results in faster repairs and less downtime for the equipment. For OEMs, incorporating such fault detection protects the system from severe damage (by shutting it down safely when electrical anomalies occur) and provides valuable data for continuous improvement of product reliability.

Building Diagnostic Features

Embedding diagnostics at the design stage is how OEMs can ensure their products meet real-world demands. In fact, many modern HVAC units already come with onboard sensors and diagnostic software to continuously track performance metrics. These systems monitor temperatures, pressures, airflow, and electrical signals, using built-in algorithms to determine if the equipment is operating within normal parameters. When an irregularity is detected, a fault code or alert is generated, often before the issue escalates.

From the perspective of service contractors and facility managers, these diagnostic features are game changers. They provide a new level of visibility into equipment health. Rather than reacting to comfort complaints or catastrophic failures, contractors can be proactive.

Moreover, building automation integration is enhanced by these diagnostic features. When a heat pump can communicate its status and fault alerts to a central building management system (BMS), facility operators can monitor all equipment from a single dashboard. As HVAC systems become more digitally connected, the line between ''mechanical equipment'' and ''information system'' is blurring; modern heat pumps not only heat and cool, they also report on their own health. OEMs that embrace this by providing rich diagnostic information will help service contractors maintain peak performance for clients, thereby adding tremendous value in the market.

The Solution: Advanced Diagnostics and Remote Capabilities

The value of diagnostics multiplies when combined with remote connectivity. If the heat pump's controller can log key performance data and transmit it wirelessly (via Wi-Fi, cellular, or building network) to service technicians or cloud-based software, troubleshooting becomes even more efficient. Field technicians can remotely access





fault codes, trend logs, and live sensor readings through a mobile app or web portal. This remote diagnostics capability provides convenience and speed. This type of connectivity greatly reduces the diagnostic time on site and gets the system back up faster, which is a huge benefit for service contractors managing multiple client installations.

Another widely used method to transmit diagnostic data in commercial buildings is via the BACnet protocol. BACnet is an open communication standard for building automation, and leveraging it allows the heat pump's diagnostics to seamlessly integrate into the building's overall management system. This offers tremendous scalability and flexibility: multiple pieces of HVAC equipment from different manufacturers can all report their status through BACnet, enabling a unified view for facility managers By using standard protocols like BACnet, OEMs ensure that the rich diagnostic information from their equipment is easily accessible and actionable in real-world installations. In turn, service contractors can tap into the BMS to get detailed insights and historical data from the heat pump whenever they need, without physically accessing the unit. This level of integration exemplifies how advanced diagnostics contribute to smarter, more resilient building operations.

In conclusion, the incorporation of advanced diagnostics in commercial heat pumps plays a critical role in meeting the needs of both OEMs and service contractors. And more importantly, building owners and occupants benefit from improved comfort, energy savings, and minimized downtime thanks to these technologies. As heating and cooling systems continue to increase in complexity, integrated diagnostics and remote monitoring capabilities are no longer luxuries but necessities for optimal performance.

[1] Climate Central – "Hotter Climate, Higher Cooling Demand." Climate Matters Series (July 19, 2023). Projection of 71% increase in U.S. residential cooling demand and 30% in commercial by 2050.

By Georgia Roberts, Marketing Manager, AVNAN

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What's Happening

Mactac Strengthens Leadership Team with Key Executive Hire and Strategic Promotions

Mactac is proud to announce several key leadership updates designed to accelerate the company's strategic growth, drive innovation, and enhance execution across the organization.



Noelle Sieradzki joined Mactac on May 12 as vice president of sales and marketing for the Graphics and Merchant Products (Sheets) areas of the business. Her expertise in the pressure-sensitive market, combined with her collaborative leadership style and data-driven decision making, makes her an exceptional fit to drive continued growth in our Graphic and Sheet segments. She will oversee a talented team, including sales, product management and marketing for these business units. Noelle brings more than 25 years of senior leadership experience spanning commercial, R&D, quality, sourcing, and supply chain functions to Mactac. She previously held key roles at Cricut, Avery Dennison, and GE, where she led teams to deliver market strategies and product innovations that achieved substantial market share growth.



Janet Page has been promoted to director of Mactac's Technical Industrial Tapes business unit. A proven leader and a key force behind Mactac's success in the industrial tape segment, Janet has consistently delivered double-digit, year-over-year growth. Her strategic focus has driven expansion in high-growth markets, including building and construction, as well as e-mobility. Janet is an enthusiastic advocate for breakthrough developments. She recently collaborated with Mactac's internal Innovation team to advance new adhesive technologies. Her cross-functional efforts have fostered a rich culture of teamwork with customer focused synergies. Janet's leadership will continue to be a cornerstone of Mactac's strategic vision.



To further advance Mactac's strategic initiatives, **Chris Barushak** has been promoted to director of Business Transformation and Strategy, where he will spearhead many of Mactac's high-impact business initiatives, including the implementation of the enterprise-wide ERP system. Chris will work to identify and prioritize Mactac's most significant opportunities for revenue growth, operational efficiency, and customer experience improvement – reinforcing the company's long-term commitment to performance excellence.

Thermocold announces new air-to-water heat pumps



Thermocold, an Italy-based heating and cooling specialist, has announced the launch of its new air-to-water heat pumps for residential, commercial and industrial buildings.

The iMEX HP R454B uses R454B as a refrigerant, which has a global warming potential (GWP) of 466, the company noted.

"The units deliver up to 45° C leaving water at -15° C outdoor temperature and can produce sanitary hot water in the summer, with leaving water temperatures reaching up to 60° C at outdoor air temperatures between 5° C and 35° C, and 55° C at ambient temperatures between -2° C and 46° C," the manufacturer said.

Further, the system is available in five versions with cooling capacities ranging from 18.5 kW and 49.5 kW and a heating capacity of 23 kW to 59 kW.

The company added that the smallest heat pump measures 2,013 mm x 838 mm x 1,333 mm and weighs 310 kg, while the largest heat pump measures 2,167 mm x 1,117 mm x 1,802 mm and weighs 500 kg.

Additionally, the heat pumps have a coefficient of performance (COP) ranging from 3.16 to 3.35 and a seasonal coefficient of performance (SCOP) of 3.72 to 4.12.

The pump systems also feature an integrated buffer tank, a pump package and integrated inverter technology, while sound levels are roughly between 65 db(A) and 69 db(A).

"The DC inverter compressors enable power consumption savings of up to 25%, making them highly efficient even under heavy operating conditions," the company added. "The unit controller can manage up to 4 units in cascade, allowing for future expansion and optimized plant performance."

tesa Appoints Head of Industrial Trade and Converting for North American Markets



Tape manufacturer tesa announced that Matt Trute joined the organization on April 21, 2025, as head of Industrial Trade & Converting North American Markets (NAM).

Trute joins tesa after a 30-year career in B2B sales, marketing, research, engineering, and management. He brings this wealth of experience to his new role leading and driving growth at tesa's NAM Trade & Converting Partners.

Trute started his career as a technical sales representative in the adhesive tape industry in Australia. During his extensive career, Trute successfully led teams across Australia, Asia, and North America. He achieved significant career milestones such as developing and commercializing high-growth portfolios and enabling sales teams to achieve triple-digit growth rates.

Trute is excited to help tesa grow to its full potential in North America. ''I've admired the quality and professionalism at tesa for many years, so now is my chance to help others see what this brand can deliver for them,'' he said. Trute also looks forward to developing his team and giving them the opportunity to take on new challenges. An Australian native, Trute and his family live in Alpharetta, Georgia.

He earned a Bachelor of Commerce from Western Sydney University and an Executive MBA from Melbourne Business School.

MROplus—Industrial Fuse Consolidation Program

Optimize your fuse inventory, improve safety, and lower operating costs. Join Littelfuse's Materials Reduction Opportunity Program. It's free.

Reduce electrical safety hazards

The Littelfuse exclusive MROplus® Program has been helping customers increase plant safety while reducing costs, downtime and inventory for over 15 years. In this industrial fuse consolidation program, our Technical Support Group analyzes a fuse inventory list and generates detailed reports to ensure the best circuit protection is being used.

Program includes:

- A streamlined current-limiting fuse inventory recommendation that can lower electrical hazards
- A guide to further reducing electrical hazards within your facility
- An annual cost savings estimate based on inventory reduction
- A detailed cross-reference guide

Program benefits:

- Obtain superior protection to safeguard personnel and equipment
- Eliminate obsolete non-current-limiting fuses to increase safety
- Organize fuse inventory to minimize confusion and save time
- Reduce inventory and costs

The ''MRO'' in MROplus® stands for Material Reduction Opportunity. Duplicate or obsolete products and materials can be eliminated so only the products necessary for operations are maintained. MROplus now provides customers the option to cross reference to multiple types of fuses including Always Indicating, Never Indicating or Direct Cross. This reduces SKUs, gets rid of waste and ensures the best protection available.

BASF Reportedly Eyes Exit from Coatings

BASF
We create chemistry

According to recent reports from Bloomberg and Reuters, BASF is actively exploring the sale of its global Coatings division, with an estimated valuation of approximately €6 billion.

Unnamed Bloomberg sources say the company has initiated outreach to potential buyers and investment firms, sharing information about the business as it considers a range of strategic options—including a full divestment or joint venture.

A BASF spokesperson told Bloomberg news that the company is ''approaching the market to explore strategic options for the remaining Coatings activities.''

Multiple private equity firms — including Carlyle (reportedly in a potential partnership with Sherwin-Williams), Bain Capital, Advent International, Blackstone, CVC, Lone Star and Platinum Equity — are said to be evaluating the opportunity.

The division, which reported €4.46 billion in 2024 coatings sales, has recently been the subject of strategic realignment within BASF. In December 2023, the company announced plans to restructure its agriculture, battery materials and coatings businesses into more autonomous units to boost profitability. In February 2025, the company sold its decorative paints business in Brazil (Suvinil) to Sherwin-Williams for $1.15 billion.

Despite the reported sale process, BASF's Coatings division continues to pursue growth initiatives. In spring 2025, the company announced a partnership with Toyota Motor Europe to advance sustainable coating solutions for vehicle production, signaling ongoing investments in innovation.

This story of the potential sale was also covered by the European Coatings Journal, which reported that internal discussions about the future of the division are currently underway. Der Aktionär further stated that BASF has ''initiated a sale process for its Coatings business.''

BASF has not yet issued a formal press release on the potential transaction. PCI has reached out to the company for comment.

Littelfuse Launches CPC2501M Solid-State Relay IC with Integrated Chime Bypass for Video Doorbells

Self-protecting, compact design simplifies installation for IoT security systems, home, and building automation



Littelfuse, Inc. an industrial technology manufacturing company empowering a sustainable, connected, and safer world, today introduced the CPC2501M, a robust, self-actuating, normally closed solid-state relay optimized for chime bypass in video doorbell systems.

Designed to replace discrete relay circuitry, the CPC2501M is the first application-specific integrated circuit (ASIC) in the Littelfuse portfolio for this function. It integrates self-protection, fault timing, and solid-state switching into a single compact 6x6 mm QFN package—simplifying video doorbell integration while enhancing reliability and safety.

''The CPC2501M chime bypass relay enables video doorbell manufacturers to make their product work with existing house installations,'' said Hugo Guzman, Product Marketing Manager, Integrated Circuits Division at Littelfuse. ''End users can replace the doorbell button with a new video doorbell unit using the existing door chime box—no need for specialized installation or added circuitry.''

Key Features and Benefits

- Integrated self-actuating logic eliminates the need for external microcontrollers or software control
- Built-in fault protection timer (~17 seconds) automatically resets during prolonged button presses or chime failure
- High-performance switching with 60 VP bidirectional voltage and 1.84 ARMS continuous load current
- Peak current capability of 5 A for handling start-up and surge conditions
- Thermally optimized 6×6 mm QFN-16 package conserves PCB space for compact module designs
- Installable behind standard 8–24 VAC doorbell transformers

Problem/Solution

As video doorbell adoption grows, so does the challenge of powering these devices using legacy home wiring and mechanical chimes. The CPC2501M addresses this by creating a power bypass path when the chime is inactive and instantly turning off that path during doorbell operation—ensuring continuous power to the camera unit and full chime functionality without complex retrofitting.

Applications and Markets

While optimized for door chime bypass in video doorbell systems, the CPC2501M is also ideal for:

- Building automation controls
- IoT devices with voltage-controlled actuation
- Security systems requiring compact, solid-state switching
- General-purpose voltage-controlled relay designs

By integrating multiple protection and logic functions, the CPC2501M simplifies design and installation while improving durability and performance in consumer and industrial environments.

Availability

The CPC2501M Voltage Controlled Non-Isolated Solid-State Relays are available in tape and reel format in quantities of 3,000. Sample requests are accepted through authorized Littelfuse distributors worldwide. For a listing of Littelfuse distributors, please visit Littelfuse.com.

For More Information

Additional information is available on the CPC2501M Voltage Controlled Non-Isolated Solid-State Relays product page. For technical questions, please contact:

- Hugo Guzman, Product Marketing Manager, Integrated Circuits Division (SBU) hguzmanjimenez@Littelfuse.com
- Anthony Konopka, Product Marketing Engineer, Integrated Circuits Division (SBU) AKonopka@Littelfuse.com

Cleveland Controls Launches Universal Adjustable Air Pressure Switch for Multiple Applications



Cleveland Controls announced the launch of its new ANS2 series of air pressure switches, a universal, field-adjustable device developed for a wide range of applications in residential and commercial HVAC systems, industrial kitchens (hoods and fryers), outdoor radiant heating, pool and spa heating, among other uses.

The ANS2 model allows for easy calibration by using an Allen key to adjust the desired trigger point, guided by a visible scale on the device cover. It is available in three adjustment ranges:

- ANS2-1000: 0.08'' wc to 1.0'' wc
- ANS2-2000: 0.15'' wc to 2.0'' wc
- ANS2-3000: 2.0'' wc to 10.0'' wc

According to the company, its simple design makes calibration and installation easy, saving time and effort for technicians in the field.

''We have been delivering exceptional products and support to our customers for more than a century. We maintain the highest standards in materials and manufacturing, combining vast experience with constant innovation. This new version reaffirms the promise we proudly make to our customers,'' said Matt Churchill, President and Chief Executive Officer.

Waytek Names Andres Caballero CEO

Effective June 2, 2025, Caballero succeeds Charlie Kanan



as CEO, focusing on strategic expansion, technology-driven innovation and sustaining the company's commitment to customer service excellence.

Effective June 2, 2025, Andres Caballero will succeed Charlie Kanan as CEO.Waytek, Inc.

Waytek, Inc. has announced the appointment of Andres Caballero as its new CEO, effective June 2, 2025. Waytek's current CEO Charlie Kanan will ensure a seamless transition as he continues in his role as chairman of the board.

Caballero has more than two decades of experience leading complex and global organizations including Fortune 100 and multinational industrial firms. Most recently, he served as president of GF Building Flow Solutions Americas, where he guided the business through a successful acquisition and record-breaking performance. Prior to that, he held senior executive roles at Uponor and Honeywell, consistently delivering growth, operational excellence, and cultural transformation.

Caballero will lead the next chapter of growth, focusing on strategic expansion, technology-driven innovation and sustaining Waytek's commitment to customer service excellence.

Caballero holds a master's degree in electrical engineering from the University of Minnesota and serves on several boards, including the Minnesota Chamber of Commerce among others.

ASHRAE Installs 2025-26 Top Leadership



Meeting in Phoenix and emphasizing healthy buildings, Society taps newly elected President, officers, and directors.

Phoenix AZ (June 23, 2025) — ASHRAE has installed its 2025–26 Society president, along with newly elected officers and directors, during its 2025 Annual Conference in Phoenix.

Bill McQuade, P.E., CDP, Fellow ASHRAE, LEED AP, will serve as the 2025-26 Society president. In his inaugural presidential address, McQuade introduced the theme for the 2025-26 Society Year, ''Healthy Buildings: Designing For Life.'' The theme emphasizes the critical role of indoor environmental quality (IEQ) in reducing environmental impacts to the built environment while supporting healthier, more resilient communities.

''Today, shelter is more than just a roof over one's head,'' said McQuade. ''Shelter encompasses the hospitals we are born in, the homes where we find comfort, the schools where we learn, and the buildings we work in...

''A well-designed shelter prioritizes indoor environmental quality, ensuring good air quality, proper lighting, thermal comfort, acoustics and access to safe water, all essential for health and comfort. Providing safe, stable, and sustainable shelter is not just a basic human need, it is a fundamental pillar of societal advancement and long-term development.''

McQuade is vice president for government affairs and global sustainability at Baltimore Aircoil Company Inc. (BAC) in Jessup, Maryland.

Elected officers who will serve one-year terms are as follows:

- President-Elect: *Sarah E. Maston, P.E., BCxP, Member ASHRAE, Director,* Colliers Project Leaders, Hudson, Massachusetts;
- Treasurer: *Ashish Rakheja, B.E., M.Tech, Fellow ASHRAE,* Director/Chief Operating Officer, AEON, Uttar Pradesh, India.

ASHRAE introduced its newest Vice Presidents who will serve a term of 2 years (Society Years 2025–2026 and 2026–2027):

- Vice President: *Trenton S. Hunt, Fellow ASHRAE,* Vice President and General Manager For Mechanical Products, NSW, Midvale, Utah.
- Vice President: *Andres J. Sepulveda, P.E., Fellow ASHRAE,* Chief Executive Officer, Commtech, Madrid, Spain.

ASHRAE introduced its newest Directors and Regional Chairs who will serve three-year terms from 2025–2028:

- Region IV Director and Regional Chair: *Heather Platt Gulledge, P.E., MBA, Member ASHRAE,* Senior Project Manager, Dewberry, Summerfield, North Carolina;
- Region V Director and Regional Chair: *Julia Timberman, P.E., Member ASHRAE,* Sales Engineer, Air Control Products, Columbus, Ohio;
- Region VI Director and Regional Chair: *Maggie Moninski, P.E., Member ASHRAE,* LEED AP, BD+C, Senior Mechanical Engineer, SINGH & Associates, Chicago, Illinois; President and Owner, A Squared Plus Engineering Group, LLC, Westminster, Maryland;
- Region XII Director and Regional Chair: *Jason Alphonso, P.E., Member ASHRAE*, OPMP, PMP, Principal/Owner, Z Service Group, Winter Park, Florida;
- Region XIII Director and Regional Chair: *Ching Loon Ong, P.E., Member ASHRAE,* CMVP, Hon Fellow AFEO, Managing Director, Confreth (M) SDN BHD, Subang, Jaya, Malaysia;
- Region XV Director and Regional Chair: *Pankaj Dharkar, Fellow ASHRAE,* President, Pankaj Dharkar & Associates, Ahmedabad, India.

ASHRAE also introduced its newest Directors-at-Large (DALs):

- *Steve Kujak, Member ASHRAE,* Director of Next Generation Refrigerant Research, Trane Technologies, Brownsville, Minnesota;
- *Daniel H. Nall, P.E., BEMP, HBDP, Fellow Life Member ASHRAE,* FAIA, LEED Fellow, Vice President, Daniel Nall, Consultant, LLC, Princeton, New Jersey;
- *Michael A. Pouchak, P.E., Fellow ASHRAE,* Principal Development Engineer, Honeywell, St. Anthony, Minnesota.

About ASHRAE

ASHRAE is an international society of more than 50,000 heating, refrigerating and air-conditioning professionals from over 132 nations dedicated to serving humanity and promoting a sustainable world. Founded in 1894, ASHRAE is an industry leader in research, standards writing, publishing, certification and continuing education, ASHRAE and its members are dedicated to promoting a healthy and sustainable built environment for all, through strategic partnerships with organizations in the HVAC&R community and across related industries.

The Society is showcasing integrated building solutions and sustainability in action through the opening of the ASHRAE Global Headquarters building in metro-Atlanta, Georgia. For more information and to stay up-to-date on ASHRAE, visit ashrae.org and connect on Instagram, LinkedIn, Facebook, Twitter and YouTube.

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Associate Manager, Public Relations
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Eliminate Harsh Noises with UniSoft Soft-Close Adapters



Grass America, a leading supplier of functional hardware for the cabinet industry, highlights its UniSoft soft-close adapters. Mounted on the upper corner of a cabinet, UniSoft provides a soft, smooth, and quiet soft-closing action that eliminates harsh, unwelcome noises that often occur when cabinet doors are shut.

With seamless installation for both heavy and light doors, UniSoft provides an ideal solution for any cabinet door application. It can be installed at multiple stages of a cabinet's lifecycle, including the production process, the time of installation, or after the cabinet is installed to retrofit existing cabinetry.

UniSoft's wide ranging applications include door overlays for face frame cabinets and frameless cabinets on full overlay doors. Highly adaptable, it can be manually adjusted by the turn of a screw to achieve the desired closing speed.

Not only is UniSoft practical, but it is also visually appealing. The adapter is non-handed with a low profile design, and its damper is concealed in a brushed nickel casing, allowing it to blend in with a hinge finish. In this way, UniSoft combines engineering ingenuity with the beauty and simplicity that are trademarks of Grass's hardware products.



Toughened, UV Curable Adhesive Features Optical Clarity

Master Bond fast curing, single component UV curable adhesives, sealants, coatings, potting and encapsulation compounds speed productivity and efficiency. They offer excellent adhesion to glass, metals, ceramics, rubber and most plastics. These one part products require no mixing and eliminate waste. Learn more:

Advantages of Master Bond UV Curable Compounds

- Extremely fast processing time
- Formulated in rigid, semi-flexible and flexible grades
- Available in syringe applicators
- Environmentally safe, no emittance of volatiles or vapors
- Prolonged storage at room temperatures

Features and Properties of UV Curing Systems

As with all products in the Master Bond family, specific grades vary in viscosity, hardness, thermal and electrical properties, but can be customized to fit your application needs.

Free radical and cationic UV curing systems are available for use. They contain a variety of oligomers, monomers, additives and photoinitiators. These liquid blends polymerize when exposed to the proper wavelength/intensity of UV light. In many cases cure speed is in seconds to several minutes and the adhesive can be employed for exact positioning. These cure on demand formulations require no heat and shorten customer lead times, improving their competitiveness/profitability in the marketplace.

From disk drives to semiconductor manufacturing to automotive electronics to displays to printed circuit boards our comprehensive line of UV curing epoxies, acrylates, urethanes are leading the way in reducing labor/assembly costs. These products can be conveniently dispensed manually/automatically and require little manufacturing space. Select systems exhibit excellent thermal stability, low shrinkage, optical clarity, resistance to thermal cycling, chemicals, moisture, solvents while meeting safety, health and ecological concerns. Special grades have secondary heat cure mechanisms for shadowed out areas and nanosilica fillers for enhanced performance.

Rigid UV and Dual Curing Adhesives

Rigid light curing products cure on demand for precise alignment between substrates requiring exact positioning. They feature good wetting properties and high optical clarity. UV curable hardcoats guard clear plastic substrates such as polycarbonates, polymethylmethacrylates from scratching, common chemicals, staining. They are employed on automotive headlights, touchscreen displays and safety glasses. Nanosilica filled UV curing and dual UV/heat cure products have been developed for advanced performance requirements. It is important to note that dual cure products will cure effectively in ''shadowed out'' areas with moderate heat exposure. They have successfully passed NASA low outgassing specifications and can cure in thicknesses of a few microns to about 1/8 inch.

Fluorescent UV Curable Compounds

Specific grades containing a blue fluorescing agent can be employed to improve quality control. Cured UV curing products can be inspected using a ''black light''. They are often used for positive identification/authentication. This can be addressed manually. The blue fluorescing agent contrasts well with multiple substrate/components and enables easy inspection even for deep curing materials. A limited quantity of the fluorescent agent is added and performance/processing characteristics including depth of cure are unaffected by their addition. Electro optic automatic devices have enabled increased design complexity and recognition of voids that can be harmful in bonding/conformal coating applications. The ''glow'' from the fluorescence of UV cured systems has been essential in enhancement of processing speeds, in ensuring reliability, eliminating any defects while meeting target specifications. Upon request, blue fluorescing agents can be incorporated into other Master Bond UV cure products.

Ziehl-Abegg Inc. proudly announces that Carmen Deese, Director of Human Resources, has been named one of Triad Business Journal's Outstanding Women in Business for 2025.

This prestigious recognition honors women in the Triad region who demonstrate exceptional leadership, vision, and impact in their industries and communities.

Deese was formally honored at a ceremony held on April 23, 2025, where she joined a distinguished group of professionals recognized for breaking barriers and driving meaningful change across business, government, and nonprofit sectors.

In her role at Ziehl-Abegg, Carmen has been instrumental in building the North American HR infrastructure to support the company's rapid growth. Her leadership was pivotal during the opening of Ziehl-Abegg's new North American headquarters in Winston-Salem—a facility that represents the company's single largest global investment to date

Carmen has championed a culture of inclusivity, mentorship, and continuous development

Beyond organizational growth, Carmen has championed a culture of inclusivity, mentorship, and continuous development. She created and implemented workplace policies that support the whole employee—

including expanded parental leave, a floating holiday, and other family-friendly benefits—which led Ziehl-Abegg to earn Family Forward NC Certification in 2024.

That same year, her commitment to shaping a supportive and forward-thinking workplace earned her the inaugural HR Impact Award from the Triad Business Journal. Through these initiatives, she has strengthened employee engagement, enhanced workplace culture, and helped position Ziehl-Abegg as an employer of choice.

''Carmen's passion for people and her ability to build systems that empower our workforce make her an extraordinary pioneer,'' said Jimmy Mitchell, Managing Director of Ziehl-Abegg Inc. ''We're incredibly proud to see her honored for the lasting impact she's making not just within our organization, but across the region.''

Reflecting on the award, Carmen shared: ''It's a privilege to be recognized among such a remarkable group of women. I'm proud to work for a company that values innovation and people equally—and that's where transformation happens.''

In addition to her volunteer work, Carmen frequently serves on local business and industry panels

Carmen's leadership extends beyond Ziehl-Abegg. She is deeply committed to giving back to the community, volunteering with organizations such as the Kellin Foundation, which supports mental health and resilience, and the Choral Arts Collective, where she contributes to fostering arts and culture in the Triad.

In addition to her volunteer work, Carmen frequently serves on local business and industry panels, advocating for initiatives that strengthen the regional talent pipeline and bring critical workforce development topics to the forefront.

Through her community engagement, she continues to champion broader access to education, career growth, well-being, and cultural enrichment across the region.

Ziehl-Abegg congratulates Carmen on this well-deserved honor and celebrates her continued commitment to shaping a stronger, more inclusive manufacturing workforce.

Series HCC and HCD HVAC/R Solution Meeting the Need for A2L Low GWP Refrigerants



Looking for a safe and reliable solution to control your HVAC/R systems that meets the current A2L refrigerant regulations? Littelfuse HCC and HCD definite purpose contactors are the answer. These electromechanical switching devices are expertly designed and engineered to meet the demands of heating, ventilation, air conditioning, and refrigeration systems.

Key Benefits:

- High Performance: Designed to handle high-current circuits with ease, ensuring top-notch performance for both inductive and resistive loads.
- Versatile Applications: Ideal for compressors, pumps, electric heating, and lighting systems.
- Durability: Designed with consistent silver thickness for increased product life.
- GWP Compliance: Meets the latest global warming potential (GWP) standards, ensuring your systems are environmentally friendly and compliant with new regulations.*

*The HCC and HCD series comply with the A2L refrigerant requirement of UL Category Control Number LZGH2/8 for Annex JJ of UL 60335-2-40.

AHRI, HARDI Sue to Stop NY Refrigerants Ban



New rules lack clarity, put strain on firms already working to comply with federal HFC phasedown, suit argues.

Heating, Air-conditioning & Refrigeration Distributors International (HARDI) and the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) have jointly filed a lawsuit against the New York State Department of Environmental Conservation (NYSDEC), challenging recent amendments to New York regulations that impose sweeping bans and restrictions on the refrigerants used in air conditioners, heat pumps, refrigeration, and water heaters.

The amended regulation, 6 NYCRR Part 494, which took effect earlier this year, significantly expands prohibitions on the sale, use, and installation of products containing hydrofluorocarbon (HFC) refrigerants in New York. HARDI and AHRI's legal complaint, filed in the New York State Supreme Court, argues that the NYSDEC did not follow the Climate Leadership and Community Protection Act (CLCPA) and failed to adhere to required administrative procedures in implementing the revised rule.

''Our members are committed to reducing the environmental impact of refrigerants,'' said Talbot Gee, CEO of HARDI. ''However, the amended Part 494 rules are overly aggressive, lack clarity, and put unnecessary strain on businesses that are already working to comply with federal HFC phasedown requirements under the AIM Act. HARDI firmly believes that regulators must follow the law, and the best interest of the industry is to follow a single

nationwide phasedown to prevent increased consumer costs.''

AHRI, the trade association representing HVACR and water heating equipment manufacturers, echoed these concerns. ''Our member companies take significant pride in providing affordable, energy efficient, essential products and equipment that ensures the health, safety, productivity, and comfort of consumers in New York and all across the nation,'' said Stephen Yurek, President and CEO of AHRI. ''Long before New York proposed its amendments to Part 494, AHRI members had already invested billions of dollars in developing next-generation refrigerant technologies. New York's regulations introduce additional costs and complexity into an ongoing transition and risk undermining the climate benefits already being achieved through these advancements.''

The lawsuit asserts that NYSDEC's amended rule conflicts with the federal regulatory framework established under the American Innovation and Manufacturing (AIM) Act, administered by the U.S. Environmental Protection Agency (EPA), in contravention to the requirements included in the CLCPA. It also highlights the lack of adequate public engagement and economic analysis required under New York law.

HARDI and AHRI are seeking to invalidate the revised portions of Part 494 and halt enforcement until the rulemaking process can be re-evaluated with proper stakeholder input and legal grounding that follows the EPA timelines.

20 Years Strong: ZIEHL-ABEGG Inc. Expands North American Operations with New Facility



Shaping the Future of Ventilation in North America

ZIEHL-ABEGG Opens Cutting-Edge Manufacturing Hub in North Carolina

Ribbon Cutting Ceremony Celebrates Major Investment and Job Creation in Winston-Salem.

Ziehl-Abegg Inc., a global leader in ventilation and fan technology, proudly announces the successful grand opening of its new North American manufacturing headquarters in Winston-Salem, North Carolina. The event was a resounding success, marked by a ceremonial ribbon cutting and inspiring speeches from key figures, including Mayor Allen Joines of Winston-Salem, CEO Dr. Marc Wucherer, and Managing Director Tobias Stein.

The grand opening event drew dignitaries, industry leaders, and stakeholders from across the region, all eager to tour the state-of-the-art facility and witness firsthand the cutting-edge technology and innovative processes that define Ziehl-Abegg's operations. The new headquarters represents the largest single investment Ziehl-Abegg has made in any location, underscoring the company's commitment to the North American market and its vision for future growth.

Mayor Allen Joines, a special guest at the event, praised Ziehl-Abegg's investment in Winston-Salem, highlighting the positive impact on the local economy and the creation of new job opportunities. ''Ziehl-Abegg's commitment to our community is commendable. This new facility will not only drive economic growth but also provide valuable employment opportunities for our residents,'' said Mayor Joines.

''We are thrilled to celebrate the opening of our new North American headquarters,'' said Tobias Stein, Managing Director of Ziehl-Abegg Inc. ''This state-of-the-art facility enhances our ability to respond quickly to the evolving needs of the North American market, ensuring we can deliver innovative, high-quality solutions tailored specifically for our customers here. It signifies our commitment to not only expanding our footprint but also to fostering local economic growth. As we continue to grow into this new facility, we look forward to hiring more people from the local community, creating new opportunities, and driving sustainable development. We are excited about what the future holds and are dedicated to driving forward with excellence and sustainability.''

CEO Dr. Marc Wucherer also addressed the attendees, emphasizing Ziehl-Abegg's dedication to innovation, sustainability, and community partnership. ''Our new headquarters is a testament to our belief in the potential and promise of this region. With integrated on-site research and development, we are uniquely positioned to respond swiftly to our customers' needs and to drive continuous innovation,'' said Dr. Wucherer.

For media representatives who could not attend, a comprehensive press kit is available, including high-resolution images from the event, detailed company background information, and exclusive quotes. These materials can be accessed in the following pages. Ziehl-Abegg looks forward to a bright future, filled with growth, innovation, and continued partnership with the Winston-Salem community.

Quotes from Leadership

Jimmy Mitchell, VP of Operations

''Breaking ground on this new facility was a monumental step for Ziehl-Abegg. With this $108 million investment, we're not just expanding our footprint—we're expanding our capabilities to serve our customers better and faster.''

''We've built this facility with the future in mind. It's designed to be flexible and adaptable, so we can continue to innovate and meet the evolving needs of our customers.''

Florian Braun, VP of Sales and Marketing

''Bionic engineering is at the core of what we do. Our new home provides the ideal environment to continue pushing

the boundaries of this technology and develop even more groundbreaking products. The new R&D center is a game-changer for us. It gives us the space to innovate and develop solutions tailored to the unique challenges faced by our customers across North America.''

''With this expansion, we are demonstrating our commitment to the North American market. By increasing our production capacity, we can better meet the growing demand for our innovative solutions. We are excited about the opportunities this new facility brings to strengthen our position as a leading provider of fan and drive technology.''

Gregg Schmidt, VP of Compliance

''Our nationwide search led us right back to where we belong—in North Carolina. The support we've received from local governments and the community has been incredible, and we're proud to call Forsyth County home.''

''Finding the right location for our expansion was a strategic decision. Winston-Salem offered the ideal combination of business-friendly environment, skilled workforce, and a strong commitment to economic development.''

Carmen Deese, Director of Human Resources

''Since announcing our move, we've not only retained our employees but have grown our team by 50%. This is a direct reflection of the positive work environment and the opportunities for career advancement we offer.''

''Ziehl-Abegg's expansion is creating a wide array of job opportunities, from CNC operators and welders to engineers, financial professionals, quality-control specialists and logistics experts. We're building a workforce that will drive our success for years to come.''

Shane Cornuet, Director of Finance

''As we continue our localization efforts, we're not just investing in the future of Ziehl-Abegg— we're investing in the future of American manufacturing. Producing more of our products in the US is a key part of our strategy to reduce costs and meet our carbon-neutral goals. This facility is a major step toward achieving those objectives.''

''This expansion aligns perfectly with our financial strategy. By increasing our production capacity and bringing more processes in-house, we will improve our cost structure and serve our customers better.''

Exhale Fans Launches Gen. 5 of the Most Efficient HVAC Delivery System, Granting Users 10% Energy Savings While Maintaining Thermal Comfort

World's only bladeless ceiling fan, with efficiency backed by Purdue, features updated longevity, performance and advancements in lighting

Exhale Fans, the creator of the most efficient HVAC delivery system produced by the world's only bladeless ceiling fan, today officially announced Gen. 5 of its energy saving flagship product, which benefits were previously identified in a Purdue University study. Substantial advancements raise the bar on energy efficiency by giving users the cleanest and most



seamless way to maintain human thermal comfort while saving 10% on HVAC energy costs, with no renovation to current installed systems required.

Gen.5 features new motor construction, LED, remote, wall switch and new PCB, which provides a more robust and streamlined experience for offices, hotels, airports, data centers, restaurants, schools, homes and indoor spaces.

''There is a very serious need for employing truly energy efficient technologies for structures of all types – residential, commercial, and public – especially regarding HVAC as we move closer to summer,'' said Richard Halsall, CEO of Exhale Fans. ''The opportunity to secure energy cost savings through Gen. 5 of our fan, all without having to reinvent the wheel in terms of structural design or equipment replacement, deems it a very important investment that has a great deal of long-term potential. Once Gen. 5 is installed, savings are immediately realized. This is proven by Purdue University's Herrick Laboratory, not just my words.''

Gen. 5 delivers truly balanced room temperature from floor-to-ceiling and wall-to-wall for all seasons, for which the previous generation is known, with a design to complement the layout and style of any room. Notable advancements include:

- Increased durability of materials: The motor is built with stronger materials for smooth operation. Bearing size is doubled with thicker metal for the center shaft and motor shell to support operational stability and long life.
- Motor protection and warning system: The motor will not operate if conditions are not normal (e.g, fan locking that could cause overheating, line voltage that is too high or too low), providing an audio warning.
- More efficient operating speed: Greater efficiency of operating speed coupled with speed stability equates to no speed reduction which often occurs with other fans on the market.
- Color selectable with brighter LED light: Warm White or Cool White LED color can be selected at the press of the remote. Four color combinations are available with an increase to 1200 Lumens. The LED is ''Full Range Dimmable''.
- Tactical push button remote: Lighted and audio response provides feedback when each command is selected. New radio transmitting remote features a long battery life, and a positive push button assures positive



Mastering High Voltage:
The Importance of Accurate Test Equipment

Accurate definition and measurement of critical electrical performance parameters are essential for ensuring the reliability and safety of high-voltage equipment and cabling. For applications which can involve tens of thousands of volts, safety risks are high, as are the demands on the test equipment used to measure the equipment and cables.

Proper calibration of the test instruments themselves is critical to achieving the strict performance needs of many equipment types. Calibration results must often meet national and international specific standards, and calibration measurements are typically conducted by certified laboratories with traceability to national standards, like those maintained by the National Institute of Standards and Technology (NIST). This article delves into the importance of high-voltage test equipment calibration and the meticulous considerations required to ensure measurement accuracy.

High-Voltage Measurement Techniques



Figure 1. Many types of equipment are used for high-voltage measurement.

Each of the various techniques for high-voltage measurement has unique advantages and needs to be calibrated using different techniques:

- Step-Down Transformers reduce high voltage to lower, more manageable levels for measurement.
- Capacitive and Resistive Voltage Dividers divide the voltage proportionally.
- Series Resistance (Microampere Measurement): Measures current through a high resistance in series with the voltage source.
- Analog Style Measurement Devices:
  - Sphere Gaps measure the voltage by observing the breakdown voltage between two spheres.
  - Electrostatic Measurement quantifies the electrostatic force between two plates.

Why Measure High Voltage?

Measuring high voltage is increasingly important as technology advances. High-voltage systems reduce current carrying requirements and minimize energy loss. Also, in many cases, voltage values determine system performance. This means the voltage sources must be accurate and reliable in order to meet systems specifications. Also, monitoring systems need to be in place to ensure that the systems perform reliably from end-to-end and year-to-year.

High-Voltage Applications by Industry

- High voltage, defined here as 1 kV to 150 kV (AC or DC), is used across various fields, including:
- Analytical Instruments: Mass spectrometers and photomultiplier tubes.
- Defense and Aerospace: Radar systems, CRT displays, and flight simulators.
- Homeland Security: Baggage inspection and explosive detection equipment.
- Inspection and Non-Destructive Testing: Systems that ensure the integrity of materials and structures.
- Manufacturing Processes: Like electron beam welding and electrostatic coating applications.
- Medical and Biotechnology: X-ray and radiographic equipment.
- Research Laboratories: Products like detectors, accelerators, and other large-scale analyzers.
- Semiconductor Equipment: Essential for ion implantation and sputtering processes.
- High Voltage Power Supplies: Fundamental in many industrial applications.
- RF Generators and Matching Networks: Used in telecommunications and broadcasting.
- Power Distribution: Critical for corona detection and cable insulation testing in electrical cables and harnesses, be they in utility networks, manufacturing plants or campuses.

Accurate high-voltage measurement is essential in these sub-systems to ensure operational efficacy and safety. Devices requiring high-voltage measurements include:

- Hipot Testers: Ensure the integrity of electrical insulation.
- X-Ray Power Supplies: Validate performance for medical and industrial imaging.
- Ion Implantation Systems: Regulate electrical systems for precise particle acceleration.
- Energy Transmission Sub-Stations: High voltages in power grids enhance efficiency and reduce losses.

Safety Considerations

Calibrating high voltages is important for safety considerations:

- Establishing appropriate earth ground conductivity prevents dangerous ground loops.
- Ensuring sufficient clearance avoids unintended flashovers.
- Proper barrier positioning protects people from high voltage areas under all conditions.
- Means to discharging stored energy in voltage systems ensures safe adjustments.
- Following Manufacturer Guidelines: Adherence to recommended practices minimizes risk.

High-Voltage Test Equipment Calibration

Calibration Standards and Accreditation

ISO/IEC 17025:2017 outlines the general requirements needed for calibration and test laboratories to be deemed technically competent to perform calibrations. Additionally, standards like ANSI/NCSL Z540-1-1994 are also recognized in the industry by defining measurement uncertainty criteria. Accredited labs undergo regular assessments to maintain their certifications. These ensure that their procedures, environment, and personnel meet high standards of competence.

Ensuring Measurement Uncertainty

When calibrating high-voltage test equipment, it's essential to account for all sources of measurement uncertainty, including:

1. **Equipment Accuracy and Precision** — Every measuring instrument has a specified accuracy, often expressed as a percentage of the reading or a fixed value. Precision, on the other hand, refers to the instrument's ability to produce consistent readings over repeated measurements. Regular calibration ensures that both accuracy and precision are maintained, aligning instrument performance with its specified tolerances.
2. **Signal Type and Frequency** — High voltage measurements can be affected by the type of signal (AC or DC) and its frequency. AC signals, especially at high frequencies, can introduce additional errors due to reactive components in the measurement system. It is crucial to ensure that the measurement accounts for this reactivity so that its accuracy is maintained.
3. **Calibration Procedures** — Calibration involves comparing the instrument's measurements to a known standard by making necessary adjustments. This process must be performed in controlled environments to minimize external influences. Calibration intervals depend on the instrument's usage and the criticality of its measurements. Optimal intervals are usually recommended by the manufacturer.
4. **Environmental Effects** — Environmental conditions such as temperature, humidity, and altitude can significantly impact measurement accuracy. For instance, temperature fluctuations can cause expansion or contraction of

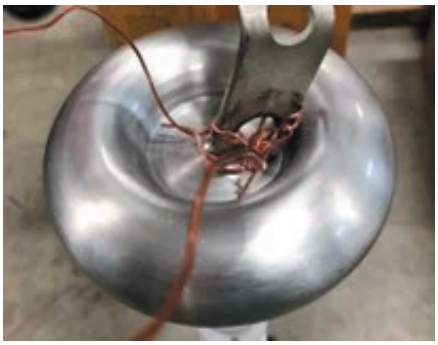
materials, affecting the physical dimensions of components and thereby the measurement. Humidity can influence the conductivity and dielectric properties of insulating materials, while altitude changes can alter the air density, affecting high-voltage discharge characteristics.

5. **Cabling and Connections** — High-quality cables and secure connections are essential for accurate high-voltage measurements. Poor connections can introduce resistance, leading to voltage drops and inaccurate readings. Additionally, cables should be chosen based on their voltage rating and insulation properties to prevent leakage currents and ensure safety.
6. **External Influences** — Uncontrolled variables, such as EMI and corona discharges, can introduce significant errors in high-voltage measurements. EMI can be mitigated by using shielded cables and maintaining proper grounding. Corona discharge, caused by ionization of the air around conductors, can be reduced by using smooth, rounded connections and avoiding sharp points that can concentrate the electric field.

Corona and Connections

Corona discharge is a common source of error in high-voltage measurements. It occurs when an electrical discharge ionizes the surrounding air, often at sharp points or within air gaps in insulation. To minimize corona:

- Smooth out connection points to reduce the risk of discharge.
- Use larger diameter wires to reduce electric field strength around conductors.
- Maintain ample separation between high-voltage components.
- Use continuous insulation without gaps to prevent internal discharges.



Fields and Interference

High voltages generate substantial electrical fields which can be influenced by nearby objects, including the operator. External electrical interference from sources like radio stations and military installations can also impact measurements. To mitigate these effects:

- Keep measurement setups away from potential sources of interference.
- Employ proper shielding techniques to protect against external fields.
- Avoid movement of objects or personnel near the measurement area during testing.

Total system uncertainty encompasses all potential sources of error in a measurement setup. This includes:

- Device and Divider Errors: Each component in the measurement system introduces its own level of error.
- Operator Bias and Location Effects: The experience of the operator and the measurement environment can affect results.
- Software Influence: Ensure the software used for data collection and analysis is accurate and reliable.

High-Voltage Test Equipment Needs to Fit the Application

The types of devices used in standards and calibration labs worldwide can provide simultaneous AC/DC voltage, frequency, peak-to-peak, and crest factor readings. In commonly used equipment like the Vitrek 4700, the meter measures up to 10kV directly and up to 150kV with their proprietary Smart Probes. It also provides a chart mode for graphic documentation of high voltage drift, ramp time, overshoot, and sag — key variables that can define failure.

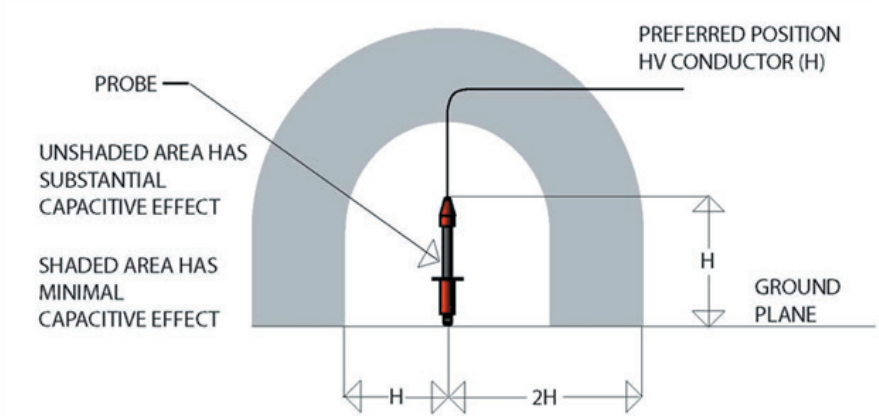


Figure 3. Diagram showing influence of external fields on high voltage.

Example @ 5kVDC Direct Input:

(0.03%*5000V = 1.5V) + 0.03V + 0.05V (1/2 0.1 V Resolution)

Base Accuracy — Floor — Resolution

+ ((1.5ppm * 5^2) * 5000 = 0.1875V) = 1.7675V

Self-Healing — Total

Accuracy calculations for equipment like the Vitrek 4700 are valid for one year from calibration. The accuracy specifications include the measurement uncertainties in the standards and methods employed by the manufacturer during calibration of the tester and probes. Measurement accuracy specification comprises base accuracy, floor, resolution, and high voltage self-heating specifications. For direct measurements, no additional calculations for accuracy at the terminal are required.

Performance and Automation

The best of the available test equipment utilizes Digital Signal Processing (DSP) technology that can provide outstanding AC and DC voltage accuracy, stability, and resolution. A simple example of such DSP is signal averaging, which can improve measurement precision or stability. Ideally, the device should support test automation with built-in Ethernet and high-speed serial communication ports, making it fully programmable for tailored testing requirements. Some equipment, like the Vitrek 4700, include a USB printer port for capturing readings and obtaining hardcopy printouts of high voltage plots. This meter and its SmartProbes come with an ISO17025 accredited calibration certificate, ensuring accuracy and traceability.

The Role of Accredited Laboratories

Accredited laboratories play a crucial role in maintaining measurement accuracy. These labs provide traceability to national and international standards, ensuring consistent and reliable calibration. For instance, Vitrek's calibration lab is accredited by the American Association for Laboratory Accreditation (A2LA) to ISO 17025:2017 and ANSI/NCSL Z540-1-1994 standards. This ensures that all measurements are traceable to the International System of Units (SI) via national metrology institutes like NIST and NRC.

Conclusion

The calibration of high-voltage test equipment is not just a technical necessity but a cornerstone of safety and reliability. By adhering to rigorous standards and meticulously accounting for all sources of measurement uncertainty, we can ensure that high-voltage systems operate with precision and dependability. Accredited labs play an indispensable role by providing the expertise and traceability needed to uphold high standards. As technology advances, the importance of accurate high-voltage measurements will only grow, making it essential for industries to invest in proper calibration practices. Ultimately, mastering high-voltage measurement is about safeguarding both the equipment and the people who rely on it, ensuring a safer and more efficient future for all.

For information on Vitrek's High Voltage Test Equipment, visit us online at Vitrek.com, email info@vitrek.com, or call (815) 838-0005.

Author: Bryan Withers, Vice-President, Engineering - Vitrek, LLC



Selecting Optimal Overcurrent Protection for Your Next Appliance Design

The choices vary, from traditional fuses to PPTCs and eFuses, but what is the best option?

Overcurrent protection is essential in all electronic products, including appliances, to safeguard components from damage caused by excessive current, such as short-circuit conditions. Several technologies exist for this purpose. The components these technologies represent are traditional fuses, Polymer Positive Temperature Coefficient (PPTC) devices, and electronic fuse integrated circuit load switches (Littelfuse® models are known as eFuses). These protection technologies, shown in **Figure 1**, have unique characteristics that make them suitable for different types of appliances. This article compares traditional fuses, PPTC devices and eFuses in terms of functionality, performance, and application suitability, to help engineers select the proper protection device for their appliance designs.

Basic Functionality and Reset Mechanism

Overcurrent protection devices differ in their response to faults and their reset behavior.



Figure 1. Traditional fuses, PPTC fuses, and an eFuse

Traditional Fuses are single-use devices that the end user must physically replace once they have blown, making them suitable for applications where failures are infrequent or fail-open scenarios are required.

Traditional fuses operate on the principle of thermal disruption, utilizing a fusible element that melts when subjected to overcurrent conditions exceeding the device's rating. This irreversible process creates an open circuit, effectively isolating the protected circuit from the fault condition.

The primary advantages of traditional fuses include reliable performance in high-current fault scenarios, predictable time-current characteristics, and minimal steady-state power consumption—their simple construction results in low manufacturing costs and defined thermal characteristics across wide temperature ranges. There are numerous types of fuses. Models protect small and large appliances with a wide range of current and voltage ratings. The fuses can have fast operation or a time-delay operation to withstand an inrush current. For small appliances, fuses can have surface mount packaging to automate printed circuit board (PCB) assembly and save PCB space.

PolySwitch® PPTC (Polymer Positive Temperature Coefficient) devices utilize the thermal properties of conductive polymer materials to provide resettable overcurrent protection. Under normal operating conditions, the polymer maintains a low-resistance state, allowing designed current flow. When overcurrent conditions cause the device temperature to exceed its switching threshold, the polymer transitions to a high-resistance state, effectively limiting current flow to safe levels.

The automatic reset capability of PPTC devices eliminates the need for manual intervention once fault conditions are removed and the device cools to its normal operating temperature.

PPTC fuses have low voltage ratings, enabling their use in portable small appliances or low-voltage DC circuits in large appliances. Compared with fuses, PPTC response time is generally slower and may not be suitable for applications requiring precise control.

The **eFuse protection ICs** offer the most sophisticated approach to overcurrent protection. They allow for electronic reset, remote control, and programmability, making them suitable for applications that require robust and intelligent protection.
In addition to overcurrent protection, eFuses incorporate protection against overvoltage and overtemperature. Models also provide soft start protection against inrush current and have an undervoltage lockout (UVLO) feature.

The eFuses excel in space-constrained applications where integration density is critical. By combining multiple discrete protection functions into a single device, eFuses reduce component count, simplify PCB layout and improve overall system reliability through reduced interconnection complexity.

However, eFuses may not be the best choice for all scenarios. They are limited to low-voltage DC circuits. In comparison to simpler devices like traditional fuses or PPTCs, the increased complexity and power consumption of an eFuse can be drawbacks, especially in

	Traditional Fuse	PPTC Fuse	eFuse
Reset Capability	No	Yes (thermal)	Yes (electronic)
Response Time	Fast or slow	Moderate	Fastest
Programmability	None	None	Yes
Multiple Protection Functions	None	None	Overvoltage, Overtemperature, UVLO, Soft start, Reverse current blocking
Cost	Low	Medium	High

Table 1. Key features comparison of traditional fuses, PPTC fuses, and eFuses

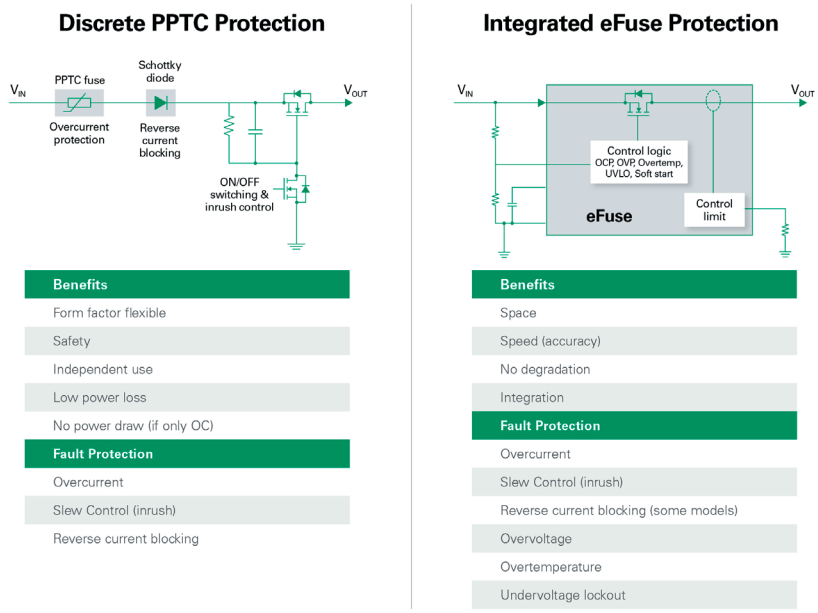
cost-sensitive or ultra-low-power small appliances. Additionally, eFuses may require firmware or microprocessor (MCU) support to unlock their complete feature set, which might not be economically feasible for low-cost portable appliances.

Each type of overcurrent protection device has its advantages and limitations. **Table 1** summarizes the features of traditional fuses, PPTC fuses, and eFuses.

Discrete Component Approach vs. Integrated Solutions

A discrete component approach involves using separate protection elements, such as PPTCs or traditional fuses, often combined with a load switch or MOSFET, to enhance control and protection. This approach offers design flexibility but necessitates the addition of circuitry to achieve comprehensive protection. It is commonly used in cost-sensitive applications or when a designer prefers modularity. **Figure 2** ***(left side)*** illustrates a typical discrete protection circuit, which utilizes a PPTC device for overcurrent protection, a Schottky diode for blocking reverse current, and external circuitry for ON/OFF switching and inrush control.

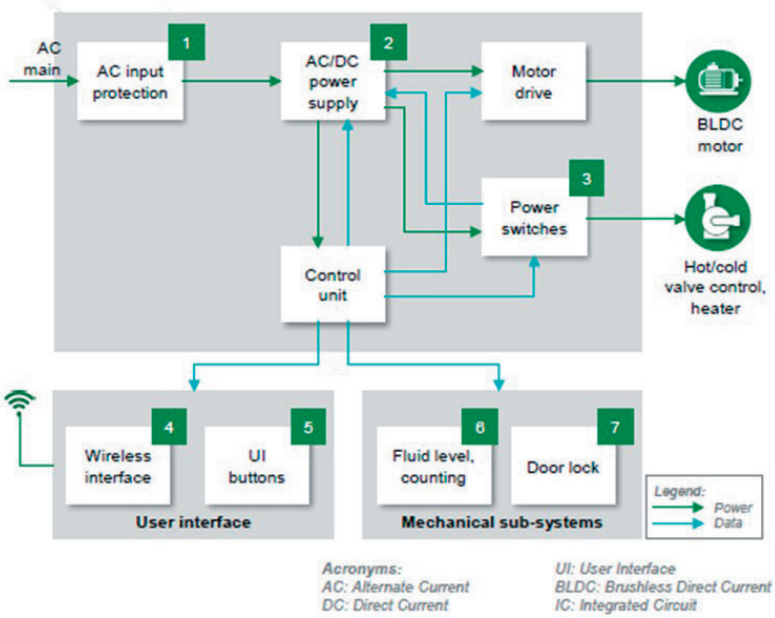
Integrated solutions, such as eFuses, embed multiple protection features into a single package. These devices offer high reliability, fast response times, and programmability, significantly simplifying circuit design. Integrated solutions also provide additional benefits, including soft-start functionality and fault logging. **Figure 2** ***(right side)*** illustrates a typical eFuse-based integrated solution that combines overvoltage protection, current limiting, and



Benefits	
Form factor flexible	
Safety	
Independent use	
Low power loss	
No power draw (if only OC)	
Fault Protection	
Overcurrent	
Slew Control (inrush)	
Reverse current blocking	

Benefits	
Space	
Speed (accuracy)	
No degradation	
Integration	
Fault Protection	
Overcurrent	
Slew Control (inrush)	
Reverse current blocking (some models)	
Overvoltage	
Overtemperature	
Undervoltage lockout	

Figure 2. Comparison of discrete overcurrent protection with integrated eFuse protection.



	Technology	Series
1	Fuse	5X20mm Fuse
	MOV	M3, Xtreme
2	Fuse	Nano 448
	TVS Diode	SACB, SMAJ
	Load Switch	LQ050
3	PPTC	LVR
	Current Sensing Resistor	WPB
	TRIAC	QJxx16xHx, QS8004xHx
4	TVS Diode Array	SP3423, SP1064
	Polymer ESD	PESD
5	Switch	PTS
6	TMR Sensor	54140
	NTC	USP12755
	Reed Sensor	Reed switch PCB, customized
7	Reed Switch	HA-15

Figure 3. Block diagram of a washing machine with a table of recommended protection, control, and sensing components.

logic control in a compact and easy-to-implement circuit.

Applications using the three overcurrent protection devices

The following sections present applications where each of the overcurrent protection devices has an advantage. A large appliance requires a traditional fuse at the power line input. A PPTC fuse can provide low-cost, simple protection for the motor in a portable appliance. For a USB-C powered and controlled appliance, an eFuse can supply all the essential protection in a single component.

Protecting large appliances

A large appliance, like a washing machine, refrigerator, dryer, or air conditioning unit, can use multiple types of fuses. A large appliance will require either 120 VAC or 240 VAC line power and can draw hundreds to thousands of watts. The power line input overcurrent option is limited to a traditional fuse, such as a cartridge fuse, which has the necessary voltage rating. The fuse also needs to have a time delay characteristic to withstand a high inrush current due to the startup current draw of a motor or a compressor. **Figure 3** illustrates a block diagram of a washing machine.

A secondary fuse is recommended to protect the AC/DC switching power supply. This fuse also must have the line voltage rating, but it can be a surface-mount package to save PCB space.

Within the DC circuitry, a PPTC fuse can protect the control circuitry. In the case of the washing machine, a PPTC fuse can protect the Power Switches block that controls the water valves. In the event of a short in a control valve coil, the PPTC fuse can reduce the current drawn to a very low level. Once the problem with the valve is corrected, the PPTC fuse will reset without the need for replacement.

The other components in the table list recommended components for overvoltage transient protection, electrostatic discharge (ESD) protection, sensing, and efficient control. These components ensure a robust and reliable appliance.

Protecting small portable appliances

For small appliances with motors, protection against locked rotor currents and short circuits is essential to ensure safe operation. Protection options include:

PPTC devices, the primary recommended component, provide simple, cost-effective, and resettable protection for battery-powered motors, especially in portable appliances

Switches and TVS diodes, which are also recommended for additional power control and transient voltage protection

eFuses, if the application has limited onboard space, requires more advanced control or if an MCU supports intelligent fault management. However, eFuses may not be ideal for cost-sensitive designs or very low-power motor control, where the complexity and added features of eFuses may increase system cost or power consumption.

Figure 4 below shows an example of a simplified, low-cost portable appliance motor control circuit using a PPTC for resettable overcurrent protection. The system includes an MCU that drives the motor and monitors current, while other discrete components manage additional protection and power control.

Protecting the USB-C Port of a portable appliance

An eFuse is a superior choice for overcurrent protection of the USB-C port used in small portable appliances such as

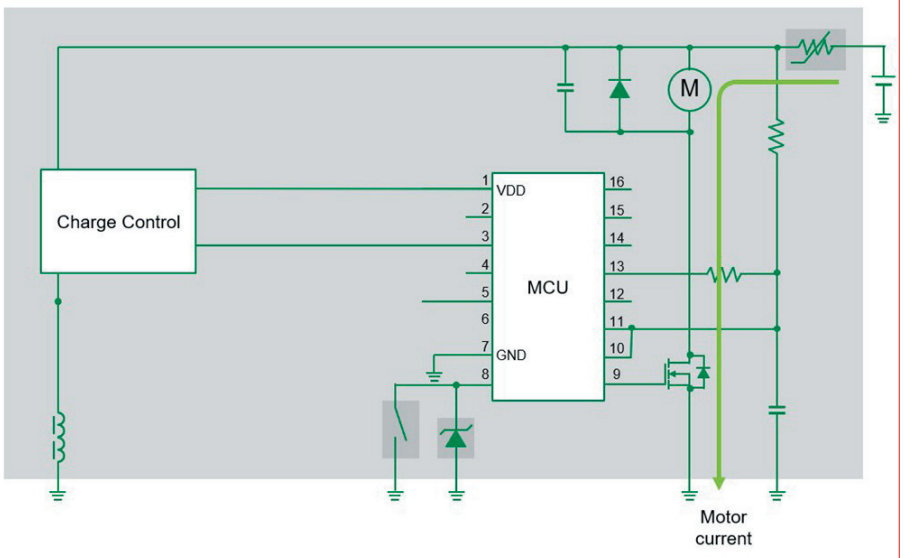


Figure 4. Example of a portable motor control circuit powered by a 3.6V Li-ion battery. A PPTC device provides resettable overcurrent protection, while the MCU controls switching and monitors motor current.

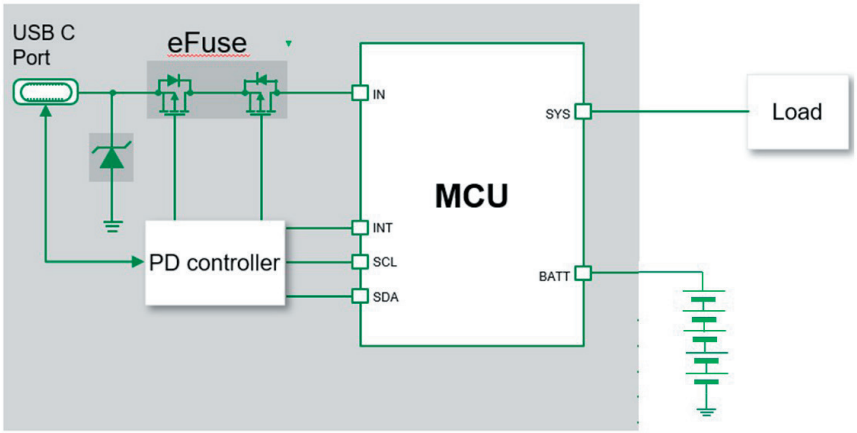


Figure 5. Example of USB-C charging protection using an eFuse and PD controller. The eFuse handles overcurrent and reverse current protection, while the PD controller negotiates power delivery with the host.

expresso makers, blenders, food processors, lamps and fans. **Figure 5** illustrates a typical USB-C charging device protection circuit. An eFuse combines overcurrent protection, overvoltage protection, overtemperature protection, and reverse current protection to safeguard the power path between the USB-C port and the appliance. The single IC conveniently combines multiple protection modes to simplify the design and save PCB space. A PD (Power Delivery) controller facilitates the negotiation of voltage and current through the USB-C port. The MCU manages appliance operations, and additional protection elements (TVS diodes for ESD and transient protection) would typically be placed near the USB-C lines.

Conclusion

Optimal overcurrent protection selection requires careful evaluation of application requirements, system constraints, and long-term operational considerations. Traditional fuses are the necessary choice for high-voltage circuits, such as circuits that connect to the power line, and for high-current protection scenarios requiring fast fault clearing and maximum reliability. PPTC devices excel in cost-sensitive applications where resettable protection and design simplicity are prioritized. An eFuse provides the most advanced protection capabilities for space-constrained, intelligent systems requiring comprehensive monitoring and control.

Success in protection device selection depends on matching device characteristics to application requirements while maintaining appropriate margins for performance, reliability and cost objectives. Engineers should evaluate each technology's strengths and limitations within the context of their specific design challenges to achieve optimal protection strategies for their next appliance design.

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eFuse Protection ICs Technology Brief



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UL 795 and Its Importance to Hydrogen Blending Systems and the Energy Transition



As industries race toward a greener future, hydrogen has emerged as a possible solution for decarbonizing energy systems. However, this alternate fuel gas comes with unique challenges, particularly in industrial and commercial applications. The binational Standard for CommercialIndustrial Gas-Fired Package Boilers, ANSI/CAN/UL 795, will play a crucial role in mitigating risks and supporting the safe and efficient integration of hydrogen heating systems into the heart of the hydrogen circular economy. It has laid the groundwork for a sustainable, hydrogenpowered future by providing a path for certifying equipment, thereby bolstering the foundation for reliable hydrogen heating systems.

The hydrogen circular economy: A new energy paradigm

The hydrogen circular economy is a transformative framework for sustainable energy. It focuses on optimizing hydrogen production, use and recycling to reduce waste and minimize environmental impact. Unlike fossil fuels, hydrogen can be produced from renewable sources and burned cleanly, without carbon emissions, and its byproducts — mainly water vapor — can be reused to create more hydrogen. This circular approach makes hydrogen a possible central figure in achieving net-zero emissions and a sustainable energy future.

However, the transition to hydrogen is not without challenges. Hydrogen's unique combustion properties — such as high diffusivity, low ignition energy and a broader flammability range — necessitate specialized equipment and rigorous safety measures. This is where UL 795 comes in. As a safety Standard for gas-fired package boilers and gas heating equipment specific to the United States, the updated UL 795 now includes natural gas with hydrogen blending up to 25% within the covered fuel gases, resulting in a certification path for commercial–industrial gas-fired packaged boilers intended for use with hydrogen–natural gas blends for heating equipment for use in the United States.

What is UL 795?

UL 795, formerly titled "Standard for Commercial-Industrial Gas Heating Equipment," defines safety and performance requirements for gas-fired heating systems. Originally designed for systems operating on natural gas or other conventional fuels, UL 795 has evolved and continues to evolve to address the growing need for hydrogen-compatible equipment.

UL 795 is now a binational Standard, ANSI/CAN/UL 795:2024. It is the first North American standard to offer manufacturers a path to certification for boilers that use hydrogen blending up to 25%, setting a new benchmark for the industry.

United States and Canadian requirements

As new technologies have diversified industrial and commercial boiler products over the years, the need to address different certification paths for additional fuel sources and blends has come into focus. The original edition of the UL 795 Standard, first published in 1952, has been modified many times over the years to accommodate changes to the industry and manufacturers' needs. UL Standards & Engagement, the publisher of the UL 795 Standard, is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a standards development organization (SDO).



This ninth edition of the Standard was developed in compliance with the ANSI and SCC requirements for the accreditation of an SDO. This joint ANSI/SCC Standard is based on — and now supersedes — the eighth edition of UL 795 and the first edition of ULC/ORD-C795-2021.

The scope of UL 795:

UL 795 now provides a certification path for hydrogen–natural gas blends as well as other traditional fuel types within its scope. The new edition includes requirements for:

- Gas-fired package boilers
- High-pressure steam and high-temperature water gas-fired boiler assemblies for the following fuel gases: natural gas, hydrogen–natural gas blends*, liquefied petroleum (LP) gas, LP gas/air blends, manufactured gas
- Furnaces
- Air heaters (United States only)

**Up to 25% hydrogen and 75% natural gas blends shall be the limit for the purposes of this Standard.*

Hydrogen blending and UL 795's role

One of the most practical steps toward a hydrogen-powered future is hydrogen blending. By enabling hydrogen blending, UL 795 supports industries and utilities in gradually transitioning from fossil fuels to alternate energy sources. This phased approach is critical to the hydrogen circular economy, as it allows stakeholders to adopt hydrogen incrementally while minimizing costs and disruptions.

UL 795-certified heating systems are intended to support the safe and effective use of hydrogen in commercial–industrial applications. In February 2024, the ninth edition of ANSI/CAN/UL 795 was published. It has now been updated to include natural gas with hydrogen blending up to 25% within the covered fuel gases, resulting in a certification path for commercial–industrial gas-fired package boilers intended for use with hydrogen–natural gas blends. UL 795 also provides coverage for heating equipment for use within the United States. UL 795 can directly support the goals of decarbonization within the hydrogen circular economy, helping industries reduce their carbon footprint while maintaining productivity.

As the first safety standard in North America to include hydrogen–natural gas blends within its scope, UL 795 has become a cornerstone of the hydrogen circular economy. Enabling industries to certify products that have adopted hydrogen safely and efficiently assists in empowering the global energy transition. Whether through decarbonizing commercial–industrial heating processes, supporting hydrogen blending or promoting resource efficiency, UL 795 is helping to build a sustainable, low-carbon-energy future. As hydrogen technologies continue to evolve, UL 795 will remain essential in facilitating their safe and reliable deployment, guiding industries toward a cleaner and more sustainable tomorrow.

By Anand Venketaraman, Regional Product Manager, Americas – HVAC & Commercial Refrigeration.
Anand Venketaraman drives the regional product management in the Testing, Inspection, and Certification at UL Solutions.



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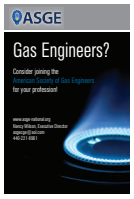
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