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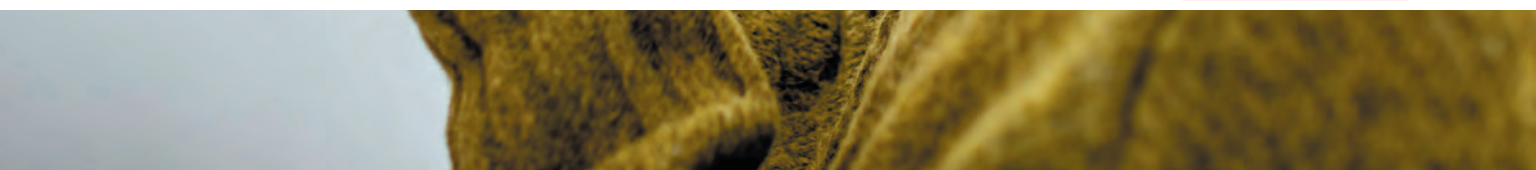
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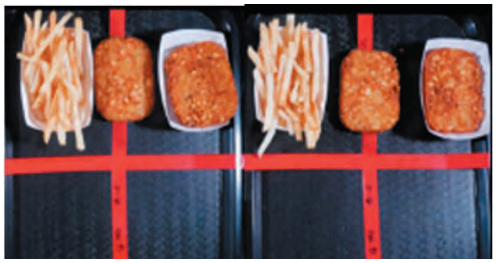
April FEATURES

6



Selecting the Best Motors and Drives For Data Center Cooling
By Aaron Reynolds and Mike Zeller, Nidec/U.S. MOTORS®.

9



Decarbonization of Commercial Foodservice Appliances with Hydrogen Blended Natural Gas
By Jacob Pixler

14



Latching In Efficiency: Solid-State Relay Unlocks Ultra-Low Power Smart Thermostat Designs
By Barry Brents, Littelfuse, Inc.

26



EWPTE 2026: Where the Wire Processing Industry Comes Together

27



Air Cleaning Blowers™: A New Technology for Appliance Air Management and Air Filtration
By *Edward Roston, founder of Air Cleaning Blowers, LLC*

18 News Beat

30 Advertisers Index

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THE DATA CENTER CONUNDRUM

For better or for worse, the data center and artificial intelligence boom is here.

The investment in the artificial intelligence and data center industries accounted for nearly 40% of the nation's gross domestic product (GDP) in the first three quarters of 2025, according to a January 2026 report from the Federal Reserve Bank of St. Louis.

A February 2026 report from commercial real estate company JLL outlines that the data center industry is seeing vacancy rates at 1% and leasing and pre-commitment rates at 92%. According to the report, those figures highlight a steady demand in construction and investment through at least 2030 with markets in Texas, Tennessee, Ohio (my home state so I take particular interest in) and Wisconsin potentially benefiting from the economic development.

Yet, despite all the investment surrounding data centers and artificial intelligence, the boom has faced opposition across the country.

Why are communities protesting against data centers?

Over the past year, communities nationwide have pushed back against data centers. The majority of the concerns have been due to environmental issues and surging utility costs. AI data centers require more resources and power than a typical data center. Since taking office, the Trump administration has been bullish on the artificial intelligence race and that support fuels a significant level of investment in the industry, despite the environmental and infrastructure concerns.

Those concerns have been the catalyst for several oppositional fronts, including the blocking of Amazon's "Project Blue" in Tucson, Arizona. In August 2025, Tucson City Council members blocked the development due to community pushback on water and energy concerns.

Similarly, a 2 million-square-foot data center proposal was shot down in Conshohocken, Pennsylvania, due to environmental concerns and utility cost increases.

In 2025, 25 data center projects were canceled in the United States, compared to only 8 in 2024 and 2023 combined. The advocacy against data centers has seen 14 states issue moratoriums (a temporary ban) within respective local communities.

What exactly does a data center do?

Most don't know this but data centers have existed for decades. They optimize data collection, information technology, research and extend computing bandwidth for cloud servers. The variety of uses can extend into several subcategories.

There are three main (and rather broad) categories for data centers: hyperscale, enterprise and service. Hyperscale data centers are large facilities, most often used for artificial intelligence, cloud services or cryptocurrency. Hyperscale data centers would fall into the large warehouse category in terms of physical size and are, consequently, the largest facilities in terms of compute and energy demands. Amazon Web Services (AWS), Google and xAI are part of this category. Enterprise data centers are company-owned servers for data storage. A separate building for a singular purpose, think a data center that is used for research data at St. Jude Children's Research Hospital or a data center that FedEx may use to categorize internal logistics or figures for the company.

Last but not least, service data centers are data centers that can be rented or leased. These facilities are also called colocation data centers. A third party owns the service racks and facility and rents the servers out to companies for use. The recently announced Legacy Power Capital development plan for the former The Walk site on Union Avenue in Memphis would be an example of a colocation data center.

Is Elon Musk building a data center?

Yes, Elon Musk is building multiple data centers via his artificial intelligence company, xAI. xAI began its data center operations and expansion in Memphis in 2024. The company has since grown its Mid-South footprint to include three main campuses.

Who has the biggest data center in the U.S.?

The 1.3 million-square-foot Citadel data center in Nevada is the largest data center in the United States and is considered the world's largest colocation data center. The facility operates within the sprawling 102,400-acre Tahoe-Reno Industrial Center. The Citadel has 130 megawatts of electric capacity, enough to power 100,000 households, according to a report from The Guardian.

However, Virginia's Loudoun County, also called "Data Center Alley,"; is considered the densest collection of data centers in the world. The Northern Virginia county has more than 200 data centers.

How many data centers are there in the United States?

According to a 2025 report from the technology advocacy group American Edge Project, there are more than 4,100 data centers in the United States, with another 2,788 planned or under construction.

Virginia, California and Texas account for a third of all active data centers in the U.S. Seven states have more than 100 data centers planned; those states include: Virginia, Texas, Georgia, Pennsylvania, Arizona, Ohio and Illinois. (Ohio recently

came under intense criticism from it's senior senator Bernie Moreno, a Republican, for giving financial incentives for the construction of a data center that would create a mere 10 jobs)

What damage does a data center cause?

According to a 2024 report from the International Energy Agency (IEA), data centers accounted for approximately 4% of the nation's electrical grid, or 183 terawatt-hours (roughly the equivalent of the entire country of Pakistan's electricity usage).

That figure is expected to grow by 133% by 2030, according to the IEA report. The report estimates by the end of the 2030s, electricity demand for data centers will equal the combined production of the aluminum, steel, cement, chemicals and energy-intensive goods industries.

A January 2025 report from MIT, outlines data center electricity consumption to approach 1,050 terawatt-hours in 2026, which would be on par with Japan's and Russia's consumption rates.

The increase in power usage has caused utility bills to rise in communities with more data centers. That figure varies by region and is significantly higher in regions with a higher density of data centers, such as Loudoun County, Virginia. Nationally, the average utility bill has increased by 8%, hardly a catastrophe but remember ''all politics is local''.

As energy demand grows, utility costs are expected to continue rising into 2026 and beyond.

Additionally, data centers, specifically hyperscale data centers, are expected to consume between 15.8 billion to 32.7 billion gallons of water by 2028, according to the 2024 U.S. Department of Energy (DOE) Report on U.S. Data Center Use.

The reliance on microgrids for power generation to meet data center energy demands has also been a growing concern due to reliance on fossil fuels.

According to the 2024 IEA report, 40% of the electricity supplied to U.S. data centers came from natural gas and 15% from coal. Another 20% came from nuclear power. Solar and wind only accounted for 24% of the electricity supply, according to the report.

The use of fossil fuels has been a point of contention, specifically, due to environmental concerns and an increase in carbon emissions, with some studies estimating that by 2030, data centers will emit 24 to 44 million metric tons of carbon dioxide into the atmosphere.

Those air pollution concerns have been a lightning rod for environmental advocacy as Musk's xAI continues relying heavily on gas turbines.

On March 4, the Trump administration announced the Ratepayer Protection Pledge, which would allow companies to negotiate separate rate structures with utility companies and state governments; and allow for the creation of off-grid power connections, such as microgrids. (The federal pledge was signed by Amazon, Google, Meta, Microsoft, OpenAI, Oracle and xAI.)

The Ratepayer Protection Pledge outlines a path for tech companies to power facilities with alternative grid connections; however, it does not outline environmental protections for communities that may be impacted by the increased water usage or environmental impacts from fossil fuel sources such as gas turbines or coal power plants. But it may alleviate consumer concerns about rate increases on their monthly utility bills.

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APPLIANCE & HVAC REPORT
Reaching Design Engineers at the OEM Level

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A synchronous motor paired with a Variable Frequency Drive delivers high energy efficiency in numerous pump and fan applications in data centers.

Selecting the best motors and drives for data center cooling

Energy efficiency and reliability are critical requirements

The tremendous growth in data centers in the last few years is undoubtedly bringing many opportunities to the HVAC and refrigeration industries. Keeping data servers cool is a critical requirement in these applications, and manufacturers are responding with advanced cooling technologies that deliver various solutions, whether through chilled water, refrigerants, or conventional forced air.

Considering that a single ChatGPT query consumes nearly 10 times as much electricity as a Google search query, the stakes are high in terms of the need for data centers to operate as efficiently as possible.

Another challenge at data centers is downtime. Various reports show that the average cost of data center downtime is $9,000 per minute, a staggering figure that illustrates why reliability of equipment is a high priority.

Conserving space in the data center footprint is also a top need, so OEMs who can provide flexibility on equipment size will stay ahead of the game.

As OEMs in the HVAC industry look to meet these three priorities, their suppliers need to be doing the same. One of the biggest areas of impact is in the electric motors and drives that power advanced cooling technologies, delivering optimized airflow and liquid movement in data centers. Motors power fans, pumps and compressors that dissipate heat from servers. They are also responsible for an estimated 40 percent of a data center's power consumption, as the cooling equipment runs continually, night and day.

Synchronous motors include multiple technologies including Synchronous Reluctance, Synchronous Reluctance with Permanent Magnet Assistance and Brushless Permanent Magnet motors. When a synchronous motor is integrated with a Variable Frequency Drive, the industry refers to those as ECM or Electronically Commutated Motors. Synchronous motors can also be paired with separate VFDs. The need for high-efficiency motors has increasingly led to the use of variable-speed motors. Utilizing variable speed on variable torque systems such as fans and pumps allows the equipment to match the cooling needs, saving up to 40-60% in energy costs compared to fixed-speed systems.

This article provides an overview of the critical role that motors play in data centers and helps fan and pump OEMs address the following:

1. Best technology for the application
2. Reliability
3. High power density (space is a premium, smaller motors are desirable)



Selecting the right motor for their products will position OEMs to help their end customers mitigate risks and cost in terms of downtime and total cost of ownership via efficiency.

Coolant Distribution Units

Coolant Distribution Units (CDUs) are used in data centers to manage the circulation, filtration and temperature of coolants for servers and processors. The CDU provides controlled coolant for heat exchangers, direct-to-chip, and immersion cooling devices.

The equipment prevents server overheating and supports high-density, space-saving racks. CDUs also ensure that the primary facility water remains separated from the secondary loop directly cooling the servers, allowing for precise, targeted cooling.

A typical CDU commonly cools up to approximately 2 MW of processing power while consuming approximately 100kw to provide circulation of coolants at full load. Matching demand of the process heat is the goal and the reason that efficiency is a high priority. Two different motor types are currently used on CDUs – synchronous and induction motors. To maximize efficiency at partial loads, synchronous motor usage is growing quickly to reduce power consumption.

Synchronous motors have zero slip and are therefore synchronized with the frequency of the power supply and the rotor has essentially zero losses. Most synchronous motors are rated as NEMA Premium® 4 or higher efficiency and will consume less energy at the same power output than induction motors. At partial loads the advantages of synchronous motors can expand to as many as 15 points of efficiency. These higher efficiency motors are more complex than the asynchronous motors, typically, and as a result may cost more.

Variable Frequency Drives (VFDs) enable the motor variable speed operation to match system demand and can be integrated (ECM) or stand alone. They can also offer precise cooling control, helping to prevent hotspots that could impact server performance. Operating at variable speed can also extend motor, fan and pump life due to less wear and tear over time.

Primary Loop Pumps

Because water conducts heat approximately 25 times more efficiently than air, liquid cooling has fast become the better option for keeping servers cool in data centers. Liquid cooling also allows for >100 kW individual rack densities, which is essential in meeting ever-increasing AI requirements.

Data centers require the use of large pumping units to move water throughout the facility. This is considered the primary loop, which supplies water to CDUs to cool the secondary cooling loop.

Commonly, NEMA Premium efficient induction motors being run on a VFD are utilized to save energy over fixed speed. The momentum in the industry is to take the next step to variable speed synchronous motors which in addition to saving energy are often smaller and lower weight and run cooler.



Redundant systems are very common for critical equipment. Having smaller motors assists in maintaining a minimized footprint.

This trend to higher power and smaller frame sizes provides the power data centers need with a smaller footprint to conserve valuable space.

Computer Room Air Handlers

Known by the acronym CRAH, these forced air units provided filtered air for clean rooms in data centers. NEMA Premium induction motors are most commonly used in this application. The use of synchronous motors is also recommended as they offer the highest efficiency needed for HVAC equipment that is running 24 hours a day seven days a week. These motors also offer reliability of operation, preventing dust particles from entering the clean room and therefore allowing the server equipment to perform at its best.

Fire Pumps

For critical fire protection, horizontal and vertical fire pumps deliver dependable, high-efficiency water movement, ensuring compliance with safety standards while safeguarding facility infrastructure.

Fire pump motors utilize induction motors, which are a straightforward design that has a simple on/off switch that is activated when needed. No variable drive motors are required. However, the use of VFDs is becoming more common to limit water hammer (a sudden start or stop in water flow) and control the system.

The best advice here is to avoid the low-priced options, which are often unreliable.

When millions of dollars of equipment is at stake, relying on a well-known, established motor is highly recommended.

Selecting reliable, high-efficiency motors and drives will help data center facilities keep energy costs down and reduce equipment downtime. Having this basic understanding of motor and drive technologies will position OEMs to offer the best solutions to meet their customers' goals.

Aaron Reynolds is Product Leader at Nidec/U.S. MOTORS®.

Mike Zeller is Market Manager, Commercial Flow, at Nidec/U.S. MOTORS®.



Decarbonization of Commercial Foodservice Appliances with Hydrogen Blended Natural Gas



Figure 3. Front Left Range Burner at 3.5 in wc on Hi setting for Natural Gas (Left) and 30% Hydrogen-Methane (Right)

While advancements have been made in controls, construction materials, and insulation within the commercial foodservice (CFS) industry, burner design has remained largely unchanged for decades. Most burners continue to be atmospheric types made from stamped metal or cast iron with drilled ports. Previous manufacturer efforts to enhance burner performance have primarily focused on modifying port configurations or adjusting air-to-fuel ratios, rather than adopting advanced combustion technologies. This technological stagnation has raised concerns that CFS appliances will be less adaptable to variations in fuel composition.

A key concern is that changes in fuel content—such as blending hydrogen with natural gas—may negatively impact cooking performance. Potential issues include inconsistent crust coloration on baked goods, uneven frying results, and variability in cooking times.

A project at GTI Energy with funding from UTD, Utilization Technology Development (https://www.utd-co.org/), to evaluate the decarbonization potential of typical CFS appliances when fueled with natural gas blended with up to 30% hydrogen. Testing was conducted on a range top and a fryer to assess the impact of hydrogen blending on emissions and cooking performance.

Results indicated that while emissions of carbon monoxide (CO) and nitrogen oxides (NOx) showed only minor variations, cooking performance was appliance dependent. For the range top, pancakes cooked with higher hydrogen blends appeared lighter in color, suggesting reduced heat transfer or slower recovery times. In contrast, a fryer tested showed no noticeable difference in the appearance of French fries or hash browns across fuel blends. This consistency is attributed to the fryer's thermostatic control system, which compensates for the lower heating value of hydrogen blends by adjusting burner operation. The range top lacks such control, making it more susceptible to performance changes.

Project Background

The commercial foodservice (CFS) sector has historically lagged in adopting advanced technologies, which presents challenges when considering the use of hydrogen-blended fuels. While there have been improvements in appliance controls, construction materials, and insulation, burner designs have remained largely unchanged for decades. Most burners in CFS appliances are atmospheric types, constructed from stamped metal or cast iron with drilled ports.

Manufacturers have previously attempted to enhance burner performance by modifying port configurations or adjusting air-to-fuel ratios. However, these efforts have not included the integration of advanced combustion technologies. As a result, CFS appliances tend to be less tolerant of variations in fuel composition.

A primary concern is that altering the fuel blend—such as incorporating hydrogen—may negatively affect cooking performance. Potential issues include inconsistent crust coloration in baked goods, uneven frying, and variability in cooking times.

A project at GTI Energy with funding from UTD, Utilization Technology Development, aims to evaluate

both the decarbonization potential and the impact on cooking performance of typical CFS appliances when fueled with natural gas blended with up to 30% hydrogen.

Approach

GTI Energy conducted testing on commercial foodservice (CFS) appliances using natural gas blended with hydrogen in concentrations ranging from 0% to 30%. The appliances were evaluated for combustion emissions—including oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), and nitrogen oxides (NO_x)—as well as flame appearance. Results were compared across the different fuel blends to assess performance consistency.

Compatibility and safety assessments were performed using established ASTM test standards. Additionally, cooking performance was evaluated to determine whether fuel blending would result in unacceptable changes in food quality or output from the perspective of end users.


Figure 1. Gas Blending Cart

Two appliances were selected from among the five most common CFS categories: fryers, ovens, griddles, ranges, and broilers. Specific models were chosen based on availability and input from manufacturers.

To support the testing, the project team designed and constructed a custom gas blending cart. This system delivered precise fuel mixtures using cylinders containing 5%, 10%, 20%, and 30% hydrogen blended with methane. These were connected to a common manifold and regulator to supply fuel to the appliances. For baseline comparison, appliances were also tested using standard house natural gas.

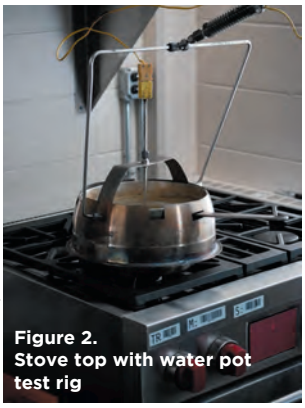
Each appliance was tested using the following test plan:

Matrix of data points:

- Test Manifold Pressures: Standard operating pressure from the appliance manual (specified)
- Burner Firing Rate (if applicable): low, medium, high
- Fuels: NG or 5%, 10%, 20%, or 30% hydrogen blended with remainder methane

At each date point:

- Image/Video of stable flame
- Combustion Emissions (Horiba)
- Temperature (location TBD)
- Performance/Efficiency
- Food quality


Figure 2. Stove top with water pot test rig

Range Top Testing

Water Boil Efficiency and Combustion Emissions Testing

The first set appliances chosen for testing were based on existing applicance population and the design being typical for appliances on the market. The first appliance tested was a range top shown in Figure 2. Emissions samples were collected using the custom hood in Figure 2 with a thermocouple attached to the hood for comparative temperature of boiling water data.

The primary objective of the range top testing was to observe whether flame appearance changed when hydrogen was blended with natural gas. Figure 3 presents images of the burner operating on 100% natural gas (0% hydrogen) and a 30% hydrogen-methane blend. Visual inspection revealed no noticeable differences in flame characteristics between the two fuel types. A complete set of burner flame images is included in the appendix of this report. Although emissions data were collected during testing, the results for this burner were highly diluted and lacked sufficient resolution for meaningful comparison. A more detailed emissions analysis was conducted on other burners evaluated in the broader study.

As shown in Table 1, the burner's efficiency remained relatively stable across all tested fuel blends. While emissions data were collected, the results were difficult to interpret due to inconsistent behavior and the absence of clear trends. However, emissions levels did not vary significantly with changes in fuel composition. In contrast, the heating load exhibited a general decline as the percentage of hydrogen in the fuel increased.

Pancake Cook Quality Differentiation Test

To assess the impact of increasing the percentage of hydrogen in methane fuel blends on cooking quality, we conducted a controlled pancake cooking test. GTI developed a procedure to evaluate the performance of natural gas under different hydrogen concentrations.

Pancake Mix:

- 1.50 lbs of pancake mix
- 1.63 lbs of water

Equipment and Settings:

- Pancake dropper with 8 settings (Setting #5 was used)
- Average weight of each pancake: 0.11-0.14 lbs
- Pan temperature: 405°F for each pancake drop

Procedure:

- Calibration Load: Establish the optimal burner rate to ensure consistent natural gas testing. The burner rate must be balanced:
- High enough to maintain consistent temperature without affecting the time between pancakes.
- Low enough to prevent temperature fluctuations.
- Burner Adjustment: Due to the derating effect of hydrogen addition, the burner will require a longer time to reheat the pan between pancakes.

Cooking Times:

- Cook Side 1 for 75 seconds
- Cook Side 2 for 60 seconds

Maintenance:

- Clean out crumbs between pancakes to ensure consistency in cooking quality.

This procedure is designed to provide a reliable comparison of cooking quality under different fuel blend conditions.

As shown in Figure 4, increasing the hydrogen percentage in the fuel blend led to a decrease in the burner's heating rate under a constant setting. This slower heat recovery resulted in less browning of the pancakes, despite identical cooking times. Pancakes cooked with 100% natural gas achieved a golden-brown color, while those cooked with a 30% hydrogen blend appeared more yellow-gold, indicating reduced Maillard reaction due to lower surface temperatures.

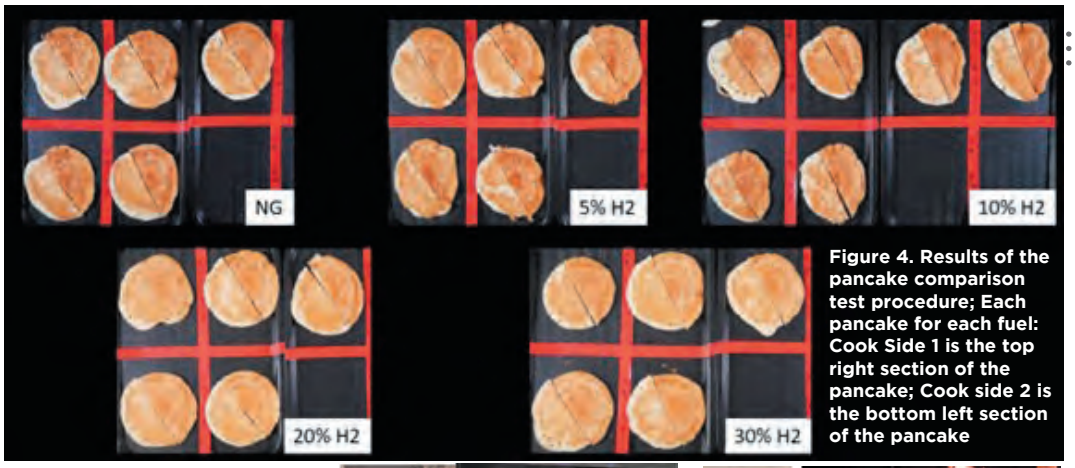


Figure 4. Results of the pancake comparison test procedure; Each pancake for each fuel: Cook Side 1 is the top right section of the pancake; Cook side 2 is the bottom left section of the pancake



Figure 5.
Fryer Burners in the appliance



Figure 6.
Fryer Burner Bench Top Testing done on phase 1

In future phases of this project, GTI Energy plans to further analyze cooking performance using quantitative methods. A computer program will be developed to empirically evaluate visual data collected during testing, replacing subjective, qualitative descriptions with objective, data-driven metrics.

Commercial Fryer

Burner Flames inside the appliance

During the fryer's preheat phase, images of the burners in operation were captured (Figure 5). However, these images did not clearly reveal distinct flame characteristics, making detailed analysis difficult. To

Burner	Gas	Heating Load	NOx - Corrected	CO - Corrected	CO2	O2	Time	Efficiency
		Btu/hr	ppm	ppm	%	%	min	
Large Front Left Burner	NG	14.5k	91.2	195.0	5.9	10.6	8.4	36%
Large Front Left Burner	5% H2	14.9k	98.2	139.0	5.2	11.6	13.1	34%
Large Front Left Burner	10% H2	14.4k	85.7	260.8	5.0	11.8	9.1	35%
Large Front Left Burner	20% H2	14.4k	78.1	267.9	5.7	10.1	8.8	35%
Large Front Left Burner	30% H2	13.4k	81.1	187.2	4.4	12.3	9.1	37%

Table 1

Appliance	Heating Rate - Pressure	Gas	Heating Load (rough number)	NOx	NOx - Corrected	CO	CO - Corrected	CO2	O2	Temp - Gas Supply Stop	Max Flue Temp
			Btu/hr	ppm	ppm	ppm	ppm	%	%	F	F
Fryer	7 in wc	NG	77.8k	42.67	100.77	64.33	151.09	5.06	12.12	334	807
Fryer	7 in wc	5% H2	78.2k	47.66	97.21	40.36	81.89	4.97	10.75	329	802
Fryer	7 in wc	10% H2	80.1k	51.32	102.98	24.14	48.02	5.77	10.54	327	899
Fryer	7 in wc	20% H2	77.7k	45.90	96.74	18.91	39.51	5.28	11.05	326	843
Fryer	7 in wc	30% H2	77.4k	47.82	109.86	7.72	17.57	4.69	11.84	329	864

Table 2. Fryer pre-heat data

address this limitation, a prior phase of the project focused on bench-top testing of the burners outside the appliance, allowing for more effective observation of flame behavior under varying hydrogen concentrations (Figure 6).

Fryer Preheat Testing

The fryer is equipped with a thermostatic control system that regulates burner operation to maintain a target oil temperature. Despite the expected derating effect associated with increased hydrogen percentage, the burner maintained a relatively stable firing rate under constant inlet pressure. This suggests that the system compensated for the lower energy density of hydrogen by increasing fuel flow, thereby sustaining a consistent heating load. The behavior indicates that hydrogen's lower density may offset its reduced heating value, resulting in performance characteristics that

Table 2 presents emissions data collected during the fryer's preheat phase. The results indicate that nitrogen oxides (NO_x) levels remained relatively stable across all hydrogen blend concentrations. Carbon monoxide (CO) a flashback event during shut-off. Although this did not affect performance during the test, it may pose a long-term safety risk and could potentially reduce the appliance's operational lifespan if not properly maintained. This phenomenon would require further evaluation by a certified safety laboratory to determine its significance and implications for commercial deployment.

Fryer Cook Quality Testing

To evaluate the fryer's cooking performance across different fuel blends, French fries and hash browns were used as test foods to assess doneness. The fryer's thermostatic control system and regulated input pressure provided a stable testing environment, allowing for consistent comparisons between fuel types (Figures 7 and 8).

Visual inspection of the cooked products revealed no substantial differences in browning or appearance across the various hydrogen blends. However, future phases of this study will incorporate quantitative image analysis to more precisely measure browning variations and cooking consistency.

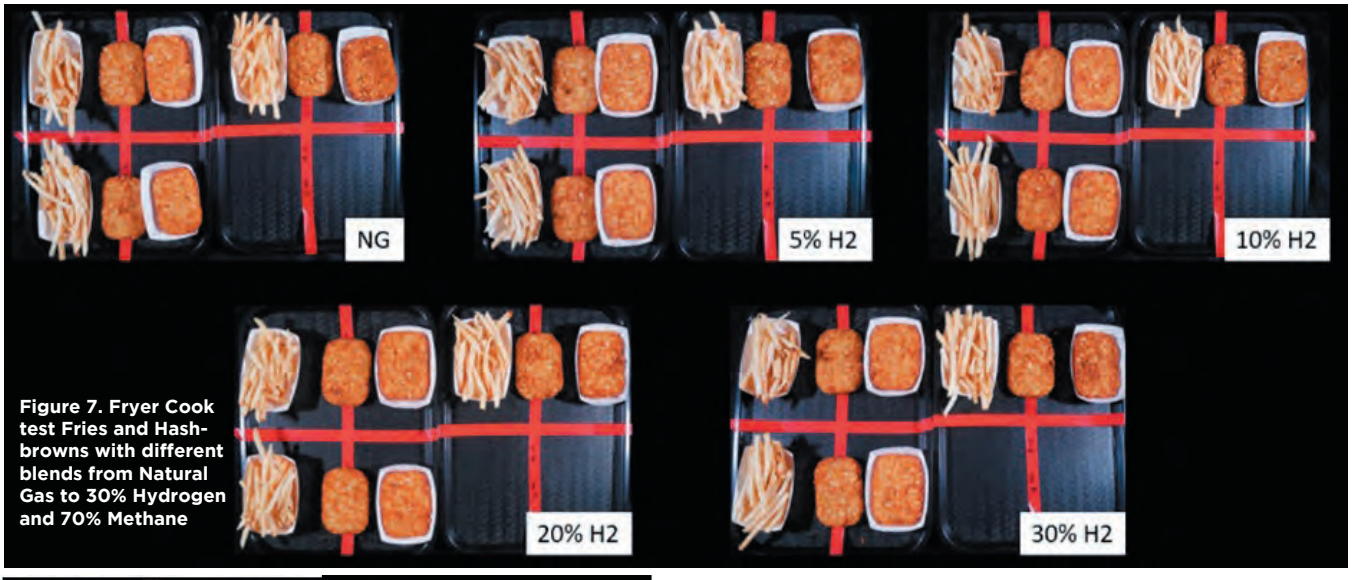


Figure 7. Fryer Cook test Fries and Hash-browns with different blends from Natural Gas to 30% Hydrogen and 70% Methane

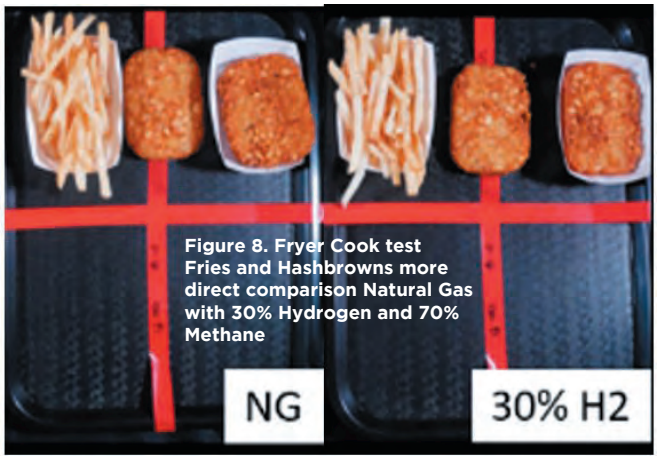


Figure 8. Fryer Cook test Fries and Hashbrowns more direct comparison Natural Gas with 30% Hydrogen and 70% Methane

One challenge in detecting performance differences lies in the fryer's thermostat, which minimizes temperature fluctuations. As a result, temperature recovery during the 3-minute cooking cycle showed no significant variation between fuel types (Figure 9).

Conclusions and Recommendations

Testing of a commercial range top and fryer using natural gas blended with hydrogen demonstrated that fuel composition can influence both emissions and cooking performance. While emissions—specifically

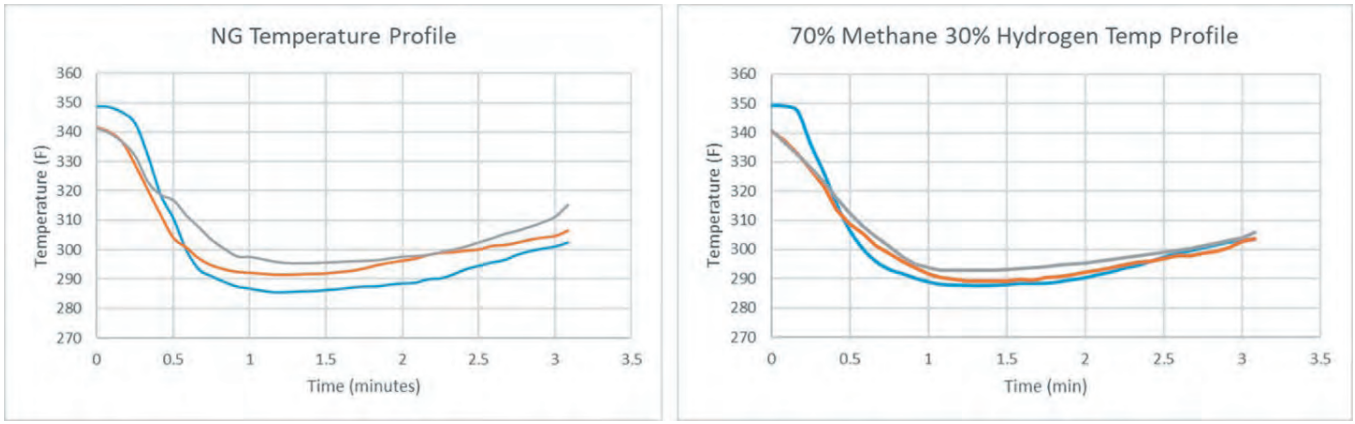


Figure 9. Fryer Cook test Fries and Hashbrowns Temperature profiles repeated 3 times for Natural Gas, and 30% Hydrogen and 70% Methane

carbon monoxide (CO) and nitrogen oxides (NO_x)—showed only minor variation across blends, cooking performance was more appliance-dependent.

For the range top, pancakes cooked with higher hydrogen percentages exhibited lighter coloration, indicating reduced heat transfer or slower recovery between cooking cycles. In contrast, the fryer showed no visible differences in the appearance of French fries or hash browns across fuel blends. This consistency is attributed to the fryer's thermostatic control system, which automatically adjusts burner operation to compensate for the lower heating value of hydrogen-enriched fuels. The range top, lacking such controls, would require manual adjustments such as increasing burner output—to maintain performance, a factor that may not be immediately apparent to end users.

Future testing will expand to additional appliance types and fuel blends, with a focus on understanding how appliance control systems influence cooking outcomes. These efforts will help determine the broader applicability and operational considerations of hydrogen blending in commercial foodservice environments.



Jacob Pixler is a mechanical engineer with a strong interest in improving energy efficiency and advancing innovation in gas appliance technologies. He holds both a bachelor's and master's degree in mechanical engineering from Marquette University, where he developed a solid foundation in system dynamics and mechanical design.

Currently a Research Engineer at GTI Energy, Jacob works on applied research projects aimed at enhancing the performance and efficiency of end-use gas appliances, particularly in the food service industry. His background includes experience in the heat treat and water heating sectors, where he gained practical insight into the intersection of mechanical engineering and materials science.

Jacob is committed to developing data-driven solutions that support more sustainable and efficient energy use. His work reflects a thoughtful approach to engineering challenges and a focus on contributing to a lower-carbon future.



Latching In Efficiency:

Solid-State Relay Unlocks Ultra-Low Power Smart Thermostat Designs New relay technology enables battery-free HVAC controls with compact, load-powered architecture



THE POWER CHALLENGE IN SMART THERMOSTAT DESIGN

Today's HVAC control systems must deliver more functionality while consuming less space and power. Homeowners demand slimmer thermostats that blend seamlessly with modern interiors. Building managers require maintenance-free systems that extend battery life or eliminate the need for batteries entirely. Installers need solutions that work with existing wiring infrastructure, particularly in older buildings where running new cables proves costly or impractical.

These requirements create significant engineering challenges. Traditional mechanical relays consume valuable PC board (PCB) real estate and generate audible clicking sounds that customers find objectionable. Battery-powered thermostats require periodic maintenance. Most critically, many legacy HVAC systems lack the common "C" wire that provides continuous power to modern smart thermostats, forcing engineers to implement complex workarounds.

The quest for quieter, more efficient controls drives innovation in solid-state switching technology. Engineers need compact, silent solutions that operate reliably while drawing minimal current from system supplies. In battery-powered applications, every microampere counts toward extending service intervals. In two-wire installations without dedicated power, the control circuit must have another energy source.

These conflicting demands — smaller size, lower power consumption, simpler installation, and higher reliability — have driven relay technology to evolve beyond traditional electromechanical designs toward solid-state solutions that meet modern control system requirements.

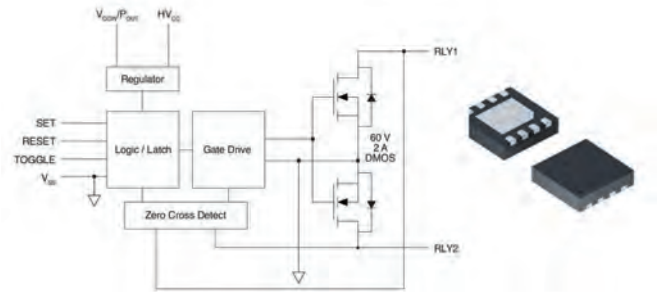
PRODUCT INNOVATION: THE CPC1601M SOLID-STATE LATCHING RELAY

Littelfuse addresses these design challenges with the CPC1601M, a 60 V, 2 A normally open (1-Form-A) solid-state latching relay that combines innovative load-powered operation with ultra-compact packaging. The device integrates power management, logic control, and DMOS switching elements into a 3 × 3 mm DFN package that occupies a minimal PCB footprint. Figure 1 illustrates the details of the CPC1601M and its compact packaging.

The CPC1601M distinguishes itself through several key innovations. Its latching architecture requires only a brief pulse to change states, eliminating continuous hold current that drains batteries in conventional relay designs. The device maintains its ON or OFF state indefinitely without consuming power, making it ideal for battery-operated thermostats and remotely located sensors.

Engineers control the relay through standard TTL/CMOS-compatible inputs. Three control pins, SET, RESET, and TOGGLE, provide flexible switching options.

Figure 1. CPC1601M solid-state relay block diagram and its 3 mm X 3 mm DFN package



A single pulse to the SET input turns on the DMOS FETS, closing the CPC1601M's "contacts." A pulse to the RESET input opens them. The TOGGLE input alternately switches states with each pulse, simplifying microcontroller interface code. This single-pulse operation draws less than 1 µA from the system supply in standby mode, preserving battery charge for months or years of operation.

The relay handles continuous maximum load currents of 2 A at an operating temperature from -40 °C to +85 °C. Its low, typical, on-resistance of 308 mΩ minimizes power dissipation and allows direct switching of contactor coils to power heating elements and other HVAC loads. The solid-state design eliminates mechanical wear, contact bounce, and audible noise, delivering silent operation and extended service life.

Blocking voltage capability reaches 60 V DC, accommodating standard 24 VAC transformer secondaries commonly found in HVAC systems. Switching speeds under 1 microsecond ensure responsive control with minimal turn-on and turn-off delays.

The device operates across a 3 V to 5.5 V supply voltage range, compatible with microcontrollers, coin cell batteries, and standard logic power rails. Its small package dimensions enable ultra-thin thermostat profiles that meet aesthetic requirements for wall-mounted controls.

LOAD-POWERED OPERATION: A BREAKTHROUGH IN ENERGY HARVESTING

The CPC1601M's most innovative feature transforms the load itself into a power source. In load-powered mode, the relay harvests operating energy directly from the open-circuit load voltage, consuming zero current from the system supply. This breakthrough eliminates the need for batteries in two-wire installations and extends battery life in portable devices.

In this example circuit, the load-powered cycle operates as follows: When the relay is in the RESET or open state, the full open-circuit voltage from the 24 VAC transformer appears across the relay terminals. Internal DMOS body diodes, D1 and D2, and external rectifier diodes, D3 and D4, perform full-wave rectification, charging an external filter capacitor, CFILT. This stored energy powers the relay's internal circuitry through the HVCC pin and provides an output voltage at the VCCIN/POUT pin.

The relay continuously monitors the voltage on the filter capacitor. With the capacitor charged to approximately 20 V, the relay can turn on its MOSFETs, energize the KI contactor relay, and allow load current to flow. As the K1 relay draws current, the filter capacitor begins discharging. The relay remains closed while the capacitor voltage drops from 20 V toward 10 V. When the voltage reaches the 10 V threshold, the relay momentarily opens at the next zero-crossing of the AC control current, and the charge cycle repeats.

This periodic opening, typically lasting well under 1 second, proves imperceptible to loads like HVAC contactor coils that have mechanical inertia. The load experiences continuous effective power while the relay harvests energy during brief interruptions. Engineers size the external filter capacitor to balance the load-powered cycle time against ripple requirements. Larger capacitance extends the time between charge cycles, which can be hundreds of milliseconds — short enough to keep loads energized continuously while long enough to maintain adequate voltage regulation.

In load-powered mode, the VCCIN/POUT pin delivers up to 10 mW at 3 V to 5 V for powering external circuits. This output can drive microcontrollers, sensors, wireless modules, and other auxiliary functions without requiring separate power supplies. Engineers can connect a low-dropout regulator to provide a stable voltage for sensitive components, or power devices directly if their operating voltage range is within the output variation.

The relay automatically detects its power source by monitoring the HVCC input pin. When HVCC receives power from the load, the relay enters load-powered mode. When HVCC remains unconnected, and the VCCIN/POUT receives battery or system power, the relay operates in conventional system power mode. This automatic detection simplifies designs that must support multiple installation configurations.

Load-powered mode offers several advantages for thermostat designs. It eliminates the common "C" wire requirement, simplifying installation in homes with

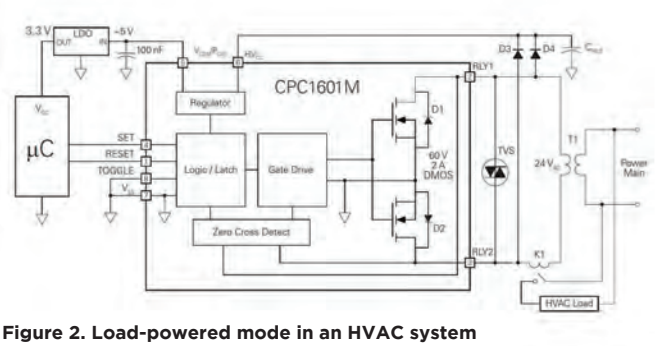


Figure 2. Load-powered mode in an HVAC system

only two-wire thermostats. Installers avoid running new cables through walls or ceiling spaces. The design reduces system component count by eliminating backup batteries and their charging circuits. End users benefit from maintenance-free operation without battery replacement intervals.

DESIGN AND INSTALLATION ADVANTAGES

The CPC1601M delivers multiple benefits that simplify design and streamline installation. Its compact area, enabling ultra-thin thermostat profiles that satisfy modern aesthetic requirements. The small footprint allows designers to pack more functionality into space-constrained wall boxes and ceiling sensors.

Solid-state switching eliminates the mechanical contacts, springs, and armatures found in electromagnetic relays. This design change removes clicking sounds that homeowners find objectionable, particularly when thermostats cycle in quiet environments like bedrooms and offices. The absence of moving parts also eliminates wear mechanisms that limit relay life in high-cycle applications. The CPC1601M withstands millions of operations without degradation, reducing warranty costs and maintenance calls.

The latching mechanism fundamentally changes power consumption patterns. Conventional relays draw continuous hold current—often tens of milliamps—to maintain energized coils. This constant drain depletes batteries rapidly and generates waste heat. The CPC1601M requires only a brief pulse to change states, then maintains its position without consuming power. Standby current remains below 1 µA in system-powered mode, extending battery life by orders of magnitude compared to traditional designs.

Zero-cross switching reduces electrical noise and extends contact life when controlling inductive loads. The relay detects near-zero current conditions and switches only when the AC waveform crosses through zero. This timing minimizes inrush currents and arc energy, improving EMI performance and reliability. Engineers enable zero-cross mode through a specific control sequence, giving them flexibility to optimize switching behavior for different load types.

The TTL/CMOS-compatible control inputs interface directly with microcontrollers without level shifters or driver circuits. Input thresholds of 1.4 V logic high and 0.5 V logic low provide noise immunity while accepting standard 3.3 V and 5 V logic levels. The inputs place minimal load on the microcontroller's I/O pins, preserving the drive current budget for other functions.

Installation simplicity ranks among the relay's strongest advantages. In load-powered mode, the two-wire configuration requires no common lead, no external power supply, and no batteries. Installers connect only the transformer secondary and load wires to existing terminals, matching the wiring of the mechanical thermostats they replace. This plug-and-play approach eliminates installation errors and reduces service calls.

Galvanic isolation remains available for applications that require electrical separation between the control and load circuits. Engineers achieve isolation by adding a few passive components that capacitively couple PWM signals across the isolation barrier. This option supports dual-transformer systems and other installations where referenced ground connections prove problematic.

APPLICATIONS IN HVAC AND BUILDING AUTOMATION

The CPC1601M targets multiple markets where compact size, low power, and reliable switching provide competitive advantages. Smart thermostats represent the primary application, particularly for retrofit installations in older buildings. The relay enables WiFi-connected, smart thermostats to operate from existing two-wire installations without adding a common wire. Homeowners gain smart home integration without rewiring costs. Thermostat manufacturers differentiate their products through simpler installation and slimmer industrial design.

Fire alarm panels benefit from the relay's battery-efficient operation. These life-safety systems must remain functional during extended power outages, placing a premium on every milliamp of battery drain. The CPC1601M's latching architecture and sub-microamp standby current extend backup battery runtime significantly compared to conventional relay designs. The compact package accommodates high-density control zones in space-constrained panel enclosures.

Security systems share similar requirements for battery efficiency and reliability. Access control panels, intrusion detectors, and surveillance systems use relays to switch auxiliary devices such as door strikes, sirens, and lighting controls. The solid-state design eliminates mechanical failures that could compromise security functions. Remote sensors powered by primary lithium batteries achieve multi-year field life without service calls.

Building automation platforms leverage the relay's dual-power-mode flexibility. Zone controllers can operate from centralized power supplies in system mode or harvest power locally in load mode. This dual capability simplifies designs that must accommodate various building infrastructure configurations. The 10 mW auxiliary power output supports wireless communication modules, enabling IoT connectivity without separate power wiring.

Industrial controls use relays in programmable logic controllers, motor starters, and process control

equipment. The compact package suits space-constrained DIN rail modules and distributed I/O blocks. Fast switching speeds under 1 microsecond enable precise control timing for synchronized operations. The solid-state design withstands vibration and shock, common in industrial environments.

Utility metering systems incorporate the relay for load control and demand response applications. Smart meters switch water heaters, HVAC equipment, and other deferrable loads in response to grid conditions. The relay's low power consumption preserves meter battery life while providing reliable switching for demand management programs. Time-of-use rate structures and peak-shaving applications benefit from silent operation that avoids customer complaints about clicking relays.

Data acquisition and instrumentation equipment use relays to switch sensor power, select measurement ranges, and route signals. The low on-resistance minimizes voltage drops in precision measurement circuits. The latching design eliminates hold current, which can generate thermal EMF errors in sensitive instrumentation.

All these applications share common requirements that the CPC1601M addresses: minimal power consumption, compact size, silent operation, and high reliability. The relay's flexibility to operate in either system-powered or load-powered mode makes it adaptable across diverse installation environments and power supply configurations.

CONCLUSION: EMPOWERING SMARTER, GREENER APPLIANCE DESIGNS

The CPC1601M solid-state latching relay represents a significant advance in control system switching technology. By combining load-powered operation with ultra-compact packaging and sub-microamp standby current, it removes traditional barriers to designing battery-free, maintenance-free HVAC controls and building automation devices.

Engineers gain practical solutions to real-world design challenges. The relay eliminates common wire requirements in thermostat installations, simplifying retrofits and reducing installation costs. Its latching architecture extends battery life from months to years, virtually eliminating maintenance calls. The 3 × 3 mm package enables slim, modern industrial designs that satisfy aesthetic requirements. Solid-state switching removes clicking noise and mechanical wear that plague electromagnetic relays.

These advantages align with broader industry trends toward energy efficiency and sustainable design. Building codes increasingly emphasize energy management and demand response capabilities. Homeowners seek smart home integration and intelligent HVAC control. Manufacturers differentiate products through enhanced functionality and simpler user experience. The CPC1601M supports all these objectives while reducing system complexity and component count.

The relay's dual-mode operation — system-powered or load-powered — provides unusual flexibility. A single device suits applications from coin-cell-powered sensors to line-powered zone controllers. This versatility reduces inventory complexity and simplifies product platform strategies. Engineers design once and deploy across multiple market segments with minimal modification.

Looking forward, the demand for compact, efficient switching solutions will only intensify. IoT devices proliferate throughout buildings, each requiring reliable control of loads while consuming minimal power. Wireless sensor-based controls often require battery power where every microampere matters. Smart building platforms demand higher device density in space-constrained installations. The CPC1601M positions designers to address these evolving requirements.

For applications ranging from residential thermostats to commercial building automation, from security systems to utility load control, the CPC1601M delivers the combination of size, power efficiency, and functionality that defines next-generation control systems. It proves that innovative solid-state technology can eliminate traditional design compromises and enable the smarter, greener appliances that markets demand.

Additional information on the CPC1601M solid-state latching relay is available at Littelfuse.com.

View the video.



Barry Brents is a Field Application Engineer at Littelfuse. He is a former U.S. Navy nuclear submarine officer and a licensed professional electrical engineer in Colorado and California. He has been with Littelfuse for 37 years (including acquisitions), and his current responsibilities include technical support, design assistance, and training for customers and salespeople. Barry received his B.S.E.E. from Texas Tech University.

What's Happening



Trane Technologies and Autodesk Collaborate to Accelerate and Simplify Sustainable Building Design

Collaboration targets critical workflows and leverages AI to simplify innovative design scenarios for engineers and architects and enable more sustainable solutions

Trane Technologies, a global climate innovator and Autodesk, Inc., a global leader in building information modeling (BIM) technology for the architecture, engineering, construction (AEC) and operations industry, announced a strategic collaboration aimed at optimizing commercial building design for sustainability.

This innovative cross-industry collaboration seeks to simplify the user experience and enable AI-assisted design exploration by integrating Trane's TRACE® software and Autodesk Revit for engineers. TRACE leads the industry in enabling accurate sizing of complex Heating, Ventilation and Air Conditioning (HVAC) systems faster and easier at any level of building realism and provides energy and economic analysis leading to more sustainable building outcomes.

"Our collaboration with Autodesk represents a significant step forward in our mission to drive reduction of building emissions through optimization of the thermal management systems as part of the building design process," said Oakley Roberts, Vice President of Innovation and Product Management for Trane Technologies. "By integrating our leading Mechanical, Electrical and Plumbing (MEP)/HVAC engineering analysis solutions with Autodesk's BIM technology, we are poised to deliver unique value to our customers and accelerate the industry's move toward sustainable building design."

Key workflow innovations will focus on enhancing MEP design process efficiency for Trane customers, facilitating decision making between architects and engineers, and laying the foundations for AI-assisted design. This will help remove manual steps, expedite the design process and promote greater accuracy.

"Our strategic work with Trane Technologies underscores our commitment to addressing the critical workflow gaps faced by engineers today, while leveraging AI and machine learning to enhance the extensibility of Autodesk's platforms," said Nicolas Mangon, VP, AEC Industry Strategy at Autodesk. "By integrating Trane's trusted capabilities into Revit, we provide engineers with tools that deliver reliable performance, while empowering them to tackle today's greatest industry challenges. Together, we're bridging the digital and physical, and unlocking data to create more efficient, sustainable buildings."

AI design exploration, connected workflow, and integration innovations developed through the collaboration are planned to initially be available in high-BIM adoption regions, such as the

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Plastics Industry Association and Society of Plastics Engineers Joined Forces

The Plastics Industry Association (PLASTICS) and the Society of Plastics Engineers (SPE) today announced they are coming together to form a unified organization that will represent the entire plastics supply chain—from technical professionals to corporate leaders, and from molecule to marketplace.

Both Boards of Directors voted last week to accept the recommendation of a task group formed to explore a potential merger. The conclusion of the group was presented to the respective Boards under the banner of "Better Together," outlining how the industry and the organizations' members would benefit by bringing these two storied organizations together.

"This is a historic day for the plastics industry," said Matt Seaholm, President & CEO of PLASTICS. "PLASTICS is leading the industry in many ways—sustainability, market insights, advocacy, and of course, NPE. SPE has built an incredible legacy of technical education, scientific research, and professional development. By bringing our organizations together, we're creating a stronger, more connected platform to serve our members and advance the industry."

"SPE is excited to be joining forces with PLASTICS," added Patrick Farrey, CEO of SPE. "For SPE members, this is about opportunity. Our technical expertise and professional development programs will now reach more people, supported by the resources and global platform that PLASTICS brings. This combination ensures we continue to serve plastics professionals while advancing the entire industry."

Under the terms of the agreement:

SPE will become a division of PLASTICS, governed by an Executive Committee modeled after SPE's current leadership structure.

SPE members will retain their membership status, benefits, and identity within the new division as part of the merged organization.

Patrick Farrey will join PLASTICS as Executive Vice President of SPE and Chief Integration Officer, leading the transition and ensuring continuity for SPE's programs and stakeholders.

"This is a transformational moment," said Jamie Clark, Chairman of PLASTICS Board of Directors. "By aligning our complementary strengths, we're building a powerful engine for workforce development, advocacy, and global engagement. This is going to be a great thing for the members of both organizations."

"SPE has always been about people—educating, connecting, and empowering them," said Scott Eastman, Ph.D., Chairman of SPE Board of Directors. "The SPE Board believes this merger will amplify our mission and position us to elevate the reputation of plastics professionals worldwide."

A dedicated landing page with more information will be available at: plasticsindustry.org/bettertogether

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Vitrek 4700 Makes Compliance with Global ISO 17025 Voltage Standards Simpler & Less Costly

Product's Diverse Capabilities & Built-In Compliance Simplify Set-up and Cut Out $2,000+ in Upfront Calibration Costs.

Vitrek's 4700 Precision High Voltage Meter is gaining recognition as the simplest deployment-ready solution for laboratories looking to achieve ISO/IEC 17025—a compliance requirement needed for a growing number of medical device, aerospace, and energy devices worldwide.

This comes as the global test and measurement market, valued at $38.9 billion in 2024, is experiencing accelerated growth driven by compliance requirements. *

With thousands of units already deployed worldwide, the 4700 is not new technology—but its relevance has never been greater. Vitrek's simple, compliance-ready approach has made the 4700 the preferred meter for laboratories that cannot afford measurement uncertainty.

The 4700 can handle the full array of needed ISO/IEC 117025 tests that would otherwise require multiple devices. Also, unlike traditional high voltage meters requiring expensive external calibration, the 4700 includes ISO 17025-accredited certification out-of-the-box, eliminating $800-$1,500 in initial compliance costs and significantly reducing audit prep time.

"Standard equipment voltage ranges have increased in many industries and ISO 17025 compliance has shifted from 'nice to have' to 'business critical' in just 18 months," said Bryan Withers, Vitrek's VP of Engineering. "The 4700 transforms compliance from a $2,000 initial cost into a competitive advantage while delivering the unmatched 0.03% accuracy that precision-critical applications demand.

Vitrek's trusted 4700 Precision High Voltage Meter fits a growing sweet spot as calibration laboratories and compliance-focused manufacturers respond to the need to address supply voltages that typical voltage meters are unable to measure. Traditional approaches to achieving ISO 17025 compliance for high voltage measurement typically require:

- Initial Integration with Companion Devices: 8-16 hrs by specialized engineers
- System uncertainty analysis: Requiring dedicated expertise
- External calibration: $800-$1,500 per device(s)

– Adoption delay: 2-4 weeks– calibration and transit

"Recent adopters have reported a 60-80% reduction in initial compliance prep time," added Withers.

The Vitrek 4700 is widely deployed in labs and manufacturing test environments where high-voltage measurement precision is mission critical. Industry analysts note that ISO 17025 requirements will become universal across all safety-critical sectors within 3-5 years, making early adoption a strategic advantage for forward-thinking organizations.

MITSUBISHI ELECTRIC TRANE HVAC US

Synchrony and METUS Renew Relationship to Offer Customers Flexible HVAC Financing for Greater Comfort

Decade-long Collaboration Continues to Provide Financing Tools for Contractors Nationwide

Key Insights:

- Synchrony and Mitsubishi Electric Trane HVAC US LLC (METUS) renewed their strategic residential consumer financing relationship, extending a decade-long collaboration since 2014.
- The multi-year agreement enables homeowners to access customizable, promotional financing for HVAC solutions with streamlined digital applications, enhancing the buying experience.
- The business relationship supports contractors nationwide with proven tools and capabilities.

STAMFORD, Conn. and SUWANEE, Ga., Dec. 4, 2025 /PRNewswire/ -- Synchrony (NYSE: SYF), a leading consumer financing company, and Mitsubishi Electric Trane HVAC US LLC (METUS), a leading provider of residential and commercial heating and cooling solutions in the United States, today announced the renewal of their strategic residential consumer financing business relationship. Effective October 1, 2025, this multi-year agreement builds upon a decade-long collaboration.

As the demand for smart, energy-efficient HVAC solutions continues to grow, Synchrony and METUS'

collaboration will play a crucial role in providing customers with both innovative products and convenient financing.

"As we mark a decade of successful collaboration with METUS, our renewed relationship underscores Synchrony's dedication to driving growth, fostering innovation, and supporting our collaborators through the evolving landscape of customer needs," said Curtis Howse, EVP and CEO of Synchrony's Home & Auto platform. "Together, we continue to pave the way for transformative solutions that empower both businesses and consumers alike."

This business collaboration exemplifies the mutual commitment of both companies to find opportunities to deliver innovative financing solutions that help enable customers to upgrade and maintain their HVAC systems with ease and flexibility. By leveraging Synchrony's customizable financing options, METUS continues to enhance the customer purchasing experience and provide robust support to its network of contractors nationwide.

"Our long-standing collaboration with Synchrony has been a key factor in empowering contractors and our customers alike through flexible and secure financing solutions. These solutions not only support the purchasing process but also drive greater confidence and satisfaction across projects," said Brinnon Williams, Vice President of Residential Business, Mitsubishi Electric Trane HVAC US LLC. "We're excited to continue working alongside Synchrony to provide the financing options that help bring these innovations within reach for more homeowners."

Since 2014, Synchrony has offered many customers of Mitsubishi Electric products various promotional financing options to cover heating and cooling systems and services. Customers can apply for credit on their own devices, with immediate access to credit upon approval. This streamlined process supports HVAC contractors by providing them with proven tools and new product capabilities to drive sales and customer satisfaction.

As the demand for smart, energy-efficient HVAC solutions continues to grow, Synchrony and METUS' collaboration will play a crucial role in providing customers with both innovative products and convenient financing.

FAQ

What did Synchrony and METUS announce?

Synchrony and Mitsubishi Electric Trane HVAC US LLC (METUS) renewed their strategic residential consumer financing business relationship, strengthening a decade-long collaboration to expand access to flexible HVAC financing and support contractor growth.

How does this compare to existing solutions and services?

The renewed multi-year agreement continues offering customizable, promotional financing and streamlined digital applications, enhancing the purchasing experience.

How do these financing solutions benefit customers?

By leveraging Synchrony's customizable financing options, METUS continues to enhance the customer purchasing experience to meet the growing demand for smart, energy-efficient HVAC solutions.

How can customers apply?

Customers can apply for credit on their own devices, with immediate access to credit upon approval with various promotional financing options to cover heating and cooling systems and services.

How does the credit application process help contractors?

Contractors will benefit from a streamlined application process, proven tools and new capabilities that are designed to drive sales and improve customer experiences.



GE Appliances Invests $150 Million in U.S. Suppliers in Reshoring Push

GE Appliances said it has awarded $150 million in contracts to American suppliers as it prepares to move manufacturing of some product lines to the U.S. from China.

The 22 suppliers will provide steel, resin, parts and components for GE Appliances to make washers and combination washer-and-dryer machines at a renovated factory in Louisville, Ky.

GE Appliances, owned by China's Haier Smart Home, said the suppliers are located across 10 states, including four suppliers in Kentucky, four in Tennessee and three in Indiana. The value of the contracts ranges from about $330,000 to roughly $41 million.

The investment adds to the company's plan announced earlier this year to spend $3 billion over the next five years to expand and modernize its U.S. factories, a move that is expected to help blunt the effects of new U.S. tariffs by reshoring some work now done in China and Mexico. The effort includes a $490 million expansion of the washing-machine factory at the company's home base in Louisville.

The contract awards come as companies increasingly seek to work more closely with their suppliers to help cut costs, control exposure to tariffs and avoid disruptions like

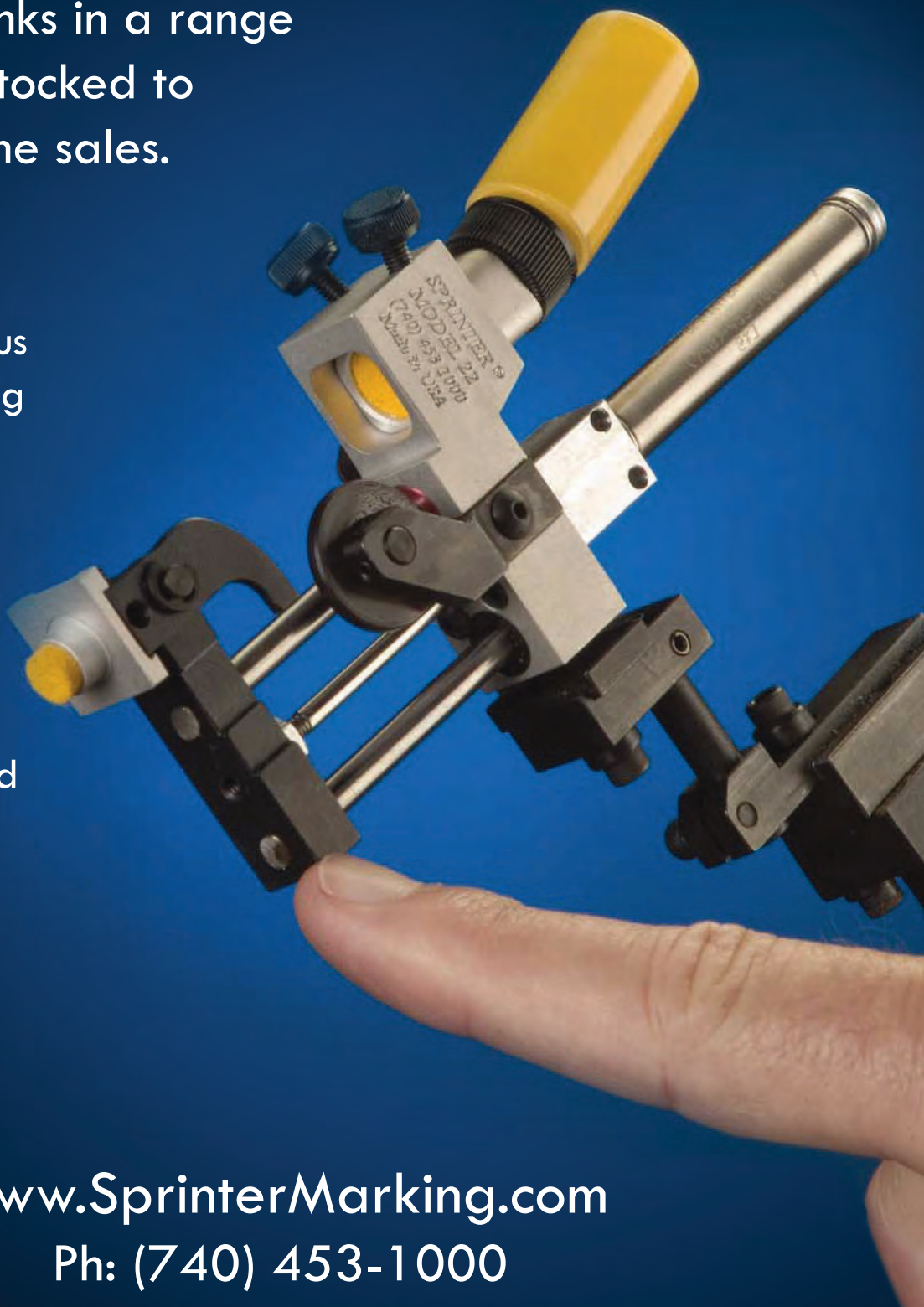
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those seen during the Covid-19 pandemic.

Ashley Eckert, senior director of sourcing at GE Appliances, said the company's new contracts are part of a shift to involve vendors from the beginning of development rather than waiting until designs are complete.

"That early collaboration, we felt like it's going to help us for design, for manufacturability, reduce lead times overall, stay competitive, and then ultimately drive a better product for both our customers and the consumer," Eckert said.

Eckert said that, as an example, one part was redesigned using a supplier's input to reduce the cost by 25%.

Suppliers say the contracts will allow them to invest in their own operations to increase production capacity.

Jones Plastic, which makes products such as the glass-and-plastic top lid of washing machines and is a longtime supplier of GE Appliances, plans to hire staff and buy more injection-molding machines and material-handling equipment.

The contract award enables Jones Plastic to "present a little bit more of a high level of confidence for what the future holds by continuing to make those investments," said Ryan Jones, co-owner and chief operating officer of the Louisville-based company.

Ethan Hamblen, chief executive of Franklin Park, Ill.-based RCM Industries, which makes aluminum die-cast parts, said he plans to buy about $5 million to $10 million of new equipment and hire at least 30 people because of the contract.

GE Appliances' largest supplier, U.S. Steel, said the deal has opened up a discussion about what else the appliance maker could purchase from the steel manufacturer.

"It moved the conversation from 'sell and buy components' to what strategically we can do together," said Marcos Corradin, the company's director of marketing and strategy.

Manufacturers have been looking to work more closely with suppliers to make their supply chains into a competitive advantage after widespread disruptions during the pandemic.

"It used to be just companies competing with companies, but now it's supply chains competing with supply chains," said Phillip Coles, a supply-chain professor at Lehigh University in Pennsylvania.

Tariffs introduced this year on U.S. imports have led some businesses to look at sourcing more products domestically, which requires finding out what's possible to source in the U.S., said Rob Handfield, a supply-chain management professor at North Carolina State University.

Some companies are "starting to become much more integrated and closely involved with suppliers, because they're recognizing they have to work together to solve these problems," Handfield said.

GE Appliances, which also makes products such as refrigerators, ovens and dishwashers, said it expects to begin production of washers and combination washer-dryers in Louisville in early 2027.

Angstrom Scientific Named U.S. Distributor for Radalytica's RadalyX Robotic X-ray and CT System.

Portable "Lab on Wheels" Brings Non-Destructive Testing Directly to the Sample

Angstrom Scientific is proud to announce its appointment as the U.S. distributor for Radalytica, a technology leader in robotic X-ray imaging and computed tomography (CT) systems for non-destructive testing (NDT) and materials characterization.

This partnership brings Radalytica's advanced imaging technology to U.S. laboratories and industries working with composites, aerospace, oil and gas, and other high-performance materials. By combining robotic automation with cutting-edge X-ray and CT imaging, Radalytica delivers unparalleled flexibility, precision, and insight into internal structures—all without compromising or damaging the sample.

"We are thrilled to bring Radalytica's innovative solutions to the U.S. market," said Bob Sommerville, CEO at Angstrom Scientific. "Their robotic X-ray and CT scanner redefines what's possible in non-destructive testing. We see enormous potential for these systems to transform inspection and quality assurance across multiple high-tech industries."

Radalytica's robotic imaging systems enable fully automated, multi-angle scanning, making them ideal for complex geometries and advanced materials. Designed for both research and industrial environments, they combine versatility, precision, and speed in a uniquely portable format.

"Partnering with Angstrom Scientific marks an exciting step in Radalytica's global expansion," said David Malan$_2$uk, Chief Commercial Officer at Radalytica. "Thanks to the mobility and portability of our scanner, we brought to market a 'non-destructive testing lab on wheels.' It literally comes to the sample and can perform scans on planes, rockets, or cars on the spot. This capability reduces costs associated with sample transportation and preparation. With Angstrom's technical expertise and strong relationships within the U.S. research and manufacturing communities, we are confident our solutions will reach and empower a wide range of new customers."

Surface Igniter Highlights the RA272KX Round Range Replacement Igniter



CSA-Approved, RoHS and REACH Compliant Replacement Solution Designed to Deliver Efficiency and Reliability

Surface Igniter, LLC., a global innovator in hot surface ignition technologies, is proud to highlight the RA272KX Round Range OEM Replacement Igniter, manufactured with the same materials and according to the same specifications as the original equipment manufacturer. This advanced igniter provides consumers and service professionals with a safe, reliable, and highly compatible solution for restoring proper oven performance.

Every detail of the RA272KX Round Range Replacement Igniter underscores its role as a trusted replacement component. Built to precise OEM requirements, the igniter ensures compatibility and reliable performance across a wide variety of oven models. Its CSA-approval reflects strict adherence to safety and quality standards, while RoHS and REACH compliance demonstrates a commitment to environmentally responsible design. To further meet consumer safety expectations, the product carries the required Proposition 65 warning, ensuring full transparency.

A major benefit of the RA272KX Round Range Replacement Igniter is its broad compatibility as a direct replacement for numerous part numbers, including WB2X9154, WB13K0001, WB13K0003, WB13K0004, WB13K10027, XL44, and many others. This versatility makes it a one-solution replacement, streamlining inventory for service professionals while giving homeowners confidence that their range can be returned to peak functionality without searching for multiple alternatives.

As functionality is central to the product's purpose, the RA272KX is designed to reliably light the oven burner, addressing one of the most common service complaints, an oven that fails to heat. By restoring heating capability, the igniter eliminates the need for costly appliance replacement and brings dependable performance back to the kitchen.

Recognizing the practical needs of installers, Surface Igniter has equipped the RA272KX Round Range Replacement Igniter kit with brackets and porcelain wire nuts to ensure a complete, secure installation. In situations where the connector plug does not align with an oven's existing wiring harness, the igniter provides flexibility: the plug can be removed and spliced directly to oven wiring, simplifying integration across multiple designs. Weighing just 0.65 pounds, the igniter is easy to handle during installation, eliminating extra steps and reducing service time.

With the RA272KX Round Range OEM Replacement Igniter, Surface Igniter continues to exemplify its dedication to engineering solutions that combine safety, performance, and convenience. Whether used in professional repair services or by homeowners replacing a failed part, the RA272KX stands as a proven solution to restore confidence in core kitchen appliances.

Weidmuller USA Introduces swifty CS: Innovative 3-in-1 Tool for Cutting and Stripping Cable Wires



swifty® CS from Weidmuller USA combines cutting and stripping cables in one tool, making electrical installations easier than ever.

Weidmuller USA, a leading provider of smart industrial connectivity and automation products and solutions headquartered in Richmond, Va., has introduced swifty CS (Cut and Strip), an all-in-one tool offering workshops a fast and effortless solution for cutting and stripping cables.

Now one tool can do the job instead of three. The combo swifty CS cutting and stripping attachment simply slides onto any uninsulated screwdriver with a 3.5 mm blade diameter so panel builders and machine builders can start working immediately in the field without needing to change tools. Just cut the wire on one side of the swifty CS attachment, strip the wire on the other side, then the screwdriver is handy to make necessary adjustments.

Features of the swifty CS tool include:

- Strips PVC-insulated fine-stranded and solid conductors up to 14 AWG
- Cuts copper conductors that are single-stranded up to 16 AWG and fine-stranded up to 14 AWG
- Ergonomic grip design ensures minimal manual effort is needed
- Automatic opening for fast and efficient operation
- Adjustment wheel for precise stripping support
- Versatile for both right- and left-handed users
- One-handed operation keeps the other hand free for extra stability
- Compact size designed to fit into any tool bag

The innovative swifty® CS from Weidmuller USA slides onto a screwdriver to create a 3-in-1 tool offering a faster and simpler solution for cutting and stripping cables.

"Combining the cutting and stripping functions in one attachment makes electrical installations easier than ever," said Carlus Hicks, Director Cabinet Products Division with Weidmuller USA. "The innovative swifty CS is ideal for screw and spring clamp terminals, ensuring a fast and efficient workflow."

When ordering, users can purchase the swifty CS slide-on attachment by itself, or they can order a screwdriver with the slide-on already attached.



Marketair Introduces Wi-Fi-Based Ductless A/C System Float Switch

Marketair Inc. introduces the AC SpeedStick, the HVAC industry's quickest to install float switch for safeguarding against property damage caused by condensate overflow in mini-split/ductless air handlers.

The AC SpeedStick WS-100 features (optional) Wi-Fi-based Internet interconnectivity. The float switch senses a condensate drain line blockage and shuts down the system, then (if Wi-Fi is integrated and available), sends a text or email notification to the HVAC service company's cellphone and/or email dispatch for immediate attention. UL-listed and compliant with the International Mechanical Code, it is easy to install. The electronic water sensing probe is a fast push-fit into the evaporator coil's secondary drain pan outlet. The ribbed, conically shaped probe's soft rubber construction provides a tight, leak-proof fit. The probe's universal color-coded wiring is preconnected to the compact 3-3/8 (L) x 2 (W) x 1-1/2 (D)-inches (85 x 51 x 38-mm) control module. The module fits inside most ductless air handlers with an integrated hanging clip and/or double-sided mounting tape but can also be installed on the cabinet exterior. The module includes communication, ground and power wiring for interrupting the current from the condenser.



Ziehl-Abegg Inc. Honors the People Powering Manufacturing Innovation on National Manufacturing Day

This National Manufacturing Day, Ziehl-Abegg Inc. proudly celebrates the skilled, passionate individuals who bring innovation to life every day on the factory floor.

From machinists and engineers to production leads and apprentices, the Winston-Salem team has played a pivotal role in making 2025 the company's strongest year yet, hiring 178 manufacturing jobs, earning multiple global sales awards, and achieving record-breaking growth month after month.

"Our manufacturing team's precision and dedication are what set Ziehl-Abegg apart," said Joachim Ley, CEO. "They're not just building fans, they're building the future of our industry."

That future is taking shape inside Ziehl-Abegg's North American headquarters in Winston-Salem, which opened in 2024 and was recognized as NAIOP NC's 2024 Industrial Project of the Year. More than just a facility, the 522,000-square-foot site exemplifies what's possible when advanced production capabilities, local talent, and a dedicated R&D department unite under one roof.

But it's the people inside who make it truly exceptional.

"We're proud to support skilled trades and create meaningful career paths in manufacturing," said Jimmy Mitchell, Managing Director. "Whether someone is just

starting out or leading a team, we emphasize training, mentorship, and long-term growth.''

Ziehl-Abegg's investment in North Carolina goes far beyond bricks and mortar. With 178 new manufacturing hires in 2025 alone, the company is strengthening the state's economy by creating stable, high-quality careers that offer more than just a paycheck. These roles include benefits, advancement opportunities, and access to technical training that helps employees build lifelong careers, not just jobs.

Through strong partnerships with local community colleges and apprenticeship programs like GAP, LEAP, and FAME, Ziehl-Abegg is building a pipeline of skilled talent right here in North Carolina. This approach helps ensure that innovation, opportunity, and economic growth remain rooted in the local community.

''We're not just building products here,'' added Mitchell. ''We're building futures, for our team members and for our community.''

National Manufacturing Day is a time to recognize these efforts and the hands behind every fan that leaves Ziehl-Abegg's Winston-Salem facility.

''It's our people who make innovation possible,'' Ley added. ''And today, we celebrate them.''

Ziehl-Abegg is actively hiring for manufacturing positions. To learn more or apply, visit https://career.ziehl-abegg.us.

Solstice Advanced Materials Completes Spin-Off From Honeywell and Begins Trading on Nasdaq

- pin-off positions Solstice to accelerate growth and unlock shareowner value as a leading pure-play specialty materials company
- Poised to benefit from strong and resilient secular trends across cooling, building solutions, advanced computing, energy, safety and healthcare
- Begins trading today on Nasdaq under the ticker symbol ''SOLS''

Solstice Advanced Materials (NASDAQ: SOLS), a leading pure-play specialty materials company, today celebrates its first day as an independent, publicly traded company following the completion of its spin-off from Honeywell. Shares of Solstice will begin trading on the Nasdaq Stock Market under the ticker symbol ''SOLS,'' effective at the market opening.

With an advanced materials heritage of more than 130 years, Solstice is positioned to build on a track record of innovation and operational excellence. Solstice technologies enable high-performance solutions for critical global sectors, including HVAC/R, semiconductor manufacturing, data center thermal management, nuclear energy, defense and life sciences. The company launches with approximately 4,000 employees, 24 manufacturing sites and four R&D centers that serve more than 3,000 customers across 120 countries and territories.

''Today marks the beginning of an exciting new chapter for Solstice,'' said David Sewell, President and Chief Executive Officer of Solstice Advanced Materials. ''Our independence positions us to capitalize on powerful secular trends shaping our industry – from regulatory-driven transitions in cooling and building solutions to the rapid proliferation of AI and advanced computing. With our differentiated technologies, unmatched customer partnerships, highly talented global workforce and experienced leadership team, we are ready to unleash our growth potential and unlock meaningful long-term value for our stakeholders.'' The spin-off was completed through the distribution of all shares of Solstice common stock. Each Honeywell shareowner of record as of the close of business on October 17, 2025, received one share of Solstice common stock for every four shares of Honeywell common stock held.

About Solstice Advanced Materials

Solstice Advanced Materials is a leading global specialty materials company that advances science for smarter outcomes. Solstice offers high-performance solutions that enable critical industries and applications, including refrigerants, semiconductor manufacturing, data center cooling, nuclear power, protective fibers, healthcare packaging and more. Solstice is recognized for developing next-generation materials through some of the industry's most renowned brands such as Solstice®, Genetron®, Aclar®, Spectra®, Fluka™ and Hydranal™. Partnering with over 3,000 customers across more than 120 countries and territories and supported by a robust portfolio of over 5,700 patents, Solstice's approximately 4,000 employees worldwide drive innovation in materials science. For more information, visit www.Solstice.com.



EWPTE 2026:
Where the Wire Processing Industry Comes Together

The Electrical Wiring Processing Technology Expo (EWPTE) 2026 returns this spring as the premier gathering for professionals across wire processing, harness manufacturing, and cable assembly. As the industry accelerates through automation, reshoring, and new design demands, EWPTE delivers a front-row seat to the technology, ideas, and conversations shaping what's next.

The 2026 program pairs a robust conference schedule with a dynamic exhibition floor, creating an environment where learning and discovery happen side by side. Attendees can dive into real-world solutions, explore new applications, and gain practical insight from experts who understand today's production challenges.



Featured Keynote: Miles Arnone

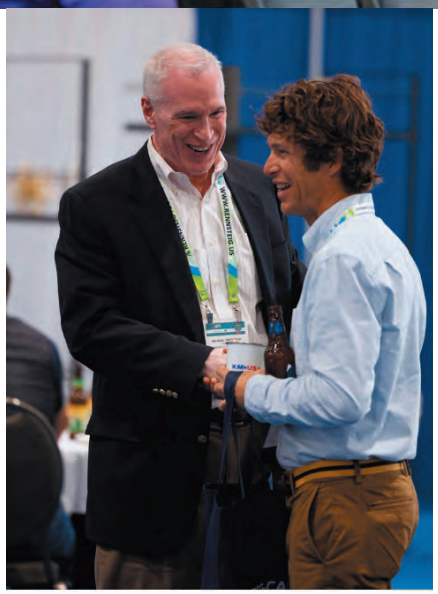
A highlight of the conference is the Wednesday morning keynote by Miles Arnone, CEO of Re:Build Manufacturing, taking place on May 6 from 8:00 to 8:45 a.m. In *Manufacturability for Design: Accelerating U.S. Innovation from Concept to Scale*, Arnone will share how designing with manufacturability in mind can shorten development cycles, strengthen domestic production, and help innovative ideas scale faster in the U.S.

Why You Should Attend

EWPTE is where decisions get informed and connections get made. From evaluating new equipment and automation solutions to exchanging insights with peers and suppliers, attendees leave with practical takeaways they can apply immediately. Whether your focus is improving efficiency, solving production bottlenecks, or planning for future growth, EWPTE offers value that extends well beyond the show floor.

Want to Exhibit?

For companies ready to put their solutions in front of the right audience, EWPTE provides unmatched access to qualified buyers and industry leaders. Exhibitors benefit from face-to-face conversations, hands-on demonstrations, and a show floor designed to encourage meaningful engagement. It's a powerful



opportunity to build relationships, showcase innovation, and position your brand at the center of the wire processing community.

See What's Next, All in One Place!

EWPTE 2026 continues to be the place where the electrical wiring processing industry comes together to learn, connect, and move innovation forward.





Air Cleaning Blowers™:

A New Technology for Appliance Air Management and Air Filtration

Air filtration in appliances and HVAC equipment has historically relied on forcing air through a separation device that captures contaminants. Whether the mechanism is disposable filter media or a cyclonic separator, the outcome is similar over time: rising pressure drop, declining airflow, increasing electrical demand, and ongoing maintenance. A proven alternative architecture is now available.

This article examines those effects from a design engineer's perspective, with particular attention to realworld energy behavior over operating life. It then introduces Air Cleaning Blowers™ (ACBs), a patented approach that separates contaminants from air without filter media and without cyclonic chambers. By eliminating debris accumulation, ACBs deliver stable airflow, pressure, and electrical consumption throughout service life.

For engineers responsible for appliance airflow, cooling, and ventilation systems, the technology offers a fundamentally different way to approach predictability, energy use, and system sizing.

The Legacy Assumption in Air Filtration

Except for slow natural processes such as settling or precipitation, air cannot be cleaned unless it moves. All conventional airfiltration technologies therefore require air to be driven through a separation mechanism.

In appliance and HVAC equipment, this typically takes one of two forms:

- **Media filtration**, where particles are captured in fibrous or porous material
- **Cyclonic separation**, where air is spun so contaminants are forced outward by inertia

Both approaches impose resistance to airflow. In both cases, that resistance increases energy consumption and varies over time.

What Happens as Traditional Filters Load with Debris

Pressure Drop and Airflow Degradation

As filter media accumulates debris, pressure drop across the element rises. Unless airflow is allowed to fall, the blower must operate at a higher point on the fan curve. In practical terms, this translates into increased torque, higher motor current, and greater heat generation.

Designers typically compensate by oversizing blowers, increasing filter area, or both. These measures delay—but do not eliminate—the underlying effects of clogging.

Energy Consumption Over Operating Life

Measured data from mediabased filtration systems show that electrical power consumption increases steadily as filters load. A clean filter represents only the initial condition; most of a system's operating life occurs at elevated pressure drop. In addition, many media filters must accumulate a minimum quantity of debris before reaching their labeled effectiveness.

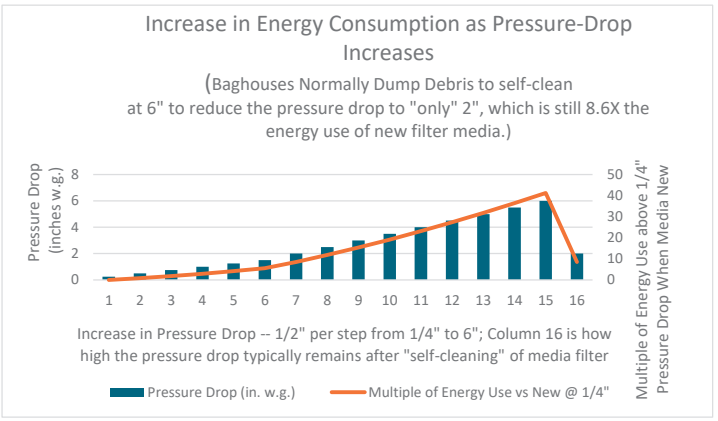
Selfcleaning media systems such as baghouses further amplify this variability. To extend service intervals, these systems intentionally allow pressure drops to rise substantially before initiating cleaning. As a result:

- Sustained power consumption between roughly eight times and more than forty times the cleanfilter baseline is common in typical operating ranges (for example, rising from approximately 0.25 in. w.g. when new to triggering cleaning near 6 in. w.g., then cleaning down to about 2 in. w.g.).
- Cleaning cycles themselves require additional energy, typically electrical power for mechanical agitation or compressed air for pulse cleaning.

From a design standpoint, this variable behavior has several consequences:

- Electrical components, ductwork, and impellers must be sized to maintain airflow at the highest expected pressure drop
- Designers and owners must trade off performance against energy and maintenance costs
- Related equipment and installations may need to be oversized or modified, often at higher initial cost

Level of Clogging	Pressure Drop (in. w.g.)	Multiple of Energy Use vs New @ 1/4"	% Increase in Energy Consumption vs @ 1/4"
New and Clean	0.25	0	0
	0.5	0.8	84
	0.75	1.8	183
	1	3.0	295
	1.25	4.2	420
	1.5	5.6	555
	2	8.6	855
	2.5	11.8	1182
	3	15.4	1535
	3.5	19.1	1913
	4	23.1	2314
	4.5	27.4	2737
	5	31.8	3180
	5.5	36.4	3643
Pre-Cleaning*	**6**	**41.3**	**4125**
Post-Cleaning*	**2**	**8.6**	**855**



*Self-cleaning central and other media-based air-filtration systems that clean themselves automatically start the process when the pressure drop across the filter reaches the setpoint (typically about 6" w.g.) and clean the media until reaching another set point (typically abpit 0,2" w.g). This chart shows that at a pressure drop of 6", the system uses **41 times** the electricity or other energy as it did when the filter elements were new and truly clean. After the cleaning the systems still use more than **8 times** the energy that they did when the media were new.

Additional Limitations of Conventional Filtration

Beyond energy consumption, traditional filtration introduces other wellknown challenges:

- **Maintenance requirements and cost**: purchasing, replacement, disposal of media, and system downtime
- **Risk of deferred maintenance**: clogged or damaged media can restrict airflow, overheat equipment, or rupture and release collected debris downstream
- **Sensitivity to moisture**: wet media increases pressure drop, weakens structurally, and may freeze, potentially blocking airflow entirely and damaging blowers
- **Flash clogging**: sudden exposure to heavy debris loads—such as dust storms, sand, heavy rain, or rotor wash—can rapidly overwhelm media
- **Scale limitations**: in environments such as mining, agriculture, or construction, debris loads and air volumes may make media filtration impractical or uneconomical

Air Cleaning Blowers™: A Different Approach

Air Cleaning Blowers™ (ACBs) were developed by eliminating the requirement to capture contaminants altogether. In most applications, the objective is not to store debris, but simply to deliver clean air continuously.

Operating Principle

ACBs employ multipatented aerodynamic geometries that exploit the difference in momentum between air and suspended contaminants. As air is accelerated:

- Particles and liquids, due to their inertia, separate from the airstream
- Contaminants are continuously ejected from the device
- Cleaned air exits as usable airflow

No filter media is used, and nothing accumulates inside the blower. As a result, airflow and pressure remain stable over time.

Blower and Cleaner Combined

Unlike media or cyclonic filters, which always impose a pressure penalty, an ACB functions as a blower. Instead of impeding airflow, it generates pressure and flow. In many applications, this eliminates the need for separate fans or blowers.

Design Implications for Appliances and HVAC Equipment Predictable Performance

Because Air Cleaning Blowers™ do not load with debris:

- Airflow remains within design tolerances
- External static pressure is stable
- Electrical power draw remains constant at a given operating point

This steadystate behavior aligns closely with standard appliance and HVAC design assumptions and simplifies performance modeling.

Simplified Sizing and Controls

Using ACBs allows designers to:

- Size blowers for required airflow only, without having to allow for clogging
- Base electrical and thermal design on a single operating condition
- Reduce or eliminate differentialpressure sensors and maintenance alarms

Installation is straightforward, and ongoing service requirements are minimal.

Performance in Harsh Environments

With no media to saturate, freeze, or rupture, ACBs operate reliably in dusty, wet, or highparticulate environments where conventional filters often struggle.

Contaminant Discharge Options

Separated contaminants may be handled in several ways, depending on application requirements:

- Discharged back to the surrounding environment

- Directed to a central collection system, with the ejection energy of the ACB augmenting duct transport
- Fed to a low-pressure-drop collector
- Recovered when the material has economic value

Effectiveness and Validation

Testing conducted by independent laboratories has shown that specific Air Cleaning Blower™ models remove essentially all test particles down to approximately 2 microns under defined and repeatable laboratory conditions, and effectively separate entrained liquids.

In addition, U.S. government testing of certain configurations has demonstrated particulate and pathogen removal efficiencies exceeding those measured for N95 masks under controlled airflow conditions. Results are model and conditionspecific and should be evaluated in the context of the intended application.

Technology Comparison

see Table 1

Conclusion

Conventional filtration technologies require appliance designers to manage rising pressure drops, increasing energy consumption, and maintenancedriven variability over a product's life. These effects influence blower sizing, electrical design, thermal margins, and overall system reliability.

Air Cleaning Blowers™ remove the source of those compromises. By separating contaminants without capturing them, ACBs deliver stable airflow and stable electrical demand from initial operation through end of life.

For engineers developing nextgeneration appliances and HVAC equipment—particularly for demanding or maintenanceconstrained environments—the technology offers a new architectural option that replaces a centuryold tradeoff with predictable, stable energy performance.

Engineer's Design Note :
Purpose: Preliminary evaluation of Air Cleaning Blowers™ as an alternative to fan plus filter architectures.

Key Characteristics (based on available test data):
• Constant airflow and power at a defined operating point
• No increase in external static pressure over operating life
• No scheduled filter replacement
• Robust operation in dusty or wet environments
Typical Applications:
• Appliance cooling air for motors and power electronics
• Enclosure ventilation and pressurization
• Equipment used in agriculture, construction, mining, or washdown conditions
Integration Guidance:
• Size for required airflow only; no clogging allowance required
• Electrical and thermal design may be based on steady state operation
• Provide an appropriate discharge path for separated debris

Edward Roston, founder of Air Cleaning Blowers, LLC and a veteran in the HVAC industry and owner of Aero Conditioner Company, LLC.

Feature/Metric	Traditional Media Filters	Air Cleaning Blowers™ (Patented Tech)
How It Cleans and Moves Air	*Physical barrier (paper/fiber other) collects debris; separate fan blows air*	*Single unit that blows and cleans air using debris' momentum to separate and eject it*
Clogging	*By collecting debris must increasingly clog*	*Do not collect debris so difficult to clog (truly self-cleaning)*
Airflow Consistency	*Resistance grows as dirt loads*	*Constant / predictable air flow*
Maintenance Required	*Continuing replacement & downtime*	*Normally almost none*
Particle Removal	*Varies by MERV rating*	*Down to 2 microns (plus removes liquids)*
Energy Consumption	*Steadily increases as media loads*	*Does not change*
Cost	*Initial and continuing for parts, labor, disposal, and energy for blower*	*Initial purchase and energy to run blower*
Gov't and Independent Testing	*Varies*	*Better than N95 mask (on specific models)*
Suitable for Liquids/Rain?	*No (can saturate media and stop flow)*	*Yes (Removes rain/spray/snow)*

Table 1

Ad Index

PRINT ADS



Continental Fan
www.continentalfan.com
13



EWPTE
www.electricalwireshow.com
Inside BackCover



Rohm
www.Rohm.com
3



Sprinter Marking
www.sprintermarking.com
23



Techflex
www.Techflex.com
7



Vitrek
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Back Cover

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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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