PREMIER ISSUE

APPLIANCE & HVAC REPORT

Reaching Design Engineers at the OEM Level

September/October 2019 VOLUME 1 ➢ NUMBER 1

9

FEATURES COVERING

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Welcome to the Premier Issue of Appliance & HVAC Report



You may be asking: Why do we exist, and why should you care?

Let's go back in time a bit. Yours truly has been involved in the publishing industry for more than 30 years. In 2007, I took the plunge and founded JABS Media LLC, which subsequently bought two brands for the automotive aftermarket: ***Aftermarket International*** and its Spanish counterpart, ***Aftermarket International en Español***. (You can find them online at www.aftermarketinternational.com)

The year 2007 was a great time to start a publishing business, right? It saw a global recession, and a movement from print to digital advertising. Lots could go wrong and some things did. But we persisted, and despite these factors, we have never had a losing year. We don't mean to be immodest, but we don't think many publishers can say that over the last decade or so.

In short, we think we know what we are doing. When we started JABS we also were involved in the publishing side of the appliance industry…on the OEM side. At that time there were two primary trade journals serving it: Appliance and Appliance Manufacturer, which was later renamed Appliance Design. A few years ago, Appliance was bought out and later folded; and earlier this year, Appliance Design was also closed, I'm sorry to say.

So, it seems to us a niche is there to be filled—that niche being a tool to provide technical information to design engineers in the OEM appliance and HVAC industries.

Why design engineers?

That is simple to explain. It's been our experience that many, if not most, component suppliers want the design engineer to buy, specify, or recommend their products and services to their purchasing departments. And we believe we can help make that happen.

Appliance & HVAC Report will be published once this year, and then proceed with a bi-monthly schedule beginning in 2020. We will reach 15,000 of these design engineers. To maintain cost control, we will be primarily digital—though if you want a print edition, you can have one for a nominal charge. Our advertising and prospect base will receive hard copies, and we also will have them at trade shows at which we exhibit. We have been accepted at AHR, and hope to be at AHAM and other shows.

So, that is our story. Our website is ***www.appliancehvacreport.com***. All issues will be available there, too, with live links to our clients' websites.

This issue:

It includes nine technical stories. If that doesn't catch readers' attention, I'm not sure what will. We also have industry news and product releases, but our main thrust is these technical features.

I'd like to thank the following companies who supplied them. Without their contributions, it would not have been easy to get ***Appliance & HVAC Report*** off the ground: **Clad-Rex, Continental Fan, Deprag, ebm-papst, EpoxySet, Fabrisonic, Hernon Manufacturing, Sprinter Marking and Microchip.**

While we believe we are off to a strong start, we realize that, as they say, "Rome wasn't built in a day." Neither will *The Report*. So feedback is needed from you, our readership.

Feel free to go to our website and leave a comment or two. Don't worry about "pulling your punches," but please try to be constructive. Or you can email them to me at ***brad@appliancehvacreport.com***.

And, while I won't do this every column, I do want to thank the following advertisers who came on-board with us right from the start: **Continental Fan, John Guest, Inc., Owens-Corning, PCB Piezotronics, Soler & Palau, Southco, Sprinter Marking, Surface Igniter and Portage Electrical Products.**

We don't trade editorial support for advertising, so while there is some overlap with the above, it's minimal.

Thanks, and we hope you enjoy our premier issue!

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Reaching Design Engineers at the OEM Level

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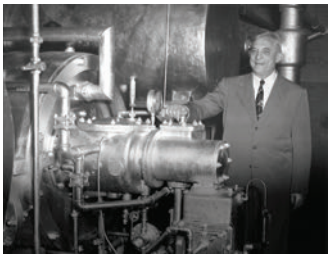
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Miscellaneous Fun Facts

1902



Willis Carrier created the first air conditioner in Buffalo, New York. Air conditioning was first installed residentially in 1914; the unit was 7 feet high, 6 feet wide, and 20 feet long!



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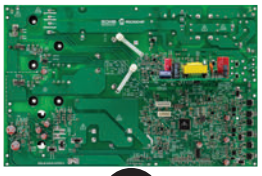
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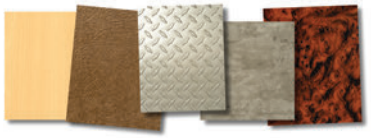
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Image of the home appliances where adhesives and sealants play a key role

Soundproofing and Vibration Resistant Adhesives

BY SIMLA AY

Vibration and sound transmission create problems for many industries. Combating the noise of a motor engine in cars, boats or planes, silencing disruptions from home appliances such as dishwashers and washer/dryer rooms or reducing the rattle of air conditioning systems are new frontiers in creating more comfortable and peaceful environments. More and more, adhesives and sealants are playing a key role in addressing these issues of vibration and unwanted sounds.

Most adhesives and sealants are naturally viscoelastic and damp sound by absorbing the energy. Epoxies, silicones and polyurethane-based adhesives are the most popular products for this task, but many adhesive types can be effective tools for noise and vibration control. These materials fill open spaces to reduce noise leakage while also absorbing energy and dispersing stress across the entire bonded surface. This, combined with insulation, significantly reduces noise, vibration and any harshness (NVH) associated.

NVH is an abbreviation and industry term commonly used in automotive manufacturing when discussing noise, vibration and harshness. The context is typically to eliminate

these nuisances from effecting the occupant's environment. As such, NVH products are generally designed for vehicles and substrates used in automotive manufacturing from steel to composites, but the same core ideas apply to appliances and other manufacturing segments where there is a desire to minimize noise.

The sound of home appliances may be irritating, impacting a person's sleeping, concentrating, level of stress and overall health. Anything over 85 decibels can harm the hearing over time. General home appliances produce around 50 decibels and the loudest ones are in 80-95 decibels range. Noise levels for some common home appliances such as a dishwasher is 55-70 decibels, a refrigerator is 50 decibels, a washing machine or an air conditioner is 50-75 decibels, a coffee grinder is 70-80 decibels, a juicer is 80-90 decibels and a hair dryer is 60-95 decibels. Home appliances like washers and dryers used to be in basements and garages. In order not to create sound problems over time, adhesives and sealants are starting to be used as alternative sound blocking materials.

How do adhesives help?

Aside from physically blocking sound waves as an insulator, adhesives are specialized to address specific NVH challenges. Structural adhesives, for example, cure into rigid forms to help create firm connections which bond separate pieces into one solid structure. With structural adhesives applied, vibrations are less capable of moving individual pieces which reduces rattling noises and extends a product's durability. This is particularly important where consistent impacts or shaking is encountered.

Threadlockers also play a role by resisting vibration, leaks and corrosion when bonding threaded fasteners in place. Washing machines, dryers and other appliances which are subjected to high frequency of vibrations should be protected against loosening fasteners with threadlockers applied to all threaded fasteners. Thread locking adhesives are often pre-applied to lock nuts and bolts against vibration and thermal expansion. As an important side benefit, they protect the fasteners from corrosion and leakage by filling all the voids between the interfacing threads.



Vibration and corrosion resistant threadlocker adhesives

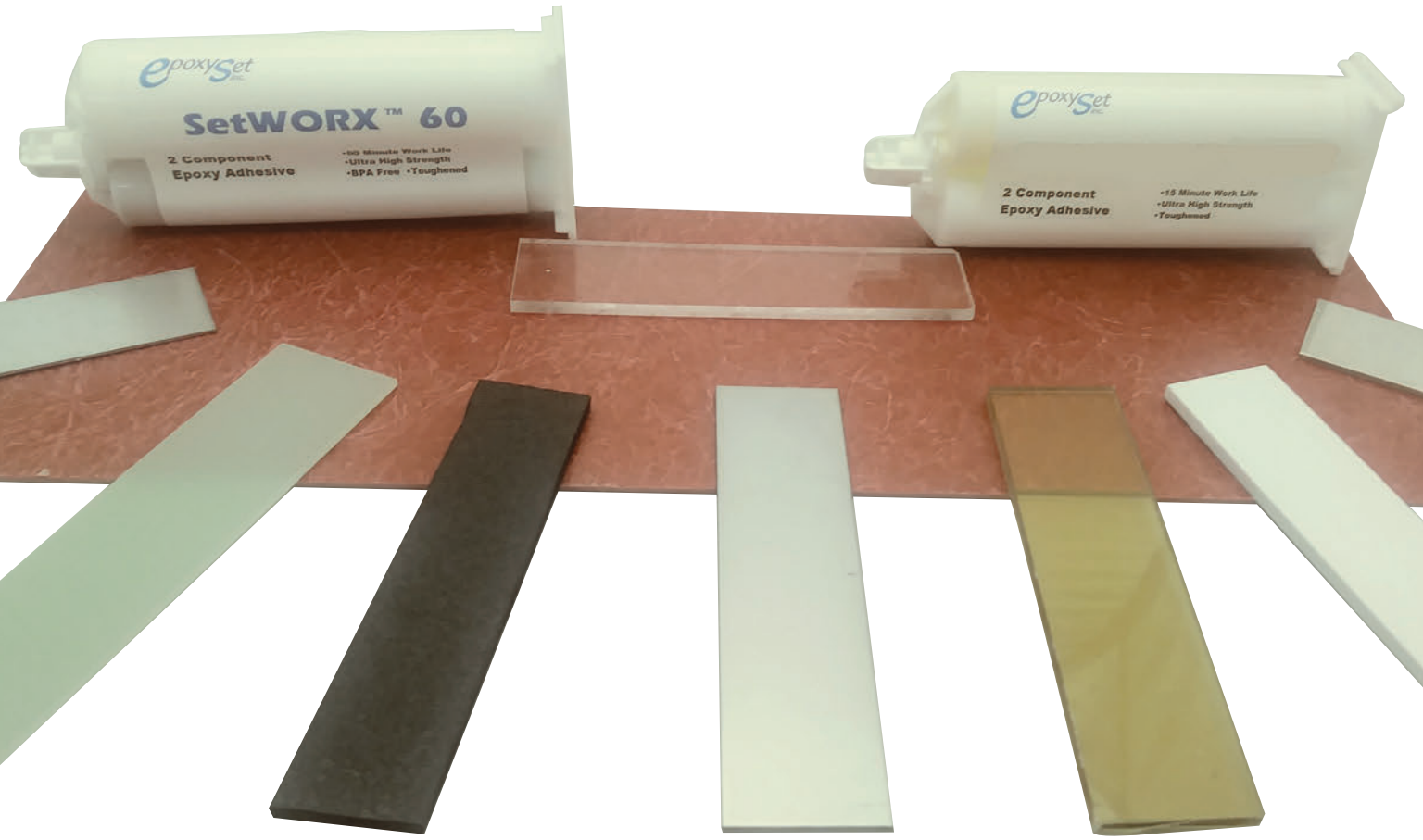
Any fastener selected for noise reduction must work with the application environment, such as hot and relatively dirty motors. In motor applications, temperature cycling tolerance and chemical resistance will be key, so be sure to review the application with adhesive specialists. Adhesives provide an economical way to control noise and vibration as they are low cost and can be applied simply with minimal alteration to substrates. NVH adhesive products often have high bond strength, easy applications and complete curing to create strong NVH resistance. ●



Simla Ay, *is a technical writer with Hernon Manufacturing, Inc. of Sanford, FL. Hernon manufactures adhesives, sealants, processing solutions dispensing equipment and customized formulations. www.hernon.com*

Hernon Manufacturing, Inc.® produces over 5000 adhesives and sealant types. A full in-house chemical laboratory ensures quick turn around on testing and development projects and an on-site machine division allows Hernon® to build, service and integrate unique dispensing systems to even the most exacting specifications. This horizontal integration helps Hernon® to provide customers with a Total Solution for any unique application.

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What You Need to Know Before Selecting High Tech Adhesives

BY BARRY SIROKA

Choosing the best adhesive for a specific application can be complex. There are many variables to be considered and numerous types of chemistries with different capabilities. An understanding of the following parameters will help to narrow the choices. Selecting the correct adhesive will reduce the number of products to be evaluated and increase the likelihood of success.

Substrates

Knowing the materials to be bonded is very important. Certain adhesives may adhere better to ceramic or glass. ''Metal'' and ''Plastic'' are generic terms which encompass many different types of materials so knowing the exact substrate is essential for determining the correct adhesive. For example, ABS and Teflon are both plastics but Teflon requires an acid etch to achieve a bond where ABS can usually be bonded with just an alcohol cleaning.

Cleanliness of the Parts

Most adhesives require that the substrates be prepared properly. Whether it's just a simple cleaning, or the ability to do more complex operations (such as abrasion, chemical etch or plasma treatment) will all come to play in selecting an adhesive.

Viscosity

The viscosity must be considered. Low viscosity (thin) products are best for thin bonds or for applications requiring wicking. Thixotropic materials (won't run) are best for use in vertical applications.

Thermal Cure vs UV Cure

UV cure adhesives are usually one part and can be cured quickly. They must be exposed to UV light to cure so at least one of the substrates must allow transmission of UV. Thermal cure materials can be cured at room temperature and/or with heat. Heat cured, thermal adhesives can require high temperatures which might be detrimental to components but, in general, they will cure faster with higher properties.

Working Life

Determine how much work life is desired. Remember that working life (time before the material gels) is generally related to cure time. For thermal cure materials, the longer the working life usually means a longer cure time (at room temperature). Single part UV cured materials can be cured quickly and the working life doesn't apply.

Configuration

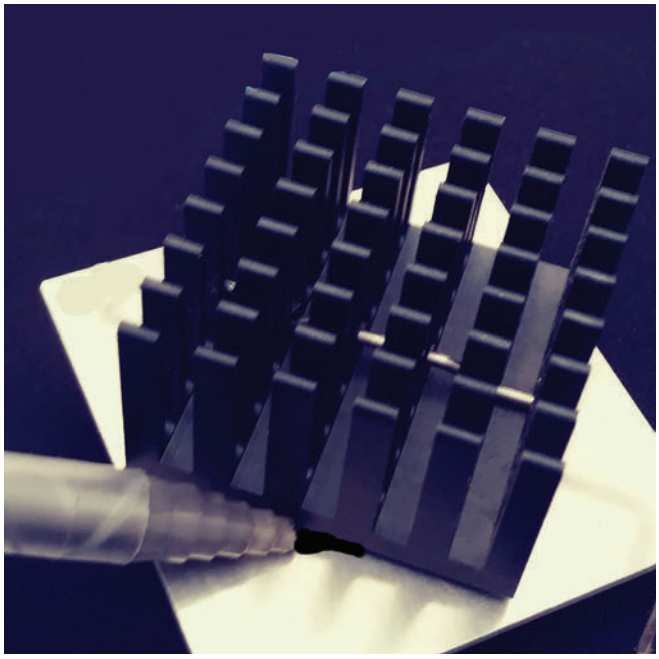
The dimensions of the parts and how they fit together are very important to determining the best material. Larger parts and thicker bond gaps may require a slower cure to reduce shrinkage. Certain adhesives are designed to work best with thinner gaps.

Required Performance

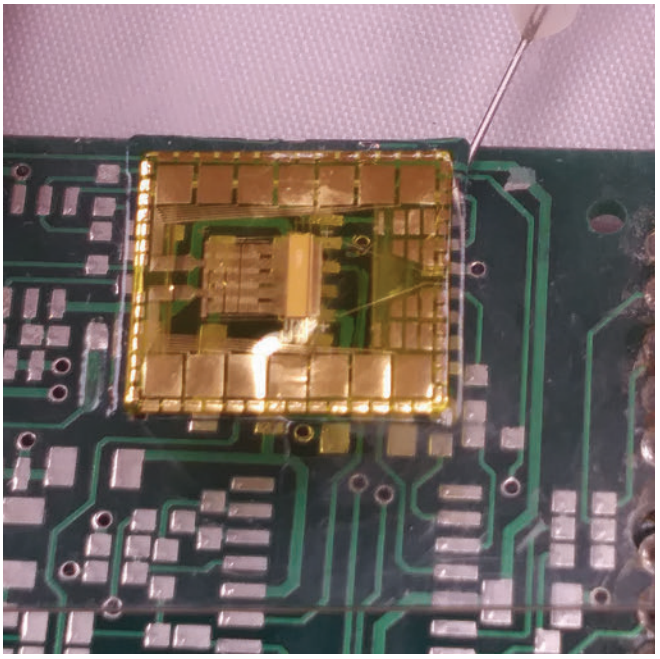
Some factors that should be understood before selecting an adhesive: **Does the adhesive need to form a structural bond?**

Ideally, a structural bonding material

Thermal cured materials may be room temperature or heat cured. Heat cured systems can be cured faster and result in better properties but high temperatures may damage components.



Delicate components require choosing an adhesive that will yield high performance as well as prevent stress.



will create a finished part that is as strong as the substrates. As stated earlier, knowledge of the composition of the substrates helps to decide the best adhesive and preparation to accomplish an ultimate bond. Also, understanding the configuration of the parts to be bonded will determine the types of adhesives for use. With most adhesives the larger the surface area of the mated parts the stronger the bond.

The bond gap is also critical. Various adhesive chemistries work best with certain gaps. In general, cyanoacrylates and anaerobics need the thinnest bond line where epoxies and urethanes are better with thicker gaps. Every chemistry can vary dependent upon how they were formulated but these are general rules.

How much mechanical stress will be on the bond during use?

This may seem obvious but the forces on the adhesive joint and the direction of those forces have a major impact on the adhesive to be used. Some chemistries may have excellent tensile strength (strength in a horizontal direction) and very little shear strength (strength in a vertical direction). Other considerations would be if there are any compressive forces or torsion on the joint. Adhesives may be formulated to be more flexible or with fillers to compensate for these stresses.

Will any stresses be consistent or intermittent?

Some adhesives can take extreme stresses for very short periods but not withstand the stress over longer periods. Others may hold up to long consistent stress as long as it is not brought on suddenly.

Other types of stress may also be of concern. For example, autoclaving is a standard practice in many industries. Many adhesives cannot withstand autoclaving. It is important to consider all stresses when selecting adhesives.

What are the temperature requirements during processing and use?

This can be an extremely important parameter. Materials with low temperature cures may not withstand high temperatures during use. Adhesives designed for high temperature uses might only cure with heat so the adhesive will have to be exposed to dry heat (an oven or a heat element).

The exposure temperatures during use are critical. Also consider if the parts with be temperature cycled. Many materials that will withstand high temperatures will crack when cycled to low temperatures and low temperature materials might lose their strength at high temperatures.

What optical properties (if any) are important?

Optical properties may be important for certain applications. If light transmission is important, we must know the wavelength being transmitted and the duration. You may also want to consider the refractive index are the substrates. Certain chemistries will not remain clear over long exposure to UV radiation.

Does the cosmetic appearance matter?

Some adhesive chemistries can be easily colored but others cannot. Some chemistries will have lot to lot variations so the final appearance can change. In applications requiring specific colors (especially for consumer products) it may be necessary to ensure that lots can be color matched.

These are some of the more important issues although for any specific applications there can be other considerations before selecting the right candidate. It is not often feasible to know all the required parameters before choosing but it is important to have as much information as possible to make an educated decision.



Many materials can be supplied with various packaging options for ease of use and manufacturing convenience. Cartridge packaging may also eliminate errors in mix ratio.

Considerations For Application

When evaluating adhesives and potting materials, it also important not only to make sure it works on a performance level but also on a production level. How will material be applied? It is a common occurrence that engineers or project managers approve a product that works perfectly for the application only to find out later

that processing it on the production floor is either inefficient and wasteful or just not possible. Considering dispensing, mixing, applying concepts early can save a lot of time and money down the line and avoid production or launch delays.

Mix Ratio: One of the biggest issues facing production lines while using 2 part polymer systems are the mix ratios. Mix ratios vary from product to product and unfortunately not as simple as 1:1 by weight and volume. Some mix ratios are also less critical allowing for higher degrees of tolerance. Alternatively, slight changes in a mix can result in changes in the physical characteristics of the product. For instance, polyamide based epoxy systems are very forgiving in mix ratios. If the product calls for a 100:80 mix ratio by weight and the actually mix ratio is off by even 10%, the finished polymer and the characteristics are not drastically different nor should it affect its performance. A tin catalyzed silicone is very vulnerable to changes in mix ratio. A 10% increase in catalyst can accelerate the polymerization process and decrease work life not allowing operators enough time to pot or encapsulate the part leading to waste material.

Amine and imidazole cured epoxies, (as well as many urethane systems) with an incorrect ratio, will result in a finished adhesive with diminished properties. If a ratio specific material is the best choice, ensure that manufacturing processes are set up accordingly to produce the best and consistent results.

While uneven mix ratios should not deter one from choosing a product, many prefer even ratios to reduce risk of mistakes. There are several options for high efficiency application of adhesive systems. Many products that have even volumetric mix ratios (1:1. 2:1, 4:1) are also available in dual barrel cartridges. These types of cartridges come different sizes and are convenient because there is no risk of weighing and/or mixing mistakes. These dual barrel cartridges can be dispensed via applicator guns which can operated either manually (like a caulking gun) or pneumatically for higher efficiency.

Conclusion: While evaluating and ultimately choosing an adhesive or encapsulating compound can be an exhausting effort, it can be made easier by considering some of the elements discussed in this article. The more information you have on the application helps to tremendously eliminate a majority of options and makes it easier in filtering the variety of products available.

Contacting the experts is also a major step in choosing the right product. Adhesive suppliers tend to have a vast amount of knowledge to know only their products but where they are used. At Epoxyset, we encourage you to speak with our technical team to assist in choosing the best adhesive for your application.

Ultimately, evaluating adhesives comes down to choosing one (or a few) and testing them in your application before deciding. ***There is no substitute for sampling and evaluating a product.*** Testing often reveals previously unconsidered parameters. ●



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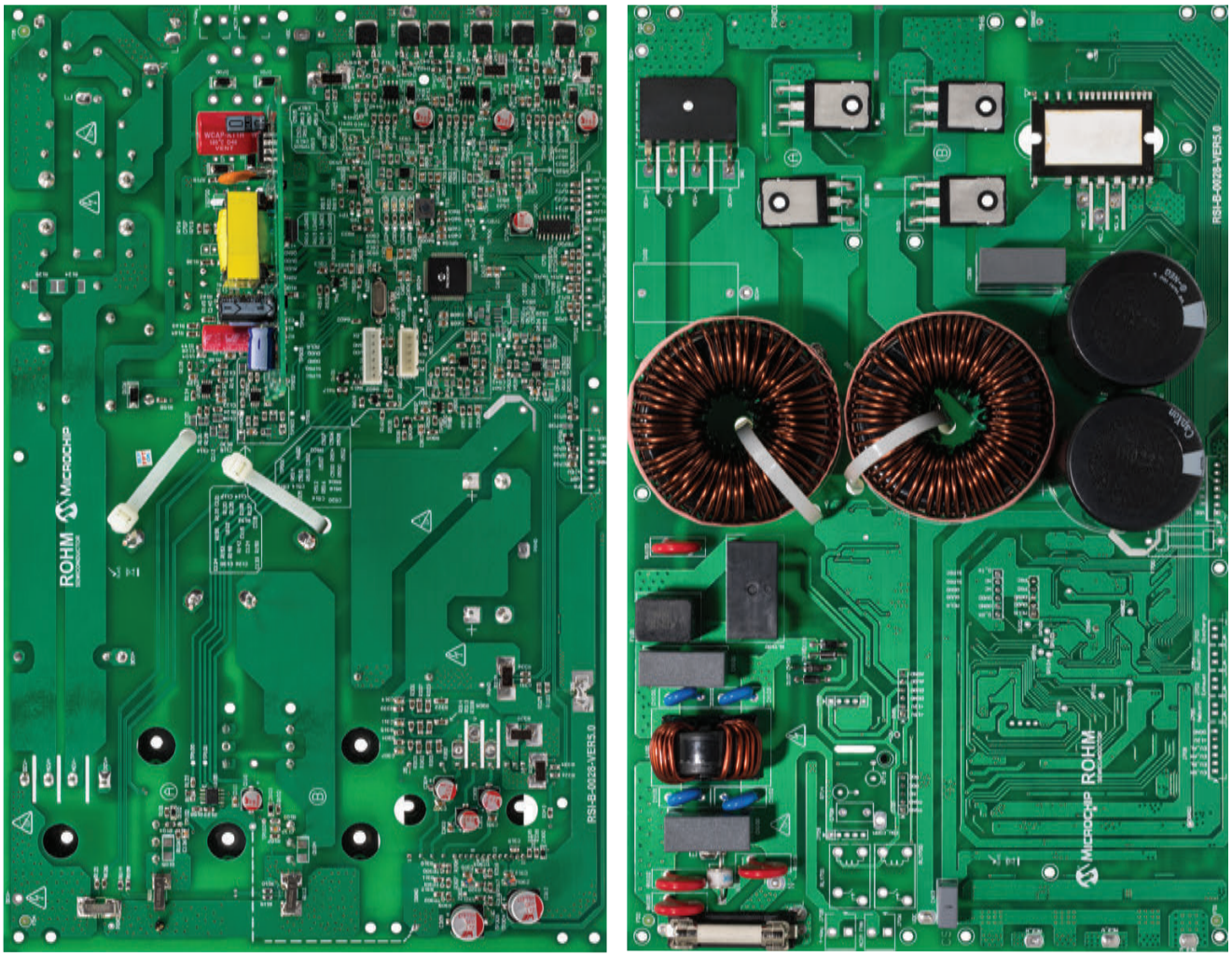


Figure 2: Front and Back of a Reference Design Board

New Air Conditioner Reference Design Helps Meet Stringent Efficiency Ratings

BY PATRICK HEATH

Air conditioners and cooling equipment are major consumers of power from the electricity grid. Governments worldwide are pushing to make these appliances more efficient and to meet stringent power factor specifications. This means that new air conditioner designs must implement complex motor control algorithms and Power Factor Correction (PFC) to obtain the highest efficiency rating.

A typical air conditioner design will use one dedicated controller for the PFC and one for controlling each motor. An efficient and cost-exective way to handle this design complexity is to use a dual-core dsPIC33CH high-performance Digital Signal Controller (DSC). Figure 1 shows an air conditioner application where three microcontrollers are replaced with just one dual-core dsPIC33CH DSC.

Our air conditioner reference design, which is based on the dual-core dsPIC33CH128MP20x family of DSCs, makes it easy to get started on your next air conditioner design. To demonstrate efficient control of air conditioner systems, it implements the condenser fan, compressor motor, and PFC control, as well as optional features like field communications, temperature sensors and electronic expansion valves. This provides the reference design with the flexibility to support many different types of air conditioner systems. And this solution replaces three microcontrollers with a single dsPIC33CH DSC.

The design also serves as a reference circuit for using Microchip's MCP14e4 MOSFET gate drivers, MCP1826 Low Dropout Regulator (LDO) for voltage regulation, MCP6V92 zero-drift operational amplifiers for current and voltage sensing, and over-voltage detection

using the MCP6541 comparator. The design has proven power stages for the high-power PFC (220V, 1.8 KW), and the condenser fan (120W) and compressor (1.34 KW) motor control.

The reference design also implements several math-intensive motor control algorithms that are required in modern, energy efficient air conditioners. These are enabled by the high-performance 100 MHz dsPIC33CH slave core. The design demonstrates algorithms such as variable speed control, sensor-less Field-Oriented Control (FOC) using a Phase-Locked Loop (PLL) estimator, Field Weakening (FW), and Maximum Torque Per Ampere (MTPA) control of Interior Permanent Magnet Synchronous Motors (IPSMs) for energy efficiency requirements. Also, algorithms for improving reliability such as wind-milling, stall detection with recovery, voltage and torque compensation are showcased in this design. The 90 MHz dsPIC33CH master core implements an interleaved PFC with sophisticated control algorithms. This allows digital PFC to be implemented with fewer components than using an analog PFC controller. A single DSC performing both PFC and motor control enables system optimizations such as tuning for energy efficiency, according to the dynamic line and load conditions.

The benefits of using the dsPIC33CH air conditioner reference design are:

- Cost reduction: It replaces three separate microcontrollers (MCUs) or DSCs in an outdoor air conditioner unit.
- Improved performance: Using a dual-core design architecture, it isolates the complex and time-critical motor control functions from the system and enables easy customization.
- Flexible platform: It provides a platform for developing a high-voltage PFC design for white goods and home appliances.

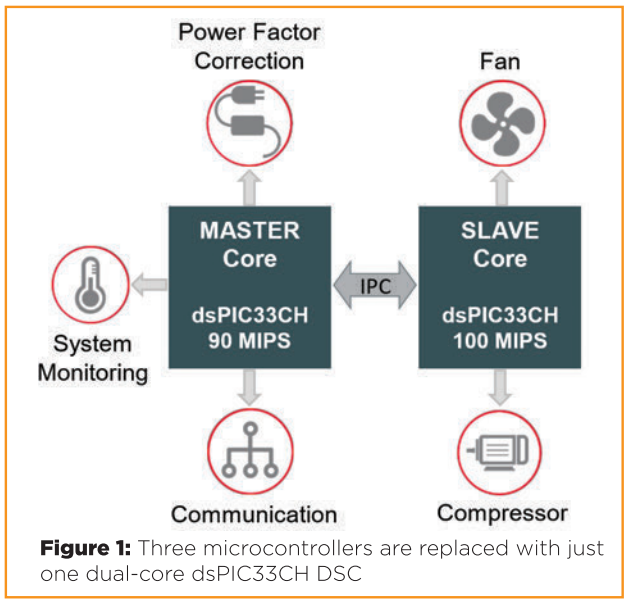


Figure 1: Three microcontrollers are replaced with just one dual-core dsPIC33CH DSC



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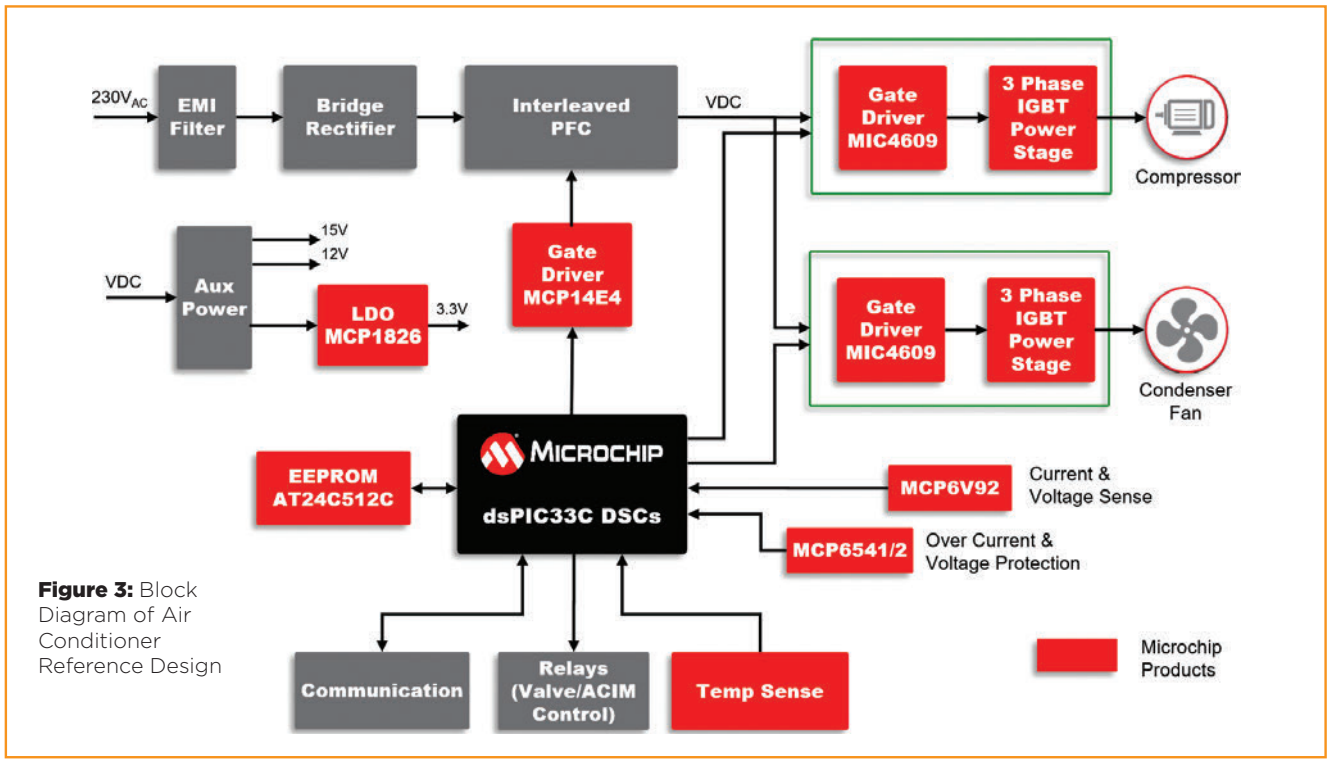


Figure 3: Block Diagram of Air Conditioner Reference Design



Fastener Assembly

BY LORI LOGAN & JOSHUA PARTEN

What are the most challenging issues that pertain to white goods from the perspective of fastener assembly?

In the past, white goods were offered by the manufacturer and the customers, generally, had no design input. However, as the demand for customization increased and the competitive market expanded, manufacturing was under pressure to produce a smarter, more reliable and more attractive product. The need to use new materials (instead of conventional flexible PVC and enamel-coated sheet steel) has dramatically increased. While keeping an eye on safety regulations, the reliability of materials, repair, and replacement needs, as well as recycling and reuse applications, the lightweight characteristics were given serious consideration. After a countless number of careful experiences, stainless steel, sheet metal or TPV were chosen and commonly used. In appliance assembly, adhesive bonding and mechanical fasteners are the two most popular assembly methods, however, especially in the white goods industry, adhesive bonding ability and performance decrease in extreme conditions. The ultra-smooth metal surface for white goods cannot be entirely joined by adhesive bonding. It requires an additional step to prime the surface and extra time to cure; this leads to a poor experience in the repair and maintenance of household appliances.

Moreover, as new environmentally friendly trends are becoming prevalent, customers are concerned about the chemicals in adhesives. As a result, today's most common lightweight fastener assembly is using flow-type screw fasteners; this method has already been proven through the automotive industry and ensures the quality of the fastener under the extreme conditions. There are now multiple types of fasteners available that belong to the "flow" type family. Those are Flowform ®, Flowpush®, FDS® Flow Drill, FLOWpoint Delta PT®. Multiple fastener manufacturers are supplying different flow-type screws for different materials because some appliance manufacturers have also started using innovative materials such as carbon fiber.

The fasteners of the "flow"-family require an assembly system that understands the importance of creating a solid joint while protecting the fastener itself. The specially formed tip of the flow fastener generates frictional heat under high pressure and at high speeds, effecting a flow process in materials, which have not been pre-drilled. At the start of the process, high speed and pressure heat soften the material through friction. The softened layers are stretched into a funnel in which multiple threads are cut at reduced speed. A formed thread is created that can accommodate a "normal" screw

if repairs ever need to be carried out. Once the flow hole has been shaped, the speed is decreased. The next step is the pre-tightening of the screw until head contact is made and the final tightening of the fastener to the preset parameters of torque and angle. The complete procedure usually takes less than two seconds.

Additional fastener components such as nuts are not required, because the assembly optimally penetrates and forms the thread for the screw so that the screw seats securely. There is no need for initial drilling or punching of holes into the material layers.

This process not only enables the connection of sheets of different materials, but it also offers clear advantages concerning processing cost and time. It is also suitable in applications with fluctuating tolerances and various components that conventional assembly systems have difficulties responding to promptly.

Why are traditional fastener assembly solutions not a solution?

Component tolerances such as deviating positions, material thickness, layer gaps, screw length tolerances or structural differences have a significant role in ensuring high screwdriving quality. Current solutions on the market for screw assembly systems respond to these parameters with separate determination for each screw position which is time-consuming. That generations of equipment provide the stroke movement and stroke-force by an air cylinder with a proportional valve. The behavior of the compressed air can prevent individual processing steps from being followed with any accuracy. The transition from the funnel forming (step 3) to the thread forming (step 4) is particularly crucial.

There is a danger that if the screwdriver speed and pressure is reduced too early, the funnel is not fully formed, and a heightened drilling torque could destroy the screw or the component. Any delay in the transition could damage the newly formed threads - compromising the joint altogether.



Another problematic issue is the feeding of the fastener. Generally, a screw is fed through a feed-hose with the "tip" first and "head" last. Since the tip of these flow-fasteners is needed to drill into the material, damage by tooling or premature touching of the part is possible. So, the perfect solution would be a feeding system that allows for the head to be fed first and then the screw is flipped at the last possible moment to be tip first. This type of feeding can be done at the same time while the previous fastener is assembled so that there is no time delay or longer cycle.

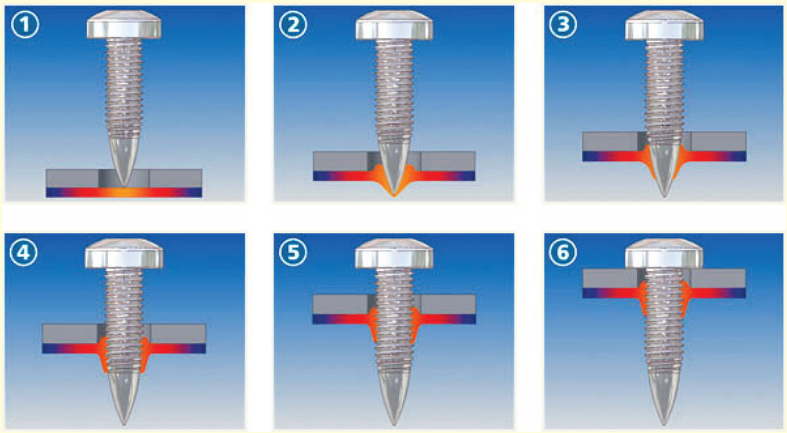
Keeping in mind that materials and fasteners often change as the requirements for product changes, it is necessary for conventional assembly systems to be rebuilt from the ground up. That is expensive and time-consuming. A much better solution would be an assembly system that can quickly and flexibly adjust to handle a different fastener, different parameters, and different materials.

The assembly systems needed for the flow-type fastener assemblies are primarily used on robots.

Using an earlier generation of

THE FLOW SCREW CYCLE
Following the Six Steps

Step 1	Heating Up	Step 2	Penetrating	Step 3	Funnel Forming
Step 4	Thread Forming	Step 5	Screwdriving	Step 6	Tightening



In between Step 1 and Step 6 the parameters such as force and speed change several times. One cycle takes about 2 seconds, depending on materials and the stack-up.

Damaged Tip



assembly system requires a lot of operator involvement, such as parameter input, parameter change, adjustments to cylinders, air, etc. If an assembly system is used, that is ADAPTIVE and where the adjustment is done automatically, less time is spent on babysitting the robot or the screwdriving system.

What features should you consider in the perfect assembly solution?

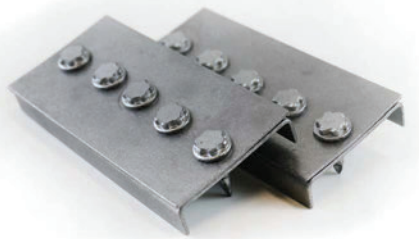
An ideal assembly should use a "Closed Loop" and ADAPTIVE assembly unit that combines EC-Servo screwdriving technology with EC-Servo stroke technology.

The communication between a twin-closed-loop system allows the automatic recognition of the penetration of the material layers - independent of the material- or screw-tolerances. Such control could continuously evaluate the relevant feedback from the control modules and automatically optimize the process; this could be done by adjusting the process variables such as the contact pressure, feed-distance, and speed. The system also ensures the ideal processing parameter, which means parameters are reliably put into action during each screwdriving cycle, as well as the connecting parts and fasteners, are exposed to the least possible stress. Costly- and time-consuming parameter adjustments and joint analysis processes should be reduced to a minimum or eliminated. Expensive and extensive repair procedures that are caused by inaccurately formed holes jammed screws, or ruined threads would be kept to a minimum. It is recommended to pre-feed the next fastener to some distribution hub, while the system is processing the current fastener. Such a perfect assembly system should be optimized to allow for the shortest possible cycle time.

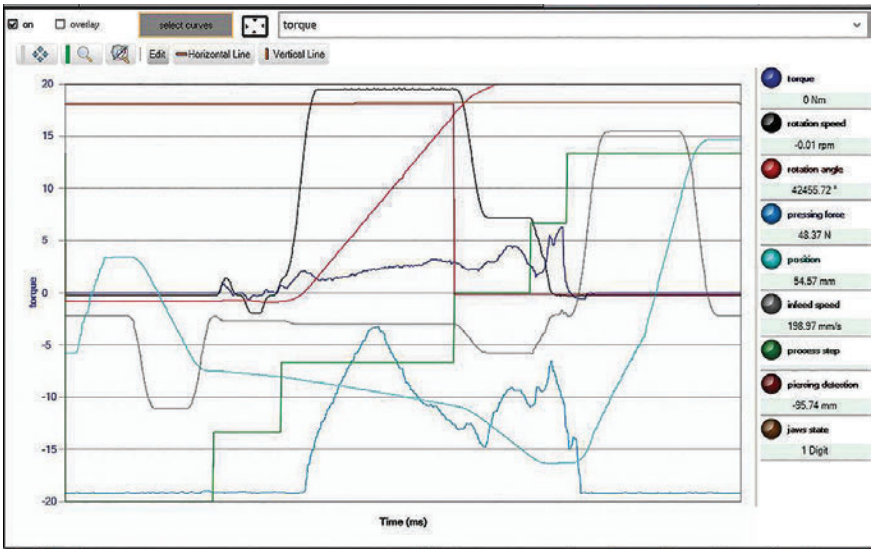
It is recommended that a precise joining will always be maintained by the assembly system to conform with the screws' thread-pitch.

A "head first" feeding principle should be implemented to eliminate any damage the fastener itself. This type of "head first" feeding feature will protect the screws' tip and its thread. Taking into consideration the need to have short feeding cycles, a screw preload feature (buffer) would optimize the cycle time. There are "on-board magazine stations" available to minimize tangling of the robot dressing or damage to any of the cables or hoses of the feeder. A predetermined number of screws is automatically fed into a magazine, and the robot would unload an empty magazine on a fastener refill-station and pick-up a full magazine.

One of the essential features must be an ergonomic, intuitively serviceable operator interface (HMI). The ideal system should have a complete recording of all processing parameters, screwdriving results, complete process-documentation, and processing analysis. It should offer unlimited parameterization of the assembly settings and outcomes; therefore, any screw position can be accurately accessed. Modular construction in connection with some quick-change adaptation would make the assembly system especially maintenance-friendly.



Flexibility should be of the utmost importance when selecting an assembly system and a choice of robot mounting either on the rear of the assembly cell or on top should be possible. ●

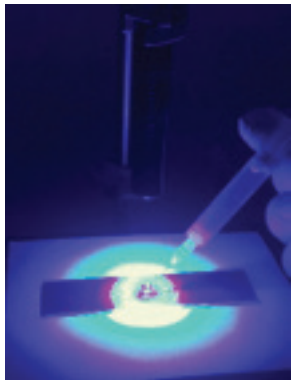


***Lori Logan**, Marketing Manager and **Joshua Parten**, Marketing Assistant, DEPRAG, Inc., www.depragusa.com*

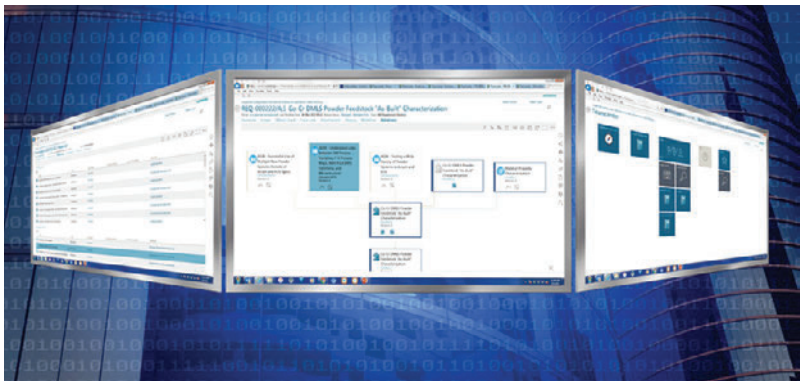


Littelfuse, Inc. introduced two series of bidirectional TVS Diode Arrays (**SPA®Diodes**) designed to protect ultra high speed consumer electronics interfaces from damaging electrostatic discharge (ESD) in applications where PCB layout is especially challenging. The SP3208-01UTG, the first TVS Diode Array in the SP3208 Series, is mechanically optimized to deliver consistently ultra-low capacitance (nominally 0.08 pF). The SP3213-01UTG, the first SP3213 Series device, offers an option for highly cost-conscious ESD protection solutions.

Both of these "Ultimate Ultra-Low Capacitance ESD Protection" devices are AEC-Q101-qualified, employ the same base die, and can safely absorb repetitive ESD strikes at ±12 kV without performance degradation and dissipate 2 A of 8/20 us surge current.



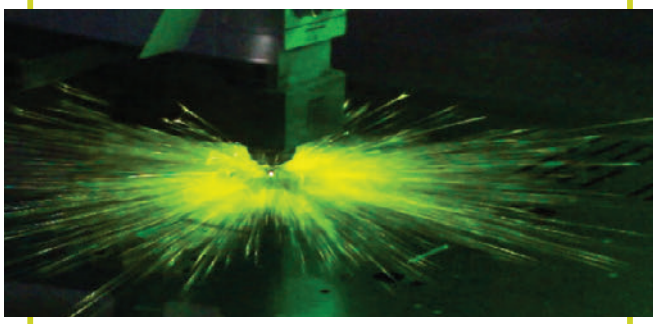
EpoxySet introduces the **UV-8701E**, Blue Light, LED curing epoxy. This unique product offers the high strength of epoxies but can be cured with 365 to 405nm light sources in under 10 seconds with a cure shrinkage of under 1%. Once cured, UV-8701 produces a rugged, semi-rigid plastic with a high glass transition temperature of 138° C.



3Degrees, LLC, a leading 3D Printing consultancy, is excited to announce the development of **TRACE**, a world-class software tool designed to solve one of the biggest challenges facing 3D Printing users: how to track, warehouse and validate key information about each item they print.

TRACE was designed by some of the leading experts in 3D Printing, and it provides a smart, intuitive system for quality management and documentation of key production and technical data for additive manufacturing (AM). This eliminates the need for companies to build their own systems, which often prove time-consuming and tedious, and may not keep pace with evolving AM standards. With TRACE, users have a simple and streamlined process with a user-friendly interface that enables traceability through all aspects of the AM workflow. It also maintains all the relevant information required for the safe and compliant operation of Additive Manufacturing facilities.

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HOW TO START USING A NEW EPOXY IN A BONDING APPLICATION

Trying a new epoxy is exciting and challenging, and we would like to share a few thoughts on this subject. Often, there is a tendency to ''get right to it'' and start the bonding process as soon as possible. This may not be a good way to move forward. Epoxies can be tenacious and difficult to remove if something goes wrong.

When the end user receives the epoxy (be it a one component, two component, or UV cure), the epoxy should be cured by itself first, and then on some mock-up parts/substrates. By curing the epoxy by itself, the end user can see exactly how the epoxy cures and check if the hardness matches up (generically) to what is mentioned on the technical data sheet.

One part systems (either heat activated or UV cured) are much easier to test, and ultimately use. With a two component system, one should mix up a few grams of the epoxy, apply it as a casting or coating, and cure it preferably in an oven. If the mix ratio used was incorrect or if parts A & B were not mixed thoroughly, the epoxy invariably will cure ''tacky'' or with blotches. Thorough mixing of parts A & B can be more difficult when both are of the same color, in which case hardness testing is even more important, to ensure that the product has been measured, mixed, and cured properly.

When the end user feels that the mixing & curing is in order, the epoxy should be evaluated on some mock-up substrates.

Courtesy of Master Bond
www.masterbond.com



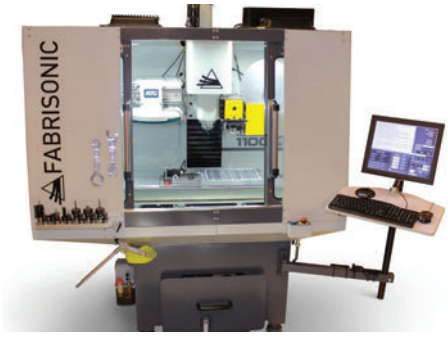




Nidec announces two new models of its fully integrated automotive traction motor system (E-Axle) and a new short range radar—the first in the world that, with a single antenna, doubles as a proximity sensor for automatic parking systems, obviating the need for separate ultrasonic sensors. Nidec's fully integrated **150 kW E-Axle**—a traction motor system comprising an electric motor, reduction gear box and inverter has been adopted by GAC NE's super e-car Aion S that will be launched in the Chinese market.







Fabrisonic LLC, a manufacturer specializing in metal 3D printing applications, announces the **SonicLayer® 1200** machine. The SonicLayer® 1200 features the same great Ultrasonic Additive Manufacturing (UAM) technology at an affordable price. It features a build envelop of 10'' x 10'' x 10'' (X,Y,Z). The patented Ultrasonic Additive Manufacturing process combines a unique room temperature metal deposition process with the ease of traditional CNC milling.

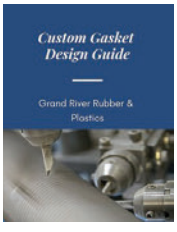


Capable Controls launch its new **Precision Series Temperature Controls**. They offer options such as:

- Diagnostic LED fault codes (rear side of board)
- Auto calibration
- Heavy duty relays rating at 10 Amps
- Mounting footprint that it compatible with most competitors
- True electronic offset via micro switches and LED indication

This control can be used in applications from Fryers, Ovens, Holding Cabinets, Grills, Griddles, Rethermalizers, Toasters and any heat related applications.

Grand River Rubber and Plastics, a 100 percent employee-owned lathe-cut gasket and vacuum cleaner flat belt manufacturer in Ashtabula, Ohio releases its lathe cut design guide to help designers and engineers choose when lathe cut gaskets are right for their application. Content includes the advantages of lathe cut gaskets as well as how to choose the correct material for their specific application.





Henkel Adhesive Technologies, a market leader with high-impact solutions in adhesives, sealants and coatings, today announced the opening of its new OEM Application Center in Rocky Hill, CT. The lab expands Henkel's capabilities to deliver innovative solutions and design customized applications, technologies and production processes.

''The OEM Application Center further advances our strategy to be a full solutions provider to our customers, especially within the industrial assembly sector,'' said Ken Forlenza, Head of Industrial Assembly and Automotive Aftermarket, North America.



WS Packaging Group, Inc. named **Mark Roy** its new chief commercial officer. A packaging innovation specialist, Roy's 25-year career has spanned private equity owned, publicly traded, and privately held companies, where he has increased sales, streamlined commercial development, and implemented CRM technologies to benefit the bottom line.

Roy will focus on driving company growth, including oversight of sales, marketing, account management, customer services, strategy, and business development.



Regal Beloit Corporation, a leading manufacturer of electric motors, electrical motion controls, power generation and power transmission components, announced it will debut a series of upgrades to its JuggerNaut motor line, released under the Century® brand. The JuggerNaut motor lineup features the upgraded Century JuggerNaut motor and the new Century JuggerNaut Pro motor with bearing current protection (BCP).



The TE Connectivity Foundation announced it will continue its support of three nonprofit organizations that advance its mission of connecting and strengthening global communities through access to technology and engineering for all, with a focus on women and underserved populations, by providing $1.3 million in grants.

Karen Leggio, chair of the TE Foundation Board of Trustees and a senior vice president at TE Connectivity, a global leader in sensors and connectors, said: "We initiated our support of this work last year, and were thrilled not only with what these organizations achieved, but with how they plan to evolve their work going forward. Each one of them took our mandate to impact underserved populations by providing access to education and careers in engineering and technology very seriously, and is focusing even more keenly on our shared goals as they look to the future."



Ayla Networks has partnered with Hamilton Beach Brands, Inc. to develop a system for automatic reordering of coffee and brewing supplies. Integrated with Amazon Dash Replenishment, the Hamilton Beach FlexBrew® Single Serve Coffee Maker leverages Amazon's secure authentication and payments systems, customer service and fulfillment network for coffee replenishment and uses Ayla technology to provide the consumer with the coffee they need, when they need it.

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Sensata's new **116CP** pressure sensor features a patented design derived from automotive grade pressure sensing technology. The plastic housing makes it ideal for residential and other lower cost pump applications. Configurations include various pressure ports, electrical outs and pressure ranges from between 0-4 to 0-16 bar.

The **PS80** is a safe and reliable automatic reset pressure switch designed for use in boiler, air conditioning and liquid-related applications. Its wide range of pressure settings, port fittings and electrical connections makes it a versatile solution.

The new **ACW4** single turn and **TCW4** multi turn absolute hall effect sensors feature an over-molded, two-part modular construction that provides engineers with exceptional design flexibility.





Melanie Cook

John Archer

Michael Del Negro



Darren Conlon

Don Lee



Jeff Van Damme



Laura Siegrist

The Association of Home Appliance Manufacturers (AHAM) recently honored home appliance industry professionals for exceptional contributions to the industry.

Melanie Cook, Chief Operating Officer, GE Appliances, a Haier company, received the ***Home Appliance Industry Leadership Award***. Since 1994, the Home Appliance Industry Leadership Award is the premier achievement bestowed by AHAM upon a member.

John Archer, Compliance Officer, MC Commercial, and **Randy Hoover**, Senior Certification Engineer, Electrolux North America (not pictured) were presented the ***Liston Durden Gordon Stauffer Distinguished Service Award*** for their outstanding contributions to advances in product safety, performance and energy efficiency.

Michael Del Negro, Managing Counsel, Product Safety, and Chief Compliance Officer for GE Appliances, a Haier company, received the ***Michael C. Thompson Public Policy Award*** for outstanding contributions and participation in the development of AHAM's strategy and public policy advocacy.

Darrin Conlon, Director of Principal Engineers - Appliances, HVACR, and Lighting, UL LLC, and **Don Lee**, Technical Advisor, CSA Group received the ***Chairman's Partnership Award*** which recognizes significant contributions to AHAM by non-member organizations, companies or individuals in recognition of exceptional service to the industry in the harmonization of U.S. and Canadian safety standards.

Laura Siegrist, Senior Manager, Government Relations, Whirlpool, received the ***Emerging Leader Award*** for contributions to federal advocacy for the home appliance industry.

Jeff Van Damme, General Counsel, Legal and Regulatory Affairs, Samsung Electronics Canada, Inc. also received the ***Emerging Leader Award*** for leadership of AHAM's Legal Operations Advisory Committee and contributions to public policy in Canada.



New UL/IEC Regulation 62368-1 implementation date has been revised to become effective December 20, 2020. UL and IEC have agreed to harmonize the implementation date. 62368 will replace 60065 (Audio/Video) and 60950 (IT) for external power supplies. The Global Transition to IEC 62368-1 has begun.



Intertek announced the completion of its first project using the Environmental Protection Agency's (EPA) ENERGY STAR® Test Method to Validate Demand Response for Room Air Conditioners. Demand response testing allows products to receive wireless communications to better control energy usage, on an HVAC (heating, ventilation, and air conditioning) system.

Demand Response testing method will allow appliances used in the home and commercial settings improve energy efficiency and usage. In addition to compliance testing on products, Intertek's Assurance program includes consulting services on product development during the R&D stage.



SCHOTT AG to acquire Australian microfluidic expert **MINIFAB**. "SCHOTT and MINIFAB share a great passion for excellence in highly precise solutions for breakthrough diagnostics applications that improve the daily lives of millions of people. Joining forces will give us the unique possibility to expand our international footprint. Our engineers, bioscientists and manufacturing experts are excited to work with the glass experts from SCHOTT to develop even better diagnostics solutions for the future," said Michael Wilkinson, Executive Director & Acting CEO of MINIFAB.



Since 1980, ebm-papst is supplying the North American market with energy efficient fan solutions from its Farmington (Connecticut) headquarters.



In an industrial park near Johnson City, Tennessee, ebm-papst has acquired 30 acres (12 hectares) of land and plans to invest USD 37 million for the expansion of a new plant.

ebm-papst is strengthening its business in North America with a second production site. In **Johnson City, Tennessee**, the world market leader for fans and motors will manufacture fans for refrigeration, air conditioning and ventilation applications. ebm-papst will move into an existing production building in Johnson City and start serial production in September 2019.

The fan specialist has also acquired 30 acres (12 hectares) of land in an industrial park near Johnson City to build a new plant there in the future. Over the next five years, ebm-papst will invest around USD 37 million in its expansion in Johnson City and plans to employ up to 200 people.

The Sherwin-Williams Vendor Awards recognize partners that develop outstanding products focused on quality and value. All are committed to providing exceptional service to Sherwin-Williams stores and distribution centers.

Trimaco: Four-time recipient Trimaco with its strong field sales organization focused on disaster restoration and new construction.

Full Circle: First-time recipient provides a wide range of products that help drive the entire drywall tools category.

Inpro: Winning the award for a second time provides a wide range of products for the growing commercial wall protection market.

The Sherwin-Williams Vendor Product of the Year Award recognizes new innovative product or product lines exclusive to Sherwin-Williams.

Variable's ColorSnap® Match: First-time Vendor Product of the Year award-winner. The ColorSnap® Match device allows both professionals and consumers to quickly and accurately match colors from the Sherwin-Williams library.



Sundaram Nagarajan (Naga) Named President and CEO of **Nordson**. He succeeds Michael F. Hilton, who plans to retire. Hilton will become senior advisor to the company and will remain on the board of directors until the end of the year.

Nagarajan joins Nordson following a 23-year career with Illinois Tool Works Inc. (ITW), serving most recently as executive vice president of the $3.3 billion Automotive OEM segment.

"Naga's passion for technology-driven innovation, knowledge of global industrial markets, and outstanding record of improving the financial results of the businesses he has run by focusing on customer intimacy, operational excellence, and employee development, make him a perfect fit for Nordson" said Michael Merriman, chairman of the board of directors.

"Throughout my career, I've thrived in driving growth and profitability by focusing on the customer while also prioritizing innovation and talent development," said Nagarajan.



Vinyl Clad Metal Usage in the Appliance Industry

BY BILL EMERY

Vinyl Clad Metal (VCM) is one of the best kept secrets in the appliance industry. Why? VCM is only produced by a few manufacturers domestically and a handful overseas. There are hundreds of pre-painted and powder coated metal suppliers in every major industrial area. It is no big secret that one of their largest targeted markets are appliance OEMs..

VCM has been used in appliance manufacturing since the 1960's and was originally used for television side panels. The early microwave ovens were predominantly designed with wood grain cases, which were made from vinyl clad metals. In the past, other appliances that were manufactured using VCM included vending machines, juke boxes, slot machines, and cable boxes.

Benefits of Vinyl Clad Metal vs. Painted Metal

Durability – VCM has 6-12 mil thick coating as opposed to 1-4 mil coating with painted metal. Extremely difficult for base metal to become exposed even after heavy abuse.

Consistant Coating – Uniform thickness. No heavy or light areas from uneven paint application.

Sound Dampening – VCM acts as an insulator to noise and vibration, allowing products to run quieter.

Finish Options – Hundreds of vinyl films are available in colors, patterns, woodgrains, leathers, natural stones, geometrics, abstracts, and metals – a product designer's dream.

Emossable – After laminating in the flat, sheets can be mechanically embossed for a deep, textured effect.

Formability – VCM can be bent, hemmed, toggle-locked, punched, louvered, roll formed, waterjet, laser cut, etc. with no delamination or finish degradation. The vinyl will follow the metal.

Corrosion Resistant – The non-porous surface is impervious to liquids, chemicals, body fluids, etc. In addition to steel, VCM can be laminated to aluminum or stainless, providing even greater corrosion resistance.

Cleanable – VCM can be cleaned with the strongest industrial solvents and chemicals with no degradation of the surface finish.

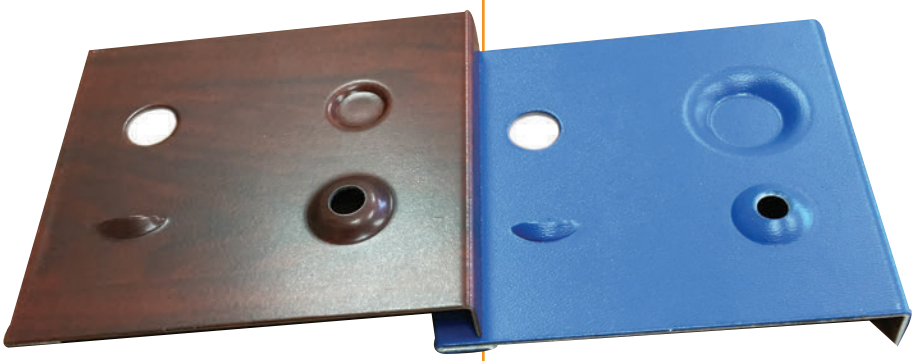
Anti-Bacterial – Custom vinyl runs can be formulated with a biocide additive and includes test data for anti-bacterial properties. Excellent for hospital and healthcare appliances and equipment.

Fire Rated – Vinyl Clad Metal carries an ASTM E-84 Class B fire rating, in addition to U.S. Coast Guard fire certification for inland and ocean vessels.

Less Rework – VCM's resistance to handling defects will mitigate a vast majority of exterior surface rework – both in-house and warranty claims from your customers.

Supply Chain Flexibility – Vinyl Clad Metal can be produced from 1 sheet to 1000 with short delivery times. Manufacturers can realize the benefit of less raw material inventory, shorter production runs, and quicker lead times.





Manufacturing Methods and Adhesion

Vinyl Clad Metal makes an excellent appliance product because of the superior adhesion of the film to the metal. This bond allows VCM to be configured to any shape the metal can withstand - with no delamination nor deterioration of the surface.

A strong bond is created by one of three methods of manufacturing: Hot laminating, polyurethane (PUR), or a pressure sensitive adhesive tape system (PSA). All of these processes require that the metal sheets be brushed and thoroughly cleaned for good adhesion. The brushing process roughens up the surface, creating peaks and valleys, and more surface area for the glue. The metal is then run through an elevated heat and high pressure wash system that removes all of the metal powder residue created from the brushing operation along with any dirt and oils that are a byproduct of sheet processing.

Hot Laminating Process – Uses a thermoplastic adhesive applied with a coating head to the cleaned metal. The sheet travels on a conveyor through a furnace where the metal is heated to 385 degrees F. The high heat cures and activates the glue and creates an extremely tacky surface. The vinyl is applied from a roll onto the metal sheet and pressure applied through a pinch roller. A quick water quench sets the glue immediately – no cure time is needed.

PUR Process – This is a hot melt glue system where vinyl is applied onto ambient temperature metal sheets. The vinyl film is applied from a roll and pressure applied with a pinch roller. No water quench is needed and cure time is very quick. PUR is a versatile system that allows other films such as high pressure laminates (HPL), cloth, and papers to be applied to wood, MDF, plastic, and other substrates.

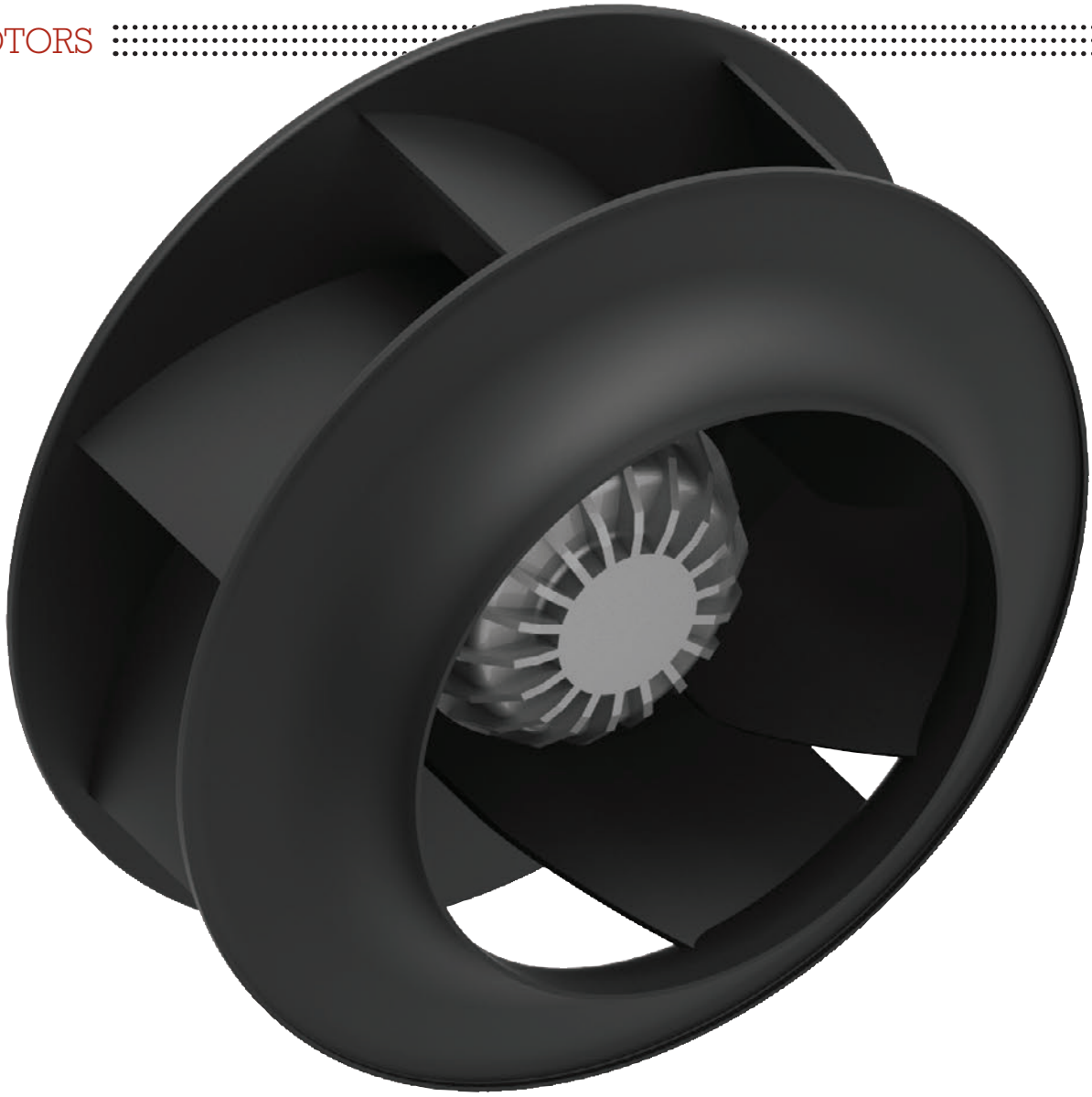
PSA Tape System – Of the 3 processes, PSA does not offer the same level of adhesion as Hot laminating or PUR. The bond is strong, but there may be some limitations when the metal is fabricated after laminating. Depending on the rigidity and memory of the vinyl, some creep back can occur from the metal edges on severe bends. PSA is a 2-sided roll of tape that is pressed onto a sheet by a pinch roller. The release liner is pulled off leaving a soft glue on the sheet. The vinyl is applied from a roll and again pressed down using the pinch roller. This process is more labor intensive and the tape is costlier than either thermoplastic or PUR glues. ●



Bill Emery *is the sales manager for Clad Rex LLC. Contact him at bemery@cladrex.com or visit www.cladrex.com*







What is a Motorized Impeller?

BY BRANDON SOMERS

A motorized impeller comprises a fan impeller that is fixed to the rotor of an external rotor motor, eliminating the need for an output shaft and resulting in lower bearing loads and vibration-free operation.

Since the motor and impeller are located directly in the air stream, the impeller also acts as a rotating heat sink, allowing for excellent heat dissipation and efficient motor cooling. This unique coupling of motor and impeller drastically reduces space requirements, allowing for easy installation and making motorized impellers perfectly suited to applications where space is limited.

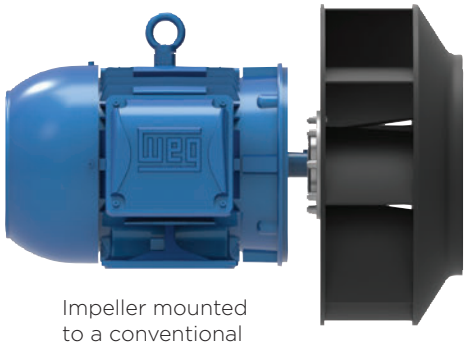
Motor Design

Internal vs. External Rotor

Motors come in a wide range of shapes and sizes, with the conventional style being the internal rotor configuration.

Internal rotor motors are designed with the stator (stationary component) fixed to the motor housing. The rotor (rotating component) is located inside the stator and transmits torque through the output shaft. A fan impeller is typically attached to the rotating shaft.

External rotor motors essentially have the opposite orientation, with the rotor rotating on the outside of the stator. This eliminates the need for an output shaft and greatly reduces the overall footprint of the motor and impeller assembly. A fan impeller can be attached directly to the external rotor, effectively creating a motorized impeller.



Impeller mounted to a conventional internal rotor motor



Comparable external motorized impeller

Operating Speeds

Conventional internal rotor motors are typically governed by a series of incremental power levels and standard speed ratings (i.e. synchronous speeds).

In comparison, the external rotor motors used in motorized impellers are designed to suit the impeller that they are coupled with. This enables them to fall anywhere along the full range of available power and speed ratings, while allowing them to be more efficient by precisely matching the performance demands. In general, they can range anywhere from 25 W up to 7,000 W, and from 1,000 rpm up to 4,000 rpm. Depending on the type of power supply that the motor is designed to accept, the speed of an external rotor motor can be controlled in a variety of ways.



AC External Rotor Motors

Alternating current (AC) external rotor motors are often available in single and three phase versions, and a variety of voltages. Most can operate interchangeably on 50 or 60 Hz frequencies. However, it must be noted that performance may vary depending on the voltage and frequency of the supply. That is why external devices that modify these parameters are used for speed control. A variable frequency drive (VFD) is typically used for three phase AC motors, while a solid-state speed controller is used for single-phase AC motors. It is also important to remember that single-phase AC motorized impellers require the use of a matching capacitor.



DC External Rotor Motors

Direct current (DC) external rotor motors are typically designed to run on 24 or 48 VDC supply; performance may vary accordingly. Speed control is much simpler with DC in comparison to AC motorized impellers because there is no need for an external device. The speed of DC motorized impellers can be controlled using either a 1-10 VDC signal or through pulse-width modulation (PWM).



EC External Rotor Motors

For applications that require both high efficiency and integrated control, electronically commutated (EC) external rotor motors are available. These motors incorporate on-board electronics that accept an AC supply and convert it to a DC output. The electronics also provide a broad range of control and monitoring functions.

EC motorized impellers can allow for closed loop control of temperature, pressure, and other parameters when either a 1-10 VDC or PWM speed control signal is coupled with an external sensor. Constant pressure control is particularly useful for ducted applications, while constant airflow control is more suited for filtered applications. Alternatively, a potentiometer can be connected to provide a manual form of variable speed control.

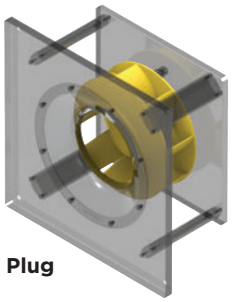
Impeller Design

Aside from motor options, motorized impellers are also available with different types of impellers. The two most common types of fan impellers are centrifugal and axial.

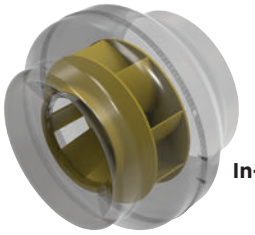
Centrifugal

Most centrifugal motorized impellers use backward curved (BC) blades because they generate significant static pressure, operate silently, and provide the highest efficiency of all centrifugal fan designs. Airfoil designs (BCA blades) can deliver even higher performance. In order to achieve optimal performance, inlet cones should be used with centrifugal impellers. Depending on the application, a motorized centrifugal impeller may be pre-installed in a fan housing.

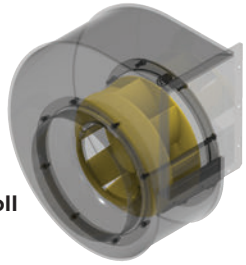
Common housing options for motorized centrifugal impellers



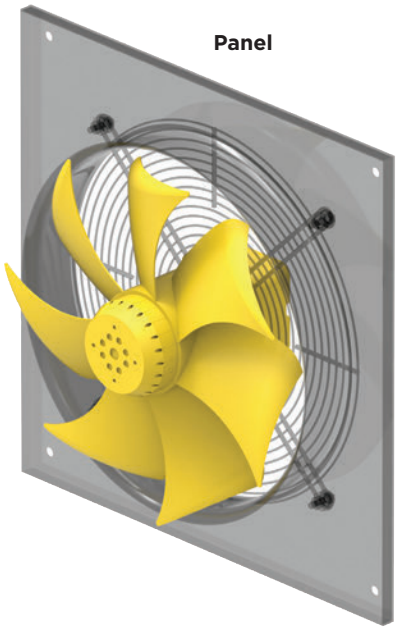
Plug



In-Line

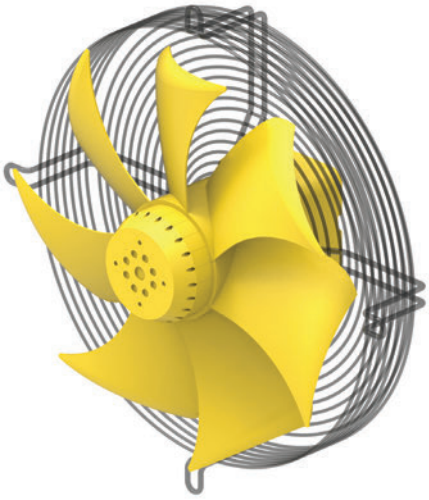


Scroll



Panel

Guard-Mount

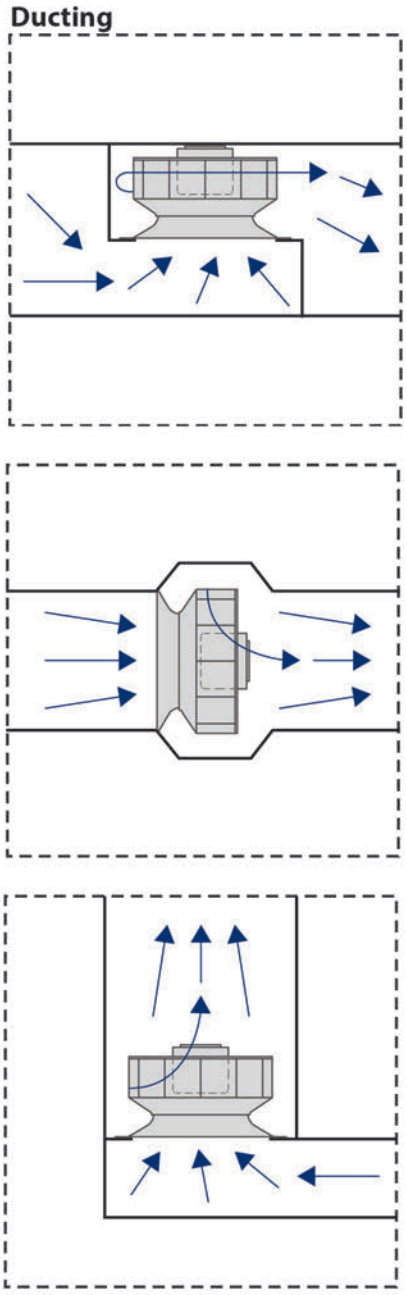


Common housing options for motorized axial impellers

Axial

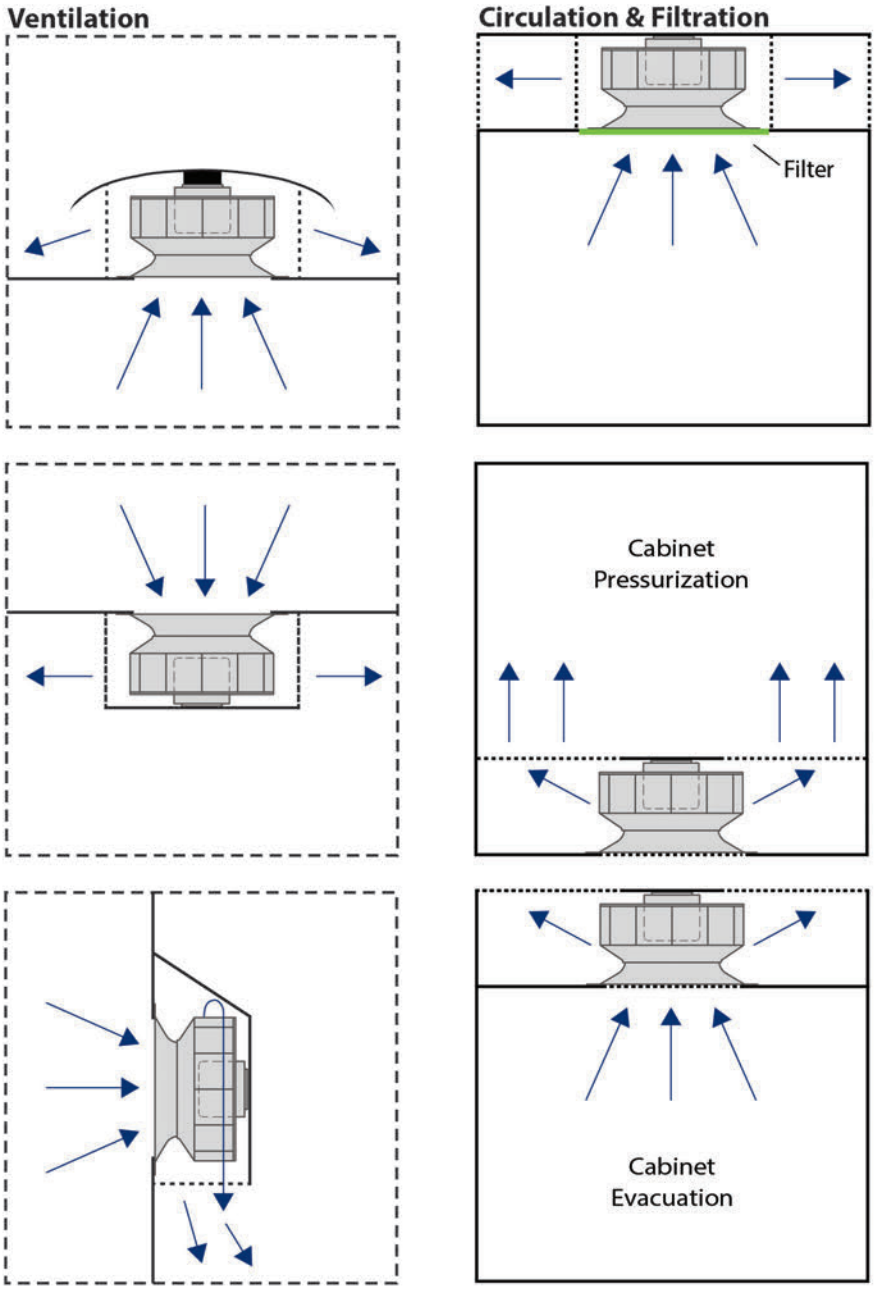
Axial motorized impellers are typically used to move high volumes of air at relatively low static pressure. For this reason, they are primarily used in non-ducted systems that require high airflow rates. Highest efficiency is obtained when using airfoil blades in these systems. Axial motorized impellers are often used for supply or exhaust applications, and they can also be pre-installed in a fan housing.

Figure 1



Installation Types

The space-saving design of motorized impellers allows them to fit into smaller enclosures, making them especially attractive for applications



with tight space constraints. Figure 1 displays some typical installation arrangements for motorized centrifugal impellers.

Applications

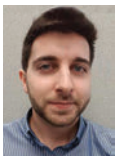
There are a lot of choices when it comes to selecting a motorized impeller. Axial or centrifugal designs can be provided with or without a housing, and with a range of AC, DC, and EC motors. This variety ensures that most demands can be met, while making it difficult to determine which option is the best solution. By evaluating the requirements of a given application, the appropriate fan must be determined on a case-by-case basis.

Why Choose a Motorized Impeller?

Motorized impellers are used in a wide range of industries. These precision-manufactured and finely tuned devices provide a range of benefits including extended service life, maintenance-free operation, along with low sound and vibration. To simplify matters even further, motorized impellers can be provided in a variety of pre-assembled housings, thereby reducing installation and assembly time.

An incredibly small footprint makes motorized impellers especially attractive for applications with tight space constraints. They are flexible enough to suit most requirements, while frequently operating at higher efficiencies than conventional fans.

These distinct advantages make motorized impellers the preferred fan choice.



Brandon Somers,
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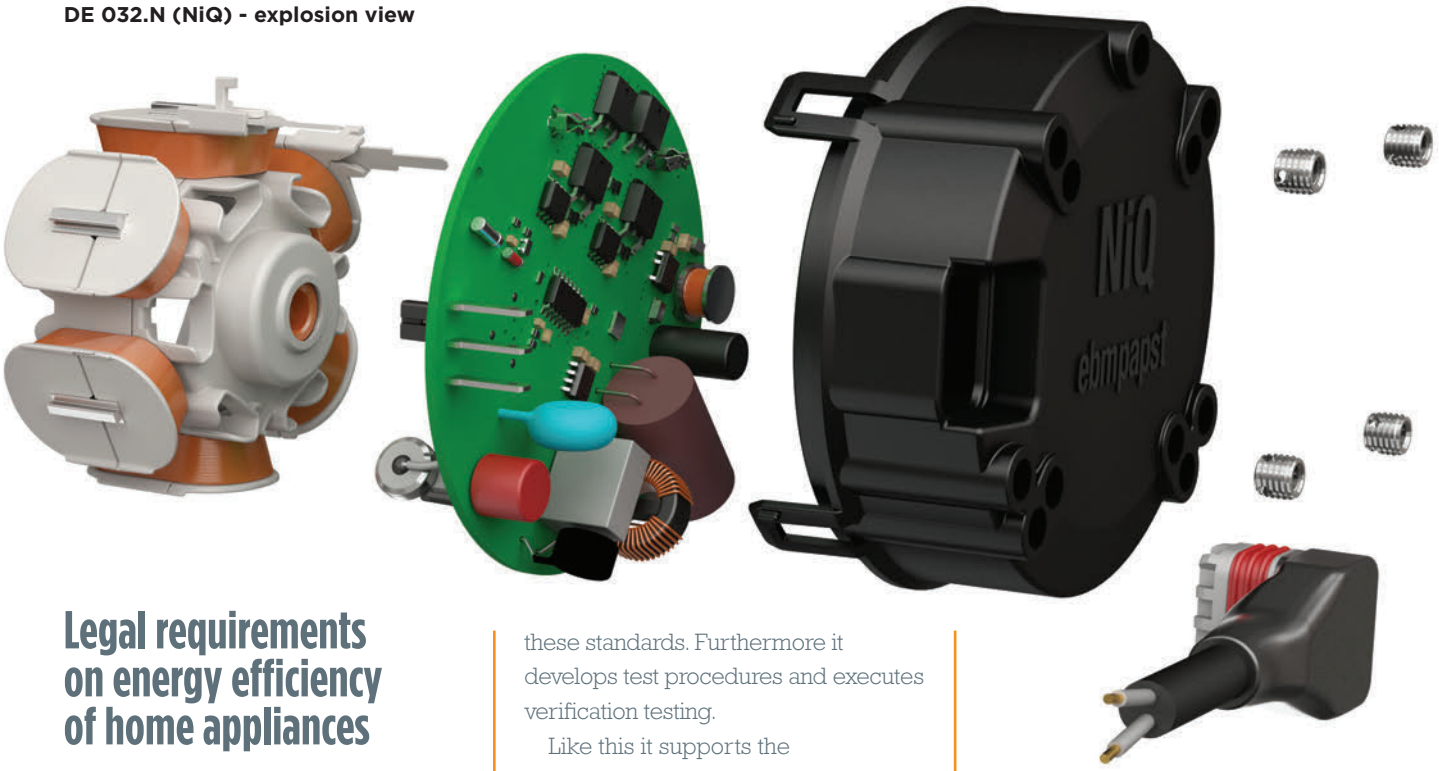


Efficient and Powerful BLDC-Motor Technology

FOR THE HOME APPLIANCE INDUSTRY

BY HANS-JÜRGEN WITHOPF

DE 032.N (NiQ) - explosion view



Legal requirements on energy efficiency of home appliances

The conservation of energy in the white goods industry is driven by continuously enhancing legal requirements on minimum efficiency grades. The specific requirements on an international level vary a lot depending on the laws, rules and directives in place.

Situation in the USA

One key element of the policy for improving energy efficiency in the US is the appliance and equipment efficiency standards. The first standard was set on a state level in California in 1974. One year later it was followed by the Energy Policy and Conservation Act (EPCA). A special focus on energy conservation standards was implemented with the amendment in 1979 and minimum efficiency standards for household appliances were established in 1987 (National Appliance Conservation Act). The Department of Energy (DOE) is in charge of reviewing and updating these standards. Furthermore it develops test procedures and executes verification testing.

Like this it supports the Environmental Protection Agency ENERGY STAR Program and the Federal Trade Commission ENERGY GUIDE labeling. In 2018, approximately 2000 manufacturers partnered with ENERGY STAR and more than six billion of such labeled products were sold since 1992.

The standards program led to gains in energy efficiency of household appliances as follows:

- Refrigerators – 75 % less energy at 20 % more storage capacity since 1973
- Clothes washers – 70 % less energy since 1990
- Dishwashers – 40 % less energy since 1990.

Since 2005 the DOE started to focus on different rulemakings / up-dates to enhance necessary test procedures. In 2013 the President's Climate Action Plan was announced. It foresees a reduction of carbon pollution by a minimum of 3 billion metric tons cumulatively by 2030. This led to an acceleration of the rulemaking process. A goal was set to reach a total of 26 standards rulemakings between 2014 and 2016 covering 30 products and 10 more between 2017 and 2020 covering an additional 12 products.

At the moment 18 standards are due for being updated. Among them are standards for refrigerators, clothes washers and commercial water heaters. On the other hand DOE started in February 2019 the procedure to revise the actual process rule established mid of the 90ies for the development of energy conservation standards and test procedures for consumer products as well as for commercial and industrial equipment.

Nevertheless some new standards just took effect:

- Dehumidifiers (home appliances) It was finalized in 2016 and took effect on June 13, 2019. A reduction of 15-25 % in energy use is expected.

Remark: In October 2019 an up-dated ENERGY STAR specification will take effect identifying models that are 10-20% more efficient than those

ENERGY CONSERVATION STANDARDS
Past Rulemaking Examples in the USA

2011	**Residential Refrigerators**	76 FR 57516 – Final Standard *Compliance Mandatory as of September 15, 2014*
	Residential Clothes Dryers	76 FR 22454 – Final Standard
2012	**Residential Dishwashers**	77 FR 65942 – Final Rule (Test Procedure)
	Residential Clothes Washers	77 FR 59719 – Final Standard *Compliance Mandatory as of 2015 respectively 2018*
2013	**Microwave Ovens**	78 FR 36316 – Final Standard *(See Also Correction Notice in 2016)*
	Residential Clothes Dryers	78 FR 49608 – Final Rule (Test Procedure) *Compliance Mandatory as of July 1, 2015*
2014	**Commercial Clothes Washers**	79 FR 74492 – Final Standard *Compliance Mandatory as of January 1, 2018*
	Residential Refrigerators	79 FR 22319 – Final Rule (Test Procedure)
	Conventional Cooking Products	First Standard Set 1990 *Rulemaking Started / In Progress*
2015	**Commercial Clothes Washer**	80 FR 46730 – Final Rule (Test Procedure) *To Be Amended Since 2016*
	Residential Refrigerators - Ice Making	Final Standard Compliance Mandatory as of January 1, 2018
2016	**Microwave Ovens**	81 FR 7965 – Final Standard – Correction Notice
	Misc. Residential Refrigeration	81 FR 75194 – Final Standard
	Including Wine Chillers	81 FR 46768 and 81 FR 49868 – Final Rule (Test Procedure)
	Residential Dishwashers	81 FR 90072 – Final Standard *Rule is Effective Since January 12, 2017*
	Commercial Clothes Washer	Pre-Publication of an Amended Test Procedure
	Conventional Cooking Products	81 FR 67219 – Rulemaking Process (Standard) *Extending Comment Period*
2017	**Misc. Residential Refrigeration**	82 FR 24214 – Final Standard 2018
2018	**Microwave Ovens**	83 FR 02566 – Data Collection Initiated (Test Procedure)
	Conventional Cooking Products	84 FR 5346 – Test Procedure – Correction Notice
2019	**Residential Clothes Dryers**	Pre-Publication of an Amended Test Procedure
	Residential Dishwashers	Pre-Publication Regarding a Petition to Create a New Product Class Request For Information on Test Procedure Put on The Agenda
	Process Rule to Develop Appliance Efficiency Standards	Notice of Proposed Rulemaking Two Public Meetings to Comment Were Held
2020	**Residential Dishwashers**	Indication of Plan to Put Notice on Energy Conservation Standards For Dishwashers on The Agenda for January 2020

dehumidifiers just meeting the new DOE standards.

• furnace fans (heating appliances). It was finalized in 2014 and took effect on July 3, 2019.

Like in the European Union a label was also introduced in the US to provide consumers information about energy consumption, efficiency and operating cost. This label is called ENERGYGUIDE. Its development was mandated by the Energy Policy and Conservation Act of 1975 and it was introduced for all products since 1980. Besides that another voluntary one exists with ENERGY STAR label. It sets more stringent requirements on energy saving than the ENERGYGUIDE.

In conclusion it could be recognized that the energy conservation standards will continue to tighten in the coming years.

Situation in Europe

By implementing the directive 2005/32/EC the European Parliament established in July 2005 a framework for the setting of ecodesign requirements for energy-using products (EuP). In October 2009 it was extended to energy-related products (ErP) in general by directive 2009/125/EC. Within this so called ErP process different product groups became the subject of an assessment about their environmental footprint. Already two working plans (2009-2011 and 2012-2014) have been conducted. A third one (2016-2019) is in progress. Part of the indicative list of new products groups of this actually running working plan are e. g. electric kettles, hand dryers or high-pressure cleaners.

Together with the eco-design requirements the European Union established an energy efficiency labeling system for the respective appliances. These labels with e. g.

EUROPEAN COMMISSION MINIMUM EFFICIENCY GRADES
Appliances

2009	**Household Refrigerating**	Lot 13 / July 22, 2009: Commission Regulation (EC) No 643/2009 *=> Under Review* *A new regulation has been decided in 2019 by regulatory committee, but Council of the EU and European parliament need to make a decision.*
2010	**Household Washing Machines**	Lot 14 / November 10, 2010: Commission Regulation (EU) No 1015/2010 (Including Washer Dryers)
	Household Dishwashers	Commission Regulation (EU) No 1016/2010 *=> both are under review* *A new regulation has been decided in 2019 by regulatory committee, but Council of the EU and European parliament need to make a decision.*
2012	**Household Tumble Dryers**	Lot 16 / October 3, 2012: Commission Regulation (EU) No 932/2012 *=> under review* *Two stakeholder meetings were held in 2018. In: May 2019 the final report has been issued and a working document has been drawn up*
2013	**Electrical and Electronic Household & Office Equipment**	Lot 25 / August 22, 2013: Commission Regulation (EU) No 801/2013 *Refers e. g. to Coffee Machines For Non-Professional Use* *=> under review as of July 2019*
2014	**Domestic Ovens, Hobs (Cooktop), Range Hoods**	Lot 22/Lot 23 / January 14, 2014: Commission Regulation (EU) No 66/2014 *=> Regular review is scheduled for 2021.*
	Wine Cooler	ENER 34 *=> A call for tenders for a preparatory study was started 2016, open status as of July 2019*
	Commercial Refrigeration	ENER 12 *=> A new regulation has been decided in 2019 but Council of the EU and European parliament need to decide.*
2015	**Non-Household Washing Machines Textile Dryers Dishwashers**	ENER 24 *=> A preparatory study was published in July 2011.* *=> A draft regulation has been discussed in consultation forum in November 2013. A regulation hasn't been implemented up to now.*
2021	**Refrigerated Vending Machines**	Energy label standards will be set for the first time for this product group as of 1st March 2021.

their colored A to G classifications and in domestic refrigeration with their A+, A++ and A+++ (special categories introduced because of the fast technological progress on energy efficiency gains) are well-known by the European consumers.

With regulation (EU) 2017/1369 from 4th July 2017 the European Union established a new energy labeling standard which foresees a rescaling of all energy labels from A to G. The plus classes as a consequence will disappear. The first appliances to follow the new label standard will be those of which ErP directives are actually under review: refrigerators and freezers, dishwashers, washing machines and washer dryers or tumble dryers.

A major novelty of the new labeling standard is the creation of an online based database "European Registry for Energy Labelling (EPREL)" with a public and a non-public section. Since the 1st of January 2019 all appliances being subject to energy labeling have to be registered there-in. With a QR-code placed on the new energy labels the consumer will be able to retrieve additional official information from EPREL.

Usage of efficient electronically commutated motors

Driven by a continuously tightened energy conservation policy, EC motors are now widely used in large white goods equipment. The high electrical efficiency of EC motors is typically between 45 % to 80 % compared to low efficiency shaded-pole motors which are typically between 15 % to 20 %. EC Motors transform the main part of its power consumption into dissipated heat and with a significantly reduced usage of resources (copper, electric sheets etc.) for their production; this not only has a positive effect on the CO2 foot print but also on the sustainable usage of resources also shown as eco-design in general.

Refrigerators and freezers

The prime example of the successful implementation of EC technology and product placement of small EC motors in white goods



applications are the refrigerators and freezers. As these appliances are permanently operated to store perishable goods for a reasonable time they are the most energy consuming domestic major appliances. Thus it has been clear that they have been in primary focus of energy conservation policies.

As a consequence, gaskets, compressors, controllers and other components have been improved to maximize efficiency. Vacuum panels started to be used as an alternative insulation, and LED lighting was introduced in high-end and premium products. EC motors in particular became very popular by increasing the efficiency of evaporator and condenser fan units whereupon mains supply driven ones permitted an easy drop-in replacement of the commonly used C-frame shaded-pole motors with their axial impellers.

Another step forward to reduce energy consumption and additional noise emissions has been the development of smart radial blowers in EC technology to be fit into optimized air ducts.

Ovens

Not only is it the energy saving capability that makes EC technology so smart. It offers a broader functionality and options for either the appliance design or its mode of operation. While standard AC shaded-pole motors could only be operated in a single direction, EC motors could be operated in clockwise or counterclockwise direction. Furthermore EC motors with variable speed capability allow the motor speed to be adjusted via sensors or following specific programs for its operation. Therefore, design engineers are in the position to control its operational behavior in detail and to adjust it according to the process requirements.

Kitchen Hoods

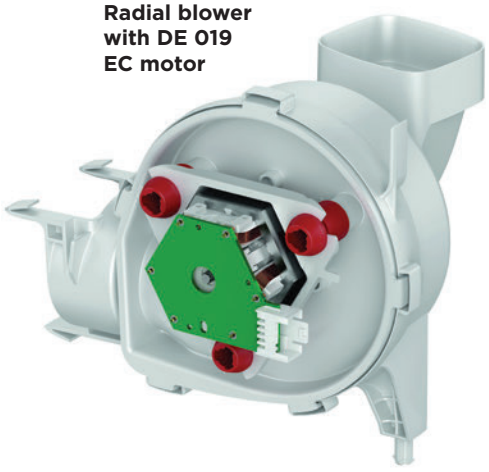
Variable speed capabilities make EC technology a perfect choice for appliances which require a correct setting for different working conditions at any time to provide the highest comfort for the consumer. Besides a nice appearance in the kitchen due to exceptional design features, a range hood has to provide sufficient suction capability to fulfill its operational duties and at an acceptable noise level. By using the signal-in of the motor interface the speed could be adjusted in different steps or even continuously. Combined with an optimized aerodynamics and assembly concept of such an exhaust fan the sound level could be kept at comfortable levels.

Dishwashers

The main process of a dishwasher is carried out by the spray arm operation; it moistens dried food residues and cleans the dishes. This is an energy consuming process. The usage of EC technology reduces the power consumption. Furthermore, an adjustable speed leads to further process optimization.

Space is extremely limited in dishwashers. Therefore, drying fans or process fans with AC motors are limited in their power density as these motors are restricted by the barrier of the synchronous speed limits from the mains supply. EC technology helps to break down these barriers. Small and powerful fans could be built with high speed motors. The reduced dimensions of an EC motor also enable its integration into the fan unit itself. The drive motor thus becomes an integral part of it.

Radial blower with DE 019 EC motor





Radial blower for evaporator use with EC motor DE 020

DE 020 EC motor with axial fan blade





Explosion view of VHD 0146



Motor Platforms

EC motor platforms are available in the market to satisfy the diverse and specific requirements of refrigerators, dishwashers, ovens or kitchen hoods. Depending on its purpose either one-phase or three-phase BLDC motors are available.

One-Phase BLDC Motors

DE 020 BLDC motor platform: These motors are widely used in domestic refrigeration. As single motors with up to 3 W power consumption and typical set speeds of e.g. 1,800, 2,100, or 2,500 rpm they provide retro-fit capabilities to easily up-grade existing appliance platforms from AC to EC. Depending on their design they are used either as an evaporator, compartment ventilation or condenser fan motor.

Special models of DE 020 motors are equipped also with the constant speed feature. This means that the motor is equipped with an internal speed control adjusting the speed according to the load situation to its set point. In combination with a DC source such motors enable customer to become independent from grid voltage/ frequency and to work with high speed accuracy at a given set points.

Integrated into a complete blower assembly they even serve to reduce complexity of parts, as to ease the assembly process as to optimize intralogistics (in-house logistic) processes on the customer side.

Apart from their usage as evaporator or condenser fans for refrigerators other versions of such EC motors are used to drive e. g. cross flow blowers or radial blowers for diverse applications. Depending on the working point required they perform with power consumption up to 20 W and cover a speed range up to 7,000 rpm.

DE 022 respectively DE 036 BLDC motor platform: These internal rotor BLDC motors are widely used to drive crossflow, axial and radial blowers. The smaller EC motor provides a power consumption of up to 20 W. Its speed range includes up to 15,000 rpm. The bigger EC motor is available in different stack sizes covering power consumption up to 350 W. Its speed range reaches up to 9,000 rpm.

In the area of professional food processing equipment such motors are operating (e.g. radial blowers) in dishwashers which require a powerful but quick drying cycle. Another application is food storage equipment where the EC motors serve to provide a constant flow of well-tempered air. Nonetheless the highlighted application for DE 036 motor based backward curved radial blowers may be a powerful but compact convection fan for e. g. space saving hot air impingement ovens used in front cooking market.

DE 032 1~ BLDC motor platform respectively DE 032.N motor: DE 032 1~ platform is the core of the DE 032.N motor (NiQ). This is a new EC motor design to replace AC Q-motors (4 pole shaded pole motors) with a drop-in replacement. It operates in its standard design with 1,550 rpm (typically used in markets with 60 Hz electricity grid) or 1,300 rpm (typically used in markets with 50 Hz electricity grid). It uses constant speed, a feature where an internal speed control is adjusting the speed according to the load situation to its set point.

Like this, one single motor could be used with impellers having different diameters. When using a wide voltage version of DE 032.N motor with 100-240 V, 50/60 Hz the motor could be operated with electricity from the grid almost everywhere in the world. Due to its modular design it could be easily adjusted to other speed settings like 1,800 or 2,200 rpm.

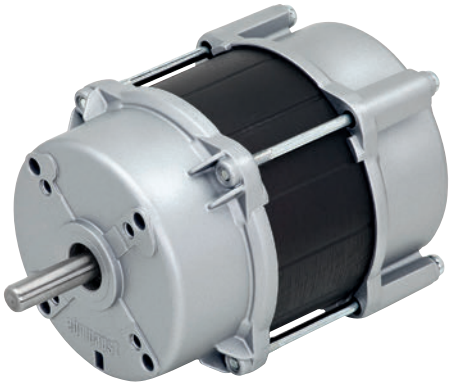
Three-Phase BLDC Motors

DE 019 BLDC motor platform: This is a versatile motor platform especially designed to be integrated into diverse products like fans or pumps. With maximum possible power consumption P1 of 20 W, a speed range up to 12,000 rpm, and combined with its open mechanical design this platform provides high design flexibility to the appliance

engineer. The functional aspect stays in the foreground. The motor becomes an integral part of a fan unit.

DE 032 3~ BLDC motor platform: This is a three-phase motor platform which fits to the specific requirements of oven cooling fans or hot air convection fans providing a maximum possible power consumption P1 of 20 and a speed range up to maximum 4,500 rpm. The motor provides a modular design with open mechanical interfaces similar to the DE 032 one-phase motor platform mentioned previously. Its assembly concept permits the usage of the same core module for different applications. With its small dimensions it targets build-in situations with limited space.

DE 043 sensorless BLDC motor platform: This is a sensorless BLDC motor available with different stack sizes. It covers a power range of 30 up to 400 W. Its maximum speed range covers up to 4,000 rpm. It provides EC technology while having comparable mechanical interfaces as the ebm-papst PSC motor series. A separate electronic box which is part of the motor and contains the commutation electronics is attached either to the motor itself or placed outside of it and connected to the motor's cable. The driver box provides a VSD interface to control the speed either by a 0-10 V analog or PWM signal. As a sensorless BLDC motor it provides a calculated speed signal.



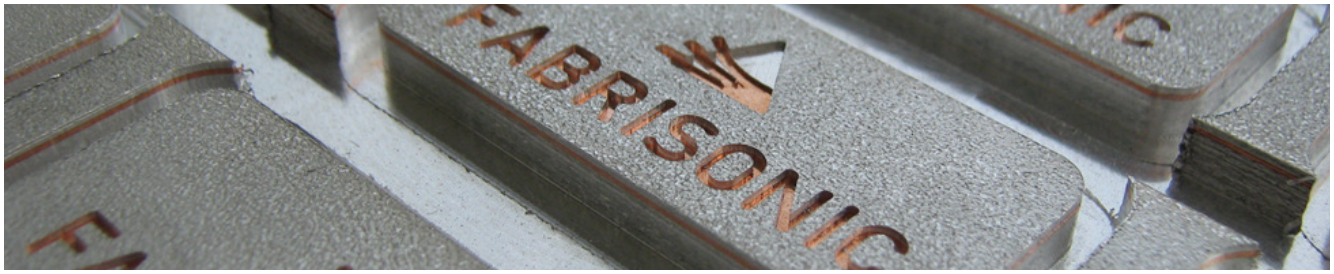
DE 043 sensorless BLDC motor

Summary

EC motor technology has become more commonplace in appliances such as domestic refrigerators and freezers, cooker hoods and washer-dryers. In some cases it became the technology standard. With its high electrical efficiency, the EC motor technology helps meet appliance-specific regulations on eco-design and market requirements for convenience and function. In keeping the same basic mechanical interfaces it is easy to substitute AC with EC motor driven products. Besides exceeding AC motors' performance limits given by the grid frequency, they allow an integrative and compact design. ●

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Building Fiber Optic Strain Sensors into Metal Components

BY ADAM HEHR

Various sensors and sensing technologies are used throughout the industry to detect and respond to external stimuli for control and monitoring purposes. These sensors are conventionally, externally attached to the component or system, because gained information is adequate for the application. In some cases, external mounting can confuse the data collection, limit the gained information, and create challenges for sensor mounting due to the use limits of adhesives, such as high temperature or humid environments. Therefore, it is desirable to build these sensors into the metal matrix directly in order to provide in-situ information and robustness. 3D metal printing offers the opportunity to build these fiber materials directly into the metal matrix.

Ultrasonic Additive Manufacturing (UAM) is a 3D metal printing technology that uses high frequency ultrasonic vibrations to scrub metal foils together layer by layer, as opposed to using a directed energy heat source—e.g., laser or e-beam. UAM systems are integrated into computer numerical control (CNC) frameworks to enable subtractive operations interchangeably with the additive ultrasonic process—a form of hybrid additive manufacturing. Ultrasonic joining is a solid-state (i.e., no melting) process, which enables direct integration of temperature sensitive components into the 3D metal part. Fiber optic strain sensors are particularly vulnerable due to their temperature sensitive inscriptions, commercially common plastic coatings, and large thermal expansion mismatch with many metal alloys (i.e., cracking susceptibility). Melt-based 3D metal printing has been used to build some fiber types into metal, yet voids around the fiber, atmosphere

Figure 1: A bracket is shown with the sensors embedded near the stress riser in the bracket, a measurement impossible to make with externally mounted strain gauges. The metal flow induced in the UAM process creates a strong mechanical joint between the fiber and matrix.

Figure 2: Live load data can be used for monitoring and control while high outputs can be used to identify and track damage evolution. (FBG strain information from fatigue test at NASA LaRC.)

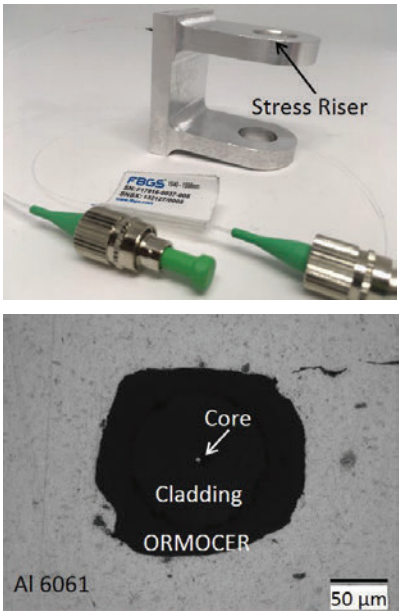


Figure 1

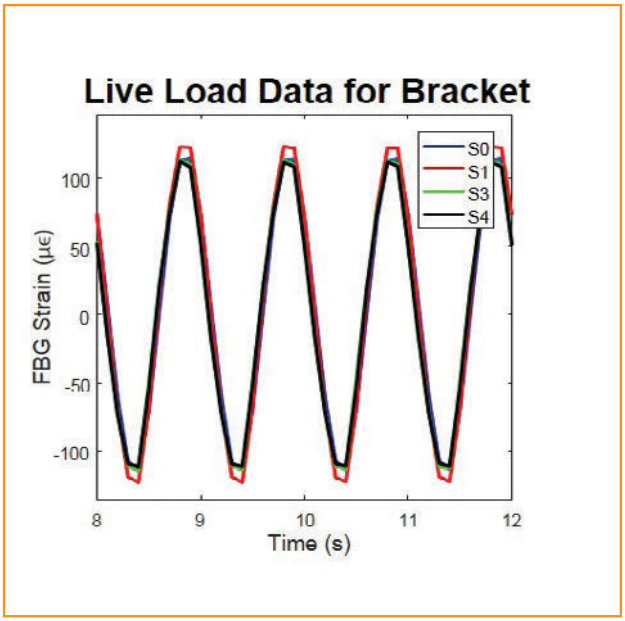


Figure 2A

requirements, dimensional accuracy, and cracking remain challenges [1].

There are many different types of fiber-optic strain sensors. Common traits are their small size, electromagnetic immunity, remote interrogation, multiplexing, low noise, high temperature operation, and long-length capability. These attributes are attractive for certain industries and applications such as aerospace, nuclear, and oil and gas. These sensors work by measuring internal stress in the fiber via light reflections.

To embed small fiber materials into a metal part, a channel path is cut during the CNC stage of the UAM process. The fiber is then placed into the channel and consolidated with the additive stage. Metal flow in the UAM process—which is like metal flow in friction stir—creates a strong mechanical joint between the matrix and sensor material, which in turn enables excellent strain transfer to the metal matrix for stress and temperature measurements. An instrumented bracket is shown in Figure 1, along with a micrograph of a consolidated fiber. The fiber is fully integrated with the metal matrix. Fundamental work has shown that the joint strength between the fiber and metal matrix is stronger than the yield stress of the metal and that the joint does not degrade with fatigue loading [2].

Fabrisonic collaborated with EWI's mechanical test lab to perform this testing. This joint robustness enables technology scale-up and application evaluation. The team is also collaborating with NASA Langley Research Center for advanced mechanical testing and analysis. Fatigue data from the bracket in Figure 1 is shown in Figure 2.

Building fiber optic strain sensors into metal using UAM is still in its infancy, yet shows strong promise. To help with technology transition and adoption, the team is working to explore other key areas. For example, sensor use is made friendlier by building fiber terminations and connectors into the part directly. Metal-coated fibers are also of interest, due to their high operating temperatures (see Figure 3). Lastly, other metal matrix alloys and applications are being evaluated in conjunction with EWI additive manufacturing group.



Adam Hehr *is a research engineer at Fabrisonic LLC, an EWI affiliate. His expertise is in sensors and sensing systems, UAM process control, and UAM applicaitons.*

Acknowledgements

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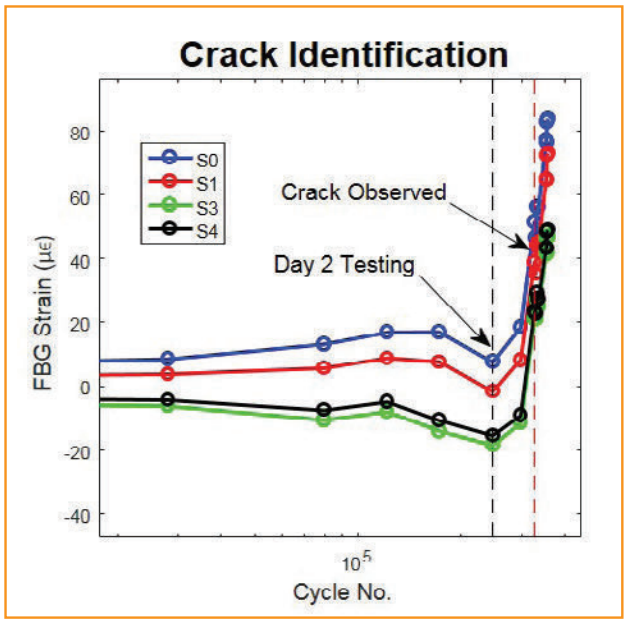


Figure 2B

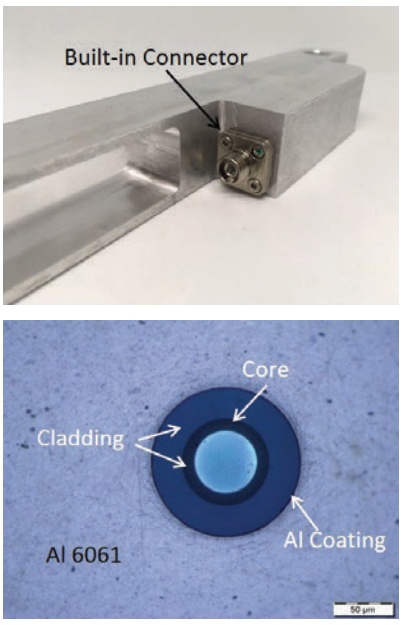


Figure 3

Figure 3: Built-in connectors are used for usability and robustness. Metal coated fibers are used for higher temperature applications.



Code Marking

BY JOHN BISHOP

Code marking is quite simply applying a readable code to a surface for identification purposes. it has increased in importance over the years due to regulatory requirements and manufacturers need to have traceability to identify components with various codes (dates / part numbers / lot numbers / visual signals of process completion / acceptance, etc.).

Code marking can be a wide range of marks from text based messages such as date, product, lot numbers, production lines, serial numbers, sell-by / use-by, alpha-numeric text, etc. to symbol type of marks such as pass / fail codes, bar codes, insertion marks, logos, dots, stripes, arrows, etc. Coding and marking are used interchangeably in this paper.

Today, many manufacturers wish to mark directly on their product as opposed to applying labels which can be of short shelf life for traceability. Some manufacturers wish that the mark is able to be discerned both in their process as well as used in the final application(s)…so called cradle to grave marks. Other manufacturers may only want the mark to be visible only in their process. Occasionally, a manufacturer may wish that the mark be invisible (UV inks) to the naked eye if they are competing with other producers making the same product. The mark may be some directly readable alpha-numeric code, symbol or a bar code(s) that provides identifiers when scanned.

Since the technologies to code mark have changed significantly from manual marking and the stencil process in early years to today's high technology laser marking, an attempt to identify all the in-between developed processes is presented. Today, no one manufacture offers the broad technologies discussed in this paper. Therefore trying to find a single source and guide to selecting a particular technology is difficult to access. Most manufacturers tend to concentrate on only one or two of the technologies. They are only a proponent for that (those) approach(s) leaving the engineer having to study the features, benefits and costs of each technology separately. Some manufacturers that offer multiple technologies offer little printed guidance on how to select a

technology assuming the engineer has a preconceived idea of what technology will work best in their application.

This article will offer overviews of each technology and where that technology fits in the possible solutions to code marking effectiveness. The paper is divided into three parts: first the types of code marking technologies available, second the considerations guiding the choice of a marking technology and lastly the pros and cons of the various technologies.

Marking Technologies

While an effort has been made to include the majority of commonly used processes, it is possible some technologies may have been overlooked since there could be subsets of these basic technologies that were not included. Small refinements in some technologies may account for this situation. The technologies described in this article are all commercially available in the Americas market.

A number of code marking systems that are generally available to industry can be broadly characterized in the following two technologies: 1) contact marking or 2) non-contact marking. Each of these technologies have sub-categories of unique technology thru different processes that are noted below. In contact marking this can be divided further into sub-categories ink transfer, chemical transfer and mechanical indentation. In non-contact marking the sub-categories are ink transfer and energy transfer. A brief description of each technology and how the specific process works:

Ink Transfer

• ***Wet ink / Reciprocating Coders*** – Ink is retained in a reservoir for the marking head to contact then invert and extend to contact the surface to be marked with the message chosen (typically rubber type for text and rubber dies for symbols like dots / arrows, etc.)

• ***Offset Markers*** – Ink is stored in a reservoir and wets a transfer surface to which then a marking head (rubber dies typically) with the message contacts for deposition on surface to be marked. Offset markers can be roll type coders that roll a message typically along a flat surface that moves. Other offset markers can be bench top type units where the product to be marked is positioned on a base and the marking head cycles to apply a mark.

• ***Thermal Transfer*** – Pre-inked ribbons are advanced for a heated marking head with the message formed in metal to heat bond wax based ink to the surface to be marked. The head does not contact the ink just the backside of the ribbon.

• ***Thermal Direct*** - Heat sensitive films are presented to a heated die message to leave a matching image in the film.

• ***Pad Printers*** – Ink is retained in a reservoir that applies ink to a die that has the message etched thinly into the surface and is then exposed to a silicone pad which picks up the ink on the surface to then be transferred to the surface to be marked.

• ***Stencil*** – An image is created in a stencil then the stencil covers the surface in the position to be marked and ink or paint is applied to the open areas on the stencil.

Chemical Transfer

• ***Chemical Etching*** – Conductive metals are electro-chemically etched by applying an electrical charge to a chemically treated surface with a stencil die that reflects the message to be etched. Parts must be cleaned first and then a masking die of message format must be affixed to the surface for electrolyte application. The electrical charge can remove from .0001'' to .01'' surface materials depending upon metal and time of charge.

Mechanical Indentation

• ***Impact High Force / Embossing*** – Typically a hard surface (metal common) die is made with the image desired and then thru high force (pressure or impact) applications leaves the impression in the surface to be marked. The die can be a set of metal stamps in alpha-numeric form or special dies made to a specific message such a part number or logo for example.

• ***Dot Peen*** – Hardened metal pointed tips are driven (pneumatically or electrically) into the surface to be marked to leave a message composed of small indents. Critical to visibility is indent shape, depth, spacing and size.

• ***Stylus*** – Hardened metal tip is controlled to scribe a line for a visible impression. Critical to visibility is indent shape, depth, spacing and size since ambient light is often used to discern message.

• ***Hot Stamping (Hot Branding)*** – A metal die with the message format is heated and then under pressure transfers the image to the surface to be marked.

Non-Contact Marking

• ***Ink Jet*** – Two types of technology are common to spray ink droplets thru the air to attach to the surface to be marked. One is called continuous ink jet (CIJ) where the ink is continuously cycled and dispersed as the message formation calls for. CIJ has one nozzle that dispenses the ink which is then deflected electrically to create the desired message. The deflected droplets form the Y dimension of the character while the X direction of the

moving web forms the thickness of the character. The other method is drop-on-demand (DOD) where the ink is only sprayed when the message calls for the droplets to mark the message. DOD has an array of nozzles to spray ink without deflection. The surface to be marked must be in continuous and steady movement. Some special ink jet marking machines have been supplied that can apply full 4 color images by UV curing UV based inks for a very durable image.

• ***Spray Markers*** – Ink is retained in a reservoir and when a mark is required a valve is opened to pressurize the ink for spraying thru an orifice to coat the surface to be marked. The resultant image is a dot.

Energy Transfer

• ***Laser Markers*** – Focused high energy beam of light is directed on a surface and the message is ablated or burned into the surface or in some circumstances the surface material is oxidized leaving a dark impression. Lasers can be used to remove a coating to leave an image below. There are several common technologies used here namely CO2, Fiber, UV and YAG laser systems. The power input to these laser can range from a few watts to several hundred watts. Higher wattage can allow quicker message impressions or deeper impressions in harder to etch materials. Each laser is steered by mirrors mounted on motors to produce marks very quickly. The laser beam is focused thru a lens to concentrate the energy for burning an image. Full line suppliers have rather extensive list of questions that address many of the attributes that can affect the decision for one technology over another.

Each of these technologies are significantly different and present their own advantages and disadvantages.

Considerations to Select a Technology

Changing topics then from the equipment used to code mark to conditions that can influence equipment choices the characteristics below should be considered when looking for a code marking system (these are not in a particular order since in some cases all the below need to considered while in others only selected characteristics need to be considered):

Material Considerations

• ***Material Types*** – Most of the common technologies above can be employed with a wide range of materials (plastic, wood / paper, metals, etc.). Some of the typical processes can present problems for certain materials like polyolefin plastics where the surface energy for chemical bonding is very poor and has to be enhanced thru chemical etching, corona treatment or plasma treatment. Glass is difficult to bond to so very few processes can be employed to mark the surface. Lasers have found some application in hard to code mark plastic and glass surfaces. Non- contact marking systems are commonly used for delicate parts.

Very hard and fragile surface materials as well as distortable surfaces can eliminate impact printers from consideration. Very soft materials are also difficult for the indentation type processes. Another factor to be considered is the porosity of the material. Often the ink selected for marking will be dependent upon the porosity of the material for drying and adhering properties. In some cases very porous materials like low density rubber are often hard to mark with single applications of ink. Some manufactures have found that multiple strikes will make the mark more visible.

Surface characteristics (flat, rough, textured, curved, irregular, round, coatings) - Since these conditions can be highly variable in each category comments will be offered for each characteristic. For flat surfaces all the code marking technologies discussed here generally can be used.

Rough and textured surfaces can limit the effectiveness of reciprocating coders and in some cases pad printers as not enough pressure can be brought to bear to extend the ink laden transfer medium (generally rubber or silicone) into the recessed areas.

Curved and irregular surfaces generally present problems for reciprocating coders. In some cases manufactures can make modification to the marking head and ink reservoir to accommodate these variations. Pad printers can often accommodate these surfaces as well ink jet and laser are largely unaffected by these conditions.

Irregular surfaces can be marked with all the non-contact marking systems and dot peen / stylus marking systems. Other contact marking systems are generally limited in capability as the transfer surface cannot be made to conform to the surface to be marked. One exception to this is offset marking machines can print a range of complex geometries by moving the product to be marked manually over the impression.

Small diameter products can be more difficult than larger diameter objects. The direction of the print from around the product to along the axis can present problems that may require special considerations like rotating the product for special marking head designs.

Coatings can be a problem for contact marking systems as the coating can mask the surface conditions and in some cases be tracked back into the ink / chemical delivery system. It is recommended that the surface to be marked be cleaned at least in the message area.

Laser systems can get around this problem by burning off the coating and the substrate to leave a message.

In all these various surface conditions, manufacturers generally will want to understand the conditions before committing to a process.

• ***Material temperatures*** – higher temperature materials that need marked can eliminate the use of inks which generally are limited to 300 degrees. Some special purpose inks are available that have much higher temperature use levels but these tend to be quite expensive. Generally, mechanical force and laser are unaffected by heat levels. On the cool side most technologies are suitable to varying degrees but can be affected if ink viscosity is changed appreciably. Also one has to consider condensation possibly influencing the surface for ink and chemical processing.

Equipment Considerations

• ***Machine physical size*** – In many OEM applications the machine envelope can be positioned into the designed structure and so the physical size is incorporated at the design stage. In other instances where code marking is required to be incorporated into an existing machine structure, the physical envelope available becomes a consideration. Some wet ink coders are available that minimize the envelope required to code mark. Non-contact marking technologies tend to be fairly small in size and have versatility in mounting position. Some technologies have the unit creating the message separated from the base machine so it may reside in a smaller envelope. Ink jet and stylus machines are examples of this situation.

• ***Frequency of Coding*** – two characteristics need to be considered. First, the speed at which the mark needs to be applied will often determine the method of marking.

MARKING SYSTEMS
Pros and Cons

System	Pros	Cons
Wet Ink	Capital cost ($1-5K) Low cost per code mark Easy to maintain Quick dry inks Good speed range (300 CPM) Low maintenance cost	Fixed message Limits on surface Message fixed Limited message size
Offset	Low capital cost ($1k-5k) High speed roll coders	Low speed on table top models Table models use paste ink Limited message size Medium maintenance costs
Thermal Transfer	Med capital ($5-10k) Good life marking head Won't fade over time	Medium Maintenance Downtime ribbon changes Ribbon waste Color printing possible
Thermal Direct	Med capital ($5-10k) Clear messages No inks	Expensive labels Medium maintenance costs Med frequency marking head changes Image retention over time reduced B&W print only
Pad Print	Capital Cost ($5-50K) Decorative color prints True color matching	Off line process Slower drying inks Ink thickens, small batches
Chem Etch	Capital Cost ($1-5k) Durable mark Doesn't stress crack surface Doesn't raise the surface Best for thin parts	Limited to conductive metals Visibility lower Mostly off line processing Chemical disposition Higher maintenance costs
Impact	Capital Cost ($5-10K) Durable mark	Slow to change message May damage substrate Die wear on hard surfaces
Dot Peen	Capital Cost ($5-25k) Durable Mark Easy to change message Best for thicker parts	Harder to read No consumables Not able to mark most plastics Often used off line Part needs to secured
Stylus	Capital Cost ($2-10K) Durable mark Easy to change message	Harder to read No consumables Not able to mark most plastics
Hot Stamp	Capital Cost ($5-15k) Durable impression High speed	Slow message change May damage substrate
Stencil	Low capital cost Range of message sizes	Easily read message Slow manual process
Ink Jet	Capital cost ($1-25k) High Speeds Quick change of message	Higher maintenance costs Surface has to be moving Image quality can be poor Marking head close to surface Marking head frequent cleaning
Laser	Good image quality Durable Mark High speed messaging No consumables Thin delicate parts 3D units can mark large areas	May damage substrate High capital cost ($5-100k) Safety shielding required

The engineer needs to know the line speed for continuous processes or cycle rate for intermittent product production. At the low end of the marking frequency (< 60 CPM) chemical etching, laser burning, dot peen printers and pad printers could be considered. These applications typically require the product to be marked to remain in a fixed position for the mark (intermittent motion). In the medium range of 50 to 300 CPM reciprocating coders come in to benefit. In these applications, typically the product mark needs to be made while the product is stationary. Typically these types of machines are used in processes up to 200 CPM. Some success has been obtained with moving product with the marking cycle based upon very high speed marking head cycling.

At the higher end of marking frequency we find the non-contact marking technologies the most used. Ink jet marking systems offer high speed marking with product moving at high line speeds (up to 2000 FPM). Lasers have been used in higher speed applications up to 500 FPM.

Secondly, consideration on how many code marks need to be applied to the product surface. Generally the above comments still apply but when multiple repetitive marks are required often times multiple machines are gang mounted and cycled at the same time.

• ***Cost*** - A very large range of machine capital cost from inexpensive stencils to very special laser systems well over hundreds of thousands of dollars can be considered. In the pros and cons of the various systems below, the author will try to supply some ranges for capital equipment.

Capital equipment is often only one component of the cost consideration equation with operating costs such as set up and tear down, operator attention, maintenance and operating supplies all can affect the cost to code a product. In some cases the high cost of acquiring the equipment can be offset with little maintenance and no operating supplies (e.g. laser marking). In other cases the lower cost capital equipment may be offset with higher costs in maintenance and operating supplies.

Visual Medium Considerations

• ***Message Format*** – ink is a very common type of code mark medium but other marks could be chemical etching, mechanical indentations and laser burning. Ink can be of various types such a solvent based pigmented variety, water based dye type ink, wax based ink, epoxy based with air or UV curing, UV inks, etc. Inks are adhered to the surface while etching, indentation and laser marks are surface and subsurface modifications for the most part. In some cases special inks like food grade ink are required or military specification inks. Manufacturers of wet ink and ink jet equipment need to be consulted for suitability in their equipment when special inks are needed. When image quality has to be ''decorative'' pad printing in four color can create a custom color specific image. Laser can create very accurate image impression in one color. Other processes are all on a spectrum of image quality of lesser degrees. Most of the other processes would describe the images they create as ''readable'' or ''non-decorative''.

• ***Durability*** – code marks durability is really a spectrum since all marks can be removed by using different chemicals and / or forces. On the highly durable side are laser burning, chemical etching and impact printers. Epoxy inks applied by offset printers are highly durable. On the medium side are pad printing, hot stamping and ink jet. The lower side of durability are ink marks applied by solvents and water solutions.

• ***Drying times*** - In some cases it is important that the message impression (ink) be imparted to a surface and quickly dry as other downstream processing would require the message to be set. In general wet ink coders, thermal printers, ink jet and chemical etching can be used for quick drying. The technologies that may have longer drying times are pad printing and offset printing since heavier / thicker inks are used in these processes.

• ***Color*** – Contact, non-contact ink, hot stamp and pad printing generally offer a range of colors which can often times make an image stand out from the background color. Often the background color of the marking surface, its porosity and other surface affects like reflectivity will have an affect on the color of the ink mark. Light blue ink often is chosen as it contrasts with a range of dark and light surfaces. Pad printing offers a large range of Pantone colors of ink for decorative marks. This technology can do single color printing and well as full four color printing. Laser marking can leave a darker mark if the substrate is burnt off otherwise it leaves a faint impression of the substrate generally. Impact and chemical etching leave the substrate color unmarked so visibility depends upon aggressiveness of these techniques.

• ***Visible / Invisible*** - UV fluorescing inks can be used with wet ink coders, pad printers, ink jet, offset markers and stencils to leave a mark that is only visible in the UV light spectrum.

Message Considerations

• ***Physical message size*** – the majority of code marking applications tend to be on the smaller (less than several square inches) side of marking applications since these are typically associated with date code, product codes, lot numbers, pass/

fail marks, logos, etc. Machines such as reciprocating coders, dot peen printers, ink jet printers, chemical etching machines, laser machines, pad printers can all be considered. The majority of these marks are less than a few square inches.

Some dot peen and thermal transfer machines can mark larger messages over 50 sq. inches. Likewise some offset marking machines mark similar larger areas.

When laser machines are mounted on an x-y table even larger messages can be created.

When larger scale messages are required stencils are often used.

• ***Surface position*** - ink jet, laser and hot stamp marking require the surface to be marked to be in close proximity with the marking head which can present problems with clearances in certain applications. Contact, impact and pad printers generally can be set back from surface to be marked. In many cases these technologies can be adjusted to allow marking in recessed areas.

• ***Message Characteristics*** (same, changing and sequential) - For repeating messages both contact and non-contact systems can accomplish this type of code mark. When requirements require a changing message a few comments apply by the different technologies. Contact coding with wet ink, offset, thermal transfer, mechanical force impact, pad printers or chemical etching requires that the typical rubber or metal dies used to transfer the message be manually changed. Ink jet, laser technology, pin printing and stylus marks can make message changes by manipulating electronic key board commands. Any of these technologies that use electronic key board commands to control message format can be used to deliver sequential marking messages.

Environmental Considerations

A common and widely used medium for marking is ink. Ink is generally formulated for visible (or non-visible i.e. UV) impression, durability, drying time and adhesion while conforming to governmental regulations (safety data sheets) for safety of material content. Ink is formulated with a "carrier" to allow flow and adherence of pigments and dyes. There are numerous grades of carriers from low / no VOC (water based) grades to higher VOC solvent based grades.

Chemical etching can be a range of solvent based solutions depending upon the material to be etched.

Laser marking does not use chemicals but off gassing of various compounds can be aggressive depending upon the base material being sintered.

The impact type marking machines are generally free of air born particulates.

Engineers need to consider the environment that the machines will be operated in. If the atmosphere will be humid, dusty or have significant temperature fluctuations these can have effects on all the ink processing machinery.

If any of the machines are installed on vibrating equipment this may affect the quality of the mark.

It also needs to be noted that in many cases customers' requirements are quite specific and that general guidelines may not be applicable to specific conditions. It is recommended that the engineer consult a selected manufacture(s) after preliminary studies are conducted to determine what technology(ies) may be of benefit. Many manufacturers offer sample marking / coding as a first step before a commitment to a technology is attempted.

In summary, the process of selecting a code marking technology is quite a complex process. Engineers can find in some cases multiple overlapping technologies capable of making a desired mark. It then becomes a difficult decision to weigh what is the true lowest cost mark that can be reliably made. One has to estimate the total lowest cost considering the capital cost of the machine as well as the operating costs over a useful time frame. Hopefully, this paper can serve as a useful primer on the technologies that can be used as well as considerations that have to weighed to select an optimal technology solution. ●

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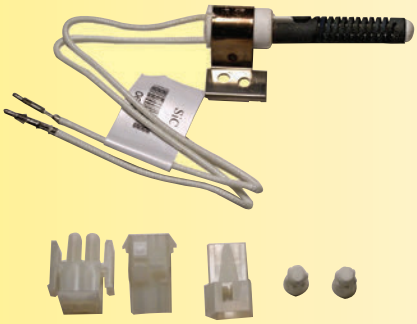
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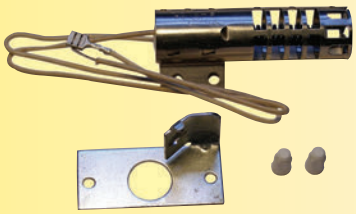
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