AHR EXPO & APEC 2022 ISSUE

APPLIANCE & HVAC REPORT

Reaching Design Engineers at the OEM Level

January 2022 VOLUME 4 ➢ NUMBER 1

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Welcome to Our First Quarterly Issue of 2022



Happy to be starting a new year. And part of that is having physical distribution at the AHR show in Las Vegas. We will be exhibiting there too. And come March we'll be at APEC in Houston. After not having events last year, for obvious reasons, we are glad to be back to see friends and colleagues, both exhibiting and attending.

Please take a look at our front cover, as it was designed for a very specific purpose. Yes, we have the words Appliance and HVAC in our title, but in our world, "Appliance" has a broader meaning. It includes lawn and garden products, power tools and medical devices. To the lay person that is not the case but to those in our industry, it does!

Are you familiar with capacitors? You should be as they are found in many different applications in our markets. So we have an informative feature on them. Thanks to the folks at InCompliance who have graciously allowed us to publish this feature that originally was in their publication.

Our brand began with one issue in autumn 2019 and we have published quarterly since then. Now we are happy to announce we are active in social media, to keep you abreast on all industry news as soon as it happens. If you haven't already done so, they should follow us on Twitter at @AppHVACReport, and on LinkedIn at Appliance & HVAC Report.

This issue has the following whitepapers in addition to the Capacitor feature:

• "Collaboratively Created Appliance Controls, No Matter the Industry" from Fenwal (part of Carrier).

• "Global HVACR Technician Roundtable" discussing the tech shortage and HVACR career opportunities and "When It Comes to Plastic Parts Assembly Laser Welding is the Clear Choice", both from Emerson.

• "How to Design Intelligent Circuit Protection and Sensing for Smart Home Locks and Access Controls" from Littelfuse.

• "5 HVAC Hazards to be Aware of During Heating Season" from Fieldpiece Instruments.

• Predicting the future isn't easy but Dinesh Kithany tries to do so with "global AC-DC and DC-Dc Merchant Power Supply Market Expected to Reach $31 Billion by 2025.

Best of luck this year to you professionally and personally. Don't hesitate to contact me at brad@appliancehvacreport.com for any comments, questions or concerns. And as mentioned above, please follow us on Linkedin and Twitter.

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Ad Index

APEC 2022 apec-conf.org	IBC
Cesar-Scott cesar-scott.com	21
Continental Fan continentalfan.com	23
Fenwal fenwalcontrols.com	17
Hernon Manufacturing hernon.com	eBlast
JBC Technologies JBC-tech.com	11, eBlast
John Guest johnguestUSA.com	IFC
Littelfuse littelfuse.com	eBlast
New Age Industries newageindustries.com	eBlast
Odawara Automation odawara.com	27
Pfeiffer Vacuum pfeiffer-vacuum.com	29, eBlast
Soler & Palau Soler-Palauinc.com	7, eBlast
Sprinter Marking sprintermarking.com	25
SurfaceIgniter surfaceigniter.com	BC
Vitrek vitrek.com	4, eBlast

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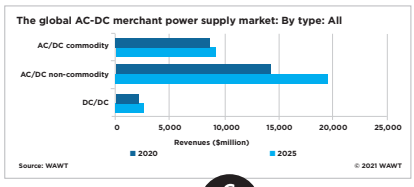
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January

CONTENTS

FEATURES



6

Global AC-DC and DC-DC Merchant Power Supply Market
by Dinesh Kithany

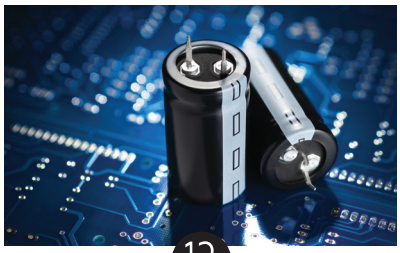
AC-DC and DC-DC merchant power supply market is projected to grow at a five-year CAGR of 4.8% from 2020 through 2025.



8

Select the Proper Pin for Your Assembly
by Jeff Greenwood

Among press fit pins, there are two general categories: Solid Pins and Spring Pins.



12

Capacitors: Theory and Application
by Min Zhang

This article presents the fundamentals and application of capacitors. What is a capacitor, and how do we select them?



18

Collaboratively Created Appliance Controls
by Marc Silverstein

Every industry relies on specific controls to manage their appliances. Finding the right controls product for your appliance can be challenging.



20

Global HVACR Technician Roundtable
by Rajan Rajendran

Panel of experts addresses the technician shortage and explores HVACR career opportunities.



24

5 HVAC Hazards
by Tony Gonzalez

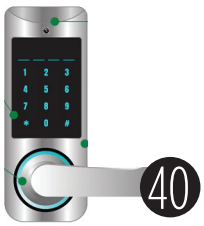
While accidents happen, there are a few ways to remain cautious for a safer, incident-free winter.



26

Five Reasons Adhesives Fail
by JBC Technologies

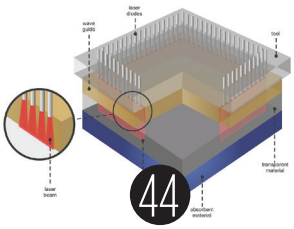
When the wrong adhesive is chosen, or proper care is not taken during the application process, the effectiveness of the part and the structural integrity of the entire assembly can be compromised.



40

How to Design Intelligent Circuit Protection and Sensing
by Ryan Sheahen

The rapid development of smart home & advanced building automation has enabled smartphone, networking, and internet-of-things (IoT) technologies.



44

When It Comes to Plastic Part Assembly, Laser Welding Is the "Clear" Choice
By Sean Leavy

In higher-end electronic, automotive and medical applications, manufacturers are delivering a higher level of aesthetics and craftsmanship.

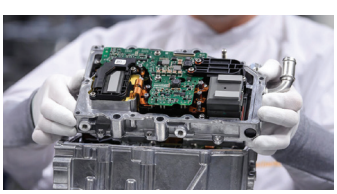
DEPARTMENTS

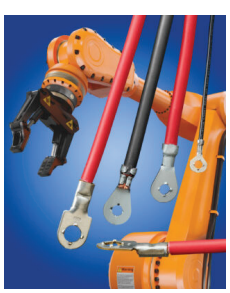
3 **Advertisers Index**

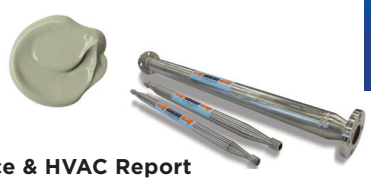
30 **News Beat**

33 **New Products**









Global AC-DC and DC-DC Merchant Power Supply Market

Expected to Reach $31 Billion by 2025

BY DINESH KITHANY

Based on WAWT's Power Supply Intelligence Service, the total global AC-DC and DC-DC merchant power supply market is projected to grow at a five-year CAGR of 4.8% from 2020 through 2025, to reach US$ 31 billion by 2025, with differing growth rates across application markets. With a nearly flat annual growth of 0.6% in 2020 being adversely impacted due to COVID-19 pandemic, this market is projected to growth by around 5% in 2021.

Growth Varies Across Application Markets

Application markets which are expected to grow much faster than the total market (4.8% CAGR) are LED lighting, Storage, Consumer, and Industrial sectors, while Networking, Servers and Medical sector would see a stable growth. The Access (Communication) market is the only application market which is expected to show a negative CAGR during the forecast period, whereas Computing, followed by Mobile device and chargers and Cellular Infrastructure markets are expected to grow at a much low relatively lower CAGR than total market from 2020 through 2025.

AC-DC Market Continues to Grow, While DC-DC Market Remain Stable

From product perspective, within the AC-DC segment, the non-commodity sector is expected to grow faster and gain revenue share, while the commodity (consumer) sector would see a decline. The revenue share of DC-DC converters would remain stable through the forecast period.

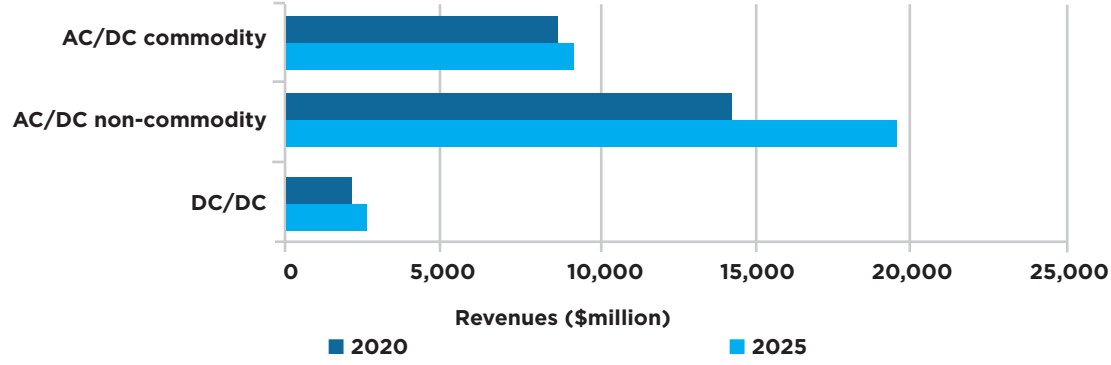
Within the AC-DC market, the rectifier/rack-mount continues to be the largest package type, followed by AC-DC open-frame/enclosed type power supplies. The DIN Rail which is the smallest product segment in terms of revenues is projected to grow the fastest in the next five years. Backed by demand across application markets, mainly datacenters, the high-power rating power supplies (>1500W) is expected to grow faster than the other power rating segments.

• Within the DC-DC converters market, the Bricks product type is the largest product segment, with quarter and eighth brick form-factor being the most popular type.

Asia to Maintain Largest Revenue Share, While Americas Expects to Grow Faster

While the Asia region is expected to maintain the largest revenue share in the next five years, WAWT projects the Americas (second largest region) would grow at a faster CAGR from 2020 through 2025, compared to Asia and EMEA. The recent COVID-19 pandemic, in addition to the geopolitical changes (US-China trade conflicts, increased import duties), current supply-chain (component shortages) resulting in increase in costs of components, have impacted the overall production landscape, with changes in cost efficiencies (cost advantages); and demand changes across end-device markets leading to further shifts in projected regional share through the forecast period.

The global AC-DC merchant power supply market: By type: All



Source: WAWT

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• The plans to shift production out of China to sub-regions such as Taiwan, Indonesia, Malaysia, India, Mexico, Vietnam, etc. though visible in 2018-2019 have been stalled a bit due to COVID-19 pandemic and other market challenges.

Market Continues to Consolidate as Top Large Companies Continue to Grow

Some major changes were witnessed in the 2020 market share ranking amongst power supply vendors considering change in market impacted due to COVID-19 pandemic, as well as position of these vendors across applications which performed differently. Top Ten power supply vendors serving the AC-DC and DC-DC merchant market, had a combined global revenue share of 44% in 2020, compared to 42% in 2019. The total power supply market is expected to consolidate further at different levels depending on the application market/sector.

Delta Electronics continues to top the 2020 market ranking charts being by far the largest global merchant power supply vendor, followed distantly by Lite-On. Aside of Delta Electronics, companies who witnessed strong revenue growth in 2020 are Dongguan Aohai Power Technology, XP Power, Ten Pao International, Astec Electronics, COSEL Group, Vicor Power, Chicony Power Technology and Advanced Energy. While there have not been any major merger and acquisition (M&A) activities in the power supply market in 2020, WAWT expects few M&A activities to be announced in the next one to two years focusing on key application markets and product segments, such Medical, Industrial and LED lighting sectors as well as within the DC-DC converters market.

WAWT, a Strategic Analyst Firm

Wired & Wireless Technologies (WAWT) is a strategic technology analyst and consultancy firm providing reliable data, analysis, insights and market intelligence on the latest technology trends and developments. WAWT offers the industry's most comprehensive research on the power supplies and wireless power market, consisting of critical market data (estimates and forecast), trends, insights, and market intelligence. Its power supply research focuses on AC-DC, DC-DC, HVDC and External Power Adapters and Chargers market, covering all application markets from access, telecom, servers, storage, networking, datacenters, LED lighting, medical, military and aerospace, industrial, railways, consumer and other key sectors. If you are interested to gain further knowledge and insights on the power supplies market, and access to its valued and insightful reports please visit www.wawt.tech and submit your enquiry.



***Dinesh Kithany**, Founder and Chief Analyst at WAWT, is an established industry expert currently focusing on power supplies and wireless power industry, with over 26 years of experience providing high-level insights and strategic advice to companies across technology sectors. Former Lead Analyst at Informa/Omdia and IHS Markit, with deep expertise in wireless power, power supplies, wired interface and connectivity technology, smart home and smart building, robots and drones, semiconductors, and wider consumer electronics markets. Dinesh, a member of PSMA, is a frequent and most sought-after speaker at key industry conferences, trade shows and events worldwide. To contact Dinesh, please visit www.wawt.tech or email him at dinesh.kithany@wawt.tech*





Why It's Critical to Select the Proper Pin for your Assembly

BY JEFF GREENWOOD

Fasteners are some of the most important parts of an assembly as they hold the entire assembly together and facilitate the interaction between the individual components. Ideally, the selected fasteners are simple to assemble, provide a quality product for the intended lifetime of the assembly, and yield the overall lowest cost of the assembly taking into account the entire manufacturing process. This article focuses on how to select the proper pin for an application. Specifically, press fit pins are discussed here as they are the most common types of pins used in modern manufacturing.

Press Fit Pin Types

Among press fit pins, there are two general categories: Solid Pins and Spring Pins. Solid Pins can have a smooth, uninterrupted surface (such as dowels) or they may be designed with retention features such as knurls and barbs. All Solid Pins are retained by displacing/deforming the host material. Conversely, Spring Pins retain themselves by exerting a radial force (tension) against the hole wall after installation. There are two different types of Spring Pins: Slotted Pins and Coiled Pins. Slotted Spring Pins are general purpose, low cost pins typically recommended for non-critical assemblies. Oftentimes, Slotted Pins are used in applications where they are manually installed into mild to hardened steel components. Slotted Pins have a gap designed for the pin to flex during installation allowing the pin to absorb varying hole tolerance. Coiled Spring Pins are available in light, standard, and heavy duty to enable the designer to choose the optimum combination of strength, flexibility, and diameter suited for varying host materials and performance requirements. Coiled Pins have 2 1/4 coils of material that enable the pin to flex both during installation to accommodate varying hole tolerance and after installation to dampen shock and vibration to prevent hole damage.

Application Evaluation

The first step in selecting a pin is evaluating the application. These are some of the many considerations when determining the proper pin for a specific application:

- What is the pin's function?
- What are the strength requirements of the pin?
- What is the material of the component in which the pin will be used?
- What environment will the pin be exposed to?
- What is the intended product lifetime and number of cycles?
- How will the pin be installed?
- What is the expected volume?

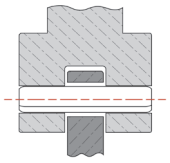
Designers should thoroughly examine the application and performance requirements early in the design stage. Not only will this guide facilitate decisions about the design of the host component(s), but it will also cover the topics of fastener selection, fastener size, material, duty, etc. Unfortunately, many designers wait until the end of the design to select a fastener. This can constrict the fastener selection process, limit performance, and force suppliers to use high-cost manufacturing processes to meet overly complicated specifications. It is recommended that manufacturers consult with pinning technical experts during the early stages of a new design so that the proper pin is selected and the appropriate specifications are applied to the mating components for the application.

Common Pin Functions

While there are many different ways to use pins, the most common are shown in Table 1. These guidelines apply the majority of the time, but each specific application should be evaluated for final determination of which pin type is most appropriate.

Hinge: There are two primary types of hinges:

1. A free fit hinge has little to no friction or drag when the latch or handle is rotated. Hinge components are "free" to rotate independent of one another.



Free Fit Hinge

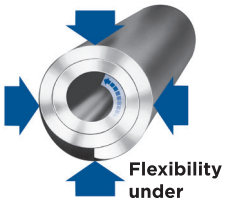
2. A friction fit hinge requires interference to prevent free rotation of components relative to one another. Depending on design intent, resistance can vary from a slight drag to a value sufficient to maintain the fixed position of components anywhere in their full range of rotation.



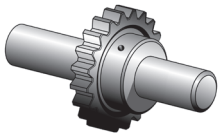
Friction Fit Hinge

All types of press fit pins should be considered when designing a free fit hinge. Solid Pins are often preferred when the pin must travel through multiple clearance holes or when there is limited engagement area in the host component. Coiled Pins are preferred when there is no axial load on the pin and for applications with shock and vibration. Slotted Pins are preferred when cost is paramount (typically at the expense of quality) and performance is sufficient. In general, Coiled Pins are preferred for friction fit hinges because they provide uniform radial tension that creates a "resistance" feel in the hinge. Additionally, Coiled Pins are far more flexible than Slotted Pins or Solid Pins, thereby reducing the risk of damage to the holes during installation and normal product usage.

Hub & Shaft: One of the primary benefits of using a Coiled Pin to affix a collar or hub to a shaft is the Coiled Pin's ability to prevent hole damage. The Coiled Pin's flexibility and ability to effectively absorb forces make it the ideal pin for most hub and shaft applications. While all three types of pins can be used to affix a hub / gear to a shaft, the Coiled Pin provides superior performance and extends the lifetime of the assembly compared to the other pins.



Flexibility under load



Locating / Alignment: The desired level of precision dictates which pin is appropriate. Coiled Pins are preferred for the vast majority of alignment applications because they conform to the holes in which they are installed and remain flexible. Therefore, maximum accuracy in alignment can be achieved with a "light" press to seat mating components. Light duty Coiled Pins are especially advantageous for low insertion forces. Wider hole tolerances can be used with Coiled Pins, which reduces the total manufacturing cost of the product. However, the more precision required, the tighter the hole tolerances need to be controlled in each component and in relation to each other.



Light Duty Coiled Spring Pin

Ground Dowels are preferred for highly critical alignment applications. Unlike Spring Pins, Solid Dowels rely on material displacement between the pin and the host components for the press fit. This requires a considerably higher installation force than either Spring Pin and requires that the holes to be precision machined, which increases cycle time and manufacturing costs.



Solid Ground Dowel

Stop: Coiled Pins, Slotted Pins, and Solid Pins are all commonly used to stop the movement of one component relative to another. For example, Coiled Pins are often used to prevent over-rotation of an actuator. When Slotted Pins are used for this purpose, it is recommended that the pin's slot is oriented opposite from the component interacting with the pin. Conversely, Coiled Pins and Solid Pins do not need to be oriented. Additionally, when Spring Pins are used as a stop pin, at least 60% of the pin's length must be retained in the static component to ensure retention as shown in Figure 2.

Figure 2

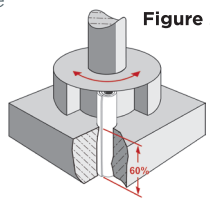


Table 1

TYPICAL PIN FUNCTIONS			
	Coiled Pin	Slotted Pin	Solid Pin
Hinge (free fit)	•	•	•
Hinge (friction fit)	•		
Hub/shaft	•	•	•
Alignment	•	•	•
Stop	•	•	•
Joining	•	•	•
Serviceable	•	•	

Joining / Retention: Coiled Pins, Slotted Pins, and Solid Pins are also commonly used to join components together. Coiled Pins and Slotted Pins hold components together with the frictional force generated from the radial tension of the pin. Coiled Pins and Slotted Pins are serviceable in the same hole.

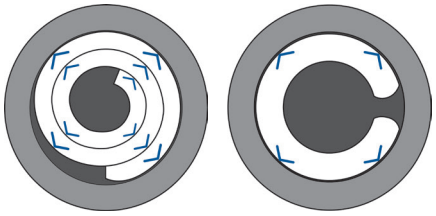


Figure 3: Radial tension in Coiled Pins and Slotted Pins

Solid Pins provide superior retention when an axial load is applied and are not removable / serviceable. This is advantageous when designers do not want users to disassemble their product. For the vast majority of retention applications, external features like knurls or barbs are preferred over ground solid dowels because they often provide cost savings.

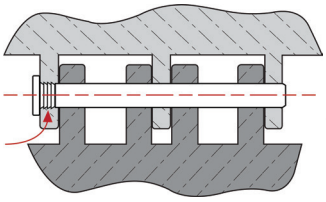


Figure 4: Barbs retain this Solid Pin within plastic component

Features, Advantages, Benefits

Each type of press fit pin serves a purpose for manufacturers. Table 2 compares the common features, advantages, and benefits for each type of pin.

General Considerations For Pin Selection

Spring Pins are typically preferred over Solid Pins because of their flexibility, lower insertion forces, and their ability to accommodate wider hole tolerances. Here are several common exceptions where Solid Pins are preferred:

- When a head is required for a positive stop or to retain a thin member to a thicker member of the assembly.
- When a smooth, uninterrupted surface is required such as when used in conjunction with a pawl or other angular component.
- When a hollow pin is not suitable such as when the designer is looking to plug a hole (i.e. restrict passage of liquids).
- When there is a need to manually align several clearance holes.
- When increased bending or shear strength is required.
- When precise hole locations need to be maintained.

Coiled Spring Pins are undoubtedly superior when it comes to assemblies subject to dynamic loading. Coiled Spring Pins have a unique combination of strength and flexibility, which allows them to dampen forces and vibration that prevents hole damage and prolongs assembly life.

While Slotted Spring Pins are used in similar applications as Coiled Spring Pins, Slotted Pins are typically preferred in non-critical, static applications where cost is prioritized over product lifetime.

Testing

It is prudent for manufacturers to perform testing with the fastener(s) that they have specified for the application to determine that the assembly performs as desired in the most extreme conditions. After testing is completed, engineers can compare measured test results with the performance requirements that were established. Ultimately, the proper pin for the application should satisfy the quality, performance, assembly, and cost goals of the manufacturer.

Table 2

COMMON FEATURES, ADVANTAGES, AND BENEFITS			
	Coiled Pin	Slotted Pin	Solid Pin
Flexes to prevent hole damage during installation	•	•	
Allows for wide hole tolerances	•	•	
Superior combination of strength and flexibility	•		
Superior performance in static applications	•	•	•
Superior performance in dynamic applications (absorbs shock loads)	•		
Superior resistance to axial load (push out / pull out)			•
Tamper resistant			•
Performance in soft materials under static loading (aluminum, plastic, etc.)	•		•
Provides positive stop / location	•	•	•
Lowest insertion force	•		
Conducive to automatic feeding	•	•	•
Serviceable	•	•	
Appropriate for critical applications	•		•

Reevaluate Product Design

The final step in selecting the proper pin is to reevaluate the overall product design. Oftentimes, the pin evaluation process identifies new information about the assembly. Many manufacturers see significant benefits when they stay flexible with their product design while the fastener is finalized. Here are some actual examples of design changes that were implemented after the fastener evaluation process that lead to performance improvements, cost savings, and/or improved quality:

1. New host material *example*: A manufacturer changed the material of their plastic housing from polybutylene terephthalate (PBT) to polycarbonate (PC) after seeing improved retention when using barbed Solid Pins.

2. Hole size *example*: A company increased the hole size in their hub & shaft from 2.95 ±0.05mm to 3.05 ±0.05mm so that they could utilize a standard off-the-shelf Coiled Spring Pin.

3. Hole tolerance *example*: A company was able to eliminate a timely honing operation by using a Coiled Pin for alignment rather than a Ground Solid Dowel.

4. Boss thickness *example*: A plastic molder witnessed cracking during prototype testing of a plastic hinge. They implemented SPIROL's recommendation to increase the boss diameter surrounding the Solid Pin from 1mm to 3mm, which eliminated the cracking problem.

5. Hinge design change *example*: A plastic molder originally designed a friction fit hinge but was unable to achieve the high swing torque requirement overtime with a Solid Pin as the plastic would relax causing the hole diameter to open up. As a result, the swing torque would diminish due to the enlarged hole size. They replaced the Solid Pin with a Coiled Spring Pin and incorporated the associated design changes to the holes to meet the desired swing torque. The redesign resulted in the swing torque being maintained beyond the expected life of the assembly.

Conclusion

Designers can optimize the performance and total manufactured cost of a product by selecting the proper pin for their product. In order to do this, it's critical that fastener options are considered early in the design stages. The most important step in selecting the proper pin is to evaluate the application in detail and establish performance requirements. Finally, the design team should test and validate the fastener(s) in prototype assemblies before final approval is given. ●



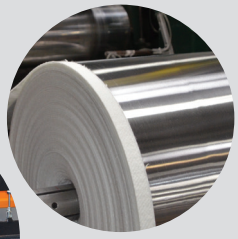
Jeff Greenwood *has 10 years of engineering experience and is the Product Sales Engineer for the Pin Product Group at SPIROL. In his role as Product Sales Engineer, Jeff has helped various companies around the world design and implement innovative fastening solutions. Additionally, Jeff has also been a key contributor with R&D projects resulting in the introduction of creative fastening solutions to the fastener industry.*

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Capacitors: Theory and Application

BY MIN ZHANG

Capacitor Design Techniques for EMC

ThCapacitors are among the most commonly used components on a circuit board. With the ever-increasing number of electronics devices (from mobile phones to cars), there has been a growing demand for capacitors. Covid 19 pandemic has disrupted the global supply chain of components from semiconductors to passive components, and capacitors have been in short supply[1].

A discussion on the subject of capacitors could easily become a book or a dictionary. To start with, there are different types of capacitors such as electrolytic, film, ceramic capacitors, and so on. Then, within the same type, there are different dielectric materials. There are also different classes. As for physical construction, there are two-terminal and three-terminal capacitor types. There's also an X2Y type capacitor which essentially is a pair of Y-capacitors packaged in one . What about supercapacitors? The fact is, if you sit down and start reading the capacitor selection guide of major manufacturers, you could easily spend a day!

Since this article is about fundamentals, I will use a different approach as I would normally do.

As mentioned before, a capacitors selection guide can be easily found with supplier websites , and field engineers can often answer most of the questions about capacitors. In this article, rather than repeating what you can find on the internet, I will use practical examples to demonstrate how to select and use capacitors. Some lesser known aspects of capacitor selection, such as capacitance degradation, will also be covered. After reading this article, you should have a good sense of using capacitors.

But first, let's answer the most fundamental question, what is a capacitor?

A Capacitor from the Field Theory Point of View

Years ago, when I was working for a company making electronics devices, we had an interview question for power electronics engineers. On the schematics of an existing product, we would ask the potential candidates "What is the function of the DC link electrolytic capacitor?" and "What is the function of a ceramic capacitor that is located next to a chip?". We would expect the correct answer to be that the DC link capacitor is used

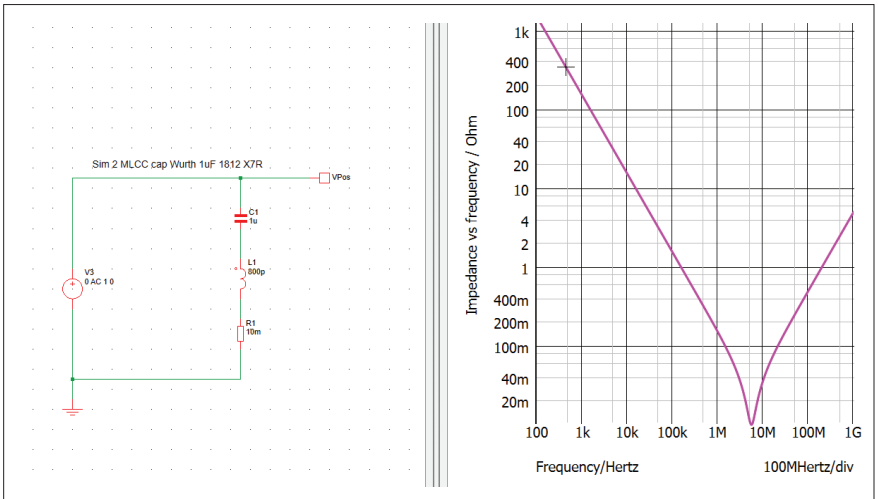


Figure 1: Spice model of an equivalent circuit of a ceramic capacitor and its impedance curve.

for energy storage and the ceramic capacitor is used for filtering.

The "correct" answers we were seeking actually showed that everyone in the design team viewed a capacitor from the simple circuit point of view, not from the field theory. There's nothing wrong with circuit theory viewpoint. At low frequency (from a few kHz to a few MHz), circuit theory often explains things very well. This is because at lower frequencies, signals are predominantly in differential mode. Using circuit theory, we can view a capacitor as that shown in Figure 1, with an equivalent series resistor (ESR) and an equivalent series inductor (ESL) causing the impedance of the capacitor to change with frequency.

This model explains the circuit performance adequately when the circuit switches slowly. However, as frequency goes up, things are becoming much more complex. At some point, components start showing nonlinearities. A simple L-C-R model has its limits when frequency increases.

Today, if I were asked the same interview questions, I would put my field theory viewing glasses on and say both capacitor types are energy storage devices. The difference is that an electrolytic capacitor can store much more energy than a ceramic capacitor. But when it comes to energy delivery, a ceramic capacitor can deliver the energy much more quickly. This explains why ceramic capacitors need to be located next to the chip, because a chip has a much higher switching frequency and switching speed compared to the main power circuit.

From this viewpoint, we can simply define two performance criteria for a capacitor. One is how much energy a capacitor can store, the other is how quickly can this energy be delivered. Both depend on how a capacitor is made, the dielectric materials, the connection to the capacitor, and more.

When a switch is closed in a circuit (see Figure 2), it indicates that the load demands energy from the source. How fast this switch closes determines the urgency of the energy demand. As energy travels at the speed of light (half of this speed in an FR4 material), it takes time for the energy to be delivered. Besides, there's an impedance mismatch between the source and the transmission line, and with the load as well. This means energy is never delivered in one trip but over many round trips and is why, when a switch is switched fast, we see delay and ringing in the switching waveform.

The fact that energy delivery takes time, and many round trips tells us we need to locate the energy source as close as we can to the load, and we need to find ways of delivering it fast. The first is often achieved by reducing the physical distance between the load, the switch, and the capacitor. The latter is achieved by clustering a group of capacitors with minimum impedance.

The field theory also explains what causes the common-mode noise. Simply put, the common-mode noise is created when a load's demand for energy is not satisfied at the instance when the switch is switched. As a result, energy stored in the space between the load and nearby conductors will be supplied to support the step demand. The space between the load and nearby conductors is what we call a parasitic/mutual capacitor (see Figure 2).

We use the following examples to demonstrate how to use electrolytic capacitors, multi-layer ceramic capacitors (MLCCs), and film capacitors. Both circuit and field theories are used to explain the performance of the selected capacitors.

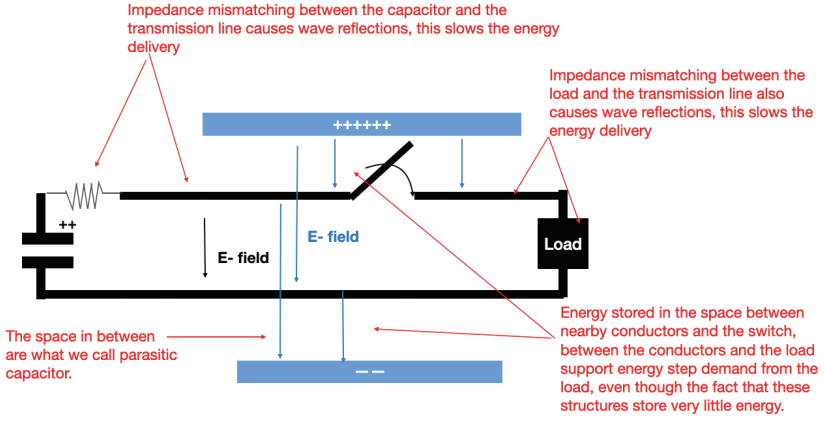


Figure 2: Energy travels in space and it takes time; impedance mismatch causes multiple round trips of energy delivery.

Electrolytic Capacitors

Electrolytic capacitors are mostly used in a DC link as the prime energy source. The selection of electrolytic capacitors often depends on:

1. Capacitance value, as this often determines the very low frequency ripple of the circuit;
2. ESR and ESL, as this determines the differential-mode noise ripple on the capacitor;
3. Temperature, as it can affect the ESR of the capacitor (in this case, the higher the temperature, the lower the ESR as the ESR is a result of the

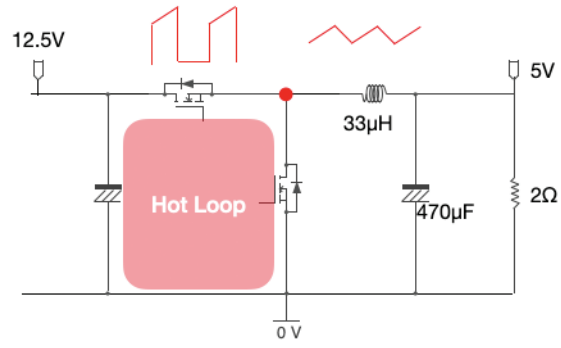


Figure 3: Hot loop area in a DC-DC converter

chemical reaction of the capacitor);

4. Aging is an important factor to consider, since the capacitance value can be significantly reduced due to temperature, humidity, stress, etc.; and

5. Leakage current.

For EMC performance, the most important feature of a capacitor is the impedance versus frequency characteristics. Low frequency conducted emissions always depend on how good the DC link capacitor is.

The impedance of the DC link depends not only on the ESR and ESL of the capacitors but also on the hot loop area as illustrated in Figure 3. A larger hot loop area means energy delivery takes longer, hence the performance is compromised.

A step-down DC-DC converter was set up to demonstrate the point. A pre-compliance EMC test set-up shown in Figure 4 performs the conducted emission sweep between 150kHz and 108MHz.

Three configurations for the input capacitors were tested:

1. One 680 µF surface mount electrolytic capacitor;

2. Two 330 µF surface mount electrolytic capacitors in parallel; and

3. Two 330 µF surface mount electrolytic capacitors in parallel, with one capacitor moved closer to the switch side.

It is important to make sure that the capacitors used in this case study were all from the same manufacturer to avoid impedance characteristics differences. When soldering the capacitor on the PCB, make sure there're no long leads as this will increase the ESL of the capacitor. Figure 5 shows the three configurations.

The conducted emission results of these three configurations are shown in Figure 6. As it can be seen, two 330 µF capacitors achieve 6 dB noise reduction performance across a wide frequency range compared with a single 680 µF capacitor.

From the circuit theory, one can say that, by having two capacitors in parallel, both ESL and ESR are halved. From the field theory, rather than having one energy source, two energy sources supplied to the same load effectively reduce the overall energy delivery time. However, at higher frequencies, the difference between two 330 µF capacitors and one 680 µF capacitor narrows. This is because high-frequency noise indicates an insufficient step energy response. When moving one 330 µF capacitor closer to the switch, we reduce the energy delivery time, this effectively increases the step response

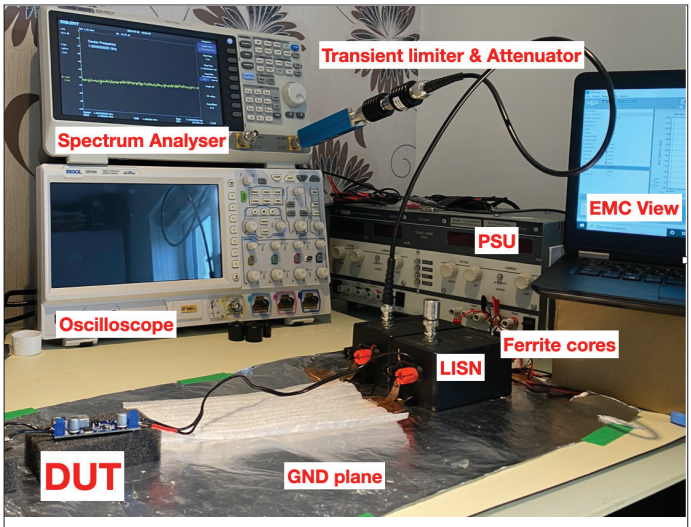


Figure 4: Bench pre-compliance conducted emission test set-up for the device under test.

Figure 5: Three configurations for input capacitors.

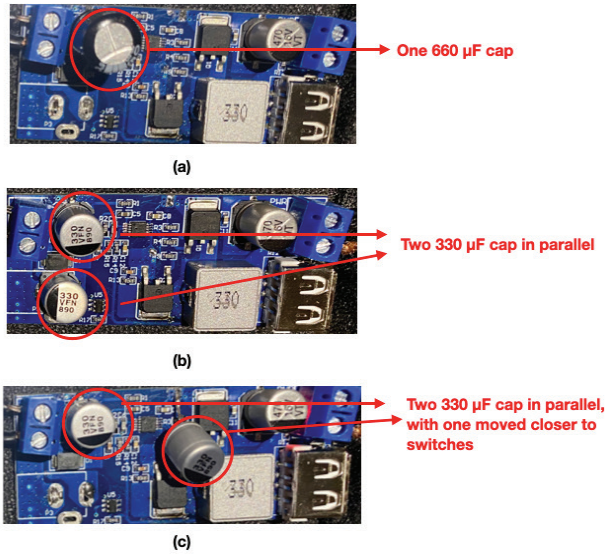


Figure 6: Conducted emission test results of three different capacitor configurations.

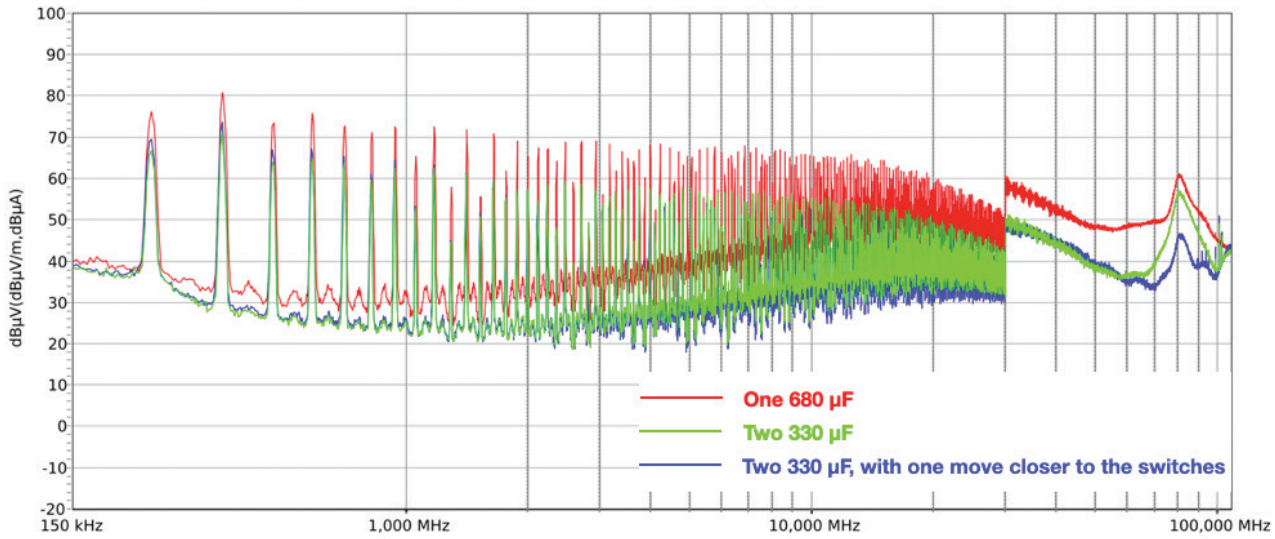
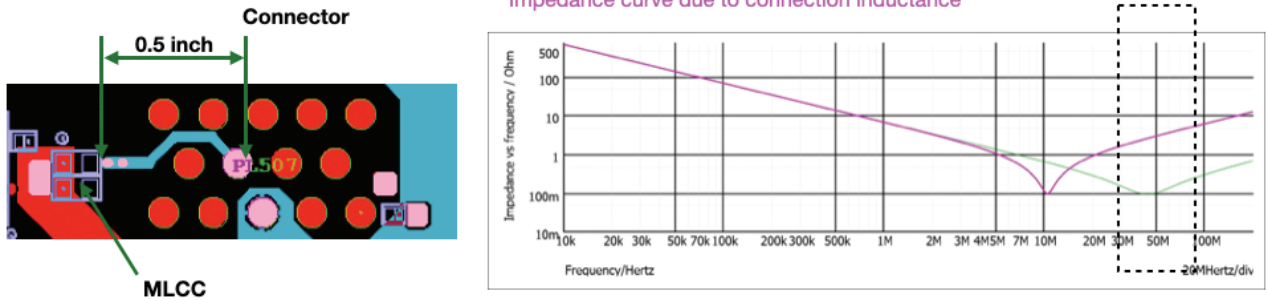


Figure 7: Long trace to the MLCC connection increases inductance.



of the capacitor.

The results tell us a very important lesson. Increasing the capacitance of a single capacitor will not usually support the step demand for more energy. If possible, use a few smaller capacitance components. There are many good reasons for doing so. First is the cost. Generally speaking, the cost of capacitors increases exponentially with capacitance value for the same package size. Using one single capacitor is perhaps more expensive than using a few smaller capacitors. The second reason is the size. The limiting factor for a product design is often the height of a component. For capacitors with large capacitance, the height is often too big to be fit in the product design. The third reason is the EMC performance as we have seen in our case study.

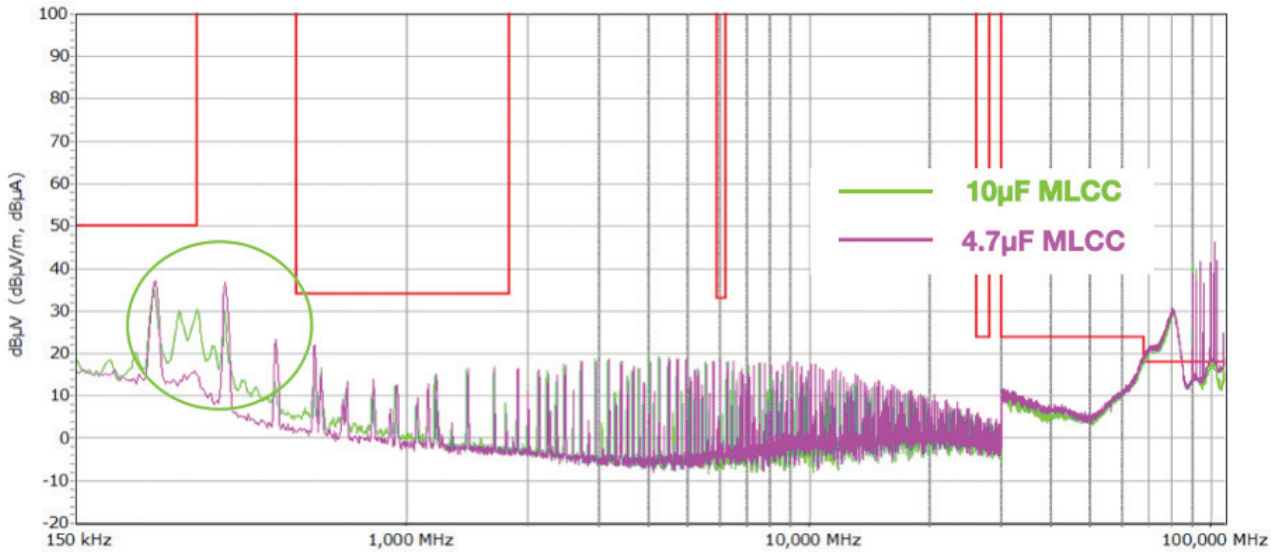
Another factor to consider when using electrolytic capacitors is that balancing resistors will be needed when you put two capacitors in series to share volage[6].

Multi-Layer Ceramic Capacitors (MLCCs)

As explained before, ceramic capacitors are tiny devices that can deliver energy fast. I often get asked the question "How much capacitance do I need?". The answer to this question is that for ceramic capacitors, the capacitance value shouldn't matter that much. The important consideration here is to work out at which frequency the speed of the energy delivery would be sufficient for your application. If a conducted emission failed at 100 MHz, then a capacitor that has the least impedance at 100 MHz would be a good option.

Here's another misconception of MLCCs. I have seen engineers spend great effort selecting a ceramic capacitor with the least ESR and ESL, only to then connect the capacitor to the RF reference point via a long trace.

Figure 8: A 10 µF MLCC introduced a resonance at 300 kHz.



It is worth knowing that the ESL of an MLCC is generally much lower than the connection inductances on the board. The connection inductance remains the single most important parameter affecting the high-frequency impedance of ceramic capacitors .

A bad example of this is shown in Figure 7. The long trace (0.5 inch long) introduces at least 10nH inductance. Simulation result shows that the impedance of the capacitor becomes a lot higher at frequency point (50 MHz) than is intended.

One of the problems with MLCCs is that they tend to resonate with the inductive structures on the board. This can be seen in the example shown in Figure 8, in which the use of a 10 µF MLCC introduces a resonance at about 300 kHz.

You can reduce the resonance by including select parts that have larger ESR, or by simply putting a small value resistor (like one ohm) in series with the capacitor. Such methods use lossy components to damp the system. Another way is to use another capacitance value to shift the resonance either to a lower or a higher resonance point.

Film Capacitors

Film capacitors are used in many applications. They are the capacitors of choice for high power DC-DC converters and are used as EMI suppression filters across the supply lines (both AC and DC), as well as in common-mode filtering configurations. We use an X capacitor as an example to demonstrate some of the key points of using film capacitors.

Generally, an X capacitor performs the following functions:

1. Attenuates the conducted noise directly from any switching events on the lines (for instance, a Triac device switching the mains AC line);

2. Together with an inductor, it forms a low pass filter for differential mode noise appearing on the lines; and

3. It helps limit the peak voltage stress on the lines if there is a surge event, so it is often used together with a transient voltage suppressor (TVS) or metal oxide varistor (MOV).

You probably already know all of these, but do you know the capacitance value of an X capacitor can be reduced significantly over years of service? This is particularly true if the capacitor is used in a humid environment. I have seen cases where an X capacitor's capacitance value dropped to only a few percentages of its rated value in a year or two, so the system initially designed with X capacitor effectively lost all the protections that a front-end capacitor could have.

So, what has been happening? Damp air can leak into the capacitor, up the wires, and between the box and the epoxy potting compound. The aluminium metallization can then oxidize. Aluminium oxide is a good electrical insulator, thereby reducing the capacitance. That's one problem all film capacitors can have. The problem I was talking about was the film thickness. Reputable capacitor brands use a thicker film, resulting in a larger capacitor than other brands. The thinner film makes the capacitor less robust to overload (voltage, current, or temperature) and less likely to self-heal as well.

If the X capacitor is not permanently connected to the supply, then you have

less concern. For instance, for a product that has a hard switch between the mains and the capacitor, size is probably more important than lifetime and you can then choose a thinner capacitor.

However, if the capacitor is permanently connected to the supply, then it must be highly reliable. Oxidation of capacitors is not inevitable. If the capacitor epoxy material is of good quality and the capacitor is not routinely exposed to temperature extremes, value degradation should be minimal.

Conclusion

In this article, a field theory view of capacitors was first presented. Practical examples and simulation results demonstrate how to select and use the most common types of capacitors. Hopefully, this information will help you develop a more complete understanding of the role that capacitors play in electronics and EMC design.

Acknowledgement

The author would like to thank Mr. Steve Berry for his technical support on this subject.

[1]F. Times, "South-east Asia's Covid surge poses latest blow to global chip supply," [Online]. Available: https://www.ft.com/content/7b678988-53d1-4a52-8866-28f109e88d79.

[2]"X2Y Technology Summary," [Online]. Available: https://www.x2y.com/techsummary.htm.

[3]T. p. center, "Capacitors Selection Guide," TDK, [Online]. Available at https://product.tdk.com/en/products/selectionguide/capacitor.html.

[4]Vishay, "Vishay Design Tools," [Online]. Available: https://www.vishay.com/how/design-support-tools/.

[5]R. Morrison, Fast Circuit Boards - Energy Management, Wiley, 2018.

[6]EMCCompliance, "Under what circumstances do we need balancing resistors for capacitors?," [Online]. Available: http://emccompliance.co.uk/qa-1.

[7]T. H. Hubing, EMC question of the week 2017-2020, Learn EMC, 2021.



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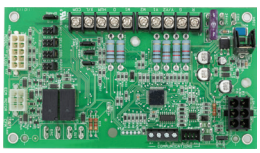
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Cascade of boilers allowing for more efficiency in large buildings



Collaboratively Created Appliance Controls, No Matter the Industry

BY MARC SILVERSTEIN

Every industry relies on specific controls to manage their appliances. Whether you're controlling fryers or commercial laundry equipment, finding the right controls product for your appliance can be challenging because, while you are the expert in your industry, developing controls can be an unnecessary burden. Choosing a trusted appliance controls company can help your product succeed and allows manufacturers to stay focused on their daily demands. Fenwal Controls, a Carrier company has a record of expertise in developing components for appliance controls. Partnering with Fenwal helps everyone win, no matter the industry. Here are some case studies of successful partnerships with key OEM customers.

Commercial Boilers and PIM®

A commercial boiler company was looking for a new approach to control their entire line of boilers. The manufacturer needed a flexible, adaptive solution that would not require programming in the factory. Their goal was to have a single control in their factory that could be easily configured to every different model and size of boiler they offered, both modulating and conventional. They also needed the flexibility to cascade multiple boilers to support larger buildings and operate boilers with multiple stages and gas valves, all from a single control. Using a collaborative approach based on extensive industry research across North America, Fenwal Controls engineers designed a new type of control that could support many different configurations with a single SKU. The Fenwal Controls PIM, or Platform Ignition Module, was developed to specifically address the needs of OEM boiler manufacturers. One unique feature developed specifically to reduce control module SKU's and shop floor programming is the Fenwal PIM ID card. By plugging in a different ID card for each boiler or size of boiler, a single PIM will run the correct program to control that boiler. Today, most of this customer's boilers are controlled with a single PIM SKU. The PIM was the result of fruitful collaboration, and this project continues to evolve as new boilers are developed and integrated into the family.

Commercial Laundry Equipment and UART

A commercial laundry manufacturer wanted to design a dryer that could be easily sold globally and increase serviceability and support at the same time. Instead of following traditional 24VAC low voltage or European 230VAC mains voltage practices, the manufacturer wanted to adopt a



Communicating commercial laundry equipment able to transmit fault conditions



High efficiency fryers improve performance with fewer components and simplified design

universal power supply design. Using low voltage DC, a universal power supply, like what is typically sold with laptop computers, can accept input voltages from 80VAC to 230VAC and output a clean DC voltage. By switching their entire design to DC, a single model of dryer could be sold globally. The company's additional goal, improving serviceability, meant improving information from the gas ignition control to the dryer's motherboard. Working together with the commercial laundry manufacturer, Fenwal Controls developed its first DC voltage direct spark ignition control with a universal asynchronous receiver-transmitter (UART) interface. The UART sends a customized digital message to the dryer's main control providing operational status and performance data. The new control was designed tested and approved for North America, Europe and Australia. Now in production for several years, Fenwal Controls has seen an increase in demand of both DC controls and UART communications and has continued to make steps to improve both technologies in the controls industry.

"There were a lot of firsts in this project, an innovative concept for a communicating DC powered direct spark ignition control. Meeting weekly with our customer ensured the product met all their goals."
– Paul Finn, Compliance Engineer, Fenwal Controls.

Alignment Provides More to Customers

Fenwal Controls and UTEC are now working together under Carrier and use a combined 226 years of experience to deliver quality products more efficiently and to support a wider range of appliance manufacturers. From agricultural equipment to elevator solutions, from heat pump & geothermal to food equipment controls and so much more, Fenwal and UTEC are so much more than HVAC.

"With Fenwal Controls and UTEC working together we are able to provide our customers a broad range of controls, user interfaces and sensors for a variety of applications. Coupled with connectivity, these solutions enable access to commissioning, monitoring and maintenance." – Suresh Ram, Managing Director, Carrier Global Controls

The alignment of Fenwal Controls and UTEC under the Carrier brand has allowed our two companies to increase our manufacturing capabilities and provide more products to more industries. And with more locations around North America and Asia, you can trust us to be better supplied to meet challenging global demands that stress businesses. Getting help when you need it is essential, so providing fast, local support and knowledge has been a major alignment priority. We're ready to support global customer needs with experts located around the world. ●



Marc Silverstein *is the Product Manager for Fenwal Controls (fenwalcontrols.com) in Ashland, MA, U.S., a part of Carrier Global Corporation, a leading global provider of healthy, safe, sustainable, and intelligent building and cold chain solutions. He has more than 15 years of experience in Product and Program Management for software and hardware technologies. He brings his experience and knowledge from other industries to Fenwal Controls. He received his BSEET from the University of Hartford's Ward College of Technology.*

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Global HVACR Technician Roundtable

Panel of experts addresses the technician shortage and explores HVACR career opportunities

BY RAJAN RAJENDRAN

The shortage of qualified HVACR technicians is arguably one of the biggest challenges facing our industry today. According to recent estimates, 80,000 HVACR technician jobs are currently unfilled — representing 39% of the total HVACR industry workforce. Emerson recently assembled a global panel of expert technicians, practitioners and apprentices to explore ideas for reversing this trend and discuss strategies for attracting the next generation of candidates. In doing so, we learned about their individual career journeys, reflected on the expanding diversity of opportunities, and validated the importance of the roles of technicians in society.

HVACR technicians serve essential functions in modern life: providing comfort cooling and maintaining the integrity of the cold chain responsible for preserving food and life-saving medicines. It's a career path that offers lifelong learning, numerous opportunities for advancement and entry-level salaries often exceeding those of many college graduates.

Although we refer to these professionals as HVACR technicians in the U.S., they are known as different titles elsewhere, such as: engineers in the UK; workers in Asia-Pacific; and experts in the Middle East. As moderator of this important discussion, I asked each panelist to elaborate on their personal experiences and explain the regional importance of technician careers — all while uncovering the expanding career opportunities and perks of the job.

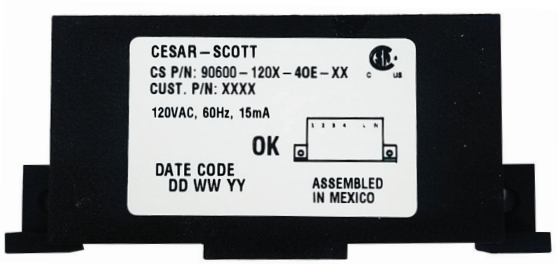
From Installer to Journeyman to Educator

Don Gillis, technical training specialist at Emerson, said his career path followed the typical trajectory for those starting out in this industry. "I am a product of the vocational school system and started my career carrying tools, cutting, cleaning and fitting copper together for new installations. After 30 years, I'm still a licensed journeyman, even though now I teach here at Emerson," he said.

Gillis said that the opportunities to shadow more experienced technicians and help them with preventative maintenance showed him firsthand how interesting this career could be. "Every day is going to bring a new challenge. As you're dispatched to each call, diagnosing systems, locating parts, and educating the customer about

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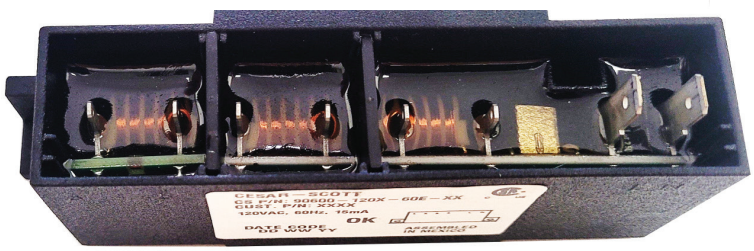


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what you discovered, you learn about a variety of issues that can impact system performance, capacity and efficiency. It's a very self-sufficient type of position where you're always solving problems," he said.

Today, Gillis passes on his expertise to the next generation of HVACR technicians who attend his classes through Emerson Educational Services. He also shared that his passion for HVACR runs in the family: his son has followed in his footsteps and started his own HVACR contracting business.

Answering the Global Call For Comfort

Currently based in Hong Kong, Joe Healy, Emerson's director of application engineering in the Middle East, Africa and Asia, relayed his more than 25 years of experience working within different countries and continents. "The first thing that comes to mind when we think about what technicians do is that they make it possible to live in the kind of environments we live in. In Hong Kong, it's extremely hot and humid; it would be nearly intolerable without air conditioning," said Healy.

He spoke to the wide range of aptitudes when it comes to approaching HVACR in different countries — from the sustainability initiatives of Australia and New Zealand to advanced technologies in Japan to the manufacturing focus of China and the challenges of underdeveloped infrastructures in India. "There is plenty of room for improvement in some of these more underdeveloped areas," said Healy. He added that the sheer diversity of approaches makes HVACR-related professions a never-ending learning experience.

Regardless of the country or region, Healy shared that HVACR technologies — and the technicians who work on these systems — are the "wheels that keep society running". Whether it's the refrigeration that enables populations to be fed, or the cooling systems within mass transportation systems, Healy said these technologies allow us all to thrive in any environment.

Rising to the Challenge in Latin America

As vice president of Emerson's engineering services and product management in Latin America, Carlos Obella recounted how his career started 35 years ago as an HVAC field technician. Fresh out of college with an engineering degree, he quickly learned from other field technicians and gained expertise in installing and servicing parallel rack compressor systems for large supermarkets.

"The best field technician I ever met was not an engineer. He specialized in parallel compressor systems and became the main refrigeration consultant for one of the biggest supermarket chains in Argentina. I learned a lot from him that has helped me throughout my career," said Obella.

Alonso Amor, Emerson's director of engineering services in Mexico, explained that the region's high ambient temperatures also place extreme demands on refrigeration and AC loads. But he said these conditions have not deterred the commitment of the region's native technicians to learn the HVACR trade. "People are eager to certify themselves and learn about our industry, despite the tough working conditions. When we travel around the region to conduct seminars, we see hundreds of attendees that are willing to learn and share their experiences," said Amor.

In addition to providing certification opportunities for candidates, Amor said that Emerson takes great pride in recruiting and employing women within its engineering services staff. "Women make our industry a more dynamic place to work and are excellent problem solvers. We're very proud that at least 20% of the engineering services staff in Mexico are women," he said.

Stepping Up Recruitment Efforts

As Emerson's director of aftermarket sales, Becky Hoelscher discussed the urgency with which our industry must recruit the next generation of HVACR technicians to replace the growing number of retiring professionals. "Baby boomers are retiring, and there simply aren't enough students or new job seekers to replace them," she said. She urged industry stakeholders to start recruitment efforts early in high school by educating students about the expanding opportunities within the HVACR profession. "Everybody knows what a nurse does or what a physical therapist does. But what does an HVACR technician do? We need to get in front of students early and entice them — show them the thermodynamics of refrigeration and how it keeps ice cream cold and relates to their lives," said Hoelscher.

Hoelscher reiterated the importance of apprenticeships and discussed federal, state and local efforts to support these initiatives. She believes that a combination of classwork learning and on-the-job training can enable students to start getting paid while working toward a certification.

"Since 1937, the National Apprenticeship Act has supported the trade professions. The United States recently passed the Apprenticeship Act of 2021, which includes a $400 million fiscal allowance for supporting businesses and helping apprentices to work, learn and get paid in the process," she said.

For students who participate in apprenticeship programs, Hoelscher noted that they have a unique opportunity to earn while they

learn and essentially start making a competitive wage in school.

"Apprenticeships allow students to get paid as they are attending a vocational school or technical college while working toward their certification. Many are already earning what a college graduate makes right out of high school," she said.

An Apprentice's Perspective

Our panel was fortunate enough to also include the perspective of Nicholas Didier, an up-and-coming HVACR technician and vocational school student who participated in a pre-apprenticeship program at Emerson's The Helix Innovation Center. As a high school senior enrolled in an HVACR program, Didier shared his motivation for pursuing an apprenticeship and how the experience set him on a path to success. Upon entering the program, his goals were to understand the basics of refrigeration and get hands-on HVACR field training.

"I knew I wanted to be an HVACR technician, and the opportunity at The Helix would help me on that path. But after being exposed to new technologies like CO2 chillers and other commercial refrigeration applications, I came out thinking more like an engineer," said Didier.

Didier's passion and efforts have already been recognized and rewarded. He earned a $1,000 scholarship from the Today's Opportunities Offering Lifetime Skills (TOOLS) program and a new Ford Ranger truck. He was also recognized via a "20 Under 20" award" in his residence's county, which has awarded students enrolled in work-based learning programs.

"HVACR has already brought me many places, taught me many things, and allowed me to meet great people," he said. Didier plans on pursuing a bachelor's degree in HVACR engineering technology at Ferris State University in Michigan.

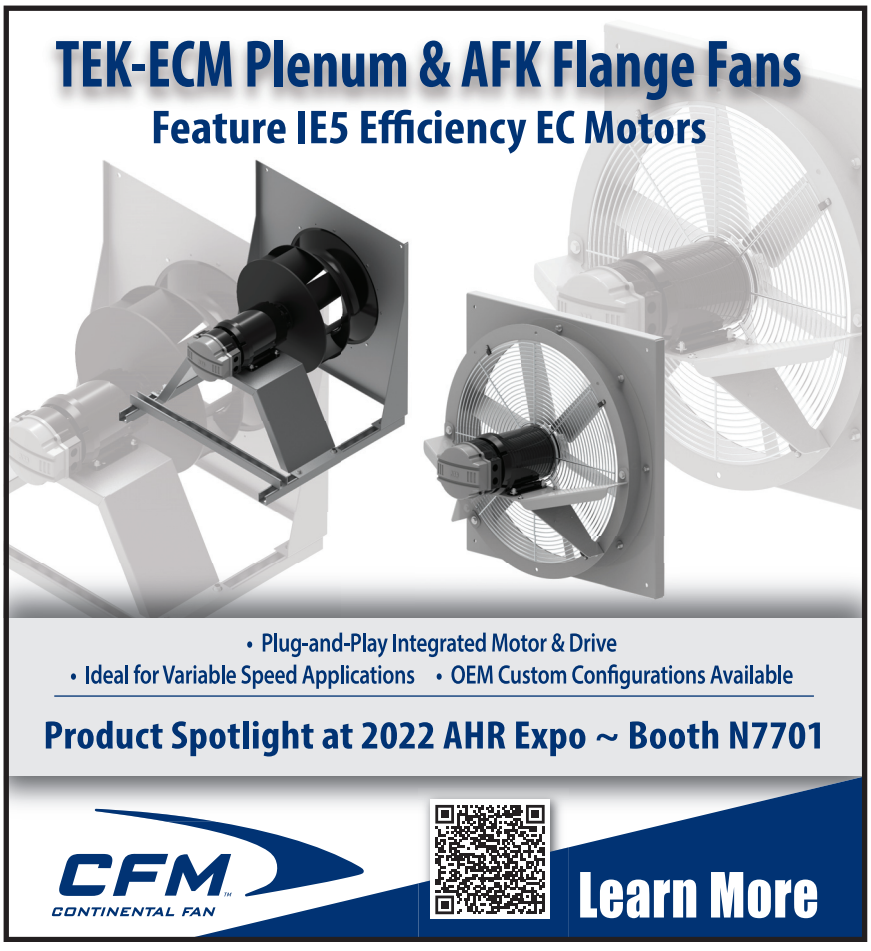
Promoting an Evergreen Career Path

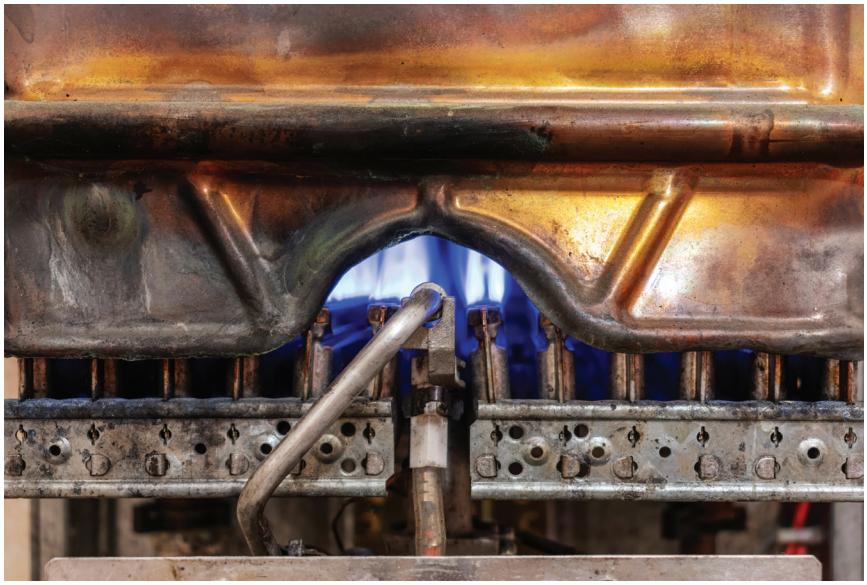
Emerson's pre-apprenticeship programs are just one way we are helping to promote HVACR careers and solve the technician shortage. Filling the need for skilled technicians will not only require outreach to vocational schools and technical colleges, but also the persistent engagement of potential students in apprenticeship opportunities will allow them to earn a paycheck while they learn this rewarding trade.

Today, HVACR careers present evergreen opportunities for students seeking long-term career growth and a viable alternative to a four-year college education. The anecdotes and individual perspectives of this global panel only scratched the surface of the emerging opportunities that await those who enter this career path. To learn more about HVACR technician careers and how to attract the next generation of candidates, please view this webinar.



Rajan Rajendran is the Global Vice President, Environmental Sustainability with Emerson's Commercial & Residential Solutions Business.





5 HVAC Hazards to be Aware of During Heating Season

BY TONY GONZALEZ

Fall is here and winter is approaching. That means we are officially in heating season. While accidents happen, there are a few ways to remain cautious for a safer, incident-free winter.

Working in colder climates has some obvious challenges. For one, HVACR professionals deal with extreme weather while working long, tiresome hours near components that could be red hot. They also deal with potentially deadly gasses like carbon monoxide, propane and natural gas.

Here are some ways to make sure technicians work safely around the most common HVACR industry hazards faced:

1. CO Exposure

This is the biggest danger, both to you and to the homeowner or building occupants. Carbon monoxide (CO), a natural byproduct of burning natural gas, is an odorless, colorless gas that is rightly known as the silent killer. While prolonged exposure can lead to death, breathing air saturated with CO for even a short time can quickly overwhelm and incapacitate you. When working around heating equipment, you should use a CO tester to confirm you're not being exposed. Be sure to follow all safety guidelines while installing a system to ensure no CO gets into the home or the conditioned space.

2. Burns

There are multiple ways an HVACR tech might burn themselves – especially in the winter. Working close to open flames and hot elements, heating systems can put out a lot of excess heat. Plus, techs often find themselves needing to solder connections and other components – the opportunities for burns are endless. The best way to stay safe is to know where the sources of heat are and work carefully and deliberately around them. Don't rush your work and don't guess if something has cooled off enough to touch.

3. Fatigue

Getting tired comes with the territory when crawling around in the dark and lifting heavy equipment. To avoid fatigue, get plenty of rest before starting your workday. Also, working safely is often the first thing overlooked when working tired. While shortcuts to remove extra steps may sound like a better option when exhausted, this can lead to incidents that put yourself or others in harm's way. If you're too tired to work safely, you're too tired to work. Don't risk it.

4. Extreme Weather

Until furnaces start shutting down, you're most likely working in cold crawlspaces and attics, and on slippery surfaces like ice-covered sidewalks. When the temperature drops this time of year, dress for the conditions. Durable, warm work boots can give you firm footing on icy steps. Also, cold fingers can easily drop tools, so wear warm gloves.

5. Electrocution

If you're working around electrical circuits or with live wires in an HVACR system, it's best to turn them off at the panel. Then, hang a tag at the panel so no one accidentally turns it on. If you work with live wires, wear the correct PPE and follow all safety precautions.

Heating season is no joke. Your safety, and the safety of others, is in your hands, so keep these tips in mind when conducting service and repair calls. ●



Tony Gonzalez *is the Technical Training Manager for Fieldpiece Instruments. He has more than 20 years of industry experience with Fieldpiece developing new products. Recently, he led the Job Link® App development team and developed Fieldpiece's wireless power clamp meters.*

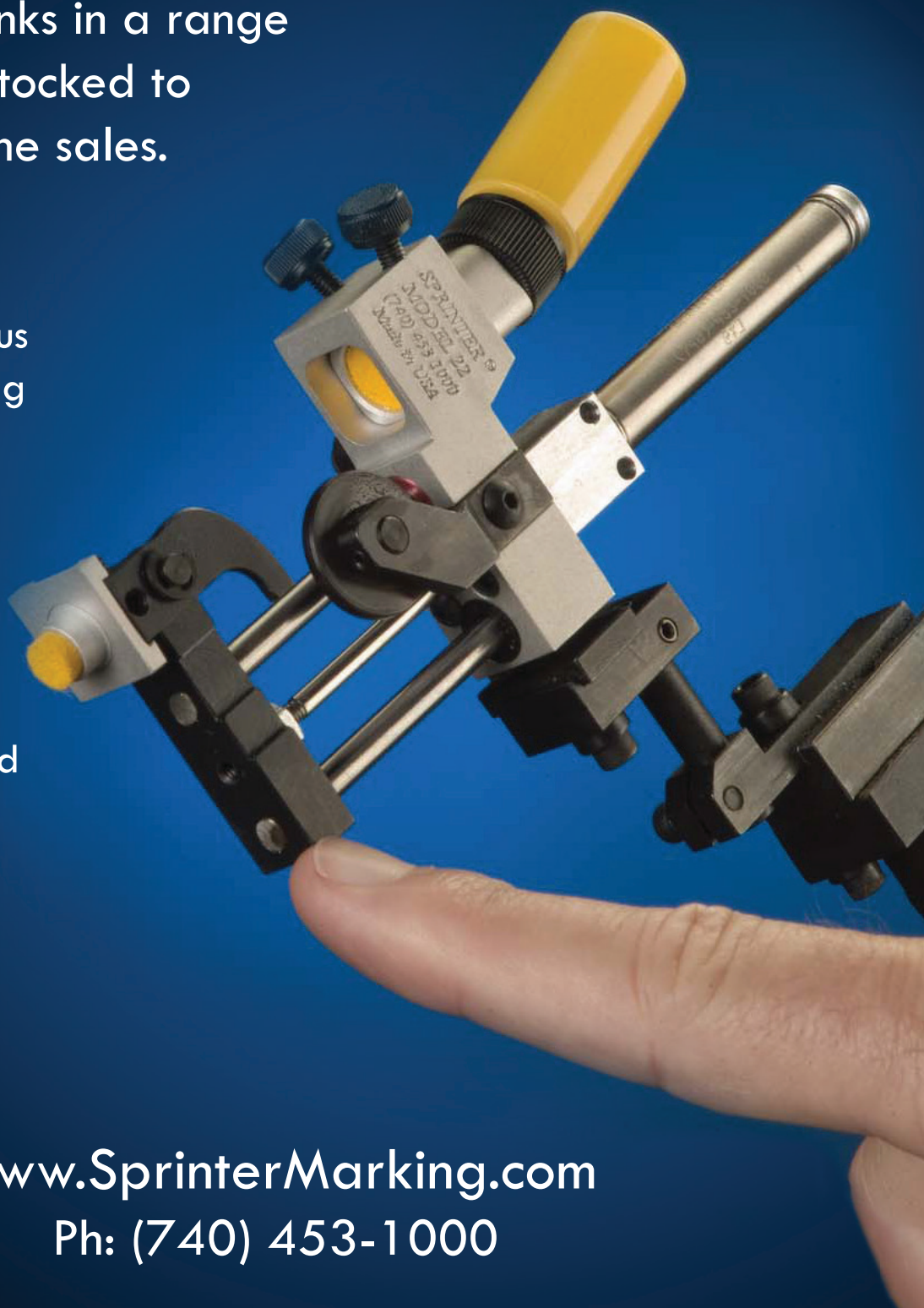
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Five Reasons Adhesives Fail

How to ensure your die-cut parts stick and stay stuck

BY JBC TECHNOLOGIES

"My parts won't stick." A customer complained that a die-cut acrylic foam tape was failing. In some cases, so severely that when their line operators pulled the red plastic release liner to apply the mating part, the entire acrylic foam patch pulled away from the substrate. After significant in-house testing that could not repeat the failure, we visited to see the problem ourselves. Upon close inspection, it became apparent that the adhesive patch was not fully adhered to the substrate. When we applied the proper pressure to form a secure bond, the adhesive worked to perfection. We later discovered that the customer was paying a piece rate for an outside assembly shop to install the pressure-sensitive adhesive patches. In their haste, operators were sticking the parts just well enough so they wouldn't fall off in transit. Without applying adequate pressure across the entire surface of the piece, the adhesive couldn't "wet out" or make

complete contact with the substrate allowing for the development of a total bond. In this case, it wasn't a part failure; it was an operator error.

When the wrong adhesive is chosen at the outset, or proper care is not taken during the application process, the effectiveness of the part and the structural integrity of the entire assembly to which it is attached can be compromised.

This article will explore five of the most common reasons adhesives fail and what we can do to avoid them. We'll learn how the surface, environment, adhesive, and application processes are interconnected and how failing to plan for even one of these critical parameters can have you and your PSA quickly facing a (un)sticky situation.

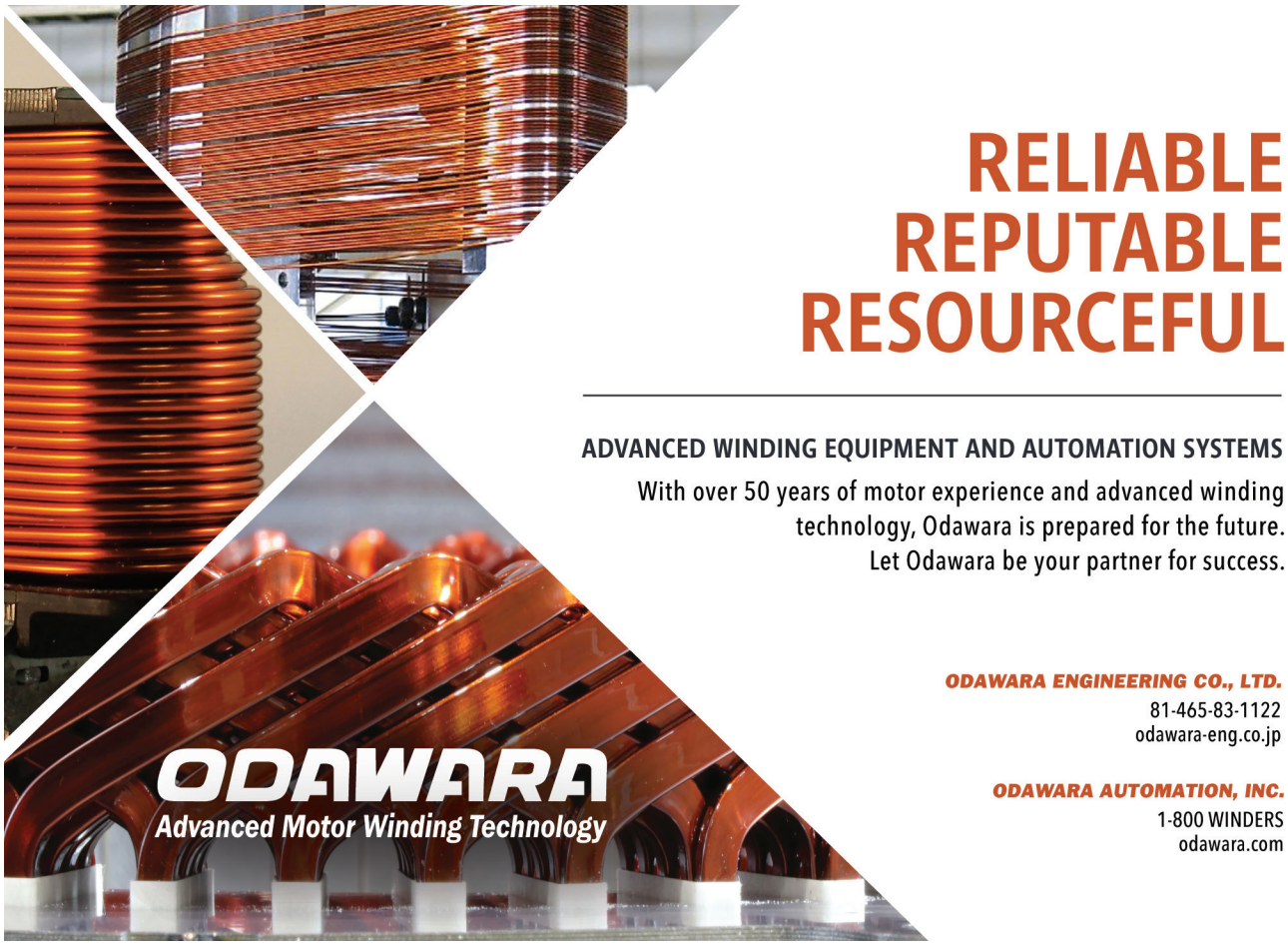
Failure Mode #1 - Surface Energy

How strongly an adhesive bonds to a given substrate depends on how well the adhesive chemistry interacts with the surface itself at a molecular level. This is where a material phenomenon known as surface energy comes into play. In very basic terms, surface energy is related to the disruption of intermolecular bonds on the surface of a given material. If the surface energy of the adhesive is not slightly lower than the substrate's surface energy, the adhesive won't form an adequate bond. Bond strength is created when the adhesive flows and covers a surface, maximizing the contact area and therefore the attractive forces between the adhesive and the substrate. This process is referred to as "wetting-out", and can be best achieved when the surface energy of the adhesive is equal to or lower than the surface energy of the substrate to which it is to be bonded.

Key takeaway: When specifying an adhesive it's vital to know whether you're dealing with a low or high surface energy bonding substrate. Adhesives can be formulated specifically for use on materials with tough to bond to surfaces.

Failure Mode #2 - Environment

As we've just learned, understanding the bonding surface is critical to the success of an adhesive.



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However, just as important is being aware of the conditions under which you will use the adhesive. After all, a gasket used in Alaskan mining equipment has a bit more to deal with than one in your coffee maker. Various environmental factors can impact the ability of an adhesive to stick and stay stuck – extreme temperatures, excess moisture, vibration – even exposure to chemicals can all play a part. If possible, we should also plan for occasional swings in any of the abovementioned environmental conditions. You can choose a suitable adhesive for 90% of the time, but it's that remaining 10% that can bite you.

Key takeaway: When specifying an adhesive, it's essential to understand where it will be used, including the environmental factors to which it will be exposed. Sharing this information with your converter will help them to be able to work through your available options more effectively.

Failure Mode #3 - Stress

Most die-cut parts with an adhesive in their construction are subject to external stress and pressure. Bending, flexing, pulling, expanding and contracting all are commonplace in the lives of seals and gaskets. But when the amount or type of stress exceeds the design strength of the adhesive, failure can occur. Here are a few examples of everyday stresses that can lead to adhesive failure:

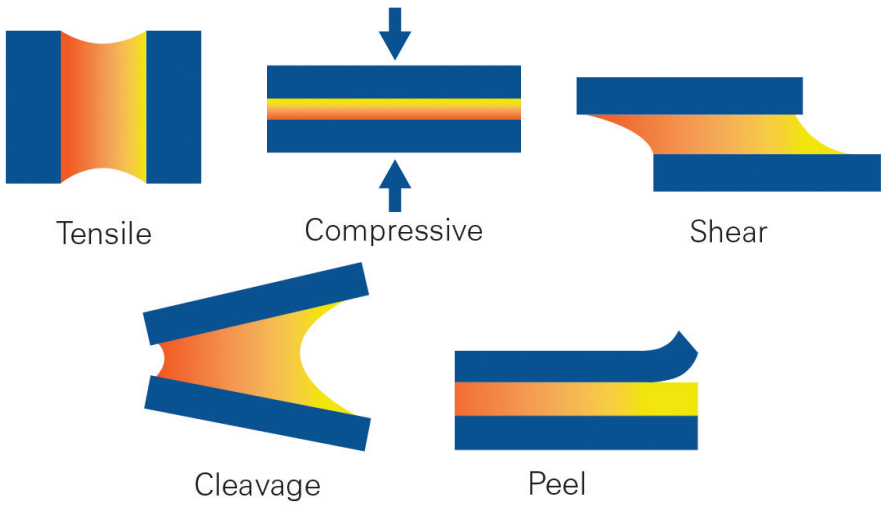
- TENSILE: This stress occurs when one substrate is pulled directly away from the other so that the pull is exerted equally over the entire joint.
- COMPRESSIVE: Like tensile stress, compressive stress is applied in a straight, in-plane direction. However, this stress is applied toward the adhesive instead of having one substrate pulled away.
- SHEAR: Shear stress is also applied in a straight plane, except that the pull is directed across the adhesive and causes it to slide to one side.
- CLEAVAGE: This stress occurs between two rigid substrates when a prying force pulls at one edge of the adhesive bond, leaving the other end under little to no stress.
- PEEL: Peel stress is very similar to cleavage stress, except when one substrate is flexible. As a result, more stress is applied to the leading edge of the adhesive bond as the adhesive tries to pull away along with the flexible substrate.

Key takeaway: When specifying an adhesive for a product design, you must account for the specific type and amount of stress on the joint or bond line.

Failure Mode #4 - Surface Preparation

When it comes to adhesives, cleanliness matters. It's crucial to ensure that the bonding substrate is free of grease, oil, dust, dirt, and other surface contaminants before affixing your pressure-sensitive adhesive-backed part. A good cleaning with a 50/50 mixture of isopropyl alcohol and water is generally sufficient in most cases. Still, heavy oils and other nasty gunk may require something a bit stronger, like an industrial cleaner or degreaser. Paints, plastics, and some metals may also require mechanically abrasive techniques to remove dirt and corrosion and impart micro-scratches on the surface that enhance bonding.

Key takeaway: If your adhesive-backed parts are falling off during assembly, a less-than-clean surface may be to blame. It a look at your surface preparation procedure before assuming that it's the adhesive that's faulty.



Failure Mode #5 – The Application Process

Just because you've done your research on surface energy and environmental conditions and you think you've selected the perfect adhesive to work with both doesn't mean you're home-free just yet. The fact is, even the best adhesive can fail if it's not applied to the substrate properly. To keep things simple, we've distilled adhesive application down to three important details:

• Pressure – It's in the name – Pressure Sensitive Adhesive. By applying a uniform external load or pressure force across the entire surface of the PSA, you force the adhesive into the microporosity of the substrate resulting in a robust mechanical bond.

• Time – Not all adhesive bonds are instant. Often, it takes time for the PSA to flow or "wet out" across the surface of the substrate. If you place parts into service before they've had time to wet out thoroughly, they will not achieve full bond strength.

• Temperature – At both extremes, the temperature at which you apply an adhesive can impact its performance. Higher temperatures can reduce adhesive viscosity and may improve wet out, while lower temperatures, especially near the freezing point, can lead to brittle PSA that cracks and bonds poorly.

Key takeaway: It's all about balance when it comes to application. Getting the right combination of time, temperature, and pressure is key to forming a stong, lasting bond.

Conclusion

Adhesives troubleshooting doesn't have to be intimidating. Just think about how much you've already learned in the few minutes it's taken you to read through this article. You now know how to spot some of the most common ways that adhesives tend to fail and even know a few ways to make sure they don't happen to you. Of course, identifying potential adhesive challenges is only part of the equation. Working with an experience flexible materials converter is "next-level". ●

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What's Happening



Sika has acquired **Bexel Internacional S.A. de C.V.**, a leading manufacturer of tile adhesives and stuccos in Mexico. The acquisition strengthens Sika's position in the large and fast-growing Mexican mortar market. In 2020, Bexel generated sales of CHF 35 million (approximately $37.9 million).

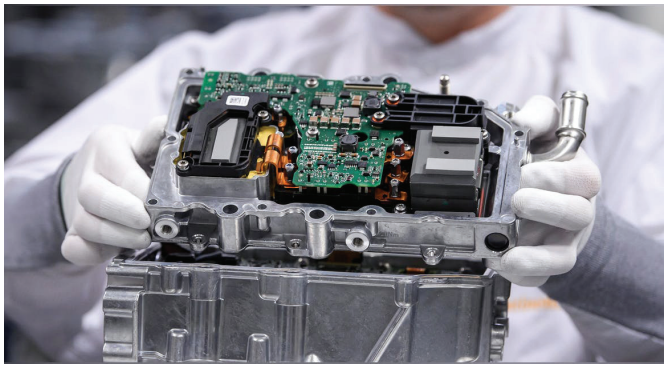
Bexel operates five production plants that complement Sika's existing geographical footprint and further support the strategic focus on big cities. The new site serving Mexico City adds important production capacity. With the combined presence, Sika reports that it now has a nationwide manufacturing coverage for mortar.

"Bexel perfectly complements our geographical footprint and our offering for the large Mexican Building Finishing mortars market," said Christoph Ganz, regional manager, Americas. "With our combined businesses and the improved market access, we have an excellent platform to further grow and strengthen our position in this market.

Cleveland-Cliffs enters technology testing partnership with U.S. Department of Energy. U.S. Energy Secretary Jennifer Granholm and U.S. Rep. Marcy Kaptur announced the partnership. "We are going to help invent the future," Kaptur declared. "This is the beginning of a new industry." Cleveland-Cliffs was one of five companies the Department of Energy selected to each receive roughly $300,000 in federal technological assistance to test new energy efficiency technologies in real-world industrial environments. DOE will pay for experts led by the U.S. National Laboratories to examine how well the technologies work.



RTE, the French public electricity transmission system operator, together with its partner **Nidec Industrial Solutions** (NIS), part of the Energy & Infrastructure Division of the Nidec Group, inaugurated "Ringo". Located in Vingeanne - Jalancourt, in the Côte-d'Or department, Ringo is RTE's first experimental site for the automated management of large-scale electricity storage. Just over a year after its announcement, the experiment, a world's first, will test the automatic management of surplus renewable electricity. This represents an important step in the process of transforming the electricity system, assisting in the energy transition from polluting to sustainable and renewable sources.

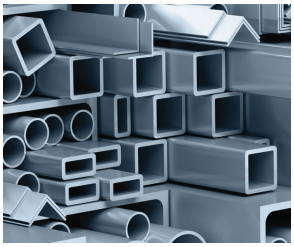


Analog Devices closes $20 billion deal to buy **Maxim Integrated**. The deal brings together the No. 2 and No. 3 players in the market for standard analog chips, giving it a broader range of technologies to take to its battle with analog semiconductor leader Texas Instruments. The deal creates an analog semiconductor giant with more than 50,000 products and a global customer base of around 125,000. The deal raises its annual revenue to the $9 billion range and free cash flow to $3 billion also bolsters its position in the automobile sector and further extends its footprint on factory floors and in consumer and medical electronics. "With more than 10,000 engineers and the increased breadth and depth of our best-in-class technologies, we are well-positioned to develop even more complete, cutting-edge solutions for our customers," said Vincent Roche, president and CEO of Analog Devices.



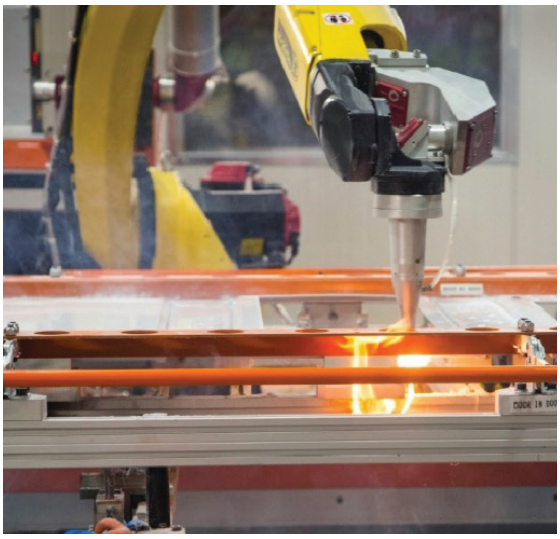
PPG introduced its 2022 Color of the Year: **Olive Sprig** (PPG1125-4) – an elegant, grounded, versatile and highly-adaptable grey-green, this color represents regrowth in a post-pandemic world, mimicking nature's resiliency.

Olive Sprig is a relaxed, but enticing green that emulates the feeling of soothing aloe vera or a fragrant plant – brightening any space with organic liveliness. A versatile color that lives well inside or outside, Olive Sprig blends in with nearly any environment.



Lincoln Electric Holdings, Inc. (Nasdaq: LECO) has acquired Overstreet-Hughes Company, Inc. ("Fabricated Tube Products," "FTP") and Shoals Tubular, Inc. ("Shoals"). FTP and Shoals manufacture copper and aluminum headers, distributor assemblies and manifolds in the United States and Mexico for the HVAC sector and have combined annual sales of approximately $50 million. The addition of FTP and Shoals further differentiates The Harris Products Group's competitive position serving HVAC OEMs with a comprehensive portfolio of solutions for the fabrication of HVAC coils, and the acquisition accelerates their growth in this attractive market.

"We are excited to welcome FTP and Shoals to Lincoln Electric and integrate their industry-leading offering and expertise into our Harris Products Group business," said Christopher L. Mapes, Chairman, President and Chief Executive Officer.



GE Appliances has opened a production line making four-door refrigerators at its plant here, part of a $60 million investment in the facility. More than 245 new manufacturing jobs have been added to support the new production line.

"Since 2016, GE Appliances has invested $1 billion in new products, technology and its U.S. operations, and created more than 2,000 new jobs, with close to 1,000 new jobs in Louisville," says Kevin Nolan, president and chief executive officer for GE Appliances. "We are committed to growing our manufacturing footprint in the United States to serve customers faster and better. This investment demonstrates our commitment to becoming the leading appliance manufacturer in the U.S."

The investment increases manufacturing capacity, enhances the company's ability to meet consumer demand and positions GEA for long-term growth. Despite the pandemic, the GEA refrigeration team successfully navigated many challenges as they worked to design and install the new line.

"The completion of this investment shines a light on the dedication of our workforce," states Bill Good, vice president of manufacturing at GE Appliances. "The plant expansion was completed during COVID, while suppliers and vendors were unable to travel to the plant and product demand was a record levels. Our teams worked tirelessly to ensure progress without disrupting production."

The four-door-refrigerator consists of a traditional fresh food area, a freezer and a convertible section that can be used as either a freezer or refrigerator. The plant will also add new quad-door and counter-depth models to its line-up in the future.

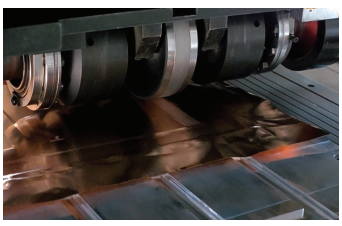


Empire Screen Printing, a leading manufacturer of screen printed products, highlights its graphics solutions for commercial and consumer appliance manufacturers. The most trusted brands in the commercial and consumer appliance markets rely on Empire to enhance and protect their brand image with creative, durable, and superior quality graphic solutions, including electronic overlays, warning/danger decals, and nameplates. Empire closely collaborates with customers to design and engineer labels, decals and overlays that visually stand out and reliably stand up to the harsh conditions of everyday use. Durability is critical, because signs of wear diminish brand image in the highly competitive appliance market. For example, particular materials and printing processes are selected to withstand the high temperatures and harsh cleaning solutions in food service applications, and for outdoor applications, crystal-line doming provides protection from UV light and from dents and abrasions.

Printing capabilities include UV LED screen printing on 3, 6, and 12 color presses, and digital and flexographic printing. Many special features and services are available for the appliance industry, including LED windows, dead fronts, and serializing, as well as chemical resistant, abrasion resistant and anti-microbial materials. Empire has an assortment of in-house stock materials and adhesives that can be combined to meet most of our customers requirements. When presented with a new material combination, Empire's R&D process performs vigorous testing to ensure durability, ink adhesion, and product performance meets our customer's desired needs. In addition, our large library of custom color builds are stored using our QColor Color Management System. For new color builds, physical color samples are created and approved by the customer. These approvals are stored and verified during the printing process to achieve precise color matching throughout the production run and provide consistency from one order to another. The end results are highly durable branding label solutions that impress and delight customer after customer.

Fabrisonic LLC, a manufacturer of Ultrasonic Additive Manufacturing machines (UAM) and 3D metal printing has developed the **SonicLayer® X Seam Welder.** A seam welder is used in continuous tube and seam, solar panels, battery anode/cathode tabbing, and connectors. Based on multiple patents and technology from over a decade of experience in ultrasonic additive manufacturing, the SonicLayer® X seam welder is tried and true in manufacturing environments. The SonicLayer® X seam welder features longitudinal ultrasonics to produce fully bonded solid-state welds. ''Increasing ultrasonic welding to 10,000 watts of power expands the scope of what is possible with a metal seam welder. This includes increases in speed, increases in material width/thickness, and a new array of metal alloys including stainless, Inconel®, and even refractory metals,'' states Mark Norfolk, CEO, Fabrisonic.

The SonicLayer® X seam welder has successfully manufactured a variety of electrical grade foils for interconnects, batteries, and flexible shunts as well as welding dissimilar metal combinations.





3DQue Systems Inc. announced **Quinly for Prusa**. The 3D printing automation package known as Quinly™ is now available for the Prusa MK3, one of the most well-respected FDM/FFF style printers on the market.

Pairing autonomous printing with Prusa MK3's outstanding reliability creates production efficiency unseen in the world of affordable 3D printing. Automate the small tasks involved with 3D printing, and spend less time with your Prusa. Create a queue of parts, and Quinly will work in the background 24/7, printing them one-by-one until the queue is empty. Quinly integrates with the Prusa MK3 seamlessly, and works with the printer's built-in error-detection tools to run the printer continuously.



H.B. Fuller recently announced a strategic partnership with **Covestro** to deliver an adhesive with a reduced climate impact for the woodworking, composites, textiles, and automotive industries. According to H.B. Fuller, the new solution represents an evolution of previous sustainable product development and will likely extend into other products and areas of production.

"We are driven by the very present need to reduce CO2 emissions and look after the world around us, and so too are our customers," said Iñaki Sigler, H.B. Fuller's global product manager for woodworking and composites. "This inspires us to continually explore new avenues to reduce our products' environmental footprint and encourage our supply chain to do the same. Together with our partner, Covestro, we see this new, strategic product development as an investment in all our futures and a commitment to a more sustainable world."

The new ingredient used in H.B. Fuller's adhesive is a bio-attributed raw material created via a mass balance approach and will replace a proportion of previous fossil raw materials. Renewable raw materials are used as feedstock at the very beginning of the value chain and processed together with fossil-based ingredients in the same production units. The characteristic of the renewable feedstock process is then attributed to the end product.

"We are excited to supply H.B. Fuller as our first customer for adhesive applications with a mass-balanced product," said Thorsten Dreier, Ph.D., head of Coatings and Adhesives at Covestro. "With the increased use of such alternative raw materials, we want to become less dependent on petrochemical feedstocks and contribute to the reduction of CO2 emissions. Alternative raw materials are part of a comprehensive program to work with our partners to drive the transition to a Circular Economy and ultimately become fully circular ourselves."

The use of an equivalent amount of the alternative feedstock is guaranteed by Covestro through a third-party verified certification method. By gradually converting its production to alternative raw materials and working with reliable partners, who in turn collaborate with many certified suppliers, Covestro aims to replace fossil materials and make its value chains more sustainable.



For half a century, engineers at **SCHOTT** have been designing the cooktops of the future. Here glass-ceramic is a key component. Since **SCHOTT CERAN®** was introduced 50 years ago, black glass-ceramic has been established in the market as the standard material for induction and electric cooktops in modern kitchens worldwide. For its anniversary year, SCHOTT is presenting the next generation: CERAN Luminoir™. The new glass-ceramic is more translucent but still deep black thanks to a new formula. The classic elegant black appearance provides virtually endless possibilities in product and lighting design and unique advantages for leading household appliance manufacturers. For users, CERAN Luminoir™ offers cooking surfaces that are intuitive to operate and dynamic – providing visual support when connecting with other smart kitchen devices.



Students and staff at Doniphan West High School in Highland, KS, are thrilled to have a newly updated welding lab with more than $175,000 of new equipment and renovations, including several new welding kits from Harris Products Group.

The project was organized by a Harris distributor, Vern Lewis Welding Supply in Arizona. The company wanted to honor its founder, Vern Lewis, and his high school alma mater. The distributor worked with the high school to fund and solicit product donations for the complete renovation of the building where Vern first learned about welding in the 1950s.

"Vern is a long-time partner with Harris Products Group, and we are honored to be part of this effort to recognize his contributions to the welding industry," said Joaquin Guerra, Harris's Sales & Marketing Director, The Americas. "Providing brand-new equipment for students could spur more interest in welding careers, which is great for the trades industry."

Lincoln Electric, parent company of Harris Products Group, also donated welding equipment to the high school.

The welding lab now bears Lewis' name. His company kept the project a secret from him until a ribbon-cutting and unveiling on Oct. 1.

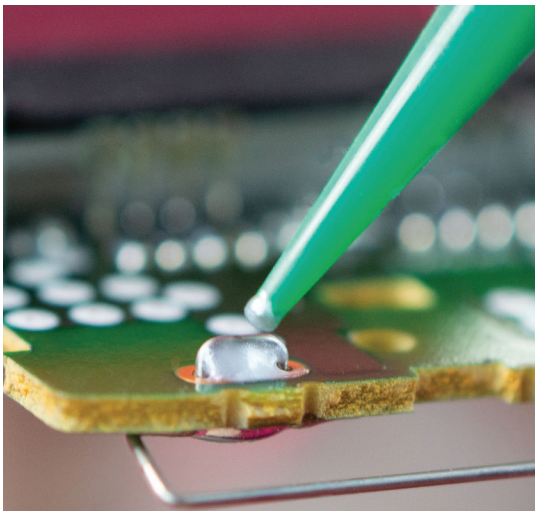


The key to safe driving is not only seeing what's in front of you—it's also knowing what lies ahead. Toward that goal, current head-up displays (HUD) in windshields can provide vital information to help drivers keep their focus on the road. To improve the performance of new generations of HUD systems, **Eastman** has launched **Saflex® Horizon LVID PVB** interlayers. Saflex Horizon LVID is a next-generation, wedge HUD interlayer for automotive laminated glass. With enhanced sheet optics, it reduces localized and dynamic ghosting for larger field-of-view (FOV) and augmented reality (AR) HUD systems.

''With Saflex Horizon LVID, automotive OEMs can establish a new standard of image quality at longer virtual image distances (LVID) to create unique user experiences while enhancing road safety,' says Dr. Hemant Dandekar, global commercial director with Eastman.

Unlike traditional head-up displays with limited content, new-generation HUD systems will bring more information to the driver's attention by enlarging the FOV size. This is achieved by extending the virtual image distance (VID) from today's range of two to three meters to distances from four to seven and a half meters.

With VID projection levels above seven and a half meters, AR features become possible as the human eye cannot distinguish the distance at which an image is projected. These new systems ultimately provide real-time vital information, such as advanced driver assistance system alerts and route guidance by overlaying dynamic graphics with real-world objects.

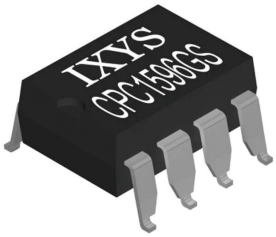


HIGHLY THERMALLY CONDUCTIVE, NASA LOW OUTGASSING SILVER FILLED EPOXY

Master Bond EP3HTS-TC is a one part, NASA low outgassing rated epoxy, with an outstanding thermal conductivity of 16-17 W/(m·K). It cures rapidly at temperatures of around 250-300°F [~ 125-150°C], and has an unlimited working life at room temperature. The material features a thixotropic paste consistency and is not pre-mixed and frozen. It is well suited for automatic dispensing equipment or manual syringes and can be applied without any tailing. Primarily, it is formulated for use as a die attach and special purpose bonding material.

"EP3HTS-TC utilizes a non-sintering silver technology to provide ultra high heat transfer capability." says Rohit Ramnath, Senior Product Engineer. "It is designed without compromise to dispensability or adhesion strength, while maximizing performance properties." EP3HTS-TC is highly electrically conductive, with a volume resistivity of less than 1x10-6 ohm-cm.

The system exhibits good dimensional stability, resists thermal cycling, and has a low coefficient of thermal expansion of 20-23 x 10-6 in/in/°C. Die shear strength is 9-12 kg-f at 75°F for a 2 x 2 mm [80 x 80 mil] area. It has a glass transition temperature of 58°C and is serviceable over the temperature range of -80°F to +400°F. This compound adheres well to a variety of substrates such as metals, composites, glass, ceramics, semiconductor materials and many plastics. Packaging is available in syringes, 20, 50 and 100 gram jars, as well as single and multiple pound containers.



Littelfuse CPC1596 Optically Isolated Load-Biased Gate Driver

The CPC1596 570V Optically Isolated Load-Biased Gate Driver is ideal for use in a wide range of power electronics applications including:

- Industrial controls,
- Automatic Test Equipment (ATE),
- HVAC controls,
- Medical devices,
- Internet of Things.

"The CPC1596 570V Load-Biased Opto-Gate Driver addresses a critical market need," said Steve Andrezyk, Senior Product Marketing Manager at Littelfuse. "Universal AC power line applications now have a custom, higher power optically isolated solid-state relay (SSR) solution without the cost of an auxiliary power supply or additional discrete devices to meet fast start-up speed requirements."

The CPC1596 offers these key benefits:

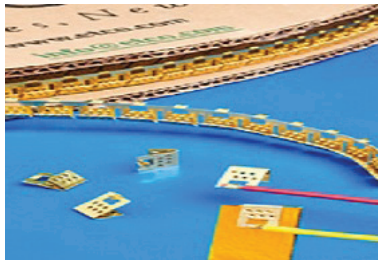
- Boosts external MOSFET start-up speed by using load-biasing.
- Eliminates the need for an opto-gate driver auxiliary power supply.
- Supports optically isolated SSR-applications for both AC and DC.
- Enables using higher power MOSFETs.
- Can be controlled from a logic port.

BUSINESSES CAN NOW CONTROL, MANAGE AND ANALYZE GAS USAGE

Harris Products Group has introduced DataSMART™, a fully automatic switchover manifold system with monitoring, tracking and reporting capabilities that can control and maximize gas use and expenses. DataSMART's proprietary software and advanced technology provide users with valuable data and analytical insights to improve efficiencies and reduce costs.

Sound business strategies are centered around data, and DataSMART is designed for a wide range of gas and pressures to suit a wide range of businesses. Whether working with low-pressure applications in analytical labs, or with high pressure applications such as laser cutting in metal fabricators, welding job shops or manufacturing, DataSMART helps companies better utilize their gas investments.





Flex Circuit Connectors Attach to Lead Wires Using Reliable F-Crimp

A line of connectors for flexible circuits that eliminates soldering and welding when attaching wires to foil and film substrates has been introduced by ETCO Incorporated of Bradenton, Florida.

ETCO FWC Series Flex Circuit Connectors attach to lead wires using an "F" style crimp by automatic wire processing equipment and have features that securely embed when staked into the foil or film substrate. Ideal for critical applications, they are designed for attaching 16 to 22 AWG wires to aluminum- and copper-foil or film laminates from 0.010" to 0.040" thick.

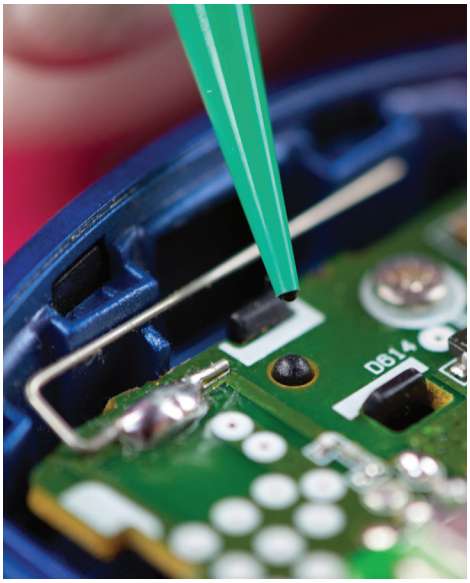
Supplied in strip form to increase production speeds and efficiency, ETCO FWC Series Flex Circuit Connectors can be made to OEM specifications in a wide range of sizes and thicknesses to accommodate different substrates. Available in brass and tinned high brass, applications include capacitors, electro-luminescent lighting and displays, flexible heaters, and relays.

Locking Ring Terminals Design is Ideal For Robotics



ETCO Locking Ring Terminals are offered in tinned-brass, plain brass, and stainless steel and attach to 12-22 gauge wire using an F-crimp for a more secure connection than conventional flag ears. Featuring four teeth that extend 0.023" from the terminal surface and are 92% of the thickness of the ring itself, each tooth has a 40-degree angle that provides sharp wedges which penetrate into painted or plain metal surfaces to stay in place.

Available with stud holes ranging from #2 through #10, ETCO Locking Ring Terminals are ideal for use in robotic arms and pick-and-place equipment subjected to vibration and where maintaining high production uptime is essential. Their robust design bites into metal and anchors the terminal to help prevent unwanted rotation during assembly, handling, and operation which can cause arcing or an electrical short with adjacent terminals.

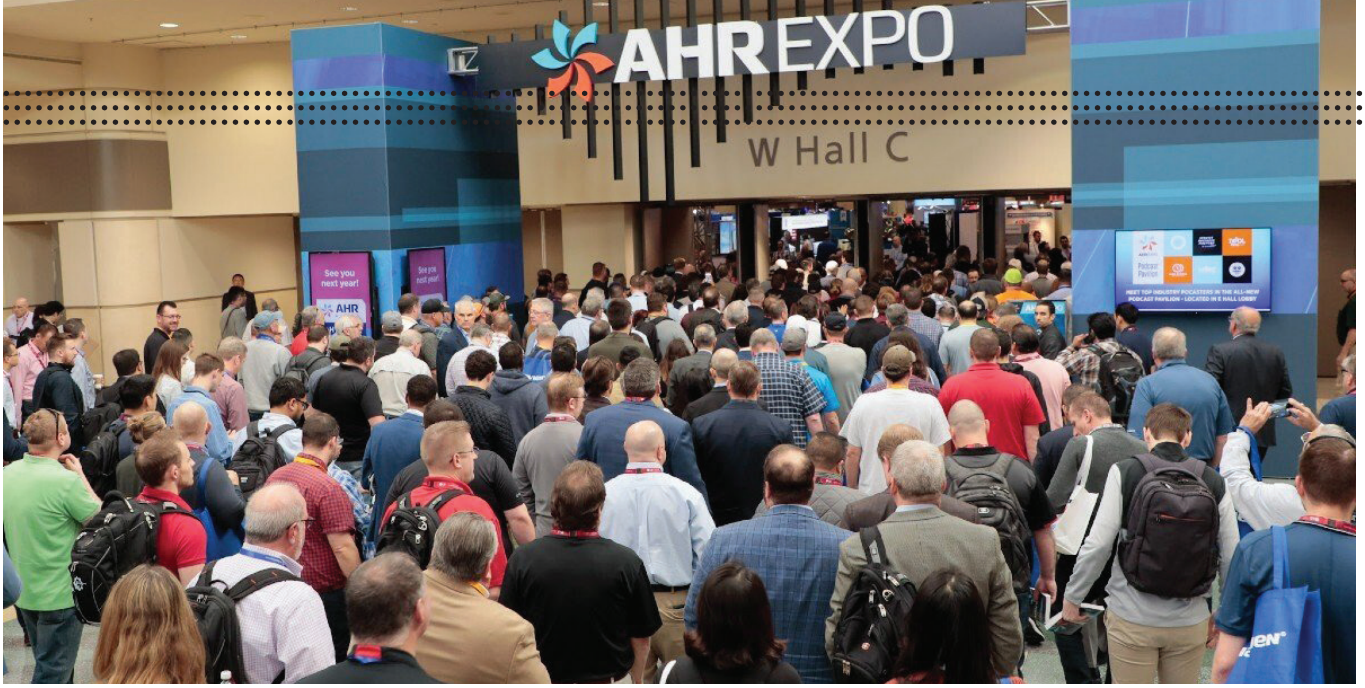


ONE COMPONENT, GRAPHITE FILLED EPOXY FEATURES ELECTRICAL AND THERMAL CONDUCTIVITY

Master Bond EP5G-80 is a one component, NASA low outgassing rated epoxy, with a moderate temperature cure requirement of 80°C for 4 hours. This graphite filled compound is not premixed and frozen and has an unlimited working life at room temperature. It offers electrical conductivity with a volume resistivity of 5-15 ohm-cm and a thermal conductivity of 2.88-3.46 W/(m•K) at room temperature.

"EP5G-80 is a specialty non-metallic system designed for heat sensitive electronic applications where high levels of conductivity are desired. Its key feature is that it does not need elevated heat to fully cure," says Rohit Ramnath, Senior Product Engineer. "Unlike other graphite filled adhesives, EP5G-80 is a smooth thixotropic paste and can be easily dispensed manually or using automated systems."

For a conductive system, EP5G-80 provides an especially high Tg of around 130°-140°C, and a tensile modulus that exceeds 1,000,000 psi at room temperature. It is serviceable over the temperature range of -50°C to +175°C and has a low coefficient of thermal expansion. Suitable for bonding, sealing and coating, EP5G-80 adheres well to a variety of substrates such as metals, composites, ceramics and many plastics. This formulation features a good lubricity and can be employed for static dissipation and EMI/RFI shielding applications. It is black in color and RoHS compliant. Packaging is available in syringes, jar and pint containers.



The AHR Expo (International Air-Conditioning, Heating, Refrigerating Exposition) today announced the winners of the 2022 AHR Expo Innovation Awards. Each year, winners are chosen in ten industry categories to represent the most innovative products and technologies hitting the market in the coming year.

''This past year was a challenge for everyone, and in unique ways, the HVACR industry,'' said Show Manager, Mark Stevens. ''Our industry was called to the front lines to put our very best products and technologies to the test. The Innovation Awards purpose is to honor those that are pushing the bar to create innovative solutions to difficult problems. We are thrilled to celebrate this year's winners and what they bring to the industry, as well as to continue to champion innovation among our professionals. ''

The Innovation Awards encourage exhibitors to submit new products and technologies for recognition via review and selection by a panel of third-party judges made up of distinguished ASHRAE members. Entrants are evaluated based on overall innovative design, the creativity of the product or service offered, application, as well as potential market impact.

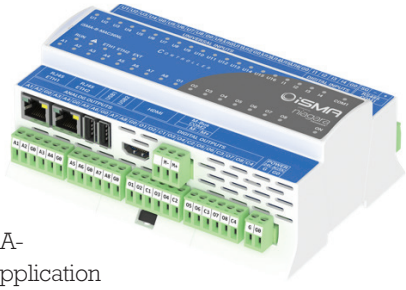
''This industry is tremendously exciting for its role in our everyday lives,'' continued Stevens. ''Now more than ever we have the chance to show the world just how important HVACR is. Manufacturers on the AHR Expo Show floor are in tune with their stakeholders and the greater needs of the world and are responding by developing new tools, products and services that offer safety, efficiency, and sustainable smart solutions.''

The Innovation Awards program serves as a metric to see the year-to-year growth in the industry. While the Awards officially recognize only a select few, the Show floor is a robust example of how manufacturers are growing the industry in exciting ways.

''AHR Show Management would like to formally congratulate each of our 2022 AHR Expo Innovation Award winners, as well as finalists and all our entrants, for their continued leadership and contribution to HVACR,'' said Stevens. ''We look forward to seeing these innovators in the marketplace in the coming year, and in-person on the Show floor in 2022.''

The 2022 AHR Expo Innovation Award Winners and finalists were selected in ten industry categories, including building automation, cooling, heating, indoor air quality, plumbing, refrigeration, software, sustainable solutions (formerly green building), tools and instruments, and ventilation.

BUILDING AUTOMATION



Winner: iSMA CONTROLLI S.p.A., iSMA-B-MAC36NL Hybrid IoT Controller powered by Niagara Framework, Booth C969

Innovation: The iSMA-B-MAC36NL master application controller family provides an all-in-one solution for mini-BMS. Created visualization can be displayed and controlled via HDMI output and 2 USB ports that enable connection of a mouse/keyboard or dedicated touch for the HMI panel. No PC, additional licenses, or additional costs are required. As MAC controllers are based on the Niagara Framework, it enables the integration of almost any existing protocol on the building network. The onboard M-Bus port, 2 ethernet ports, and the RS485 port can be integrated with just one device. Finally, the controller has an onboard dip and rotary switches that can be used as a part of the application. All of the features of the controller are managed by dedicated modules in Niagara Framework to accelerate the installation process and thus reduce labor costs.

Finalists in this category include: BrainBox AI, BrainBox AI; CUBE USA, CUBE Edge IOT



COOLING

Winner: Danfoss, Danfoss Turbocor® VTCA400 Compressor, Booth C3906

Innovation: The new VTCA400 from Danfoss offers improvements on traditional centrifugal compressor designs that are large in physical size and footprint, which ultimately lead to higher cost and space constraints for the end user. The VTCA400 solves this problem by using a patent-pending hybrid compression design that uses a combination of mixed flow and radial impellers enabling both high-performance and a compact footprint. In this design, the first stage impeller uses a mixed flow impeller with both axial and radial components while the second stage impeller uses a radial design. The hybrid compression design allows for a compressor footprint that is half the physical size and weight of a conventional radial-only design. It also maintains high efficiency levels —a 10% improvement in full load efficiency and 30% improvement in IPLV above ASHRAE 90.1-2019 minimums when considering a three (3) compressor, 1200-Ton system.

Finalists in this category include: Copeland Compressors and Condensing Units / Emerson, Copeland™ oil-free centrifugal compressor; Teqtoniq GmbH, Teqtoniq TRC150 Oil-Free Centrifugal Compressor



HEATING

Winner: Carrier, Infinity® 24 Heat Pump with Greenspeed® Intelligence, Booth C1310

Innovation: The Infinity® 24 Heat Pump with Greenspeed® Intelligence is Carrier's highest-efficiency and most advanced heat pump with up to 24 SEER and 13 HSPF for premium energy savings, extremely quiet performance and premium comfort features. The unique, variable speed compressor of this unit allows it to adapt its output to the needs of the home with infinite adjustments between 25 - 100% capacity. The heat pump offers excellent humidity control and is capable of removing up to 400% more moisture than standard systems. Based on Carrier testing, all data was run with the systems cycling once they met the assumed home load. The assumed load at AHAM conditions (80/70, 80) is the capacity of the variable-speed running continuously in dehumidification mode. The difficult conditions load was determined by a Wrightsoft® load calculation for a home in Florida at 69 OD 72/63 ID. This condition was provided by a customer in Florida as "worst case."

Finalists in this category include: HVAC Manufacturing and Technology Inc., SpaceGain Air Handling Units; Addison, FrostShield Defrost-Free Heat Pumps



INDOOR AIR QUALITY

Winner: Antrum, AntrumX™ IAQ Facilities Monitoring System, Booth C1071

Innovation: AntrumX is a patented centralized sensing technology. AntrumX monitors IAQ for 32 spaces from a single location, using one sensor for every 16 rooms. Consolidating one centralized sensor for multiple spaces increases sensor accessibility while ensuring better overall control. Centralized sensing ensures better overall control because the data from 16 spaces comes from a single source, allowing building managers to optimize their ventilation strategy, and save energy without sacrificing IAQ. Additionally, the AntrumX has the ability to transport air without moving parts. Leveraging the building's pressure differential between supply and exhaust, AntrumX is able to move air samples from each space to the Sensor Pack without adding energy to the system.

The Sensor Pack also monitors multiple data points across multiple rooms. Using over-the-air software updates and a state-of-the-art hardware design, the Sensor Pack can be customized to sense what's required today and be easily exchanged or updated as requirements change over the life of the building.

Finalists in this category include: LG Electronics USA, Inc., LG Split Rooftop DOAS (Dedicated Outdoor Air System) with Energy Recovery Wheel; TZOA, HAVEN IAQ



PLUMBING

Winner: Franklin Electric / Little Giant, Inline SpecPAK, Multi-Pump Pressure Boosting System, Booth C4334

Innovation: With only 14.5 inches deep, its unique smaller footprint makes the Franklin Electric Inline 1100 SpecPAK Pressure Boosting System small enough to be hung in a small utility closet or wall hung to preserve critical floor space. The system's Inline 1100 constant pressure pumps are quiet, compact, self-contained, and versatile. Powered by water-cooled motors, it delivers quieter operation versus traditional air-cooled motors.

The self-contained design delivers a "plug and play" solution that is part of a complete package centered around easy installation, operation, and durability. The ability to

expand is a foundational and distinctive benefit. Both the suction and discharge headers are sized to accommodate the flow rate from the maximum speed of four pumps. Quick and easy disconnects to the main panel allow customers to disconnect each pump individually with minimal system disruption.

Finalists in this category include: Lochinvar, LLC, Lochinvar Commercial Heat Pump Water Heaters; Towle Whitney LLC, GEN-5 Platform

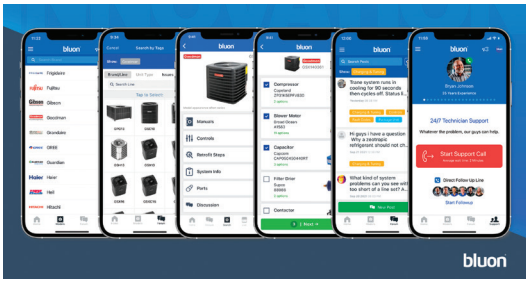
REFRIGERATION



Winner: ebm-papst Inc., AxiEco 630-910 Axial Fan, Booth C3324

Innovation: The AxiEco 630-910 incorporates new impeller geometry with a rotating diffuser and optimized blade design in order to reach a low noise level and high-efficiency. The steep air performance curve provides a pressure increase of more than 700 Pa, which is extraordinary for axial fans. With a maximum air flow of up to 30,000 m^3/h the AxiEco 630-910 covers a wide range of different applications, especially those where high-efficiency and high back pressure are key. The integrated commutation electronics with an active PFC (power factor correction) as an option enables the fan to be used in applications with low harmonics requirements, without any external filtering measures.

Finalists in this category include: Copeland Compressors and Condensing Units / Emerson, Copeland™ horizontal variable speed scroll compressor for refrigeration (1 to 4 HP); Johnson Controls, Inc., ZS series horizontal scroll compressors with R290 and variable speed compatibility



SOFTWARE

Winner: Bluon, Inc., Bluon Support Platform, Booth C6617

Innovation: The Bluon Support Platform is a mobile application that becomes a centralized hub for HVAC technicians. Bluon was built for technicians, by technicians, and provides detailed system information, just-in-time training, best practices and 24/7 live tech support. The app's most important function is its ability to make the lives of technicians easier by providing a single, trustworthy source of detailed HVAC system information, along with live tech support when needed in the field. The main features of the free app include: a comprehensive unit database of 40,000 HVAC model numbers spanning 75+ brands, with 75,000+ original manuals, troubleshooting guides, wiring diagrams, and technical specifications; best practices known as "pro-hacks" for a wide-range of situations; easy to use calculators for SH/SC, airflow, pressure setpoints, TXV sizing, etc.; HVAC training videos and tools that techs can use on the job; a revolutionary HVAC forum that gets techs the info they need when they need it; 24/7 live tech support; and a replacement parts identification tool cross-referenced by model numbers and compatible part numbers.

Finalists in this category include: CoolAutomation, Service Provision App; Interplay Learning, SkillMill™

SUSTAINABLE SOLUTIONS

(formerly Green Building)



Winner: Enginuity Power Systems Inc, E/ONE Home Power System, Booth N7435

Innovation: Enginuity's E/ONE Home Power System is a modern rethinking of a classic combined heat and power system. Using clean and plentiful natural gas, the E/ONE produces both electricity and heat for homes or businesses. Since the E/ONE is capable of making more power than the home or business requires, the additional power can be sold back to the grid, generating income for the E/ONE's owner. In addition, the E/ONE leverages the reliability of the natural gas distribution network to replace conventional backup generators. E/ONEs easily produce all the electricity needed to operate homes or businesses, therefore the periodic blackouts such as those recently seen in Texas and California will not affect the product's ability to function.

Finalists in this category include: Caleffi Hydronic Solutions, Commercial domestic hot water (DHW) recirculation systems combine energy efficiency and water conservation; Danfoss, Danfoss Turbocor® TGS380 Compressor

TOOLS & INSTRUMENTS



Winner: Fluke Corporation, Fluke 378 FC Non-Contact Voltage True-rms AC/DC Clamp Meter with iFlex, Booth C2737

Innovation: The Fluke 378 FC true-rms clamp meter uses FieldSense technology to make testing faster and safer, all without contacting a live conductor. The meter measures accurate voltage and current measurements through the clamp jaw. It works

by clipping the black test lead to any electrical ground and putting the clamp jaw around the conductor which results in reliable, accurate voltage and current values on the display. The 378 FC clamp meter includes a unique PQ function that senses power quality issues automatically. When making FieldSense measurements, the 378 FC will detect and display power quality issues, relating to current, voltage, power factor or any combination of the three. This allows for quick determination if an upstream supply problem exists, or if there is a downstream equipment problem.

Finalists in this category include: Climatech International S.A., F-100 Cordless Stud Welder Machine; RIDGID / Emerson, RIDGID® PCS-500 Pipe Saw

VENTILATION



Winner: Aldes, InspirAIR® Fresh, Booth C2734

Innovation: The InspirAIR® Fresh contains new innovative design features. A newly developed counterflow enthalpic core and unique fan scrolls ensure 75% sensible recovery efficiency at 32F as tested to the new CSA 439 standard required as of October 2020. Occupants can also expect to get ample fresh filtered air due to variable speed EC motors that adjust speed to changes in pressure due to stack effect and filter loading. The InspirAIR® Fresh is designed to provide optimal fresh air, regardless of filter type. Currently, ERVs are rated for use with a basic filter, and when using a MERV13 or HEPA filter, the airflow is reduced significantly.

Finalists in this category include: Carrier, Carrier Aero® 39M with ECM Direct Drive Plenum Fans; LG Electronics USA, Inc., LG Split Compact DOAS (Dedicated Outdoor Air System)

"It's always exciting to follow along as these products and services come to life in the marketplace," said Stevens. "What's more, is to see others work to keep pace with innovation and develop new solutions. We are thrilled to be back in-person and headed to Las Vegas for a return to business. We hope you'll join us and these winners in action on the Show floor before they hit the market."

Funds raised from the entry fees of the Innovation Awards competition will be donated to a Vegas-area charitable cause. More information to follow.

Registration for the 2022 AHR Expo is free until January 30, 2021, and can be completed on ahrexpo.com.



Advanced Energy launches **TEGAMLink™ T2.0** mobile app for direct streaming of critical temperature data to factory software.

Companion app to the TEGAM 930 Series Bluetooth® thermometers with convenient Touch Entry™ keyboard extension helps improve accuracy and analysis of data

Advanced Energy, a global leader in highly engineered, precision power conversion, measurement and control solutions – today launched its TEGAMLink™ T2.0 mobile application, a companion app to the TEGAM 930 Series Bluetooth® thermometers for pharmaceutical and food safety applications. The app enables users to stream and record real-time temperature data directly from the production floor to programs and quality management systems using a convenient Touch Entry™ keyboard extension, providing an automation capability for customers to implement Industry 4.0 in their factory.

"Developed for the TEGAM 930 Series thermometers, TEGAMLink T2.0 improves accuracy and analysis of temperature data collection and measurement by automating data entry and transfer. This eliminates the manual process, which is a critical problem faced by our customers," said Gerry Blumenstock, vice president, industrial and medical products, Advanced Energy. "The app is compatible with Android and iOS devices, making it extremely easy to implement with existing equipment, software and systems."

The app's Touch Entry keyboard extension enables direct entry of temperature readings into form fields, documents, spreadsheets and quality management systems without the need to modify already installed hardware or software. The app also offers device pairing for enhanced data security, remote thermometer control and strip chart function. It is available for download in both Android and Apple App Stores.

The TEGAM 930 series of data-logging thermometers offers best-in-class accuracy and durability in harsh environments. In addition to wipeable surfaces, they are designed to withstand the rigors of industrial environments with a MIL-PRF-28800F, Class 2 shock, drop and vibration rating.



MULTI-TOUCH CONTROL PANEL

ABB's new **CP600-Pro** is designed for applications requiring true glass touchscreens for clear information display and easy operation. The CP600-Pro ensures reliable operation within a wide environmental temperature range of -4 through 140 °F. Aluminum front frames ensure IP66 protection. All black front design is a good match for multiple applications either in landscape or portrait format. Available in 5, 7, 10.1, 15.6 and 21.5 inch screen sizes. Three Ethernet interfaces. Supports up to three networks. A serial port simplifies integration of products without network inter-faces, and USB ports and SD cards facilitate backups and system updates.



Rapid Water Technologies will introduce its patent-pending **Nanobubble Generators** to the Power Generation and HVACR industries at two national trade shows in 2022.

The innovative Nanobubble Generators naturally remove and prevent the buildup of biofilm and other deposits in commercial and industrial water use. When Rapid Water Technologies Nanobubble Generators are installed on cooling towers and heat exchangers, they transform the noncondensable gases that already exist in the water into millions of nanobubbles/ml of water. The flow of nanobubbles through the system creates cleaner water, improves heat transfer, makes chemicals more efficient, lowers maintenance costs and extends equipment life. POWERGEN International has selected Rapid Water Technologies to participate in its Initiate Program, which showcases start-ups and entrepreneurs that are championing innovation within the power industry.

Attendees can find Rapid Water Technologies at the POWERGEN Initiate Pavilion January 26-28 in Dallas. Rapid Water Technologies will also be showcasing its Nanobubble Generators as a first-time exhibitor at the AHR Expo, Jan. 31 – Feb. 2 in Las Vegas. At booth C5410, attendees can learn more about applications for nanobubble technology in the HVACR industry and take advantage of discounted pricing available only at the show. Models start at just $5,000 and are installed as simple, side-stream applications. After installation, customers have experienced savings of 5-35% on costs associated with heat transfer efficiency, chemical use, equipment maintenance, system cleaning and repair, water use, sanitization, and increased production. At a very low capital investment, the ROI on Rapid Water Technologies is fast -- as little as 3 months.One customer saw $17,000 annual savings in cleaning costs after installing a Rapid Water Technologies Nanobubble Generator on a domestic hot water system. Another manufacturer is saving $26,500 in yearlycleaning and chemical costs after an installation on the company's process water. Rapid Water Technologies Nanobubble Generators are proudly made in the USA. Trained and certified welders build our products in an ASME Code Shop. Rapid Water Technologies stands behind its Nanobubble Generators.

Servoflo Corp annonces its **PMF83000** mass flow sensor designed for medical devices and industrial applications with flow rates from 0-15 SLPM up to 0-100 SLPM. The sensor die uses a pair of thermopiles to detect changes in the temperature gradient caused by mass flow. Designed for respiratory care and other medical applications as well as environmental monitoring, fuel cell, and other industrial applications. Additional features include:

- Flow repeatability of 0.5% FS
- Long-term stability with minimal null drift
- Solid-state sensing core with no surface cavity or fragile membrane
- Resistant to clogging and pressure shock
- Fast response time of less than 5 ms
- Linear analog output of 0.5 to 4.5V and digital I2C output
- Overpressure of 50 psi
- Optional bi-directional flow sensing





Master Bond EP40TC is a two part epoxy system, designed for bonding, sealing and encapsulating applications where thermal conductivity and electrical insulation are required. With a high thermal conductivity value of 8-11 BTU•in/(ft2 •hr•°F) [1.16-1.60 W/(m•K)], it is formulated with a small particle size filler making it ideal for filling small cavities and applying the product in thin sections. Its volume resistivity is greater than 1015 ohm-cm.

''EP40TC's key distinguishing factor is that there is no compromise on the bond strength while providing excellent elongation and toughness. It has a high strength profile with a tensile lap shear strength of 2,300-2,500 psi, an elongation of 60-70%, and a tensile modulus of 5,000-15,000 psi,'' says Rohit Ramnath, Senior Product Engineer. ''Also, it meets NASA low outgassing specifications which is a prerequisite for many aerospace, electronic, and optical applications.''

Serviceable from -100°F to +300°F, this toughened system resists thermal cycling, vibration and shock. EP40TC exhibits a high peel strength of 40-60 pli and Shore D hardness of 70-80 at 75°F. It features a convenient 1:1 mix ratio, and cures in 2-3 days at room temperature or faster with the addition of heat. This compound adheres well to a variety of substrates such as metals, composites, glass, and many plastics. EP40TC is available in standard packaging, as well as premixed and frozen syringes.

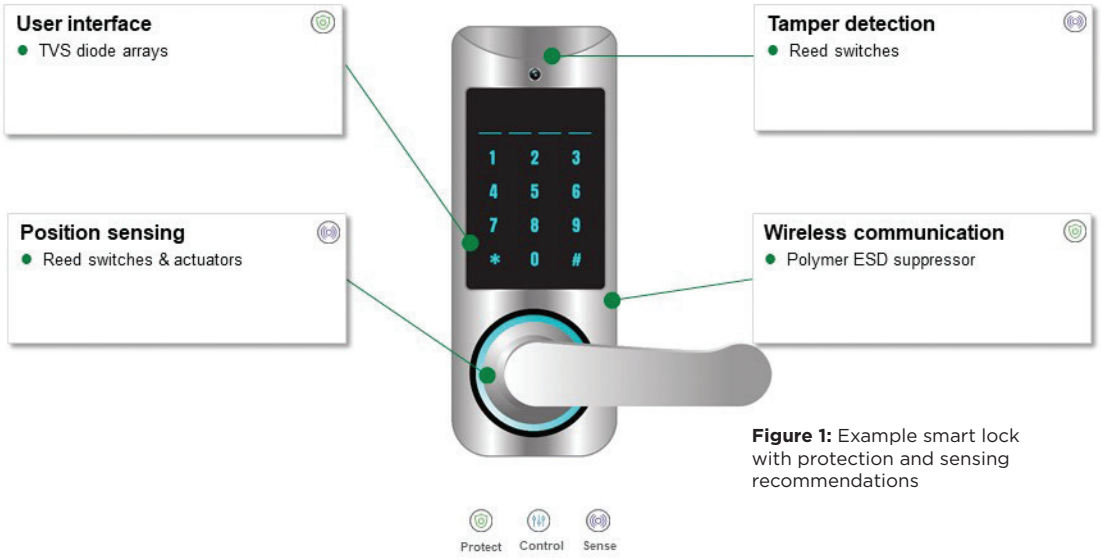


Figure 1: Example smart lock with protection and sensing recommendations

How to Design Intelligent Circuit Protection and Sensing For Smart Home Locks and Access Controls

BY RYAN SHEAHEN

The rapid development of both smart home and advanced building automation is enabled by a combination of smartphone, networking, and internet-of-things (IoT) technologies. These technologies provide increased automation, control, and security that gives homeowners and office occupants enhanced convenience and comfort along with greater safety. Wherever a homeowner or office occupant is, they can easily view the status of their door locks and window and door access.

Today's engineers that design home and building security products, such as smart locks and window and door sensing devices, need to ensure that their devices are not creating a false sense of security for their customers. An important step to improving overall reliability and safety is to understand the protection and sensing components required to comply with applicable safety standards and to ensure safe, robust, and reliable products.

The smart locks market alone is seeing high growth and is opportunistic for innovation. The global growth for smart locks is expected to have a compound annual growth rate (CAGR) of 25 percent with unit growth expanding to about 23 million units in 20241. The residential market represents the majority of the growth, which will be around 70 percent. As with smart locks, the increased awareness of personal security will drive global growth of window and door sensors, especially in developing economies. Shipments are expected to increase to around 465 million units in 20242. This growth is at a CAGR of around nine percent. The market for smart home safety and security products is clearly a healthy, attractive market.

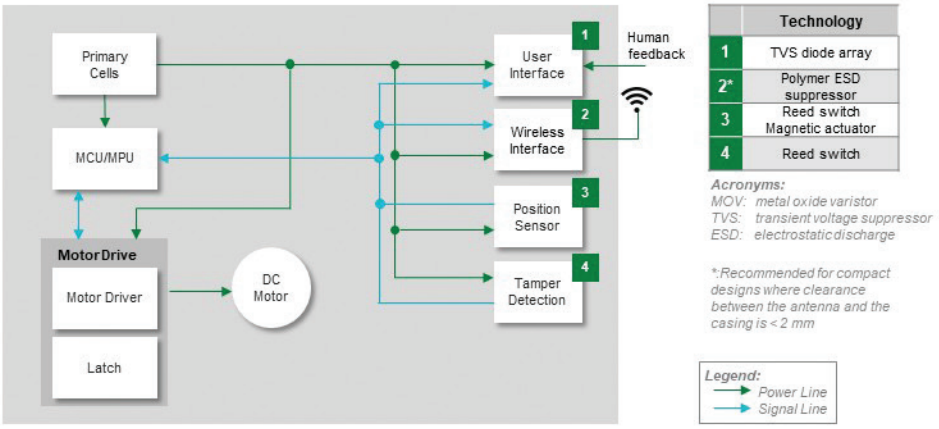
Protecting Smart Lock Designs

Smart locks consist of a keypad for manual access, a wireless protocol link for smartphone access through a software application, a sensor that monitors the position of the door handle, actuators to lock or unlock the door, and sensing to detect any effort to circumvent the lock. An example smart door lock with recommended circuit protection and sensing components to ensure reliable operation is shown in Figure 1. A detailed block diagram of a smart lock showing the recommended placement for the protection and sensing components is shown in Figure 2.

The prime danger to smart lock electronics is electrostatic discharge (ESD). Both the user interface and the wireless interface are susceptible to ESD from end-users.

The User Interface provides a keypad that a person must contact

Figure 2: Smart lock block diagram showing the circuit blocks where protection and sensing components are recommended



with their finger to enter the pre-programmed access code. All users are a source of ESD, particularly in very dry environments. Designers should protect the User Interface circuitry from ESD to avoid damage to the sensitive electronics.

For ESD protection, consider using a transient voltage suppressor (TVS) diode or TVS diode array. TVS diodes are Zener diodes built with silicon avalanche technology and can offer a minimum protection level of ±15 kV of ESD voltage. A TVS diode array can house up to six Zener diodes to protect five signal lines and provide a ground reference (Figure 3). The advantage of a TVS diode array is that one space-saving component in an 0402 surface-mount package can protect up to five lines. The impact on the circuit is minimal; a TVS diode array can have a leakage current of only 1 µA. If a higher level of ESD protection is needed, individual diodes can provide ESD protection for each signal line. A single TVS diode (Figure 4) can withstand as much as ±30 kV. Regardless of the configuration that is used, place the TVS diodes as close to the circuit's input as possible to prevent any ESD transient from penetrating into the circuitry.

The Wireless Interface links to a cellular network, wireless LAN, or WiFi network to communicate with

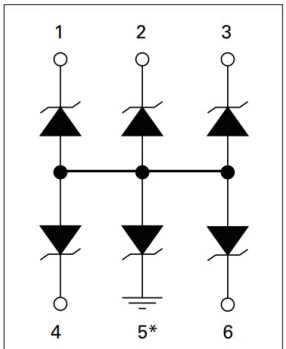


Figure 3: Example 5-line TVS diode array

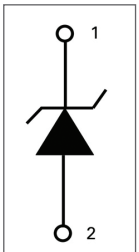


Figure 4: A single TVS diode

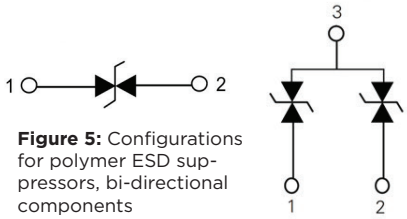


Figure 5: Configurations for polymer ESD suppressors, bi-directional components

smartphones or other networked devices. Because it is exposed to the external environment, the Wireless Interface requires ESD protection. A polymer ESD suppressor is the recommended component. The benefit of a polymer ESD suppressor is its ability to respond to and absorb any ESD transients while having a negligible impact on the characteristic impedance of the Wireless Interface output. Polymer ESD suppressors withstand a ±8 kV direct contact ESD and a ±15 kV air strike. Typical capacitance for the component is a low 0.06 pF. Response time to a transient is very fast, under 1 ns. The ESD suppressor should be as close to the input antenna connector as possible. Figure 5 shows two configurations for polymer ESD suppressors, bi-directional components.

Sensing Recommendations For Smart Locks

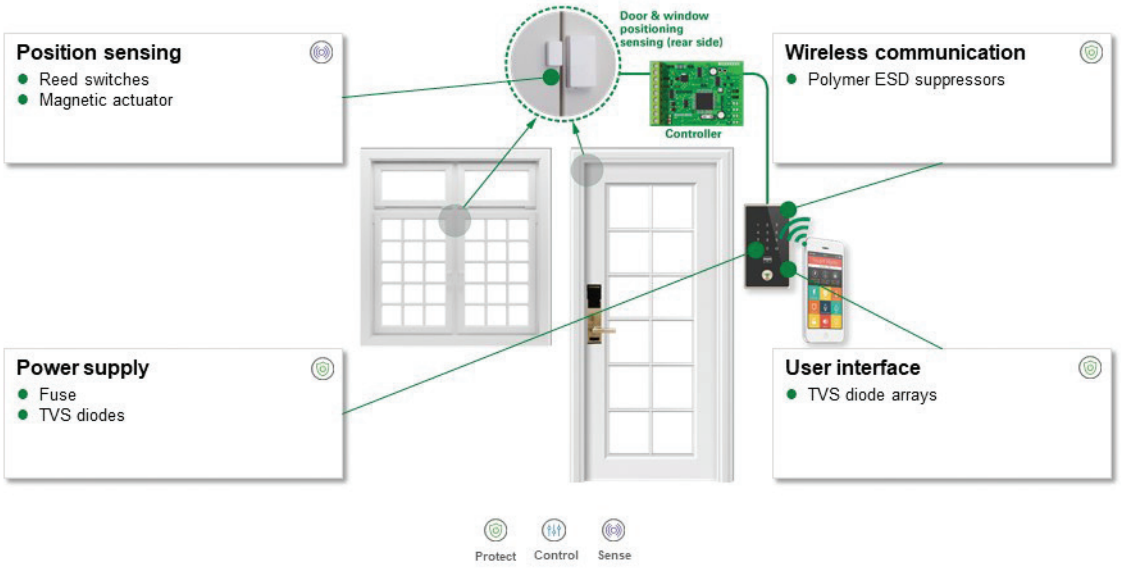
To ensure doors are completely seated in their door frames requires sensors at each location for detection. As a low-power sensing solution for battery-operated smart locks, consider a reed switch with a magnetic actuator. Reed switches do not require any drive power. They are also hermetically sealed for long life in any environment. Versions can switch 10 W with ratings up to 0.5 A or up to 200 V. The switches are very well-suited for use in low voltage controller circuits. In addition, surface mount versions are available for automated circuit board assembly.

Consider a cylindrical magnetic actuator designed for mounting on door frames. An AlNiCo magnet is the recommended material. The size can be as small as 5 mm x 25 mm.

The Tamper Detection circuit will also require a sensor. This sensor alerts the user if the lock has been compromised and the door has been opened. Again, a reed switch with an actuator is recommended. The combination reed switch-actuator consumes a minimal amount of power while maximizing battery life. Consider a reed switch-actuator pair with adjustable sensitivity to ensure a fast response to a tampered lock.

It takes only four components to provide protection and sensing for smart locks. These components consume a minimum of printed circuit board space and ensure a safe and reliable product.

Figure 6: Example wireless window and door sensing system with protection and sensing recommendations



Protecting Wireless Door and Window Sensor Designs

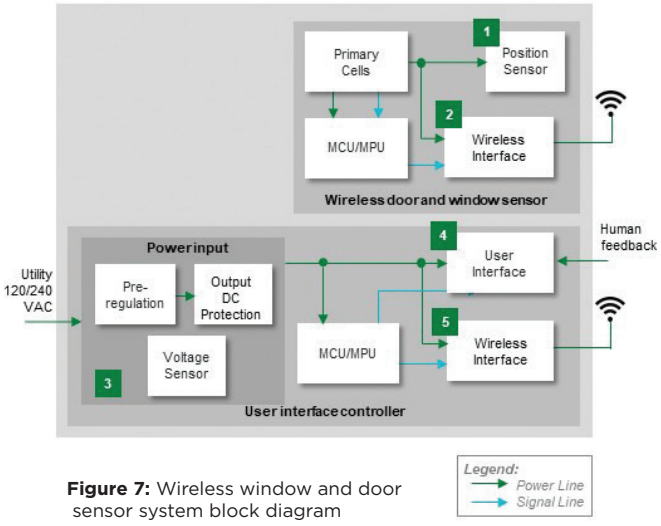
Sensors provide information on the state of wireless windows and doors throughout a home or building. Users can obtain information on whether windows and doors are open or closed from any location. An example hardware configuration for both a wireless door sensor and a wireless window sensor is shown in Figure 6. The diagram also shows several recommended circuit protection and sensing components for each of the hardware elements.

There are two main elements of the system (Figure 7). The sensor circuitry detects the position of the window or door and reports the information to a controller which is also the interface for the user and the transmitter of information to any location. The sensing circuitry that is on the door and window must allow for movement; thus, the circuitry itself must be battery-operated. The User Interface Controller (UIC) and keypad are in a fixed location so that it can be AC line powered. Using the AC line power is a typical commercial application.

As with the smart lock, designers should consider a reed switch-magnetic actuator for proximity detection. With no activation power required, the reed switch extends the battery life of the sensor system. The Wireless Interface circuit blocks in the sensor and the user interface controller can use polymer ESD suppressors to ensure protection from ESD while maintaining the integrity of the RF transmission. Also similar to the smart lock, the User Interface circuit block with its keypad should have ESD protection from human contact. A TVS diode array can protect the sensitive signal lines from ESD transients.

Where AC power and an AC-DC power supply energize the User Interface Controller, designers need to protect the controller from potential threats from the AC line. Potential damage to the electronics can come from overcurrent conditions, lightning strikes and other voltage transients, and ESD transients. By using the correct fusing and voltage transient protection devices, designers can protect their designs from these conditions

There are numerous fuse specifications that should be taken into consideration including the fuse's



	Technology
1	Reed switch Magnetic actuator
2*	Polymer ESD suppressor
3**	Fuse
	MOV
	TVS diode
4	TVS diode array
5*	Polymer ESD suppressor

Acronyms:
MOV: metal oxide varistor
TVS: transient voltage suppressor

**: Recommended for compact designs where clearance between the antenna and the casing is < 2 mm*

***: For commercial installations, the power input from AC mains is provided*

Figure 7: Wireless window and door sensor system block diagram

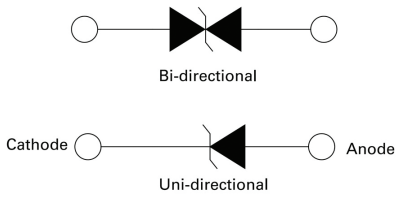


Figure 8: Bi-directional and uni-directional TVS diode configurations

operating characteristics and the case style to meet a wide range of design objectives. Consider time-delay or slo-blo fuses to avoid nuisance shutdowns. Also, designers should select the fuse current rating to accommodate short-term overloads such as in-rush currents where applicable. Other considerations include the interrupting rating which defines the maximum overload current the fuse can interrupt. This parameter trades off with fuse size. If a small fuse is needed, the designer will need to make sure that the fuse can withstand the available short circuit current supplied by the AC line. A final consideration is the fuses' cold resistance. If power consumption is a prime concern, then designers should look for a fuse with low cold resistance.

To safely absorb the energy from a voltage transient on the AC line from lightning or motor turn-on and turn-off spikes, consider employing a metal oxide varistor (MOV). These components can absorb a current surge as high as 10,000 A from an 8/20 µs transient pulse. A 20mm MOV can also absorb greater than 500 J of energy.

As an alternative component to the MOV, consider using a TVS diode. These components are developed for protecting sensitive circuits from lightning and other transients and can withstand as much as 1500 W of power from a 10/1000 µs pulse. To minimize power consumption, TVS diodes will draw less than 1 µA under normal operating conditions. Also, a TVS diode can respond quickly to transients in less than 1 ps. Surface mount (SMD) versions are available to both reduce the PC board space required and minimize assembly labor. Designers can select either a bi-directional diode or a uni-directional diode Figure 8).

Just like smart locks, it does not take many components to protect window and door sensing circuits. Designers have numerous options to select the most suitable versions for their specific applications.

Understand and Comply With Applicable Industry Standards

Building automation and smart home electronics designers should have a working knowledge of the standards that apply to the products they are developing. It is important to incorporate these requirements during the development phase of any design project. Failure to accommodate the standards can lead to expensive re-design work, delays in product introduction, and potential cost overruns. In addition to general product safety standards such as the IEC 61000 series which define requirements for withstanding ESD, electrically fast transients, and lightning, specific standard exist for electronic locking and related products. Table 1 lists the applicable standards for electronic locking and related devices. The documents cover both North America and China and are essential reference materials for engineering teams that design smart locks and window and door sensors.

Robust Reliability Results in End-User Satisfaction

It is a tremendous competitive advantage for manufacturers of smart locks and window and door sensing products to have a reputation for quality, reliability, and convenience. By using the appropriate protection and sensing components, designers will contribute to achieving safe and robust products for end-users. Fortunately, only a small quantity of components is needed to fully protect their product and comply with safety standards. With low-energy sensors, designers can maximize battery life to minimize the frequency of battery replacement. Electronics designers have a many alternative components that they can use. A final recommendation for achieving optimal home automation designs is to take advantage of the expertise of the component manufacturers and seek their advice.



Ryan Sheahen *is the Global Strategic Marketing Manager for the Electronics Business Unit. His responsibilities include the development of marketing collateral, management of marketing activities for new product launches, and performing marketing studies and feasibility analysis for new product ideas.*

References:
[1] Smart Lock Market Size. Grandview Research. February 2020.
[2] Window Sensors Market Outlook. Outlook Market Research. May 2019.

Standard	Title	General scope	Littelfuse Technology	Market
UL 1034	Standard for burglary-resistant electric locking mechanism	These requirements apply to the construction, performance, and operation of burglary-resistant electric locking mechanisms and their related devices, such as control units, control switches, and power supplies, and the like used to secure and release doors	Fuse, MOV	North America
GA 374	Burglary-resistant electronic locks	This standard is applicable to the design, manufacture, inspection, and acceptance of burglary-resistant electronic locks	Fuse, MOV	China
GA 701 - 2007	General specifications for burglary resistant fingerprint locks	This standard applies to fingerprints as an input signal to identify and address relevant information to electrically control the mechanical locking mechanism's opening and closing of certain anti-destructive power locks	Fuse	China

Table 1: Applicable standards for electronic locking and related products

When It Comes to Plastics Part Assembly, Laser Welding Is the "Clear" Choice

BY SEAN LEAVY

Every designer and manufacturer strive to inject a sense of thoughtful design and authentic craftsmanship into the assembly of their products. Likewise, experienced consumers with an eye for beauty might point to a piece of ceramics, an upholstered chair, a precision tool or instrument, or the fit and finish of a classic car. However, this aesthetic is more difficult to achieve in mass-production of plastic parts, even though they offer the benefits of light weight, lower cost, consistent strength, and almost unlimited design flexibility in terms of part size, shape and color.

The methods used in assembly of plastic products are typically optimized for speed and simplicity, rather than for cleanliness, aesthetics and finish quality. Along with fasteners, adhesives and snap-fits, there are a range of friction-based joining methods — ultrasonic, vibration, spin and hot-plate welding. For any product, each method may offer certain advantages that fit with your design and manufacturing capabilities, the size and output of your production run, and the degree of labor versus automation that your assembly process must achieve.

Yet, in a growing range of higher-end electronic, automotive and medical applications, manufacturers are delivering a higher level of aesthetics and craftsmanship in the assembly of plastic parts using laser welding technology. And the same technology can be successfully applied in appliances and related products.

This gentle and ultra-clean joining process is remarkably versatile: It can join a broader range of polymer materials than friction-based joining processes like ultrasonic welding. It can also provide reliable hermetic seals, precisely aligned parts and nearly invisible weld joints in a single cycle lasting only seconds. Relatively recent technical developments also make it possible to join two clear-plastic components.

The process itself is simple: Laser welding uses light generated by laser diodes in the 980 nm wavelength. This light is concentrated through fiber optic bundles connected to the weld tooling, then precisely aimed through wave guides that are positioned to cover the weld area of the parts. The concentration of the bundles over the part varies according to the heating density required for welding.

Emerson offers Simultaneous Through-Transmission Infrared® (STTIr®) laser welding technology developed through its Branson™ brand of solution. The STTIr process differs from other laser technologies, such as "track and trace," because it heats the entire weld surface at one time. This process ensures precise heating while reducing the clamping force required for assembly. The resulting laser welds are highly precise, with such narrow "collapse depth" between the welded part surfaces that finished welds often appear nearly invisible.

Traditional Laser Welding

Traditionally, laser welding has required two distinctly different parts be used in each assembly. The part nearest to the light source is made with material that is "transmissive" or "clear" to the laser wavelength used. The mating part uses material that is "absorbent" or "black" to the wavelength of the laser light (see Figure 1). This difference in material was critical to achieving the heat required to complete the weld.

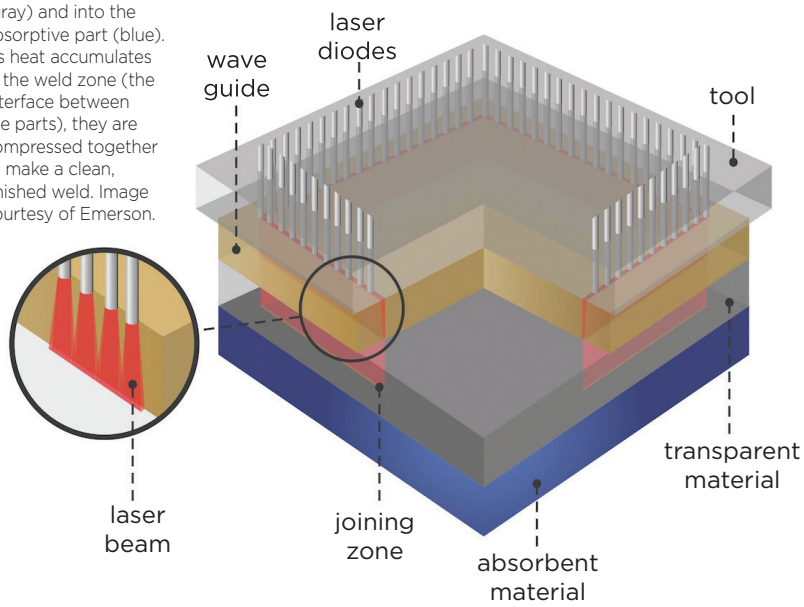


Figure 1: This top-down view shows a typical laser welding process. The tube-like structures at the top are laser diodes, positioned around the perimeter of a welding tool, shown in gray. The inset at left shows how laser beams are projected through a waveguide (the yellow layer) at the base of the welding tool, then through the transparent part (gray) and into the absorptive part (blue). As heat accumulates in the weld zone (the interface between the parts), they are compressed together to make a clean, finished weld. Image courtesy of Emerson.

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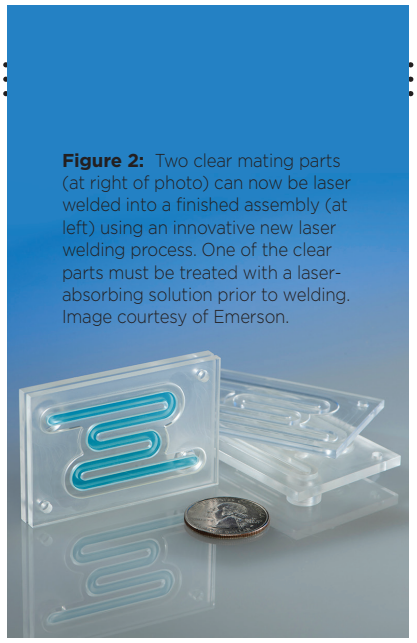


Figure 2: Two clear mating parts (at right of photo) can now be laser welded into a finished assembly (at left) using an innovative new laser welding process. One of the clear parts must be treated with a laser-absorbing solution prior to welding. Image courtesy of Emerson.

New "Clear-on-Clear" Laser Welding

As noted above, a recent innovation now makes it possible to weld two transmissive, or "clear-on-clear," parts using Branson STTIr laser welding technology from Emerson. The key to this process is to precision-treat the weld surface of one of the clear parts with a laser-absorbent compound prior to welding. The laser absorber consists of microparticles of pigment dye or carbon black that are suspended in a carrier fluid such as isopropyl alcohol or acetone. During the welding process, the laser energy hits the absorber and consumes it, releasing heat energy that conducts through the weld zone of both mating parts. Then, the two parts are bonded together under compressive force (see Figure 2).

Low-Force Laser Welding For Delicate Parts

Yet another advance, this time with the actuator technology used on the laser welder, enables precise positioning and laser welding of extremely small and delicate plastic parts. The new Branson GLX-Micro laser welder is equipped with this electromechanical actuator, which can precisely control ultra-low clamping forces as low as 1 Newton (see Figure 3). When combined with the ability of laser welding equipment to precisely aim heat energy, the actuator's ability to manage low clamping force simplifies the joining of parts that are extremely small and delicate, complex in geometry, or embedded with electronic components, wiring or sensors. When ultra-low compressive forces are used in the weld process, the risk of part deflection, bending, cracking, or damage to embedded electronics is virtually eliminated.



Figure 3: The benchtop Branson GLX Micro Laser Welder has an advanced, low-force actuator assembly that virtually eliminates the risk of deflection, bending or cracking of delicate parts during the laser welding process. Image courtesy of Emerson.

Conclusion

In summary, laser welding offers a range of important benefits to product assembly operations, including:

- **Superior aesthetics**. Manufacturers increasingly use laser welds for their aesthetics because they are precise and flash-free. Weld lines are virtually invisible.
- **Greater part-design freedom**. While traditional plastic welding methods often require flat-plane parts, laser-emitting waveguides can conform precisely to complicated part geometry, enabling laser welding of part designs that maximize aesthetic or functional performance. Laser welding also frees designers to employ multiple reflective compartments or to embed sophisticated electronics, sensors or lighting such as organic light-emitting diodes (OLEDs), resulting in more striking, brand-differentiating part designs.
- **Excellent weld quality**. Laser welds require no friction, vibration or movement. Laser-emitting waveguides can conform precisely to even complex part geometry in order to ensure rapid and uniform melt across the weld interface. The result is a uniform, consistently strong weld joint with precise melt-collapse depth and perfect part alignment.
- **Low mechanical stress**. The latest laser welders, such as the Branson GLX family from Emerson, can manage ultra-low clamp forces, enabling delicate or larger parts to be joined without introducing mechanical stress, so there is no need for part annealing or material stress reduction.
- **Ultra-cleanliness**. Laser welding produces no flash or particulates. It is a cleanroom-capable process that is equally at home on any production floor.
- **Great versatility.** Laser welding technology can bond a very wide range of polymer materials, including PC, PA, PS, ABS, Elastomers (TPU, TPE), PP HDPE, LDPE, PETG, PBT, PPS, PMMA, PEEK, COCs, and more.

Today's products, whether appliances, cars, computers or wearable devices, demand not only superior design and functionality but also superior execution in assembly to maximize appeal, usability and durability. Already the leader in aesthetics and cleanliness for plastic parts assembly, laser welding technology continues to evolve, complementing its usability with a wide range of materials by greater use in a wide range of applications. ●



Sean Leavy *is the regional product manager – Americas for Emerson's Branson Welding & Assembly business. He is responsible for implementing global marketing and product strategy for laser welding and other products in the Branson assembly technology portfolio. Leavy has an MBA from Simon Business School at the University of Rochester.*

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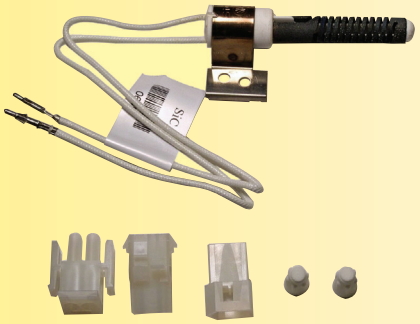
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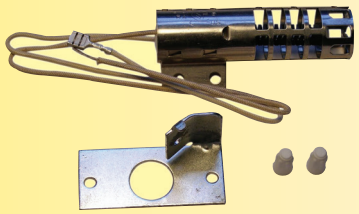
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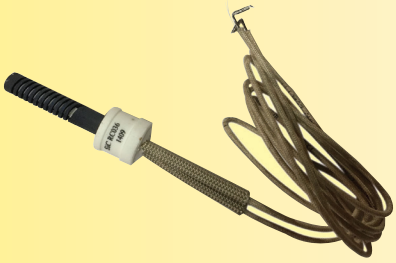


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