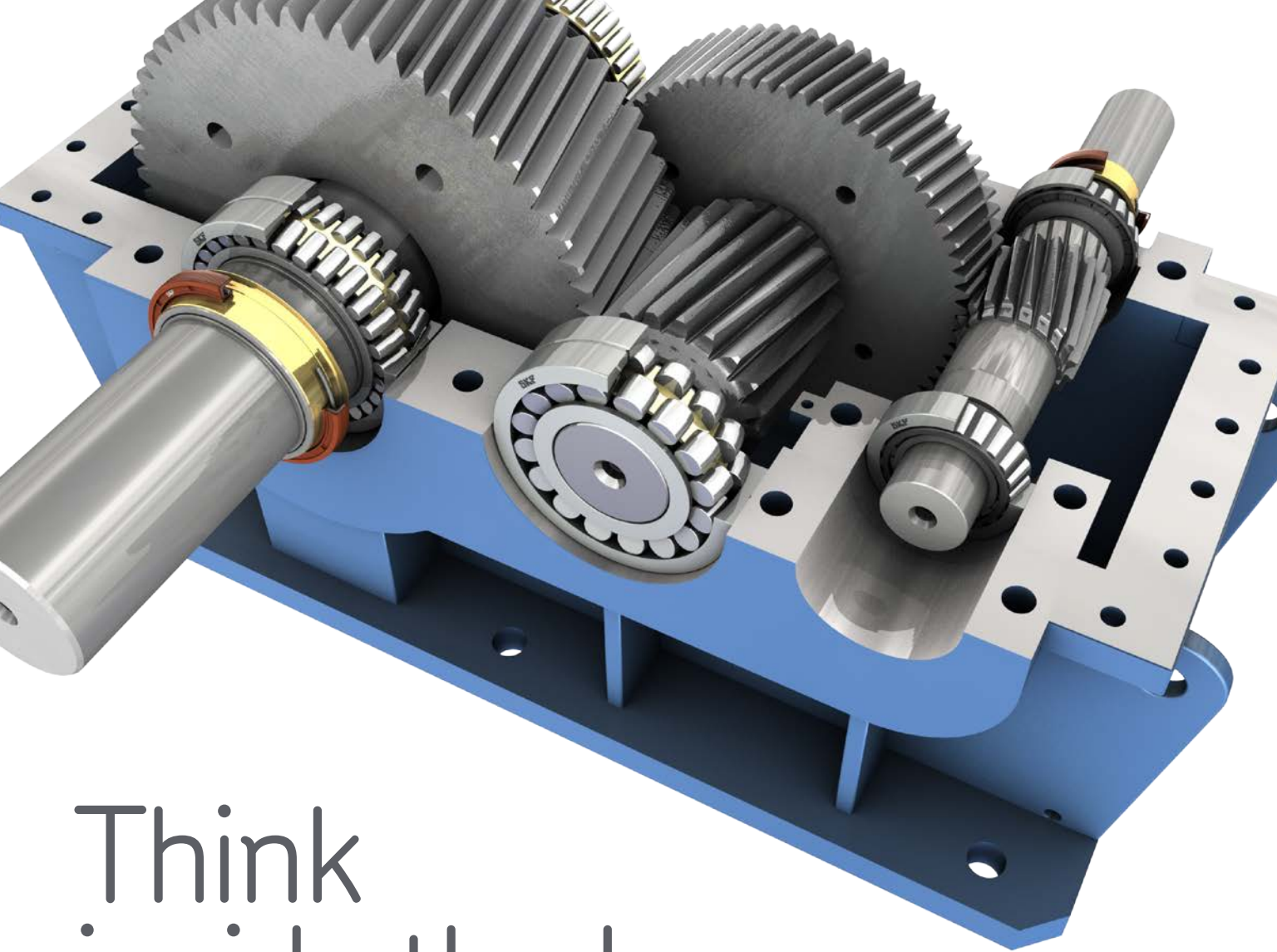


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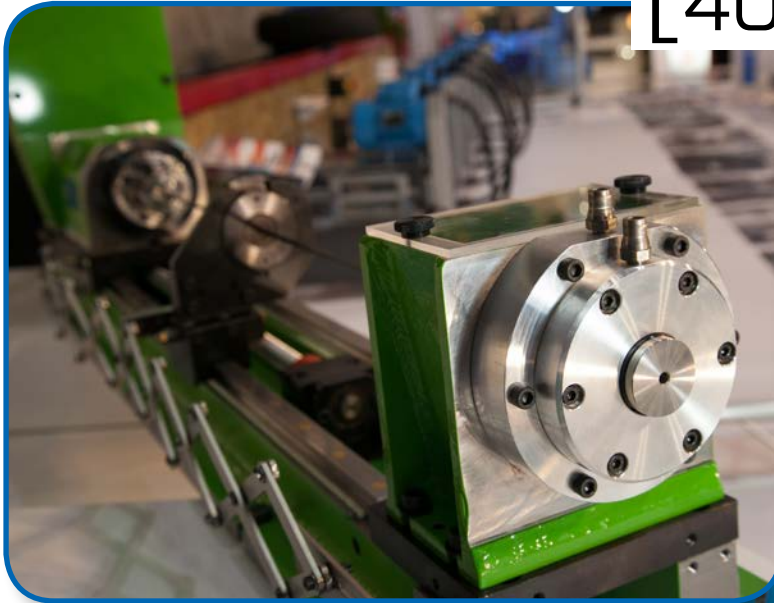
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2017 BUYERS GUIDE!

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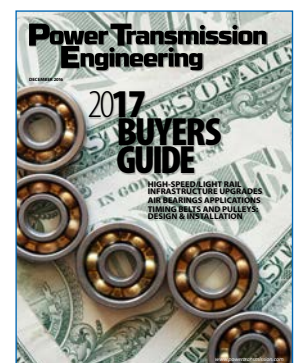
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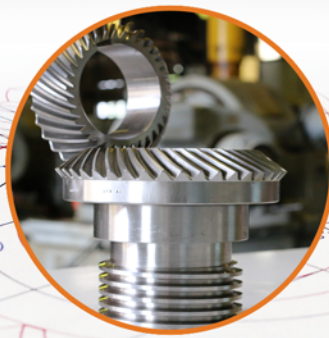
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PTE Videos

Synchronous-reluctance drive systems — comprising Siemens' SIMOTICS reluctance motor and SINAMICS standard converter, optimally coordinated with one another — ensure high efficiency, dynamic performance and ruggedness. Check out a video on this at www.powertransmission.com.

Motor Matters

George Holling discusses presentations and technologies featured at Infolytica's Engage 2016 Conference (www.infolyticaengage.com) and the future prospects of virtual prototyping. Read this and other PTE Blog entries at <http://powertransmission.com/blog/>.

Social Media

Have you browsed our Twitter page recently? We've added the latest PT news and product information from AGMA, Voith, Heidenhain, Renold and Gear Motions. Check out these and other PT manufacturing topics here: <https://twitter.com/PowerTransMag>

Facebook is another resource that features updates on the Motor Blog, additional Ask the Expert resources and a quick and convenient way to renew your PTE magazine subscriptions: <https://www.facebook.com/Power-Transmission-Engineering-524202381060172>



Event Spotlight:

SciTech 2017

From its creation in 1963, the American Institute of Aeronautics and Astronautics (AIAA) has organized conferences to serve the aerospace profession as part of its core mission. Spanning over 70 technical discipline areas, AIAA's conferences provide scientists, engineers, and technologists the opportunity to present and disseminate their work. SciTech 2017 takes place January 9-13 in Grapevine, Texas. For more information, visit www.aiaa-scitech.org.

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This issue, we're pleased to present our annual **Buyers Guide**. It's our comprehensive directory of suppliers of mechanical components, including gears, bearings, motors, couplings, clutches, brakes, gear drives and more. This directory represents our best effort to give you updated information about the companies who can provide you with the components you need to design, build and maintain better machinery.

But it's not nearly as good as it could be.

Don't get me wrong. We're proud of our work. We put a lot of time and effort into making sure it's as complete and accurate as possible. But at the end of the day, there isn't enough space to do the directory justice. We'd love to provide you with even more in-depth, even more comprehensive information like this.

And the fact is, we already provide it, at www.powertransmission.com. All of the categories you find listed here in our printed directory are broken down further on the website. So whether you need spiral bevel gearboxes, keyless locking devices or tapered roller bearings, you can find all the appropriate suppliers at www.powertransmission.com. Even better, many of the companies listed there have provided in-depth information describing their companies' specialties and strengths. In addition, we're constantly adding new companies to the site, so by the time you read this, there will probably already be some suppliers online who aren't listed in this printed directory.

Please visit the site and have a look. We're confident you'll find some excellent suppliers for the mechanical components you need.

And we hope you'll also spend some time exploring the site, because what's true of the Buyers Guide is also true of most of our content. That is, there's always more information online—nearly 10 years of magazine content. So if you find

something you like in the magazine, you'll find plenty of related content on the website. Just type what you're looking for in the search box, and you'll find technical articles, features and news items related to your topic.

Plus, we post a lot of content on the website that never appears in print. The blog is a great example. If you visit www.powertransmission.com/blog, you can read insightful articles and bonus technical content from our resident bloggers George Holling (our motors expert) and Norm Parker (our bearings expert), along with online exclusives from our editors.

Many of those online exclusives appear in our e-mail newsletters. Beginning in January, we're expanding the newsletters to twice per month, which will enable us to bring you even more content—covering more subjects, in greater depth—than ever before. If you are not currently receiving the newsletters, I encourage you to sign up at www.powertransmission.com/subscribe.htm. You only get them if you opt in, and you'll be missing out on a lot of exclusive content if you don't. You can also renew your subscription to the magazine at the same time, and we'd appreciate it very much if you took the time to do so.

As always, we're interested in your feedback. You can let us know how we're doing anytime by sending an e-mail to wrs@powertransmission.com.

2016 BUYERS GUIDE

2016 PTE Buyers Guide

About This Directory

The 2016 *Power Transmission Engineering* Buyers Guide was compiled to provide you with a handy resource containing the contact information for significant suppliers of power transmission components.

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ACCESSORIES

ABL Products Incorporated
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Acorn Industrial Services
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The HPD is a versatile drive used in punching and nibbling machines. The transmitted force can be adapted individually to meet the specific operation profile. When power requirements are low, the HPD uses a partial load operation at high speed in order to achieve high productivity. During punching or forming, it automatically switches to full load operation delivering up to 300 kN at any time and at any point of the cylinder stroke. Despite its flexibility, the HPD requires only 4 kW of power at 600 strokes/min.

The functional principle of the HPD is that of a closed loop hydraulic system without directional valves or servo valves. The pump connects directly to the cylinder allowing it to operate as a hydrostatic gear—without friction or wear. Together with the linear cylinder, it is also virtually wear-free,

operators benefit from an extremely robust and low-maintenance solution. The system is absolutely overload-safe because it has no mechanical gear.

Voith uses a modular design and standardized components to make system integration of the HPD remarkably easy. The standardized electronic and mounting interface is easily recognizable as it is found throughout the Voith punch drive offering. This includes the proven Voith HS4 controller, an integrated electronic controller that recognizes even complex parameter structures independently.

The self-adaptive hydraulic gear reduces the inverter capacities and servomotor power required for the HPD. The system requires no additional cooling as there is not a brake resistor and significantly reduced heat loss is achieved. The complexity and space



requirements in the control cabinet are therefore further reduced. In contrast to servo-mechanical alternatives, which operate with a peak current input of 200 A, the innovative Voith drive requires only 50 A.

For more information:

Voith Turbo
Phone: (717) 767-3200
www.voith.com

R+W

BELLOWS COUPLING ADDED TO HIGH-SPEED LINEUP

Bellows couplings are well known in highly dynamic precision applications because of their continuous symmetry, high torsional rigidity, and low moment of inertia. Many of the same characteristics are also

very well suited to high speed operation. Standard design balance for bellows couplings is typically up to 10,000 rpm, with the limiting factor being only the clamping hubs for attachment to the drive shafting, and with additional balancing allowing for much higher operational speeds. Drawing on its years of experience in designing and manufacturing special bellows couplings for extreme speed (up to 150,000 rpm), R+W has released a new standard design.

The new SP3 coupling features an integral clamping ring system, with the base hub components held

to a very high level of concentricity between the two respective bores during the assembly process. The external clamping ring provides the advantage of symmetrical construction even when it comes to the small amounts of deformation during clamping compression onto the shafts. Any small inconsistencies in tightening the clamping system are contained to the ring itself, with the coupling straightness remaining highly accurate during installation. Available sizes range from 60 Nm to 500 Nm, with much higher torque capacities, custom flanges and materials on request.

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Moog

PITCH CONTROL SLIP RING OFFERS MODULAR DESIGN FOR WIND TURBINES

Moog Components Group Limited, a division of Moog Inc., has announced the introduction of a new pitch control slip ring. The EPA3 slip ring is the next generation of advanced slip ring products specifically developed for the wind energy market. It is well suited for both large and small wind turbines.

quired. It can also be used on the yaw axis of small wind turbines. Speeds range from 0 to 100 rpm with through-bore model sizes up to 54mm available.

Building on Moog's heritage in the wind turbine market, this new product offers customers a technically more



A key advantage of the Moog slip ring is its high reliability, modular design that can be scaled and optimized for most requirements. The slip ring provides the most advanced contact technology available in the market while extending the life of the product to reduce field maintenance. No maintenance (cleaning) is required.

The slip ring can be part of a large wind turbine electric pitch control system with the option to integrate hydraulic pitch control systems if re-

advanced slip ring solution with extended life at a lower cost of ownership. The slip ring utilizes Fiber on Tip (FOT) power contacting technology. The new flexible design is easier to manufacture than conventional slip rings and decreases time to market. In addition to wind turbine applications, the new slip ring can also be used in industrial machinery and medical equipment.

For more information:

Moog
Phone: (540) 552-3011
www.moog.com

OES

VERTICAL ROTATION STAGE FEATURES WORM DRIVE AND DEEP GROOVE BALL BEARINGS

The precision AR59-AV Motorized, 30mm Clear Aperture Vertical Rotation Stage from Optimal Engineering Systems, Inc. (OES) features a 180:1 precision worm drive and deep groove ball bearings for a high resolution of $\pm 0.001^\circ$ when microstepping (10 micro steps-per-step). The parallelism of the table is less than 50 μm . The AR59-AV vertical rotation stage is ideal for: Micro robotics, metrology, vision systems, positioning of mirrors and lasers, laser machin-



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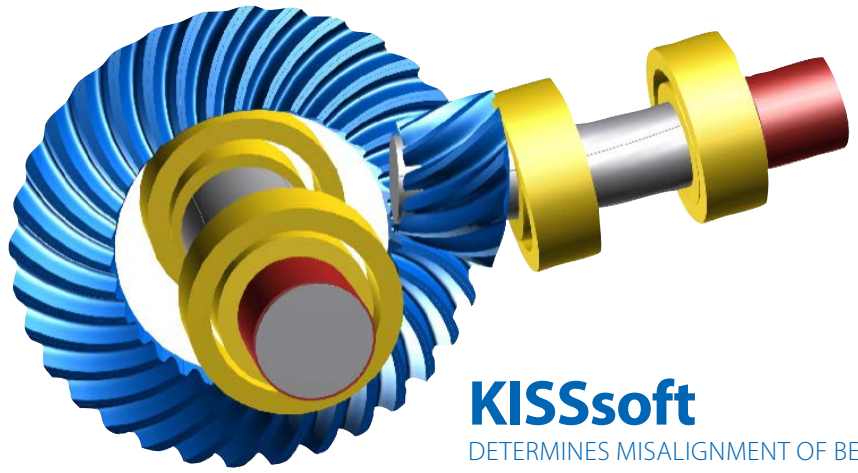


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For more information:
Optimal Engineering Systems, Inc.
Phone: (888) 777-1826
www.oesincorp.com



KISSsoft

DETERMINES MISALIGNMENT OF BEVEL GEARS IN LATEST UPDATE

The relative position of the pinion and the ring gear is critical in determining the wear patterns of bevel gears. To determine the bevel gear misalignment, the displacements of the shafts can be directly determined in *KISSsoft Release 03/2016* by linking the shaft files to the bevel contact analysis. The VHJ displacement values are defined from the respective ratios of the two shafts with regard to the pinion as well as the ring gear. This information is then taken into account in the contact calculation (module ZC30). The flank micro-geometry of bevel gears is dependent on the gear-cutting method which is used. The user can apply topological modifications using the topology of an existing bevel gear design. In *KISSsoft* (module ZC13) the running behavior of the bevel gears can then be checked using bevel gear contact analysis. Further applications using this module are the design of 3D models for the 5-axis milling process or for external FE studies.

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Pittman

RELEASES 32 BRUSHLESS MOTORS INTO E-COMMERCE

Pittman has released the EC044A and EC042B Series brushless motors into its 24-Hour Pittman Express e-Commerce store. Both EC044A and EC042B Series come with the new E30 encoder and PLG42S planetary gear that yield an outstanding level of performance in a truly compact assembly.

The EC044A is an economical 44 mm brushless motor available in a range of lengths, windings and gear ratios to accommodate a range of user application requirements. Performance ranges from 0.04 Nm (6 oz-in) to 4 Nm (600 oz-in) of rated torque with rated speeds from 40 to 4,500 rpm. Although stock gear ratios range from 4-100:1, optional ratios go to 512:1 yielding 14 Nm of output.

The EC042B is the latest Pittman motor addition, effectively doubling rated torque in a smaller 42mm diameter. Performance ranges from 0.06 Nm (9 oz-in) to 8.8Nm (1200 oz-in) of rated torque with rated speeds from 40 to 4,500 rpm in stock solutions. The EC042B comes with the same options available in the EC044A in both stock and standard configurations.

The PittmanExpress e-Commerce store with 24-hour shipment offers a range of immediately available solutions. It is understood, however, that one cannot predict all customer needs and as such also have the option of modifying motors to meet users' unique requirements. Motors can be specified with a range of different windings, speeds, gear ratios and encoder outputs.

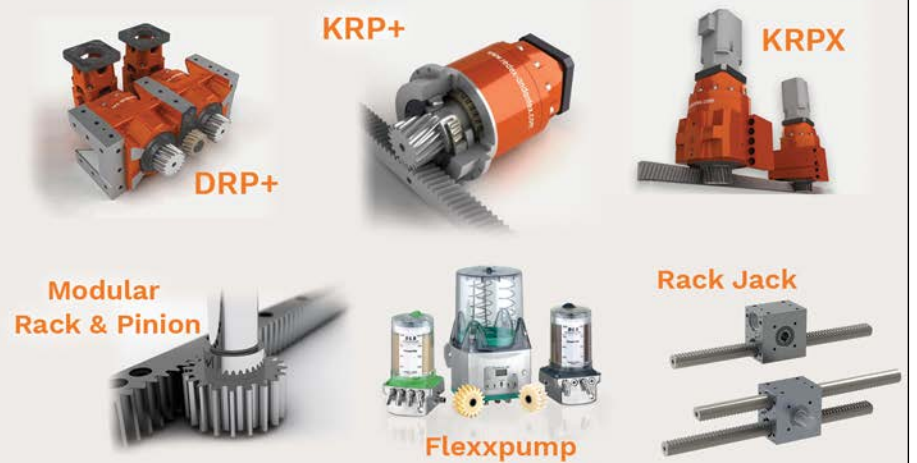
Brushless motor users should gear up for their next development project with new Pittman motor technology and go online to the PittmanExpress e-Commerce website at the website below to view the latest motor and gearmotor solutions available for immediate delivery.

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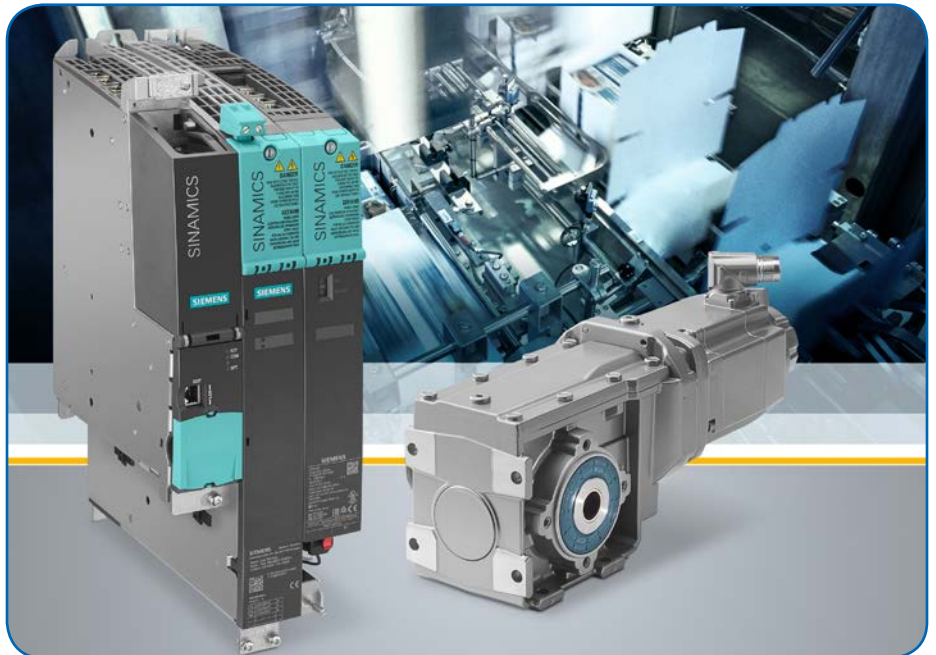
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Siemens

SERVO DRIVE SYSTEM OFFERS HIGH EFFICIENCY FOR GEARED MOTOR APPLICATIONS

Siemens has expanded its extensive drive portfolio for servo applications to include the Simotics S-1FG1 servo geared motors, which are designed for use with the Sinamics S120 drive system. Sinamics S120 drives and Simotics S-1FG1 servo geared motors are an integral component of Siemens

for precise, dynamic motion sequences and is available in the following versions: helical, parallel shaft, bevel and helical worm gearboxes with up to 25 transmission ratios, depending upon the type of gear and gear size required. The helical gearing of the gearboxes reduces noise and offers high efficiency.



Totally Integrated Automation (TIA), which reduces engineering time and costs. Pre-fabricated Motion-Connect signal and power cables offer an easy and reliable method of connecting the components. The units have electronic rating plates and the motors are connected via the Drive-Cliq system interface, so the system can be brought online quickly.

The engineering of the Simotics S-1FG1 servo geared motor includes high efficiency and low torsional backlash

With its highly integrated functionality and scalable number of axes, the S120 drives are suitable for use in a number of demanding motion control applications such as printing and packaging machines, storage and retrieval machines, material handling conveyor systems and dosing pumps.

For more information:
Siemens Industry, Inc.
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Ruland

EXPANDS METRIC RIGID COUPLINGS WITH STEP BORES

Ruland has expanded its line of rigid couplings to include metric sizes with step bores. This gives equipment manufacturers designing precision servo driven systems or shaft-to-shaft connections a wider range of standard in-stock products to choose from. The couplings are available in one- and two-piece clamp styles with or without keyways.

Ruland supplies rigid coupling hardware with a proprietary coating called Nypatch to resist vibration and maintain holding power. Nypatch is applied 360 degrees around several threads of the socket head cap screws to prevent them from loosening under vibration, causing a reduction or loss of torque transmission during operation. It also provides for even seating of the screw, repeated installations and prevents galling. All metric hardware tests beyond DIN 912 standards for maximum torque capabilities.

Clamp type rigid couplings wrap evenly around the shaft to provide high torsional holding power without damage to the shaft caused by set screws. Two-piece clamp styles have a balanced design with opposing screws for reduced vibration and higher speed capabilities. They have the additional benefit of being able to come apart completely for in-place servicing without the need to remove additional components.

Metric rigid couplings are offered in sizes ranging from 3 mm to 50 mm. They are manufactured from bar stock in Ruland's factory in Marlborough, Massachusetts, and are RoHS2 and REACH compliant. The Ruland name is stamped on each rigid coupling for ease of identification. Rigid couplings are made from 1215 lead-free steel or 303 stainless steel sourced from carefully selected North American mills to ensure product consistency.



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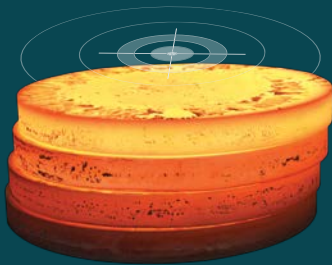
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AutomationDirect has added Schmersal IP69K-rated pushbuttons, selector switches and indicator lights. These control and signaling devices have special design features that make the devices suitable for food processing, pharmaceutical, and medical applications. With an ingress protection rating of IP69K, this Schmersal 22 mm series is also suitable for marine applications, traffic systems, commercial vehicles, and for use in dusty and dirty environments. When utilized in food processing machines, these devices comply with the special cleaning requirements of the industry to prevent cross-contamination, particularly when used in machines that process raw goods. Schmersal 22 mm (IP69K, N Series) control and signaling devices include illuminated and non-illuminated pushbuttons, emergency stop / mushroom push-

buttons, selector switches, and indicator lights. The smooth, modular design of the contact and light terminal blocks makes the devices easy to install and easy to clean. Schmersal 22 mm control devices start at \$12.00.

For more information:

AutomationDirect
Phone: (770) 889-2858
www.automationdirect.com



J.W. Winco

ANNOUNCES LINE OF INDEXING PLUNGER MECHANISMS

J.W. Winco, Inc., recently announced GN 417 Metric Size Zinc Die-Cast Indexing Plunger Latch Mechanisms with Rest Position. The RoHS compliant indexing plunger latch mechanisms are used for applications where the plunger has to stay in its retracted position. To achieve this, the knob is rotated by 90 degrees after being retracted, as a notch keeps the plunger in this position. The design of the holes / slots allows for fixed or adjustable mounting of the latch mechanism base onto Tubing or T-slot aluminum structures. A receptacle for the Indexing Plunger Latch Pin with adjustable slots in the base is also available upon request. The plunger housing is zinc die-cast, with a black plastic coated textured finish, while the plunger pin and spring are stainless steel. The pull knob is constructed from a matte black glass fiber reinforced nylon plastic which is not removable.

For more information:

J.W. Winco, Inc.
Phone: (800) 877-8351
www.jwwinco.com



Mitsubishi Electric

LAUNCHES CNC CONTROLLER AT SPS IPC DRIVES

The new Mitsubishi Electric C80 CNC CPU unit mounts alongside an iQ-R Series PLC's existing module, allowing nanometer scale control over machine tool functions. When applied as part of an iQ-R Platform it contributes toward integrated control over an entire manufacturing production line. Not only does this improve overall performance, but due to ease of integration and a common programming environment — GX Works3 — it can save a considerable amount of time in the design and commissioning phase. Being faster to install and commission reduces set-up costs, while replacing on-machine controls with a full Mitsubishi Electric arrangement can also reduce hardware costs when used to control a CNC production line for example.

The new C80 CNC Series enables a full production line control system to increase its added value and reduce its Total Cost of Ownership (TCO) in five key areas: improvements in pro-



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ductivity, ease of use, connectivity, functional safety and reliability.

The C80 Series CNC controller made its European public debut at the SPS IPC Drives show in Nuremberg, Germany, 22-24 November, 2016 on Stand 391 in Hall 7.

The most important feature of the C80 CNC CPU module and iQ-R PLC combination according to Key Account Manager Frederik Gesthuysen, is the facility to manage complex production lines with a single control platform. "The advantages of integrating a powerful CNC controller with our most advanced modular PLC, the iQ-R, is clearly the performance gain you get from having both devices communicating via a high speed bus; together they are able to coordinate and manage a complete production line from



the robots and machine tools to the HMIs and overhead displays. Fast data management and perfectly synchronous operation not only speeds up production, but can improve quality and allow for more operations to be packed into a smaller space, both of which will increase profitability," he said.

This is a major advantage for the end user, but the benefit for automation system designers and installers is just as great: using one programming platform and components that are designed to work together completely removes any compatibility issues with using controllers from multiple vendors.

The C80 CNC and iQ-R PLC offer a range of benefits for automotive industry, where the original development work was carried out. Where there are other gains to be made however is with other complex automated manufacturing applications that would otherwise have employed several different CNC solutions and controllers. Configured with up to 3 CPUs (21 part systems and 48 axes) for example, the C80 is capable of controlling highly complex machines.

For more information:

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Neugart USA introduces its new compact right-angle, flange-mounted WPLFE gearbox for applications with tight space constraints and powerful torque requirements.

Depending on the frame size, this gearbox requires up to 30 percent less space than comparable right angle gearboxes. With lifetime lubrication and minimal installation height, WPLFE has the flexibility to mount in any direction to help optimize small spaces. This model's standardized flange interface makes it easy to mount drive components—such as pulleys, belt drives, rack-and-pinion systems, linear units and rotary tables.

In addition, WPLFE's large flange output shaft diameter provides five times the torsional stiffness of an output shaft with a feather key. WPLFE also comes with deep, low-friction groove ball bearings that produce little heat, ultimately improving the lifetime performance of the gearbox and drive.

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JVL

STEPPER MOTOR SERIES OFFERS MORE TORQUE AND SIZING OPTIONS

JVL Industri Elektronik A/S recently announced the development of its MIS23 series integrated step motors. The MIS23 motors are available in three different sizes but come with two different types of motors; three with standard high torque stepping motors and two versions with ultra high torque stepping motors with 40 percent more torque. The motors can be operated as "stand alone" or via a control unit. Eight I/O's can be individually parameterized as digital inputs/outputs or analog inputs.

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In Transit

Infrastructure Upgrades Offer Unique Opportunities for Rail Industry

Matthew Jaster, Senior Editor

The average travel time to work in the United States is 25.4 minutes, according to the U.S. Census Bureau.

This number is probably low if you factor in a traffic accident in New York City, light rain in Chicago or it's simply Tuesday in Los Angeles. It's safe to say 25.4 turns into 45 minutes in many areas of the country at seven o'clock in the morning.

"This is 45 minutes that commuters have to focus on the road and nothing but the road," said Anant Bhat, industry manager rail at Schaeffler. "We see an opportunity where employees can become more efficient by working during their commutes instead of focusing on the transportation itself."

These business models have worked in Europe and Asia and there continues to be a great deal of investment from both state and federal government to build a similar rail infrastructure here in the United States, according to Bhat.

Case in point: Amtrak signed a contract with Alstom in August 2016 to produce 28 next-generation high-speed train sets that will replace the equipment used to provide Amtrak's premium Acela Express service. The

new train sets will allow for increased service including half-hourly service between Washington D.C. and New York City during peak hours, and hourly service between New York City and Boston.

The contract is part of \$2.45 billion investment on the heavily traveled Northeast Corridor. These high-speed trains will operate initially at speeds up to 160 mph and will later be capable of speeds up to 186 mph; taking full advantage of future infrastructure improvements.

In addition to high-speed train projects, several U.S. cities are planning light rail upgrades including New York, Chicago and Seattle. And smaller cities are beginning to develop more efficient light rail systems (some 170 billion in public transit funding was approved on Election Night). This is vital if the United States continues to pursue a *mass* high-speed rail initiative in the future.

The key to the success of high-speed rail in the United States will be to upgrade light rail systems in the smaller U.S. cities to feed them into high-speed train networks in the larger cities, according to Bhat.

On the global front, BMI Research re-

leased a report recently claiming mass transit, high speed rail and freight are all steadily experiencing an infrastructure boom in urban areas in order to make cities much more sustainable.

"As population centers continue to grow, the need for alternative forms of transportation for both freight and public transit will be needed," said Greg Gerardi, business development railway at SKF. "Efficiency of travel will always be most important to the public and our transit network will need to provide seamless transport without inconveniencing passengers or delaying the delivery of goods. This means less downtime and better reliability of our rail network."

A Systematic Approach

In order for future rail projects to succeed, a systematic approach is necessary. It goes far beyond just a bearing installation, according to Schaeffler's Bhat. It's no surprise that companies like Schaeffler, Timken and SKF have the engineering expertise and diverse product catalog to reach this market.

"Traction motor bearings, gearboxes, axlebox bearings, housings and condition monitoring equipment all



Timken developed an AP-2 bearing design with internal geometry specifically designed to reduce bearing torque and increase bearing load rating (photo courtesy of Timken).

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play a significant role in these applications,” Bhat said. “Schaeffler’s X-life bearings have extended rating life and longer operating time through superior surface quality and optimized internal design which makes them suitable components for rail. The company also offers traction motor bearings that are insulated to provide protection against electrical currents.”

Bhat added that Schaeffler’s anti-corrosion coating and surface treatments offer several durability benefits to bearings used in rail applications.

“Imagine you’re traveling on a light rail in San Francisco which is very humid due to the moisture in the atmosphere. The bearings could get rusty and begin breaking apart. This is where an impact corrosion coating can protect the bearing and offer a greater life-cycle,” Bhat said.

SKF offers journal bearing designs for the global rail market that utilize synthetic greases, low friction sealing solutions, logarithmic roller profiles, and polymer cage technology.

“The culmination of these compo-

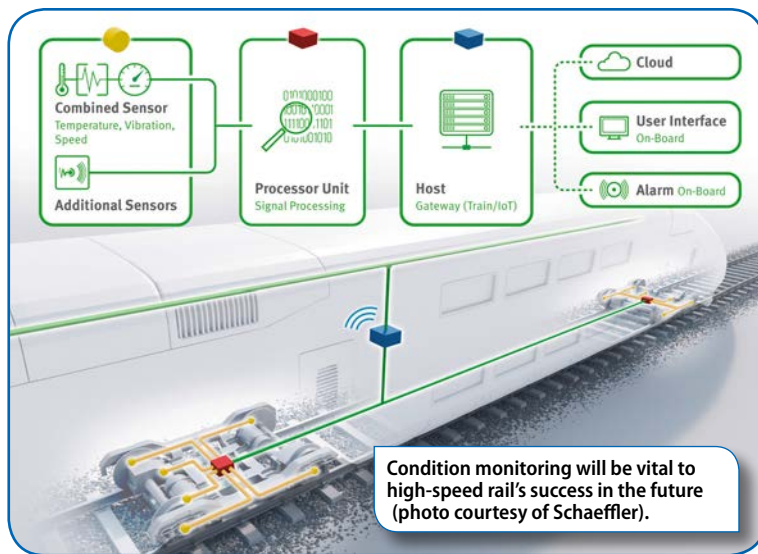
nents creates a bearing with lower operational temperatures and less wear, which ultimately increases bearing life and performance,” Gerardi said.

Polymer cage technology offers a safety factor not found in conventional bearings.

“In a situation where the bearing may become starved for lubrication, the polymer acts as a self-lubricating

component as it starts to melt, giving the train operator the extra critical time it may need to bring the train to a stop before catastrophic failure occurs,” Gerardi added.

On the transit side, SKF offers turn-key solutions for non-drive axle assemblies on light rail vehicles and axlebox/bearing solutions for most passenger rail applications.



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Difficult drive system service found on many rail platforms today requires a robust cage and roller design. SKF utilizes unique material and design combinations to satisfy these harsh requirements. “Our patented INSO-COAT technology protects the bearing from stray electrical current damage, improving the overall life and performance of the bearings, motor, and gear box,” Gerardi said.

Timken developed its AP-2 Short G bearing with rail applications in mind.

“One of the high-focus areas for iron ore miners seeking to optimize their operations is the need to move larger loads more efficiently along the rail link that transports ore from mine to port,” said Alan Buchanan, chief engineer for rail, at Timken. “The axle journal roller bearings are directly affected by the increased car-loading desired by operators. The bearings become one of the critical rail wagon components that influence the overall reliability of the system.”

Timken recognized that the current roller bearing design could be enhanced and introduced the AP-2 Short G bearing concept.

“Timken developed an AP-2 bearing design with internal geometry specifically designed to reduce bearing torque and increase bearing load rating while maintaining the same envelope space as the currently used “short” G bearing. This bearing provides greater levels of performance and reliability, while allowing operators to continue using the existing bogie, side frame, and wheelset,” Buchanan added.

Proactive vs. Reactive Analysis

Structural impact, temperature fluctuations and environmental concerns all factor into machine and component health in rail applications. Engineers welcome the opportunity to plan rail maintenance in advance and know exactly what’s happening within these systems before failures occur.

“We presented an innovative condition monitoring system at InnoTrans (Berlin, Germany) where data evaluation serves the purpose of achieving higher average speeds, greater operating performance as well as longer maintenance intervals for future train

generations while also improving reliability,” Bhat said.

Compact sensor units specially developed for rail applications are used to measure structure borne sound, temperatures and speeds on the axle-box bearings, which permits the detection of damage such as rolling bearing damage and out of balance on the wheel rims. In addition, the drive motor and the gearbox can be monitored on a motorized bogie frame using vibration measurement.



Axle bearing and housing for rail application (photo courtesy of Schaeffler).

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- Load strength calculation
- Gear geometry calculation
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- Roll

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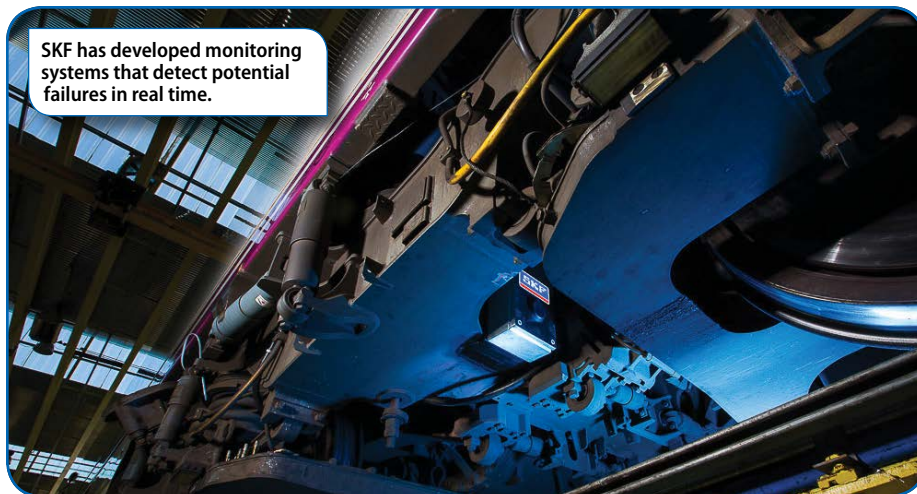
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“The customer is not required to have vibration-specific expertise or to perform manual evaluations. The operator or maintenance technician is connected to the Cloud and can monitor the condition of individual axlebox bearings and even entire axleboxes and bogies,” Bhat added.

With safety and interoperability being key concerns of every rail operation, SKF has developed systems that not only monitor for potential mechanical failures but also for safety conditions such as component cracks and derailment. SKF has dedicated a considerable amount of resources in developing condition based maintenance platforms that can detect potential failures in real time.

“Our IMx-B system has the capability to monitor any rolling element for vibration and temperature anomalies and alert train operations of a potential problem, giving the operator the ability to schedule a repair rather than having unplanned downtime,” Gerardi said.

Timken’s Brister said that general freight rail journal bearing applications



are typically monitored by trackside detection systems both for temperature and acoustic signatures. These systems monitor the bearings for their safety and reliability in service.

Crossover Potential

Many of the bearing technologies utilized in rail applications have been adapted from other industrial segments. Buchanan cites an original Hydrodynamic Labyrinth (HDL) seal

development at Timken that started in the automotive and heavy truck applications, and was modified for use in rail journal bearings.

“Similarly, I believe what Timken develops relative to FE designs, specifically as related to heat generation and torque, could apply to rail bearings. These may be especially beneficial in applications such as high-speed gearboxes,” Buchanan said.

SKF polymer cage technology was

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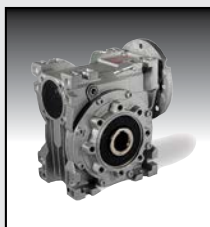
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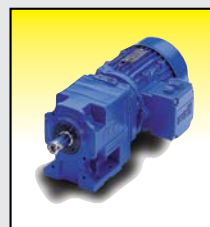
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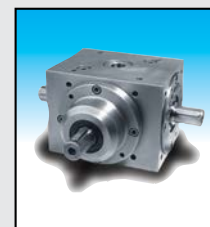
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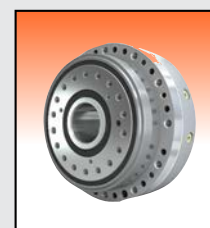
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adopted for rail from the automotive industry. Its performance capabilities were realized early on and introduced into rail almost 20 years ago. "Likewise, the same condition monitoring technology we use in rail has seen much success in other industries such as wind energy, pulp and paper, and offshore oil platforms," said Gerardi.

Schaeffler exchanges information about its bearing technology to other industrial segments. "For example, insulated coating bearings can be applied to e-motors or wind generators. We can apply the same knowledge to bearings across a large range of industrial segments where temperature, corrosion, and environmental elements play a role in determining the lifespan of the equipment," Bhat said.

"With the increased spending on infrastructure and new equipment, the United States is heading in the right direction. It's an exciting time for the passenger rail industry."

— Anant Bhat,
The Schaeffler Group

Schaeffler's proprietary Manrodur rolling bearing material, in combination with carbonitriding (a case hardening process that uses carbon and nitrogen), has already proved very successful in wind turbines that are subjected to high loads as well as in steel mills. With its High-Capacity TAROL Class K (HCT-K) tapered roller bearing that is used in heavy freight railway traffic; Schaeffler is currently expanding the range of applications for this high-performance steel. Initial Manrodur bearings have been undergoing rigorous testing under actual operating conditions since April 2016.

All in all, the rail bearing operating environment can be especially challenging. "There can be high levels of shock and vibration and climate extremes. Lessons learned relative to component design and performance can be transferred to other industries," Timken's Buchanan added.

2017 Market

These components are better equipped for rail systems at a time when many cities around the world are looking to expand and renovate mass transit. Transportation is an area that will always have growth potential in terms of energy efficiency, sustainability, smart cities and personal mobility.

InnoTrans 2016 (a trade show specifically-focused on the global railway industry) featured more than 2,955 exhibitors from 60 countries. The Out-

door Display featured 127 innovative vehicles with several international product debuts. The show attracted 144,470 trade visitors from more than 140 countries to Berlin.

The InnoTrans Convention featured eleven events in the five main forums, dealing with mobility issues now and in the future. For example, at the Dialog Forum the focus was on digitalization in rail passenger and freight transport, and on the technology for digital services.

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Next-generation bogie schematics (photo courtesy of Alstom SA).

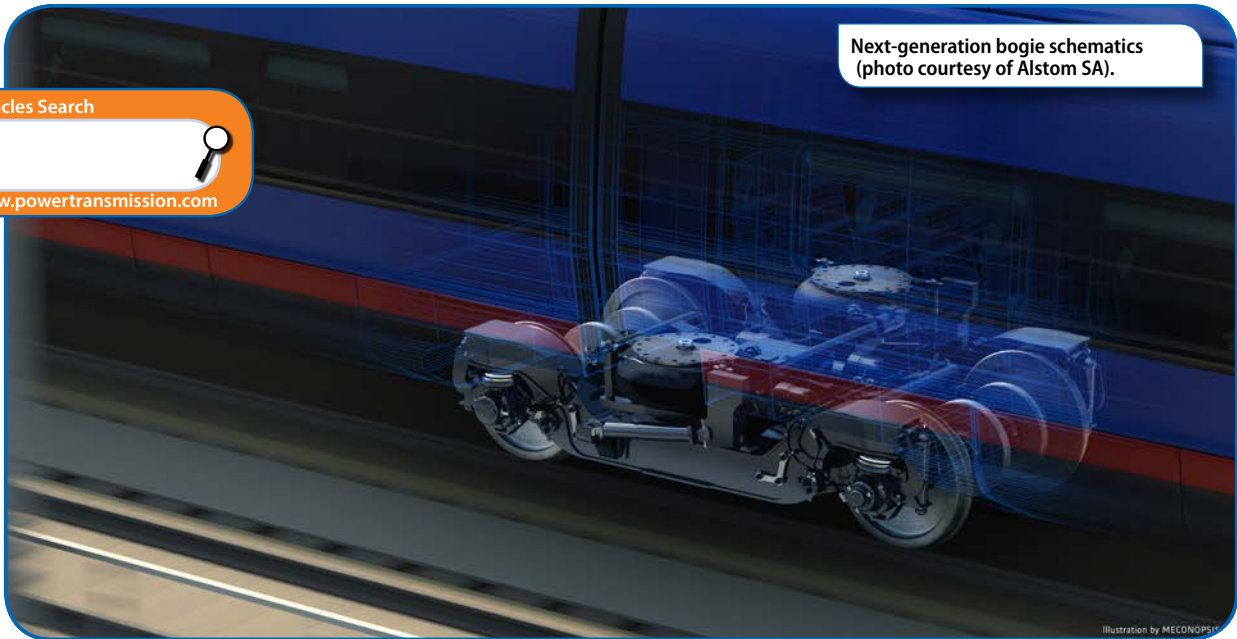


Illustration by MECONPSH

“The massive potential of the industry, and its future prospects, were very evident at InnoTrans 2016,” said Jürgen Fenske, president of the Association of German Transport Companies (VDV). “These impressions were confirmed time and again during the course of the event. It has shown that rail transport around the world is an efficient, modern and ecological form of transport for the future.”

Bhat sees great promise for new rail projects here in the United States. “The passenger rail network is well estab-

lished in Europe, especially Germany. With the increased spending on infrastructure and new equipment, the United States is heading in the same direction. It’s an exciting time for the rail industry.”

As the rail industry expands and develops here in the States, the emphasis moving forward will be on safer, quieter and more efficient components and systems. It’s an area to keep an eye on for future business in power transmission. **PTE**

For more information:

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A next generation train set in Washington D.C. (photo courtesy of Alstom SA).



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Certified Bearing Specialist Extends Bearing Life for Bakery Application

A Chicago-area bakery was replacing the tray support bearings in its ovens on a reactionary basis. Their weekly inspection cycle was resulting in two mechanics spending an average of 20 labor hours per week to replace failed bearings. The premature bearing failures were caused by a combination of the high heat and humidity in the ovens, resulting in lubrication failure and contamination. When BDI was asked to recommend a solution, the bakery was averaging one month of bearing life in this application.

BDI suggested SmartLUBE, a solid graphite fill applied to standard bearings to provide constant lubrication and prevent contamination. SmartLUBE can withstand up to 660° Fahrenheit for extended periods and carries an NSF H-1 food grade certification. SmartLUBE is used on various types of bearings with exceptions being those with non-metallic cages. Several sizes and types of bearings are available. Stock products include bearings from AMI, Nachi and EBC. SmartLUBE can also be applied to popular bearing brands.



Based on the 12-month average life established in the testing, this bakery documented \$726,573 in annual cost savings from the three ovens it has in service. Additional ovens at the customer's other bakeries are presently being retrofitted with SmartLUBE bearings.

The \$726,573 cost saving was calculated based on reduced bearing consumption, reduced labor to replace bearings, and increased oven production due to reduced downtime for maintenance. This calculation was reviewed and approved by the customer's plant maintenance manager. **PTE**



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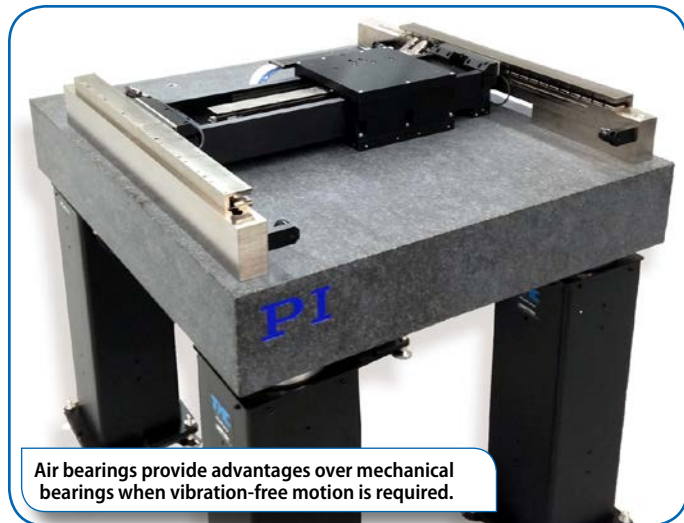


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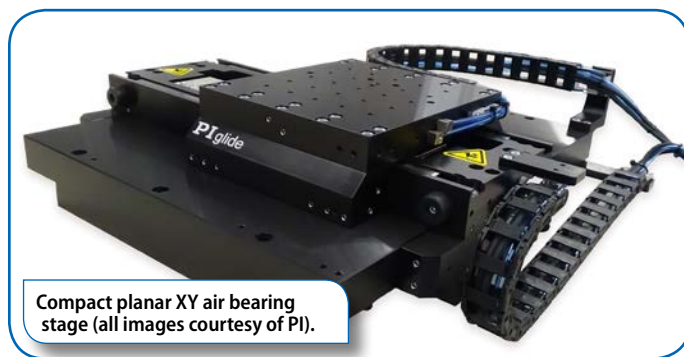
Eight Reasons to Use Air Bearings Over Mechanical Bearings

PI (Physik Instrumente) L.P.



Air bearings provide advantages over mechanical bearings when vibration-free motion is required.

Mechanical guiding systems, such as crossed-roller bearings, work well for most motion control applications; however, when precision, angular repeatability, and geometric performance (runout, straightness...) are critical or where submicron bearing rumble is problematic, air bearings are recommended. An air-bearing stage is a rotary or linear positioner that floats on a cushion of air, using one of several preload mechanisms, nearly eliminating mechanical contact and thus wear, friction, and hysteresis effects. Here are eight reasons why an air-bearing stage might be the right choice for your application:



Compact planar XY air bearing stage (all images courtesy of PI).

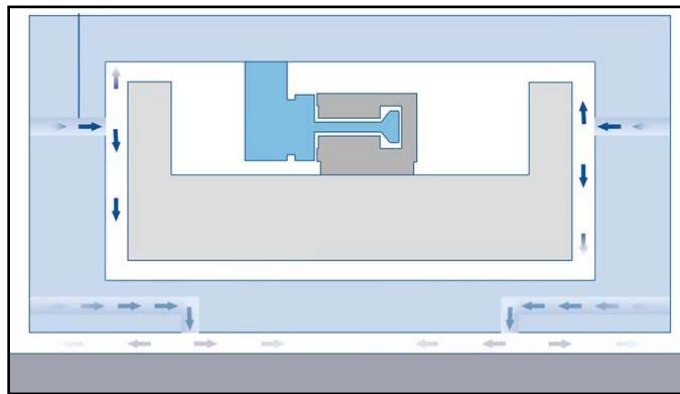
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air bearings

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1. Frictionless, High Precision Motion

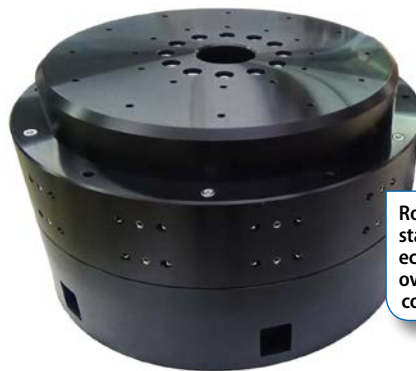
A direct-drive motor and high-resolution encoder can position a moving carriage supported by an air bearing to within nanometers in a linear application or within tenths of arc-seconds in rotational applications. The lack of friction and mechanical contact means there is minimal hysteresis or reversal error, making it highly repeatable and ideal for many inspection and manufacturing operations. Stiction is virtually eliminated, improving resolution capabilities and reducing in-position "hunting" (limit cycling), and position repeatability can be obtained within a few fundamental encoder counts. Similar precision can be obtained by piezo flexure guided stages, however over much smaller travel ranges. Magnetic levitation is another option.



How planar air bearing stages work

2. Highly Constant Velocity and High Scanning Speeds

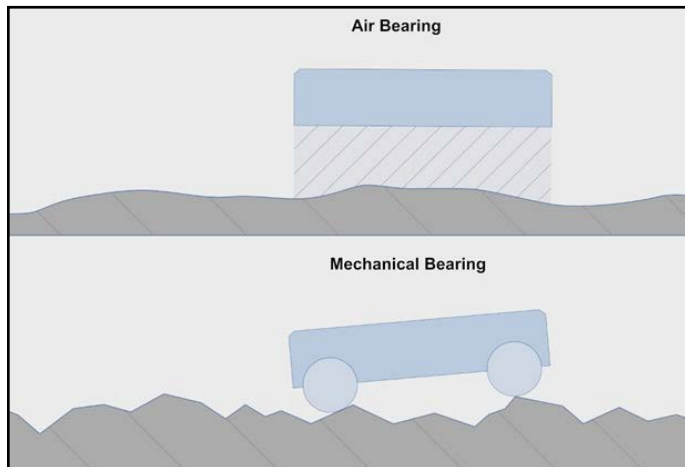
The lack of mechanical bearing elements means there is nothing to get in the way of smooth, controlled velocity (stability to better than 0.01 percent). Experiments and processes like inertial sensor testing, tomography, wafer scanning, and surface profiling require continuous motion at tightly controlled speeds are best served by air-bearing systems.



Rotary air bearing stages reduce wobble and eccentricity significantly over their mechanical counterparts.

3. Minimized Runout Errors

Linear air bearing stages have incredibly straight and flat travels, and pitch, roll and yaw errors can be measured in tenths of arc-seconds. Rotary stages can have tilt (wobble) errors less than 1 arc-second. Additionally, the angular performance of an air bearing is remarkably repeatable. This guarantees optimal part quality and measurement reliability for applications like mirror and optics inspection, semiconductor inspection, and medical device manufacturing.



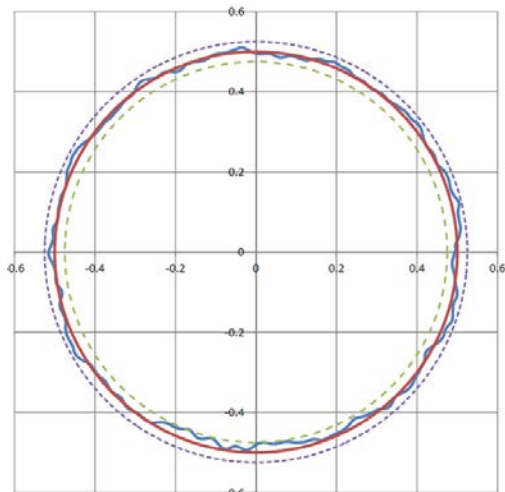
Surface averaging effect of an air bearing improves straightness / flatness of motion and reduces high-frequency bearing rumble.

4. Long-Range Motion Beyond Flexure Stage Capabilities

Piezo-driven flexure stages and actuators can satisfy many high-precision positioning applications. However, these designs are usually limited to a few millimeters of travel. Use an air bearing linear stage for travels of 25 mm or more. PI manufactures linear air bearings with travels up to a meter, and even greater with a custom design.

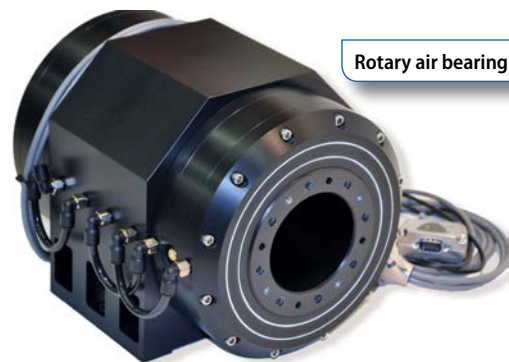
5. Wobble-Free or High Speed Rotary Motion is Needed

Rotary air bearings are exceptionally stiff and can deliver highly precise rotary motion. Radial, axial, and wobble error motions are much smaller than most mechanical bearing solutions can provide, and the rotary motion is very smooth,



Radial runout error motion of a 300mm rotary air bearing stage for use in a synchrotron beamline test facility is less than +/-35 nanometers. Wobble error motion is calculated to be +/-0.2 µrad (+/-0.04 arc-sec).

since there are no roller elements. Rotary positioning stages generally can achieve speeds up to 600 rpm, while air bearing spindles are used in higher speed applications. Rotary bearing designs can be mounted with the plane of the table in either the horizontal (i.e., turntable) or vertical orientations.



6. Minimal Maintenance

There are no contacting parts to undergo wear and tear, and no regular maintenance procedures to be performed, like lubrication. An air-bearing stage is essentially maintenance-free. Further, the system is highly stable; since there is no wear, the performance characteristics should not change over the life of the system. There is little need for re-calibration. Moving cables and hoses are often the only wear items in an air bearing system.

7. No Particulate Generation

Because air bearings are wear-free, they generate virtually no particulates that can become airborne. This makes them ideal for cleanroom applications like optics inspection, wafer inspection, bio-pharma research, and flat-panel display inspection. For extremely clean applications, it is recommended that the air bearing operate using 99.9 percent pure nitrogen.



Spherical air bearings can be used to simulate zero gravity.

8. Precise Force Control and Sensing

Air bearings are virtually frictionless, which means when they are coupled with a direct drive motor or voice coil, they are ideal for micro- and nano-Newton force control applications. Such applications can include pick-and-place of delicate items, materials testing, and coordinate measuring applications. **PTE**

For more information:

PI (Physik Instrumente) L.P.
Phone: (508) 832-3456
www.pi-usa.us

Timing Belts and Pulleys — Operations

Timing Belt Design and Installation Suggestions

SDP/SI

Low-Speed Operation

Synchronous drives are especially well-suited for low-speed, high-torque applications. Their positive driving nature prevents potential slippage associated with V-belt drives, and even allows significantly greater torque carrying capability. Small pitch synchronous drives operating at speeds of 50 ft/min (0.25 m/s) or less are considered to be low-speed. Care should be taken in the drive selection process as stall and peak torques can sometimes be very high. While intermittent peak torques can often be carried by synchronous drives without special considerations, high cyclic peak torque loading should be carefully reviewed.

Proper belt installation tension and rigid drive bracketry and framework are essential in preventing belt tooth jumping under peak torque loads. It is also helpful to design with more than the normal minimum of six belt teeth in mesh to ensure adequate belt tooth shear strength.

Newer-generation curvilinear systems like PowerGrip GT2 and PowerGrip HTD (PowerGrip and HTD are registered trademarks of the Gates Corporation.) should be used in low-speed, high-torque applications, as trapezoidal timing belts are more prone to tooth jumping and have significantly less load carrying capacity.

High-Speed Operation

Synchronous belt drives are often used in high-speed applications—even though V-belt drives are typically better suited. They are often used because of their positive driving characteristic—no creep or slip—and because they require minimal maintenance, i.e.—don't stretch significantly. A significant drawback of high-speed synchronous drives is drive noise. High-speed synchronous drives will nearly always produce more noise than V-belt drives. Small-pitch synchronous drives operating at speeds in excess of 1,300 ft/min (6.6 m/s) are considered to be high-speed.

Special consideration should be given to high-speed drive designs, as a number of factors can significantly influence belt performance. Cord fatigue and belt tooth wear are the two most significant factors that must be controlled to ensure continued success. Moderate pulley diameters should be used to reduce the rate of cord flex fatigue. Designing with a smaller pitch belt will often provide better cord flex fatigue characteristics than a larger pitch belt. PowerGrip GT2 is especially well suited for high-speed drives because of its excellent belt tooth entry/exit characteristics. Smooth interaction between the belt tooth and pulley groove minimizes



wear and noise. Belt installation tension is especially critical with high-speed drives. Improper or low belt tension allows the belt to ride out of the driven pulley, resulting in rapid belt tooth and pulley groove wear.

Smooth Running

Some ultrasensitive applications require the belt drive to operate with as little vibration as possible, as vibration sometimes has an effect on the system operation or finished manufactured product. In these cases the characteristics and properties of all appropriate belt drive products should be reviewed. The final drive system selection should be based upon the most critical design requirements, and may require some compromise.

Vibration is not generally considered a problem with synchronous belt drives; low levels of vibration typically result from the process of tooth meshing and/or as a result of their high tensile modulus properties. Vibration resulting from tooth meshing is a normal characteristic of synchronous belt drives, and cannot be completely eliminated. It can, however, be minimized by avoiding small pulley diameters and instead choosing moderate sizes. The dimensional accuracy of the pulleys also influences tooth meshing quality. Additionally, installation tension has an impact on meshing quality. PowerGrip GT2 drives mesh very cleanly, resulting in the smoothest possible operation. Vibration resulting from high tensile modulus can be a function of pulley quality. Radial runout causes belt tension variation with each pulley revolution. V-belt pulleys are also manufactured with some radial

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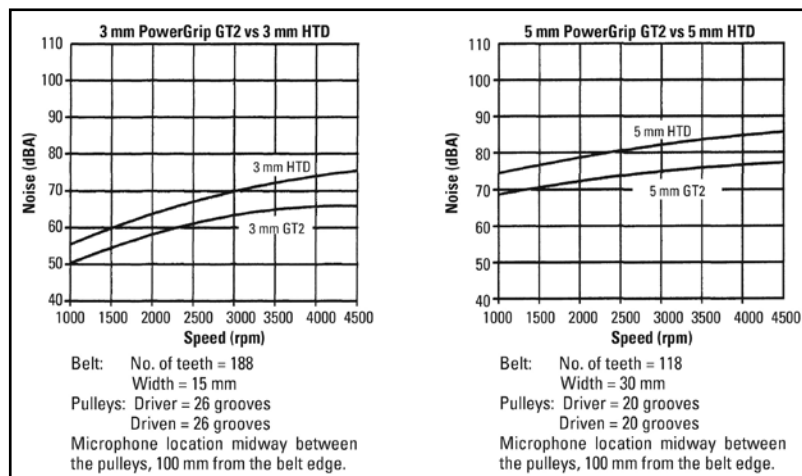


Figure 1 Comparison of noise levels for various belts. (All images courtesy SDP/PI.)

runout, but V-belts have a lower tensile modulus, resulting in less belt tension variation. The high-tensile modulus found in synchronous belts is necessary to maintain proper pitch under load.

Drive Noise

Drive noise evaluation in any belt drive system should be approached with care. There are many potential sources of noise in a system, including vibration from related components, bearings, and resonance and amplification through framework and panels.

Synchronous belt drives typically produce more noise than V-belt drives. Noise results from the process of belt tooth meshing and physical contact with the pulleys. The sound pressure level generally increases as operating speed and belt width increase, and as pulley diameter decreases. Drives designed on moderate pulley sizes without excessive capacity (over-designed) are generally the quietest. Power-Grip GT2 drives have been found to be significantly quieter than other systems due to their improved meshing characteristic (Fig. 1). Polyurethane belts generally produce more noise than neoprene belts. Proper belt installation tension is also very important in minimizing drive noise. The belt should be tensioned at a level that allows it to run with as little meshing interference as possible.

Drive alignment also has a significant effect on drive noise. Special attention should be given to minimizing *angular* misalignment (shaft parallelism). This assures that belt teeth are loaded uniformly and minimizes side-tracking forces against the flanges. *Parallel* misalignment (pulley offset) is not as critical of a concern as long as the belt is not trapped or pinched between opposite flanges. Pulley materials and dimensional accuracy also influence drive noise. Some users have found that steel pulleys are the quietest, followed closely by aluminum. Polycarbonates have been found to be noisier than metallic materials. Machined pulleys are generally quieter than molded pulleys. The reasons for this revolve around material density and resonance characteristics as well as dimensional accuracy.

Static Conductivity

Small synchronous rubber or urethane belts can generate an electrical charge while operating on a drive. Factors such as humidity and operating speed influence the potential of the charge. If determined to be a problem, rubber belts can be produced in a conductive construction in order to dissipate the charge into the pulleys and to ground. This prevents the accumulation of electrical charges that might be detrimental to material handling processes or sensitive electronics. It also greatly reduces the potential for arcing or sparking in flammable environments. Urethane belts cannot be produced in a conductive construction.

The RMA (Rubber Manufacturer's Association) has outlined standards for conductive belts in their bulletin IP-3-3. Unless otherwise specified, a static conductive construction for rubber belts is available on a made-to-order basis. Unless otherwise specified, conductive belts will be built to yield a resistance of 300,000 ohms or less, when new.

Nonconductive belt constructions are also available for rubber belts. These belts are generally built specifically to the customer's conductivity requirements. They are generally used in applications where one shaft must be electrically isolated from the other. It is important to note that a static conductive belt cannot dissipate an electrical charge through plastic pulleys. At least one metallic pulley in a drive is required for the charge to be dissipated to ground. A grounding brush or similar device may also be used to dissipate electrical charges.

Urethane timing belts are not static conductive and cannot be built in a special conductive construction. Special conductive rubber belts should be used when the presence of an electrical charge is a concern.

Operating Environments

Synchronous drives are suitable for use in a wide variety of environments. Special considerations may be necessary, however, depending on the application.

Dust. Dusty environments do not generally present serious problems to synchronous drives as long as the particles are fine and dry. Particulate matter will, however, act as an abrasive resulting in a higher rate of belt and pulley wear. Damp or sticky particulate matter deposited and packed into pulley grooves can cause belt tension to increase significantly. This increased tension can impact shafting, bearings and framework. Electrical charges within a drive system can sometimes attract particulate matter.

Debris. Debris should be prevented from falling into any synchronous belt drive. Debris caught in the drive is generally either forced through the belt or results in stalling of the system. In either case, serious damage occurs to the belt and related drive hardware.

Water. Light and occasional contact with water (occasional wash downs) should not seriously affect synchronous belts.

Prolonged contact (constant spray or submersion) results in significantly reduced tensile strength in fiberglass belts, and potential length variation in aramid belts. Prolonged contact with water also causes rubber compounds to swell, although less so than with oil contact. Internal belt adhesion systems are also gradually broken down with the presence of water. Additives to water such as lubricants, chlorine, anti-corrosives, etc. can have a more detrimental effect on the belts than pure water. Urethane timing belts also suffer from water contamination. Polyester tensile cord shrinks significantly and experiences loss of tensile strength in the presence of water. Aramid tensile cord (*man-made, high-performance fibers with unique combination of characteristics, such as high strength and no melting point*) maintains its strength fairly well, but experiences length variation. Urethane swells more than neoprene in the presence of water. This swelling can increase belt tension significantly, causing belt and related hardware problems.

Oil. Light contact with oils on an occasional basis will not generally damage synchronous belts; prolonged contact with oil or lubricants, either directly or airborne, results in significantly reduced belt service life. Lubricants cause the rubber compound to swell, break down internal adhesion systems, and reduce belt tensile strength. While alternate rubber compounds may provide some marginal improvement in durability, it is best to prevent oil from contacting synchronous belts.

Ozone. The presence of ozone can be detrimental to the compounds used in rubber synchronous belts. Ozone degrades belt materials in much the same way as excessive environmental temperatures. Although the rubber materials used in synchronous belts are compounded to resist the effects of ozone, eventually chemical breakdown occurs and they become hard and brittle and begin cracking. The amount of degradation depends upon the ozone concentration and duration of exposure. For good performance of rubber belts, the following concentration levels should not be exceeded (parts-per-hundred-million):

- Standard construction: 100 pphm
- Non-marking construction: 20 pphm
- Conductive construction: 75 pphm
- Low-temperatures construction: 20 pphm

Radiation. Exposure to gamma radiation can be detrimental to the compounds used in rubber and urethane synchronous belts. Radiation degrades belt materials much the same way excessive environmental temperatures do. The amount of degradation depends upon the intensity of radiation and the exposure time. For good belt performance, the following exposure levels should not be exceeded:

- Standard Construction: 108 rads
- Non-marking Construction: 104 rads
- Conductive Construction: 106 rads
- Low Temperatures Construction: 104 rads

Dust generation. Rubber synchronous belts are known to generate small quantities of fine dust, as a natural result of their operation. The quantity of dust is typically higher for new belts, as they run in. The period of time for run-in to occur depends upon the belt and pulley size, loading, and speed. Factors such as pulley surface finish, operating speeds, installation tension, and alignment influence the quantity of dust generated.

Clean room. Rubber synchronous belts may not be suitable for use in clean room environments, where all potential contamination must be minimized or eliminated. Urethane timing belts typically generate significantly less debris than rubber timing belts. However, they are recommended only for light operating loads. Also, they cannot be produced in a static conductive construction to allow electrical charges to dissipate.

Static-sensitive. Applications are sometimes sensitive to the accumulation of static electrical charges. Electrical charges can affect material handling processes (like paper and plastic film transport), and sensitive electronic equipment. Applications like these require a static conductive belt, so that the static charges generated by the belt can be dissipated into the pulleys, and to ground. Standard rubber synchronous belts do not meet this requirement, but can be manufactured in a static conductive construction on a made-to-order basis. Normal belt wear resulting from long-term operation or environmental contamination can influence belt conductivity properties.

In sensitive applications, rubber synchronous belts are preferred over urethane belts since urethane belting cannot be produced in a conductive construction.

Belt Tracking

Lateral tracking characteristics of synchronous belts is a common area of inquiry. While it is normal for a belt to favor one side of the pulleys while running, it is abnormal for a belt to exert significant force against a flange, resulting in

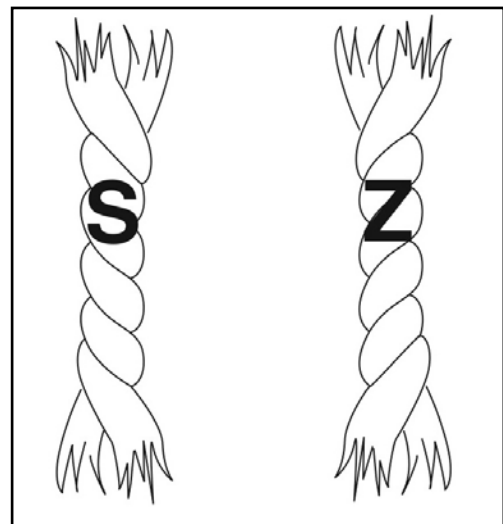


Figure 2 Cord twist.

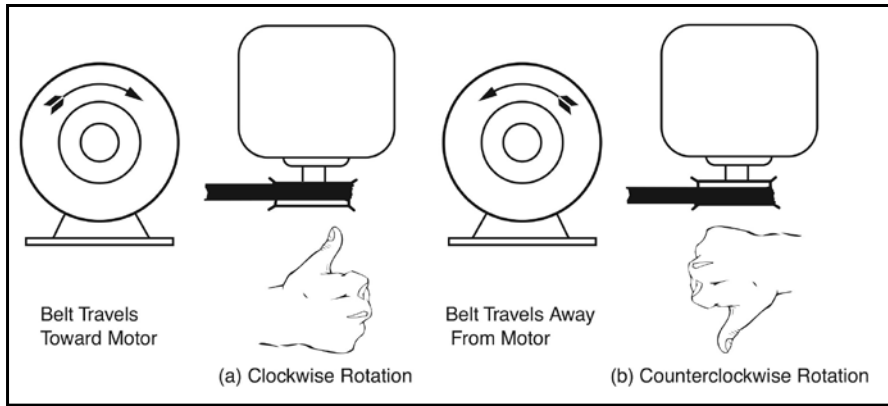


Figure 3 Right-hand rule applicable to “S” twist.

belt edge wear and potential flange failure. Belt tracking is influenced by several factors; in order of significance, they are as follows:

Tensile cord twist. Tensile cords are formed into a single-twist configuration during their manufacture. Synchronous belts made with only single-twist tensile cords track laterally with significant force. To neutralize this tracking force tensile cords are produced in right- and left-hand twist (or “S” and “Z” twist) configurations. Belts made with “S” twist tensile cords track in the opposite direction to those built with “Z” twist cord. Belts made with alternating “S” and “Z” twist tensile cords track with minimal lateral force because the tracking characteristics of the two cords offset each other. The content of “S” and “Z” twist tensile cords varies slightly with every belt that is produced. As a result, every belt has an unprecedented tendency to track in either one direction or the other. When an application requires a belt to track in one specific direction only, a single-twist construction is used (Figs. 2 and 3).

Angular misalignment. Angular misalignment, or shaft non-parallelism, causes synchronous belts to track laterally. The angle of misalignment influences the magnitude and direction of the tracking force. Synchronous belts tend to track “downhill” to a state of lower tension or shorter center distance.

Belt width. The potential magnitude of belt tracking force is directly related to belt width; wide belts tend to track with more force than narrow belts.

Pulley diameter. Belts operating on small pulley diameters sometimes tend to generate higher tracking forces than on large diameters. This is particularly true as the belt width approaches the pulley diameter. Drives with pulley diameters less than the belt width are not generally recommended, as belt tracking forces can become excessive.

Belt length. Because of how tensile cords are applied to the belt molds, short belts may tend to exhibit higher tracking forces than long belts; the helix angle of the tensile cord decreases with increasing belt length.

Gravity. In drive applications with vertical shafts, gravity pulls the belt downward. The magnitude of this force is minimal with small pitch synchronous belts. Sag in long belt spans should be avoided by applying adequate belt installation tension.

Torque loads. Sometimes while in operation a synchronous belt will move laterally from side to side on the pulleys, rather than operating in a consistent position. While not generally considered to be a significant concern, one explanation for this is varying torque loads within the drive. Synchronous belts sometimes track differently with changing loads. There are many potential reasons for this; the primary cause is related to tensile cord distortion while under pressure against the pulleys. Variation in belt tensile loads

can also cause changes in framework deflection and angular shaft alignment, resulting in belt movement.

Belt installation tension. Belt tracking is sometimes influenced by the level of belt installation tension. The reasons for this are similar to the effect that varying torque loads have on belt tracking. When problems with belt tracking are experienced, each of these potential contributing factors should be investigated in the order that they are listed. In most cases, the primary problem will probably be identified before moving completely through the list.

Pulley Flanges

Pulley guide flanges are necessary to keep synchronous belts operating on their pulleys. As discussed previously in the “Belt Tracking” section, it is normal for synchronous belts to favor one side of the pulleys when running. Proper flange design is important in preventing belt edge wear, minimizing noise and preventing the belt from climbing out of the pulley. Dimensional recommendations for custom-made or molded flanges are included in tables dealing with these issues. Proper flange placement is important so that the belt is adequately restrained within its operating system. Because design and layout of small synchronous drives is so diverse, the wide variety of flanging situations potentially encountered cannot easily be covered in a simple set of rules without finding exceptions. Despite this, the following broad flanging guidelines should help the designer in most cases:

Two-pulley drives. On simple two-pulley drives, either one pulley should be flanged on both sides, or each pulley should be flanged on opposite sides.

Multiple-pulley drives. On multiple-pulley (or serpentine) drives, either every other pulley should be flanged on both sides, or every pulley should be flanged on alternating sides around the system.

Vertical shaft drives. On vertical shaft drives, at least one pulley should be flanged on both sides, and the remaining pulleys should be flanged on at least the bottom side.

Long span lengths. Flanging recommendations for small synchronous drives with long belt span lengths cannot easily be defined due to the many factors that can affect belt tracking characteristics. Belts on drives with long spans (generally 12 times the diameter of the smaller pulley or more) often require more lateral restraint than with short spans. Because

of this, it is generally a good idea to flange the pulleys on both sides.

Large pulleys. Flanging large pulleys can be costly. Designers often wish to leave large pulleys unflanged to reduce cost and space. Belts generally tend to require less lateral restraint on large pulleys than small, and can often perform reliably without flanges. When deciding whether or not to flange, the previous guidelines should be considered. The groove face width of un-flanged pulleys should also be greater than with flanged pulleys. (See next page, Table 1, for recommendations.)

Idlers. Flanging of idlers is generally not necessary. Idlers designed to carry lateral side loads from belt tracking forces can be flanged if needed to provide lateral belt restraint. Idlers used for this purpose can be used on the inside or backside of the belts. The previous guidelines should also be considered.

Registration

The three primary factors contributing to belt drive registration (or positioning) errors are belt elongation, backlash, and tooth deflection. When evaluating the potential registration capabilities of a synchronous belt drive, the system must first be determined to be either static or dynamic in terms of its registration function and requirements.

Static registration. A static registration system moves from its initial static position to a secondary static position. During the process, the designer is concerned only with how accurately and consistently the drive arrives at its secondary position. He/she is not concerned with any potential registration errors that occur during transport. Therefore, the primary factor contributing to registration error in a static registration system is backlash. The effects of belt elongation and tooth deflection do not have any influence on the registration accuracy of this type of system.

Dynamic registration. A dynamic registration system is required to perform a registering function while in motion with torque loads varying as the system operates. In this case, the designer is concerned with the rotational position of the drive pulleys with respect to each other at every point in time. Therefore, belt elongation, backlash and tooth deflection will all contribute to registration inaccuracies; further discussion about each of the factors contributing to registration error is as follows:

Belt elongation. Belt elongation, or stretch, occurs naturally when a belt is placed under tension. The total tension exerted within a belt results from installation, as well as working loads. The amount of belt elongation is a function of the belt tensile modulus, which is influenced by the type of tensile cord and the belt construction. The standard tensile cord used in rubber synchronous belts is fiberglass. Fiberglass has a high tensile modulus, is dimensionally stable, and has excellent flex-fatigue characteristics. If a higher tensile modulus is needed, aramid tensile cords can be considered, although they are generally used to provide resistance

| Belt Type | Nom. Face Width Unflanged | | Nom. Face Width Flanged | |
|-----------------|---------------------------|-------|-------------------------|-------|
| | inches | mm | inches | mm |
| MXL | +0.125 | — | +0.040 | — |
| XL | +0.190 | — | +0.060 | — |
| 2 mm Gr2 | +0.118 | +3.00 | +0.039 | +1.00 |
| 3 mm Gr2 & HTD® | +0.157 | +4.00 | +0.049 | +1.25 |
| 5 mm Gr2 & HTD® | +0.197 | +5.00 | +0.059 | +1.50 |

* Add Table Values to Nominal Belt Width for Nominal Face Width

to harsh shock and impulse loads. Aramid tensile cords used in small synchronous belts generally have only a marginally higher tensile modulus in comparison to fiberglass. When needed, belt tensile modulus data is available from our Application Engineering Department.

Backlash. Backlash in a synchronous belt drive results from clearance between the belt teeth and the pulley grooves. This clearance is needed to allow the belt teeth to enter and exit the grooves smoothly with a minimum of interference. The amount of clearance necessary depends upon the belt tooth profile. Trapezoidal timing belt drives are known for having relatively little backlash. PowerGrip HTD drives have improved torque carrying capability and resist ratcheting, but have a significant amount of backlash. PowerGrip GT2 drives have even further improved torque carrying capability, and have as little or less backlash than trapezoidal timing belt drives. In special cases, alterations can be made to drive systems to further decrease backlash. These alterations typically result in increased belt wear, increased drive noise and shorter drive life.

Tooth deflection. Tooth deformation in a synchronous belt drive occurs as a torque load is applied to the system, and individual belt teeth are loaded. The amount of belt tooth deformation depends upon the amount of torque loading, pulley size, installation tension and belt type. Of the three primary contributors to registration error, tooth deflection is the most difficult to quantify. Experimentation with a prototype drive system is the best means of obtaining realistic estimations of belt tooth deflection.

Additional guidelines that may be useful in designing registration critical drive systems are as follows:

- Select PowerGrip GT2 or trapezoidal timing belts
- Design with large pulleys with more teeth in mesh
- Keep belts tight; control tension closely
- Design frame/shafting to be rigid under load
- Use high-quality machined pulleys to minimize radial runout and lateral wobble **PTE**

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CORRECTION AND UPDATE

The article "An Open-and-Shut Case: Greases for Gear Applications," by Dr.-Ing. Johann-Paul Stemplinger, appeared in the September 2016 issue of *Power Transmission Engineering*. Dr. Stemplinger, who wrote the paper when he worked for FZG, has been, since January 2016, Manager Transmission Testing for Audi AG in Ingolstadt, Germany, and this information was not included in his biographical sketch that appeared with the article. We apologize for this oversight.

In addition, we'd like to share with you the following brief description of FZG and its work:

FZG — AN OVERVIEW

The Institute for Machine Elements, perhaps better known as the Gear Research Centre (or quite simply FZG) is an integral part of the Faculty of Mechanical Engineering at Technische Universität München in Germany. Founded in 1951 by Prof. Dr.-Ing. E.h. Gustav Niemann, FZG now occupies a leading position in research, development and standardization as the international competence center for issues concerning mechanical drive technology. Since October 2011, the institute has been led by Prof. Dr.-Ing. Karsten Stahl. The development of methods and tools for the reliable determination of fatigue life, efficiency and vibration characteristics of gears and transmission elements is the focus for all research activities at FZG. More than 75 employees work at the institute, which has comprehensive facilities for the examination and testing of different machine elements such as gears, synchronizers, clutches and rolling element bearings. There are close contacts to industry, both in education as well as in research, in order to be able to offer modern education as close as possible to practical demands and to orient research to current challenges in practical applications. Conversely, new scientific knowledge and methods are provided to industry. **For more information, please visit www.fzg.mw.tum.de.**

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The 2016 *Power Transmission Engineering* Buyers Guide was compiled to provide you with a handy resource containing the contact information for significant suppliers of power transmission components.

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Bold Listings throughout the Buyers Guide indicate that a company has an advertisement in this issue of *Power Transmission Engineering*.

How to Get Listed in the Buyers Guide

Although every effort has been made to ensure that this Buyers Guide is as comprehensive, complete and accurate as possible, some companies may have been inadvertently omitted. If you'd like to add your company to the directory, we welcome you. Please visit www.powertransmission.com/getlisted.php to fill out a short form with your company information and Buyers Guide categories. These listings will appear online at www.powertransmission.com, and those listed online will automatically appear in next year's printed Buyers Guide.

Handy Online Resources

The *Power Transmission Engineering* Buyers Guide – The listings printed here are just the basics. Visit our online buyers guide for the most comprehensive directory of suppliers of gears, bearings, motors, clutches, couplings, gear drives and other mechanical power transmission components, broken down into sub-category by type of product manufactured:

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www.bellowstech.com

Bevel Gears India Pvt. Ltd.
www.jamalgears.co.in

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www.c-flex.com

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CCTY Bearing
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CENTA Corp.
www.centa.info

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www.certifiedreducer.net

Challenge Power Transmission (Aust) Pty. Ltd.
www.challengept.com

Challenge Power Transmission PLC
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www.cmtco.com

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www.daidocorp.com

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www.deltron.com

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www.drivecomponentsllc.com

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Duff Norton Sales South Pacific
www.dnsales.com.au

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www.eagleplc.com

Electro Steel Engineering Company
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Emerson Industrial Automation - Drives & Motor
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www.industrialsparesfromindia.com

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Exlar Actuation Solutions
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Festo Corporation
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FMC Engineering
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Framo Morat Inc.
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Gil Equipamentos Industriais Ltda.
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Gleason Plastic Gears
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H2W Technologies
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Hidrax
www.hidrax.eu/en/

Houston Pump and Gear
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www.kinematicsmfg.com

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www.drivelines.co.uk

Duff Norton Sales South Pacific
www.dnsales.com.au

Dunkermotoren USA Inc.
www.dunkermotor.com

Dynamic Structures and Materials, LLC
www.dynamic-structures.com

Eagle PLC
www.eagleplc.com

Electronic Machine Parts
www.empregister.com

Emerson Industrial Automation - Drives & Motor
www.emersonindustrial.com

EquipNet
www.equipnet.com

Festo Corporation
www.festo.com/usa

Flux Drive Inc.
www.fluxdrive.com

Force Control Industries
www.forcecontrol.com

FSI Technologies Inc.
www.fsinet.com

GKN Land Systems
www.gknlansystems.com

GMB Associates
www.gmbassociates.co.uk

GoHz Power Supply Inc.
www.gohz.com

Hallmark Industries Inc.
www.hallmarkind.com

Hansen Corporation
www.hansen-motor.com

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www.heidenhain.com

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www.hoffmann-tech.ch

HPB Motion Control Co. Ltd.
www.hpb-industry.com

IBT, Inc.
www.ibtinc.com

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www.icpltd.co.uk

Inertia Dynamics, Inc.
www.idicb.com

Intellidrives, Inc.
www.intellidrives.com

ISC Companies
www.isccompanies.com

Johnson Industries Ltd.
www.brakes.ca

JVL Industri Elektronik A/S
www.jvl.dk

K+S Services
www.k-and-s.com

KB Controls
www.kb-controls.com

Kinematics Manufacturing, Inc.
www.kinematicsmfg.com

Kollmorgen Div. of Danaher
www.kollmorgen.com

Leeson Electric
www.leeson.com

Lenze Americas
www.lenze.com

Magtrol, Inc.
www.magtrol.com

Marshall Wolf Automation Inc.
www.wolfautomation.com

Mavilor Motors, S.a.
www.mavilor.es

Maxcess
www.maxcessintl.com

Maxon Precision Motors Inc.
www.maxonmotorusa.com

MICO, Incorporated
www.mico.com

Micronor Inc.
www.micronor.com

Midwest Motion Products
www.midwestmotion.com

Mitsubishi Electric Automation, Inc.
us.mitsubishielectric.com/fa/en

Modicon PLC
www.modiconplc.com

Motion Industries
www.motionindustries.com

MROSupply
www.mrosupply.com

New Power Electric (USA) LLC
www.usa-newpower.com

New Torque, Inc.
www.clutches-brakes.com

Norwin Electronics Limited
www.norwin.co.uk

Novotec Argentina SRL
www.novotecargentina.com

Onvio LLC
www.onvio.com

Ormec
www.ormec.com

Parker Hannifin SSD Drives Div.
www.parker.com/ssdusa

Phytron, Inc.
www.phytron.com

PI (Physik Instrumente) L.P. Piezo Actuator Nano
www.pi-usa.us

Potomac Electric
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Power Electric
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www.powerinverter.org

Precipart
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PTD Outlet: Power Transmission Distributors
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Rae DC Products Group
www.raemotors.com

Regent Controls, Inc.
www.regentcontrols.com

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www.rowland2.com

Sesame Motor Corp.
www.sesamemotor.com.tw

SEW-Eurodrive
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LYMAN SC 29635
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www.seweurodrive.com

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Tampa Armature Works- TAW
www.tawinc.com

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www.team-ind.com

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www.tecowestinghouse.com

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www.thomsonlinear.com

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www.tolomatic.com

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www.vlmotion.com

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www.wajax.com

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www.weg.net

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WorldWide Electric Corporation
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www.yaskawa.com

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www.acidon.com.br

Acionac Indústria e Comércio Ltda
www.acionac.com.br

Acorn Industrial Services
www.acorn-ind.co.uk

Affiliated Distributors
www.adhq.com

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Agro Engineers
www.agroengineers.com

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www.aiscoinc.com

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Ameridrives Power Transmission
www.ameridrivespowertransmission.com

Ametric / American Metric Corporation
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Applied Dynamics
www.applied-dynamics.com

Applied Power Solutions
www.apscorp.com

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www.aredist.com

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www.bellowstech.com

Bervina
www.bervina.com

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www.cjmco.com

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www.centa.info

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www.cestari.com.br

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Duff Norton Sales South Pacific
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Electromatic Engineers Pvt. Ltd.
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Electro Steel Engineering Company
www.indiamart.com/tyginc

Elliott Manufacturing
www.elliottmfg.com

Esco Couplings N/V.
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Flexocon Engineers Private Limited
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Formsprag Clutch
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MES Inc.
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www.mgw.by

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Moventas Ltd.
www.moventas.com

NDE Power Transmissions
www.ndepower.com

Netshape Technologies, Inc.
www.netshapetech.com

New Power Electric (USA) LLC
www.usa-newpower.com

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www.naclutch.com

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OEP Couplings, a Division of Oren Elliott Products
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Ondrives US Corp.
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www.orttech.com

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www.ptintl.com

Pacific Industries
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Palmer Johnson Power Systems
www.pjpower.com

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www.pic-design.com

Pinpoint Laser Systems
www.pinpointlaser.com

Pix Transmissions Limited
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Popular Mechanical Works
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PowerDrive LLC
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PTD Outlet: Power Transmission Distributors
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Ringfeder Power Transmission USA Corp.
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Ringspann Corporation
www.ringspanncorp.com

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Taiwan Precision Gear Corp.
www.tpg-tw.com

Taiwan United Gear Co., Ltd.
www.tugear.com.tw

TB Wood's
www.tbwoods.com

Team Industries
www.team-ind.com

Techcellence India
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Tien Yi Gear Works Co., Ltd.
www.tienyigear.com.tw

Timothy Holding Co., Ltd.
www.timothyholding.com

Transmission Machinery Co., Ltd
www.transcyko-transstec.com

Transply Inc.
www.transply.com

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Chesterfield Electric Motors
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Dalton Bearing Service, Inc.
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heliumleaktesting.com

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www.oeminternational.com

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Popular Mechanical Works
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Precision Pump and Gear Works
www.ppg-works.com

FLUID POWER

Acorn Industrial Services
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www.rowland2.com

Rubena a.s.
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S.M. Shah & Company
www.hydraulicvanepump.com

Shanghai DE Mechanical Gears Co., Ltd.
www.gearvalves.com

T.E.A. Machine Components
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Taiwan United Gear Co., Ltd.
www.tugear.com.tw

Techtop Industries, Inc.
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WorldWide Electric Corporation
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American Gear & Engineering
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Trojon Gear Inc.

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Unigear Industries

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Vision Quality Components, Inc

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VW Broaching Service Inc.

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www.minigears.co.uk

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Motion Industries
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Moventas Ltd.
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MT Tool & Manufacturing
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Netshape Technologies, Inc.
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Baldor Basics: Motors

Edward Cowern, P.E.

Beginning with this initial installment — and with the gracious permission of ABB/Baldor Electric — we are pleased to announce the beginning of a new series — *Baldor Basics: Motors*. This is a collection of basics-driven, motor-intensive articles authored by former Baldor engineer Edward Cowern, PE — a respected name by many in the electric motor industry. During his tenure at Baldor, Cowern — now enjoying his retirement — was tasked with producing a number of motor- and basics-related tutorials, primarily in response to a steady flow of customer questions regarding motors. Today's customers continue to ask questions and seek answers to address their various motor-related issues. As with Cowern's original introduction to the series, we hope you find these articles useful and would appreciate any comments or thoughts you might have for future improvements, corrections or topics.

— The Editors

Types of Motors

The most reliable piece of electrical equipment in service today is a transformer. The second most reliable is the 3-phase induction motor. Properly applied and maintained, 3-phase motors will last many years. One key element of motor longevity is proper cooling. Motors are generally classified by the method used to dissipate the internal heat.

Several standard motor enclosures are available to handle the range of applications — from “clean-and-dry” (indoor air handlers) to the “wet-or-worse” — as found on roofs and wet cooling towers.

Open drip-proof (ODP) motors are good for clean and dry environments. As the name implies, drip-proof motors can handle some dripping water provided it falls from overhead or no more than 15 degrees off vertical. These motors usually have ventilating openings that face down. The end housings can frequently be rotated to maintain “drip-proof” integrity when the motor is mounted in a different orientation. These motors are cooled by a continuous flow of the surrounding air through the internal parts of the motor.

Totally enclosed fan-cooled (TEFC) motors are cooled by an external fan mounted on the end opposite the shaft. The fan blows ambient air across the outside surface of the motor to carry heat away. Air does not move through the inside of the motor, so TEFC motors are suited for dirty, dusty, and outdoor applications. There are many special types of TEFC motors, including corrosion-protected and washdown styles. These motors have special features to handle difficult environments. TEFC motors generally have “weep holes” at their lowest points to prevent condensation from puddling inside the motor. As in open drip-proof motors, if the TEFC motor is mounted in a position other than horizontal, the end housings can generally be repositioned to keep the weep holes at the lowest point.

Totally enclosed air over (TEAO) motors are applied in the air-stream on machines such as vane axial fans where the air moved by a direct connected fan passes over the motor and cools it. TEAO motors frequently have dual HP ratings, depending on the speed and temperature of the cooling air. Typical ratings for a motor might be: 10 HP with 750 feet-per-minute of 104 °F air, 10 HP with 400 FPM of 70 °F air, or 12.5 HP with 3,000 FPM of 70 °F air. TEAO motors are usually confined to original equipment manufacturer (OEM) applications be-

cause the air temperature and flows need to be predetermined.

Totally enclosed non-ventilated (TENV) motors are generally confined to small sizes (usually under 5 HP) where the motor surface area is large enough to radiate and convect the heat to the outside air without an external fan or air flow. They have been popular in textile applications because lint cannot obstruct cooling.

Hazardous location motors are a special form of totally enclosed motor. They fall into different categories depending upon the application and environment, as defined in Article 500 of the National Electrical Code.

The two most common hazardous location motors are **Class I—explosion-proof**, and **Class II—dust ignition-resistant**. The term explosion-proof is commonly — but *erroneously* — used to refer to all categories of hazardous location motors. Explosion-proof applies only to Class I environments — i.e., those that involve potentially explosive liquids, vapors, and gases. Class II is termed dust ignition-resistant; these motors are used in environments that contain combustible dusts such as coal, grain, flour, etc.

Single-phase motors. Three-phase motors start and run in a direction based on the “phase rotation” of the incoming power. Single-phase motors are different — they require an auxiliary starting means. Once started in a direction, they continue to run in that direction. Single-phase motors are categorized by the method used to start the motor and establish the direction of rotation.

Table 1 The three categories generally found in HVAC applications

| Category | Approximate HP Range | Relative Efficiency |
|-------------|----------------------|---------------------|
| Shaded pole | 1/100–1/6 HP | Low |
| Split Phase | 1/25–1/2 HP | Medium |
| Capacitor | 1/25–15 HP | Medium to High |

Three Categories Generally Found in HVAC Applications

Shaded pole is the simplest of all single-phase starting methods. These motors are used only for small, simple applications such as bathroom exhaust fans. In the shaded pole motor, the motor field poles are notched and a copper shorting ring is installed around a small section of the poles (Fig. 1).

The **altered pole** configuration delays the magnetic field build-up in the portion of the poles surrounded by the cop-

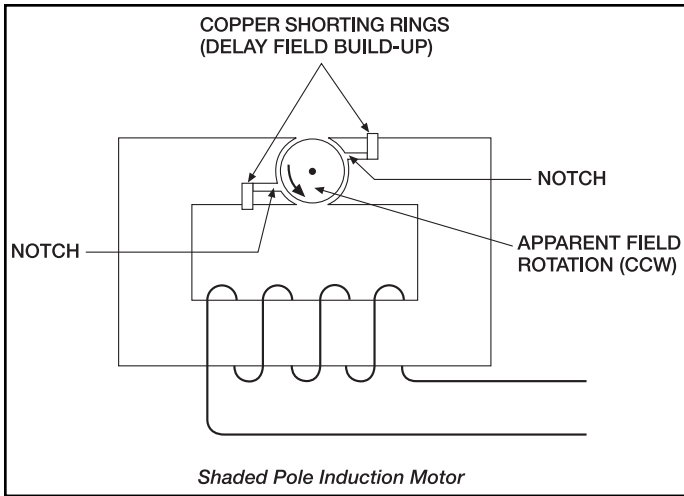


Figure 1 Shaded pole is the simplest of all single phase starting methods.

per shorting rings. This arrangement makes the magnetic field around the rotor seem to rotate from the main pole toward the shaded pole. This appearance of field rotation starts the rotor moving. Once started, the motor accelerates to full speed.

The **split-phase** motor has two separate windings in the stator (stationary portion of the motor) (Fig. 2). The winding shown in black is only for starting. It uses a smaller wire size and has higher electrical resistance than the main winding. The difference in the start winding location and its altered electrical characteristics causes a delay in current flow between the two windings. This time delay, coupled with the physical location of the starting winding, causes the field around the rotor to move and start the motor. A centrifugal switch or other device disconnects the starting winding when the motor reaches approximately 75% of rated speed. The motor continues to run on normal induction motor principles.

Split-phase motors are generally available from $\frac{1}{25}$ to $\frac{1}{2}$ HP. Their main advantage is low cost. Their disadvantages are low starting torque and high starting current. These disad-

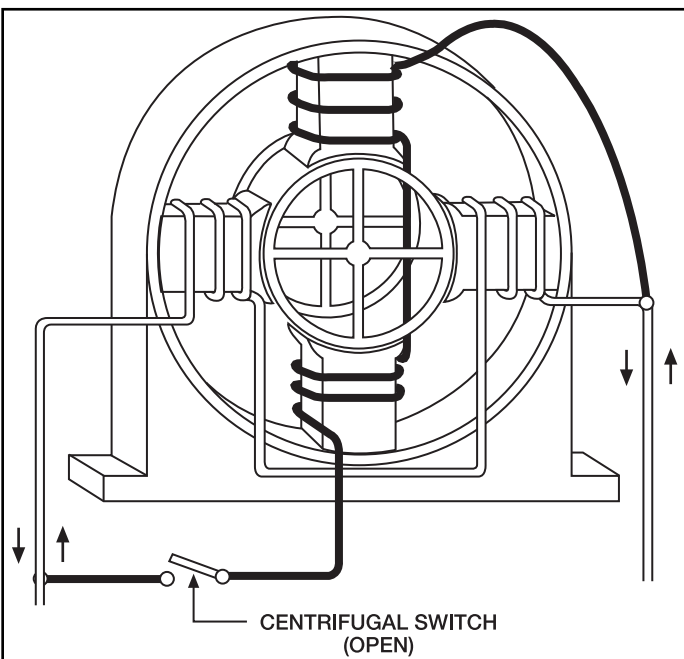


Figure 2 The split-phase motor has two separate windings in the stator.

vantages generally limit split-phase motors to applications where the load needs only low starting torque and starts are infrequent.

Capacitor motors are the most popular single-phase motors. They are used in many agricultural, commercial and industrial applications where 3-phase power is not available. Capacitor motors are available in sizes from sub-fractional to 15 HP.

| Table 2 Capacitor motors categories | |
|---|----------------|
| Category | Usual HP Range |
| Capacitor start — induction run | 1/8–3 HP |
| Single value capacitor (also called permanent split capacitor or PSC) | 1/50–1 HP |
| Two-value capacitor (also referred to as capacitor start capacitor run) | 2–15 HP |

Capacitor motors fall into three categories:

Capacitor start induction run motors form the largest group of general purpose single-phase motors. The winding and centrifugal switch arrangement is similar to that in a split-phase motor. However, a capacitor start motor has a capacitor in series with the starting winding. Figure 3 shows the capacitor start motor. The starting capacitor produces a time delay between the magnetization of the starting poles and the running poles, creating the appearance of a rotating field. The rotor starts moving in the same direction. As the rotor approaches running speed, the starting switch opens and the motor continues to run in the normal induction motor mode.

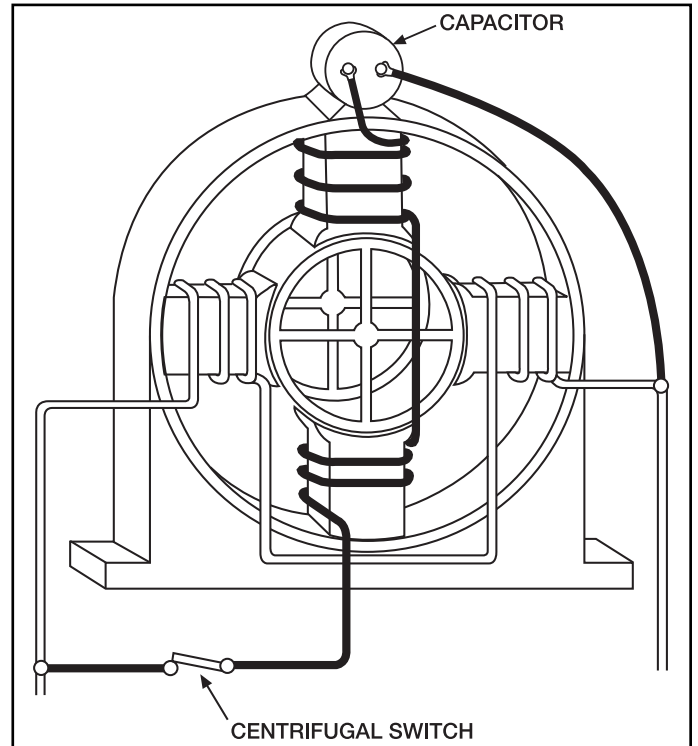


Figure 3 A capacitor start motor has a capacitor in series with the starter winding.

This moderately priced motor produces relatively high starting torque (225 to 400% of full-load torque) with moderate inrush current. Capacitor start motors are ideal for hard to start loads such as refrigeration compressors. Due to its other desirable characteristics, it is also used in applications where

high starting torque may not be required. The capacitor start motor can usually be recognized by the bulbous protrusion on the frame that houses the starting capacitor.

In some applications it is not practical to install a centrifugal switch within the motor, as these motors have a relay operated by motor inrush current. The relay switches the starting capacitor into the circuit during the starting period. When the motor approaches full speed the inrush current decreases and the relay opens to disconnect the starting capacitor.

Single-value capacitor motors, also called permanent split capacitor (PSC) motors, utilize a capacitor connected in series with one of the two windings. This type of motor is generally used on small sizes (less than 1 HP). It is ideally suited for small fans, blowers, and pumps. Starting torque on this type of motor is generally 100%, or less, of full load torque.

Two-value capacitor motors. The two-value capacitor motor is utilized in large horsepower (5-15 HP) single-phase motors (Fig. 4).

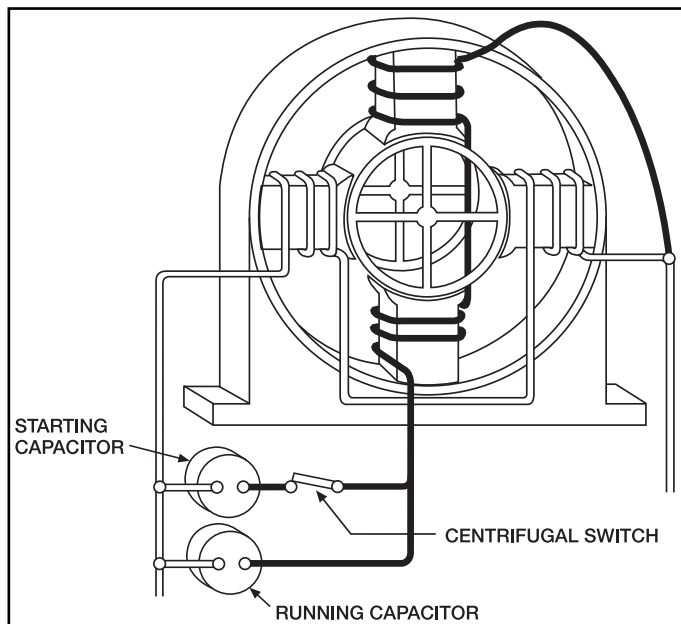


Figure 4 The two value capacitor motor is used in large horsepower single phase motors.

The running winding, shown in white, is energized directly from the line. A second winding, shown in black, serves as a combined starting and running winding. The black winding is energized through two parallel capacitors. Once the motor has started, a switch disconnects one of the capacitors, thus letting the motor operate with the remaining capacitor in series with this winding of the motor.

The two-value capacitor motor starts as a capacitor start motor but runs as a form of a two-phase or PSC motor. Using this combination, it is possible to build large single-phase motors having high starting torques and moderate starting currents at reasonable prices. The two-value capacitor motor frequently uses an oversize conduit box to house both the starting and running capacitors.

Motors Operating on Adjustable Frequency Drives (AFDs)

In the infancy of adjustable frequency drives (AFDs), a major selling point was that AFDs could adjust the speed of “standard” 3-phase induction motors. This claim was quite

true when the adjustable frequency drives were “6-step” designs. The claim is still somewhat true, although **pulse width modulated (PWM)** AFDs have somewhat changed the rules, PWM drives are electrically more punishing on motor windings — especially for 460 and 575 volt drives.

Standard motors can still be used on many AFDs, especially on HVAC fan, blower, and pump applications, as long as the motors are high-quality, conservative designs that use **inverter spike resistant (ISR)** magnet wire. On these variable torque loads a relatively small speed reduction results in a dramatic reduction in the torque required from the motor. For example, a 15% reduction in speed reduces the torque requirement by over 25%, so these motors are not stressed from a thermal point of view. Also, variable torque loads rarely need a wide speed range. Since the performance of pumps, fans, and blowers falls off dramatically as speed is reduced, speed reduction below 40% of base speed is rarely required.

This naturally leads to the question — “What is meant by high-quality, conservative designs?”

Basically, this means that the motor must have phase insulation, should operate at a relatively low temperature rise (as in the case with most premium efficiency motors), and should use a high class of insulation (either F or H).

In addition, it is frequently desirable to have a winding thermostat in the motor that will detect any motor overheat conditions that may occur. Overheating could result from overload, high ambient temperature, or loss of ventilation.

Inverter duty motors being offered in the marketplace today incorporate “premium efficiency” designs along with oversized frames or external blowers to cool the motor, regardless of its speed. These motors are primarily designed for constant torque loads where the affinity laws do not apply. Inverter duty motors usually have winding thermostats that shut the motor down through the AFD control circuit in case of elevated temperature inside the motor. Inverter duty motors also have high-temperature insulating materials operated at lower temperatures. This reduces the stress on the insulation system. Although some of the design features of inverter duty motors are desirable for HVAC applications, HVAC applications usually do not require inverter duty motors.

Note that some cautions should be observed. Generally speaking, the power coming out of an AFD is somewhat rougher on the motor than power from a pure 60 cycle source. Thus it is not a good idea to operate motors on AFDs into their service factors.

In addition, when an old motor (one that has been in service for some time) is to be repowered from an adjustable frequency drive, it may be desirable to add a load reactor between the AFD and the motor. The reactor reduces the stress on the motor windings by smoothing out current variations, thereby prolonging motor life.

Reactors are similar to transformers with copper coils wound around a magnetic core. Load reactors increase in importance when the AFDs are going to run in the “quiet” mode. In this mode the very high carrier frequency can create standing waves that potentially double the voltage peaks applied to the motor. The higher voltage can stress the motor insulation enough to cause premature failure.

Service factor. Some motors carry a service factor other than 1.0. This means the motor can handle loads above the rated HP. A motor with a 1.15 service factor can handle a 15% overload, so a 10 HP motor with a 1.15 service factor can handle 11.5 HP of load. Standard open drip-proof motors have a 1.15 service factor. Standard TEFC motors have a 1.0 service factor, but most major motor manufacturers now provide TEFC motors with a 1.15 service factor.

The question often arises whether to use service factor in motor load calculations. In general, the best answer is that for good motor longevity, service factor should not be used for basic load calculations. By not loading the motor into the service factor, the motor can better withstand adverse conditions that occur. Adverse conditions include higher than normal ambient temperatures, low or high voltage, voltage imbalances, and occasional overload. These conditions are less likely to damage the motor or shorten its life if the motor is not loaded into its service factor in normal operation.

NEMA locked rotor code. The “NEMA code letter” is an additional piece of information on the motor nameplate. These letters indicate a range of inrush (starting or “locked rotor”) currents that occur when a motor starts across the line with a standard magnetic or manual starter. Most motors draw 5 to 7 times rated full-load (nameplate) amps during the time it takes to go from standstill up to about 80% of full-load speed. The length of time the inrush current lasts depends on the amount of inertia (flywheel effect) in the load. On centrifugal pumps with very low inertia, the inrush current lasts only a few seconds. On large, squirrel cage blowers the inrush current can last considerably longer.

The locked rotor code letter quantifies the value of the inrush current for a specific motor. The lower the code letter, the lower the inrush current. Higher code letters indicate higher inrush currents.

The table lists the NEMA locked rotor code letters and their parameters:

Table 3 Code letters usually applied to common motors

| NEMA Code Letter | Locked Rotor KVA/HP | NEMA Code Letter | Locked Rotor KVA/HP |
|------------------|---------------------|------------------|---------------------|
| A | 0–3.15 | L | 9.0–10.0 |
| B | 3.15–3.55 | M | 10.0–11.2 |
| C | 3.55–4.0 | N | 11.2–12.5 |
| D | 4.0–4.5 | O | not used |
| E | 4.5–5.0 | P | 12.5–14.0 |
| F | 5.0–5.6 | Q | not used |
| G | 5.6–6.3 | R | 14.0–16.0 |
| H | 6.3–7.1 | S | 16.0–18.0 |
| I | not used | T | 18.0–20.0 |
| J | 7.1–8.0 | U | 20.0–22.4 |
| K | 8.0–9.0 | V | 22.4 and up |

| | F | G | H | J | K | L |
|------------|-------|-------|---|------|------|---|
| 3 phase HP | 15 up | 10–7½ | 5 | 3 | 2–1½ | 1 |
| 1 phase HP | | 5 | 3 | 2–1½ | 1, ¾ | ½ |

The code letters usually applied to common motors are:

The proposed design E motors, which will have very high efficiencies, will have higher inrush currents than the motors currently available. These motors will require special considerations when sizing circuit breakers and starters for these mo-

tors when they become available. The 1998 National Electrical Code incorporated some special provisions for these proposed Design E motors.

Insulation Classes

The electrical portions of every motor must be insulated from contact with other wires and with the magnetic portion of the motor. The insulation system consists of the varnish that jackets the magnet wire in the windings along with the slot liners that insulate the wire from the steel laminations. The insulation system also includes tapes, sleeving, tie-strings, a final dipping varnish, and the leads that bring the electrical circuits out to the junction box.

Insulation systems are rated by their resistance to thermal degradation. The four basic insulation systems normally encountered are Class A, B, F, and H. Class A has a temperature rating of 105 °C (221 °F), and each step from A to B, B to F, and F to H involves a 25 °C (45 °F) jump. The insulation class in any motor must be able to withstand at least the maximum ambient temperature plus the temperature rise that occurs as a result of continuous full-load operation. Selecting an insulation class higher than necessary to meet this minimum can help extend motor life or make a motor more tolerant of overloads, high ambient temperatures, and other problems that normally shorten motor life.

A widely used rule of thumb states that every 10 °C (18 °F) increase in operating temperature cuts insulation life in half. Conversely, a 10 °C decrease doubles insulation life. Choosing a one-step higher insulation class than required to meet the basic performance specifications of a motor provides 25 °C of extra temperature capability. The rule of thumb predicts that this better insulation system increases the motor’s thermal life expectancy by approximately 500%.

Motor Design Letters

The National Electrical Manufacturers Association (NEMA) has defined four standard motor designs using the letters A, B, C and D. These letters refer to the shape of the motors’ torque and inrush current vs. speed curves. Design B is the most popular motor. It has a relatively high starting torque with reasonable starting currents. The other designs are only used on fairly specialized applications. Design A is frequently used on injection molding machines that require high pull-out torques. Design C is a high-starting torque motor that is usually confined to hard-to-start loads, such as conveyors that are going to operate under difficult conditions.

Design D is a so-called “high-slip” motor and is normally limited to applications such as cranes, hoists, and low-speed punch presses where high starting torque with low starting current is desirable. Design B motors do very well on most HVAC applications. **PTE**



Better Energy-Efficient Flow Rate Regulation

Reducing Energy Consumption by Implementing Variable Speed Drive Concepts

Marco Bison

Introduction

Implementing a power-on-demand concept based on variable speed drives allows for energy saving in any application that involves pumps or hydraulic systems. And when used in combination with an intelligent wiring and communication system, relevant machine data can also be easily recorded — the basis for comprehensive power management.

Using energy efficiently not only saves companies money, but also saves resources and combats climate change. Pumps are an important starting point in improving energy efficiency, as they are among the largest industrial electricity consumers. On average, roughly 45% of the total costs related to a pump's service life are energy costs.

Low-Cost or High-End

Nevertheless, there exists great potential for pumps vis-à-vis energy savings — especially for pump applications and engines based on hydraulic technology. However, the overwhelming majority of applications currently in use are operated by motors and pumps running at a constant speed.

Take, for instance, hydraulic power units which now are typically constructed from inexpensive, asynchronous motors, motor starters and fixed-displacement pumps — all of which require relatively small investment. And yet they consume a large amount of energy, given that the overall hydraulic power unit is designed to support the maximum pressure and volume flow required. Energy is wasted because it delivers this maximum output — whether application-driven or not. In addition, heat inflow into the hydraulic fluid via the constantly operating pump is high, so additional cooling capacity is required.

To increase the energy efficiency of such a system, the fundamental approach is to operate the main pump of the machine at variable speed. Thus, only the *required* power is made available to the system whenever needed.

As a high-end solution, this can be achieved with a four-quadrant, direct drive; i.e., a servo drive controls the speed of the pump and, therefore, the pressure and volume flow. In this case the oil need only be actively cooled to a limited extent.

All in all, such a unit consumes significantly less energy than a system with constant pressure. However a direct drive can only supply one process. If hydraulic power is needed for several different processes, an equivalent number of power units are required. The four-quadrant, direct drive with servo motors is thus a solution that belongs at the upper end of the scale in terms of required investment.

Cost- and Energy-Efficient Solution with Speed Control

Eaton provides a more cost-effective alternative. In this solution a variable speed starter or variable frequency drive takes over the control of the speed of the pump — i.e., with vari-



Figure 1 The machine model jointly developed by Eaton and solution partner ATP Hydraulik is based on three different drive concepts and demonstrates potential energy efficiency gains. (All images courtesy Eaton Corp.)



Figure 2 Through integration of an intelligent wiring and communication system, the hydraulic power unit is already IoT-ready, meaning that mechanical engineers and end users can, regardless of location, obtain an up-to-date, detailed overview of all relevant data, such as temperature and pressure.

able frequency drive more complex functionalities can be handled, *and* the variable speed starter is more cost-effective and easier to put into operation.

A conventional asynchronous motor is used as a drive, whereby motors from the IE2 to IE4 efficiency classes can be used, depending on operating cycles and runtimes. A further increase in energy efficiency can be achieved by using permanent magnet motors, but that also involves higher investment costs.

The motor control unit receives data from a sensor about the pressure in the hydraulic system and, based on this, adjusts the motor's speed to the volume flow requirement of the hydraulic devices consuming the energy. This power-on-demand concept also can supply several parallel processes with similar volume flows and pressure requirements, thereby controlling various actuators via direction control and proportional or servo valves. At the same time, users of this configuration will also benefit from longer machine life due to lower levels of heat generation, increased operator safety, compact design, and improved comfort by reducing pump noise.

Energy Savings of More Than 50%

With a machine model that was jointly developed with solution partner ATP Hydraulik AG (info@atphydraulik.ch), Eaton was able to illustrate the energy efficiency of this drive concept. Three hydraulic units were operated in parallel; one system was a basic solution controlling the motor and pump at a constant speed; the second was the servo solution using the servo controller; and, in the third, a variable speed starter controlled the main pump based on the power required. Therefore this machine model allows a direct comparison to be made of the units in terms of dynamics, energy consumption and total cost of ownership (TCO). The advantages of the variable speed hydraulic power unit were clear. Based on the basic solution, it

could be proven that the power-on-demand concept meant achieving energy savings of approximately 60%.

Eaton has also confirmed this saving potential in practice as part of a retrofit measure on a 20-year-old, 50 t injection molding machine. To date, their hydraulic unit has been constantly driven with a conventional 15 kW asynchronous motor. The volume flow of the pump is mechanically controlled; even at low-volume flow, the motor drives the pump at a constant speed of 1,500 revolutions and so consumes large amounts of energy. This drive was upgraded using a variable frequency drive (Eaton PowerXL DA1), a permanent magnet motor and an axial piston pump (Eaton 425 piston pump). By making the control of the motor load-dependent and only providing it with the power that the process requires, energy

consumption can be reduced from 5.6kWh to 2.8kWh, or by around 50%. Assuming that the machine operates for two eight-hour shifts, 300 days a year, the annual energy savings for each machine amount to EUR 2,016 (\$2,257 U.S.). The period for achieving return on investment (ROI) in this case is 2.2 years.

IoT-Ready for Cloud-Based Power Management

However, reducing energy consumption is only the first step towards an energy-efficient system. The next is to create the conditions for a power management system. Extensively recording and analyzing energy and machine data are the only possible ways to monitor energy consumption, thus identifying opportunities for improvement and checking the impact of the measures implemented. This requires the use of numerous sensors, such as for measuring pressure, positions or temperature, as well as for recording information about the operational status of each individual component.

In the case of a traditional set-up where individual cables are connected, this translates to considerable, additional reliance upon wires and cables for transmitting the information from the relevant component to the programmable logic controller (PLC). An intelligent wiring system at the device level, such as Eaton's SmartWire-DT, offers clear advantages in comparison. It allows components such as switching devices, circuit breakers, pushbuttons, sensors and actuators to be connected to each other using a single cable instead of using elaborate point-to-point wiring. The cable supplies power to the connected devices while also supporting data communication. At the same time, standard components are turned into intelligent, communication-enabled devices using an ASIC module.

As the I/O modules of SmartWire-DT are available with IP67-rated protection, sensors and actuators can also be con-

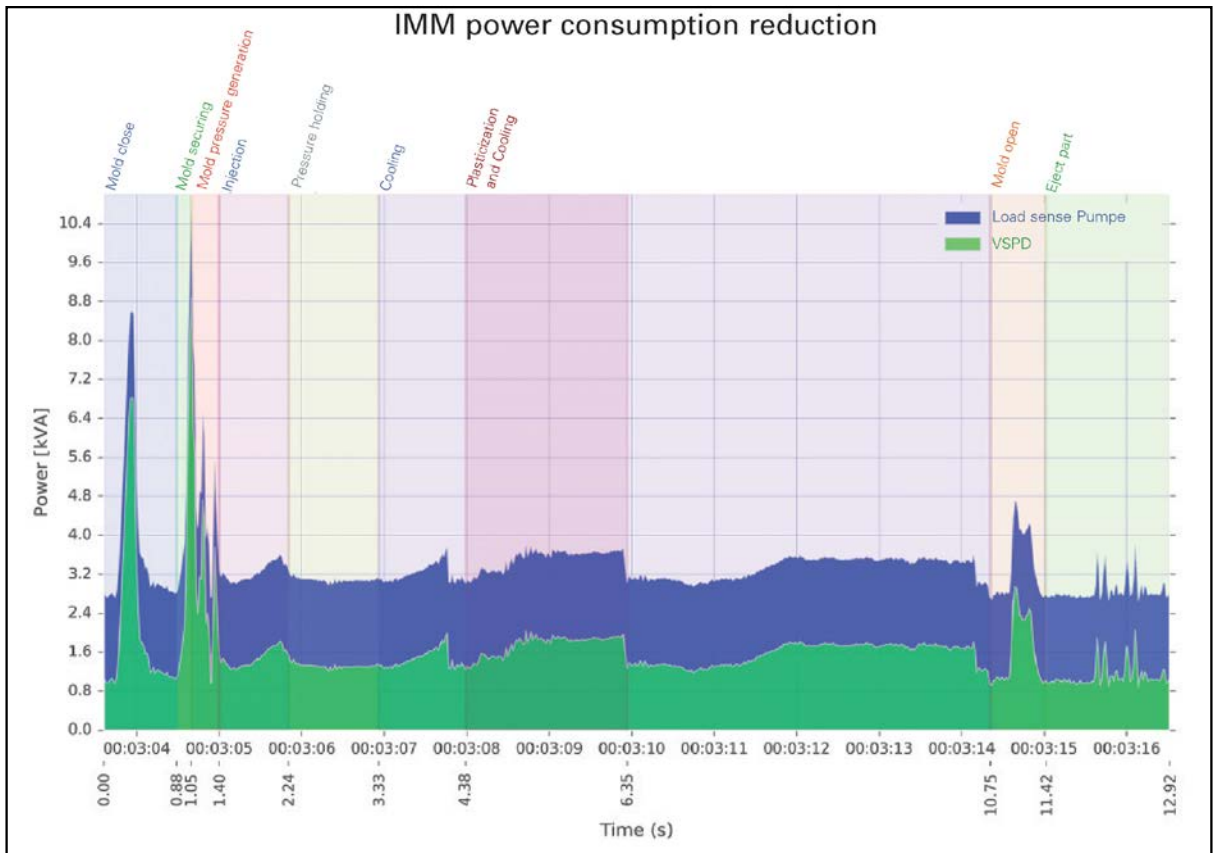


Figure 3 Thanks to a retrofit project, an injection-molding machine achieved energy savings of around 50%.

nected in the field. This means that data from a machine or system monitoring vertical movement of cylinder, temperature or pressure can be easily recorded and used for power management. By using gateway modules, SmartWire-DT makes it possible for users to connect the system to all popular controls and fieldbus systems, such as Profibus, Profinet, CANopen, Modbus TCP, Ethernet/IP, Powerlink or EtherCAT—and to the Internet—therefore making it IoT-ready. If control devices are used with an OPC UA interface, all data—down to device level—can, for instance, be supplied for cloud-based, power management software. **PTE**

NOTE: *Eaton white paper—“Planning and Operating Hydraulic Power Units to Provide Greater Energy Efficiency”—provides additional information on this subject. It is available (in English) for free download at: www.eaton.eu/moem-ee.*

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Marco Bison began his career with Eaton in 2007 and is presently manager/mechatronic technologies in the EMEA Industrial Control and Protection Division, Business Development Group. He holds a B.Sc. in electrical engineering and an executive MBA from the University of Applied Sciences in Switzerland. He is primarily focused on Eaton's electro hydraulic solutions for the machinery OEM segment and is leveraging both businesses to demonstrate the unique value of the Eaton solution to customers and partners. Bison is driving customer insights through design burst activities and innovation events, which are key for developing the next generation of products and solutions.



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Baldor Electric's John Malinowski

RECOGNIZED FOR ENERGY EFFICIENCY CONTRIBUTIONS

John Malinowski, Baldor Electric Company's senior director of industry affairs, was recently recognized with the MS'16 Award at the 2016 Motor Summit in Zurich, Switzerland. The MS'16 award is for his personal engagement to make IE3 premium efficiency motors the global market standard. Malinowski has been instrumental to Baldor and has been a voice and advocate for motor manufacturers working with standards organizations and government agencies.



The award was presented at the 2016 Motor Summit, a bi-annual event held since 2007 in Zurich. The event brings selected international experts together from research; federal governments; utilities; motor, pump and fan manufacturers; original equipment manufacturers (OEM); motor systems users and other interested parties to discuss motor and drive technology, new global efficiency programs and market transformations. The event is hosted by Impact Energy, a member of the Swiss Agency for Efficient Energy Use (S.A.F.E.), in collaboration with the Electric Motor Systems Annex (EMSA) of the IEA 4E (International Energy Agency Technology Collaboration Program on Energy Efficient End-use Equipment) and the national program SwissEnergy.

Industrial electric motors have had their efficiency regulated by the U.S. Department of Energy since 1997 and Natural Resources Canada since 1998. The European Union, Mexico, Australia, Saudi Arabia, China, Brazil and many other countries have legislated Minimum Efficiency Performance Standards (MEPS) to set efficiency levels for motors sold for use in their countries. Malinowski has worked with these groups to set and harmonize efficiency levels across the globe. (www.baldor.com)

The Timken Company

ACQUIRES EDT CORP.

The Timken Company recently announced that it has acquired EDT Corp., a manufacturer of polymer housed units and stainless steel ball bearings used widely by the food and beverage industry.

"We market a broad range of bearing housed units and are pleased to add the EDT line to our portfolio," said Chris Coughlin, group president for The Timken Company. "We see this acquisition as an excellent strategic fit, allowing Timken to simultaneously build on the inherent strengths of the EDT team and leverage our expanded marketplace offering, thereby increasing our presence in the food and beverage segment."

EDT Corp. is based in Vancouver, Wash., and serves a well-established customer base primarily through North American distributors with whom Timken has long-standing relationships. EDT bearings are designed and manufactured to meet the highest level of food safety and sanitation requirements. The line includes a range of non-corrosive, greaseless, wash-down-resistant and extreme temperature bearings and accessories. In 2015, EDT Corp. revenue was less than \$10 million.

Timken has an industry-leading portfolio of housed unit bearings consisting of Timken, Fafnir, Revolve and now EDT-branded products serving general industrial and other diverse markets such as metals, mining, lumber and food and beverage. The company offers a variety of durable, high-performance housed unit bearing styles, including ball and spherical roller bearing, solid-block tapered and spherical roller bearing, and split spherical and cylindrical roller bearing designs, that withstand the harshest operating conditions. (www.timken.com)

Renold Gears

EXPANDS SALES TEAM

Renold Gears has continued to expand its sales team with the appointment of **Jeff Powell** to the position of gearing sales manager in Westfield, New York. Powell will be responsible for providing customer support in the United States and South America for the company's entire range of industrial gear products and services to OEMs, distributors and end users.



Powell has worked in gear manufacturing since 2002 and has extensive experience of machining, fitting and assembly of industrial and precision gear drives. He joined Renold in 2011 as a regional sales manager with responsibility for all of the company's Torque Transmission group products, which includes a wide range of couplings and gears. This new appointment will enable Powell to dedicate all of his time providing support to customers of Renold Gears.

He enjoys spending quality time with his wife, two young daughters and the family's English Bulldog. His hobbies include travelling, football, golfing and fishing. According to Renold Gears' commercial director, Roger Godson, the appointment reflects the company's commitment to customers in the Americas and meets the growing demand for its products and services across a wide range of industry sectors. (www.renold.com)

Hansford Sensors

OPENS U.S. OFFICE

Hansford Sensors has announced it is expanding its presence in the United States by opening a joint sales and service operation based in Texas. This new office will be the latest addition to the Hansford group of wholly or partly owned subsidiaries in Poland, Australia, Germany and India plus an extensive sales network of over 30 independent Hansford Sensors distributors around the world.

The new company in the United States will be a joint venture between Hansford Sensors, Reliability Direct and STI and will be headed up by Dave Gallagher of Reliability Direct, who has many years' experience working with condition monitoring across a wide range of industrial sectors.

Managing Director of Hansford Sensors, Chris Hansford, remarks: "This is a significant step for Hansford Sensors. We have been selling into the North American market for some



time now and it feels like the time is right for us to open an office and increase our presence there. The shift from preventative to predictive maintenance in many industry sectors means that the global condition monitoring market is expected to grow significantly and as a company we have an ambitious growth strategy to meet that. This new operation is an integral part of our program of developing a strong network of local sales and customer support centers in key locations on each continent. It is important to us to be able to offer excellent and local customer and technical support for our products."

Hansford Sensors manufactures an extensive range of industrial accelerometers, including 4-20 mA transmitters, AC vibration and velocity sensors, switches and switch modules, plus enclosures, connectors and cables. Many of these are engineered to meet the needs of individual customers or specific applications, with all products being backed by comprehensive customer and technical support services. (www.hansfordsensors.com/us)

Parsons Peebles

APPOINTS ROBERTSON CHIEF OPERATING OFFICER

Parsons Peebles recently announced the appointment of **Graeme Robertson** to the position of chief operating officer. Robertson joins Parsons Peebles from the Sulzer organization and has held a number of senior roles for several years. He has significant experience in all of Parsons Peebles' target markets. In addition to his market and operational experience, Robertson brings an excellent technical and commercial understanding to the business.



"Graeme has an excellent reputation in the market amongst customers and peers and we're delighted to welcome him on board. He will significantly strengthen our drive to further improve our customer experience and service excellence which is critical to our development," said Frank Barrett, CEO of the Parsons Peebles Group.

Robertson further added, "Parsons Peebles is where it all began for me many years ago, as a young keen apprentice, and so I'm excited to be re-joining Parsons Peebles at this dynamic period of the company's growth. I look forward to supporting the business as it diversifies into new market sectors offering new products and services. Having previously worked with many of the customers with which we are looking to strengthen our relationships, I hope to bring a wealth of knowledge and understanding to the business. Parsons Peebles has a great reputation and portfolio of products and services which I'm delighted to help build up even further." (www.parsons-peebles.com)

A screenshot of the Power Transmission Engineering website. The page features a navigation menu, a search bar, and several content sections including "POWER NOW SMB 30", "PTC ASIA 2015", "The True Cost of Bearing Lubrication", "Don't Tap the Glass", and "The Path to Smarter Bearings". A sidebar on the right lists various products and services. At the bottom, there is a large blue banner with the text "Power Transmission Engineering" and a list of key features: "Technical content free for everyone", "Comprehensive Buyers Guide", and "The latest news". The website URL "www.powertransmission.com" is displayed at the bottom.

Beckhoff Automation

OPENS SALES AND SUPPORT OFFICE IN TEXAS

Hot on the heels of continued rapid growth in automation sales in the southern U.S., Beckhoff Automation has opened a regional sales and support office in Plano, Texas. A significant move in expanding local customer service capabilities, this new 2,600 square-foot office will provide high-level sales and engineering expertise, particularly for customers in the south-central United States.

The eighth such regional facility in the U.S., the Plano facility includes sales offices, engineering labs and training facilities. Customers throughout the area now enjoy the convenience of attending more local training sessions focused on Beckhoff hardware and software solutions, as well as various areas of programming such as PLC, motion control, safety technology, IoT connectivity and more.

“This new regional office in Plano is the latest investment by Beckhoff in North America to intensify our local presence for customers,” explains Aurelio Banda, CEO and president, Beckhoff Automation. “We are also opening a new office in the Cincinnati area, with additional offices and expansions for Beckhoff Canada and Beckhoff Mexico to follow shortly, further enhancing our local footprint in North America.”

“The new Plano facility fills a growing need for more local training and support in the southern U.S.,” adds Joe Martin, regional manager, south region at Beckhoff Automation.



“Whether supporting oil and gas applications, manufacturing, machine builders or other industrial applications, this region offers outstanding opportunities for expanded customer outreach and improved local support for their operations. PC- and EtherCAT-based control solutions have seen impressive growth in many industries, given the inherent flexibility and high performance. Increasing our local, customer-facing presence in this way demonstrates Beckhoff’s commitment to serving these industries. It also provides significant advantages to customers in the region and an avenue to get more powerful automation solutions into the hands of innovative American companies.”

Beckhoff Automation has numerous regional offices across North America: the Savage, Minn. North American headquarters (Minneapolis area) as well as in Mechanicsburg, Pa.; Charlotte, N.C.; Woodridge, Ill. (Chicago area); San Jose, Calif.; Mill Creek, Wash. (Seattle area); and Mississauga, Ontario (Toronto area). (www.beckhoffautomation.com)

PTDA

CELEBRATES SUCCESSFUL 2016 INDUSTRY SUMMIT

Seven hundred and fifty people from the power transmission/motion control (PT/MC) industry, including nearly 590 delegates, came together October 19-22 in San Diego, Calif., where tools and information to Lead in Disruptive Times were delivered through cutting edge presentations, the latest in business and market information and a venue to help build the networks that are so critical to business success.

The PTDA 2016 Industry Summit, held at the Marriott Marquis San Diego Marina, is now history, but many predict the conference will have lasting reverberations as industry leaders take home what they learned and implement new ideas in their industrial distribution and manufacturing businesses from over 12 countries.

“Participation in the PTDA Industry Summit is the most effective way to build relationships and make connections in the power transmission/motion control industry. Coupling the networking opportunities with the inspiring IML Talks and Deeper Dives as well as the economic outlook from Alan

Beaulieu makes this meeting a business requirement,” said LeRoy Burcroff, vice president sales, Bearing Service Inc., Livonia, Mich., who is currently serving as president for the Association.

Sean Hickey, president, Lafert North America, Mississauga, Ontario, Canada, who serves as chair of the PTDA Manufacturer Council echoed that sentiment, “The quality of the networking events is second to none. Every year, it surpasses our expectations,” he said.

PTDA 2016 Industry Summit at a Glance

- Held October 19-22, 2016, at Marriott Marquis San Diego Marina, San Diego, Calif.
- Theme: Lead in Disruptive Times
- Outside of the United States, international participants attended from Belgium, Canada, China, Costa Rica, Finland, Germany, Italy, Mexico, Philippines, Poland and the United Kingdom (www.ptda.org)

Hydraulic Institute

PREPS CENTENNIAL CELEBRATION IN 2017

The Hydraulic Institute (HI) will celebrate its centennial in 2017 and is pleased to announce a new logo as part of a larger initiative to position HI for the next 100 years of service to the pump industry. The new logo is a key element of HI's overall brand refresh and redesign process.

The logo includes a hidden "H" that reflects the nature of pumps; always there, working behind the scenes; and arrows that represent a pump's purpose — flow and movement. This movement reflects the evolution over the past 99 years from when pump manufacturers first came together to discuss common issues and develop technical standards.

Today's HI welcomes engineers and designers from pump and supplier organizations. HI also works directly with end-users, owners and operators who share their experience and challenges. This collaboration helps HI create a full range of resources from standards to training and certification to help users know more about - and get more from - their pumping systems. Anticipating the needs of an energy conscious audience, HI is taking a comprehensive approach linking its test standard, lab accreditation and product labels around the HI Energy Rating which promotes energy efficiency but also qualifies labeled products for utility rebates.

"The new programs built to support the HI Energy Rating are great examples of HI's expanded focus and long-term vision for the industry. The image of flow and the movement depicted in the logo represents a new Hydraulic Institute" explained Michael Michaud, executive director of the Hydraulic Institute. "Hopefully when you see the new HI logo, you will connect to the progress the industry has made in performance, reliability and efficiency over the years. And throughout 2017, when you see the centennial logo, we should all be reminded of the Hydraulic Institute's century of service to the industry." (www.pumps.org)

Continental

RECEIVES AMBASSADOR OF ENERGY EFFICIENCY AWARD

Continental's St. Marys, Ohio, plant, its premier North American manufacturing facility for engineered products, recently received the Ambassador of Energy Efficiency award from Efficiency Smart, a Columbus-based company that assists companies with implementing energy-efficient products and services.

"We are proud to receive this award," said Frank Smith, St. Marys' plant engineering manager. "We had a great experience working with Efficiency Smart for our energy-efficient lighting upgrades. Their technical staff proved a valuable resource in measuring our energy usage and verifying the amount of energy and financial savings."

During the year, Continental partnered with Efficiency Smart to replace metal halide lights in its facility with high-performance T8s (HPT8s). The company also installed LED wall-packs and LED flood lights. "Since we operate 24 hours a day, the new lighting fixtures were able to reduce the company's electric costs significantly," said Smith. "As a result of

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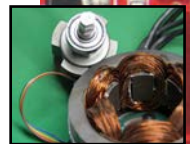
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the project, we expect to save 348,000 kilowatt hours (kWh) of energy annually and \$341,500 over the lifetime of the installed products.”

The St. Marys plant is the 30th recipient of the Ambassador of Energy Efficiency award since its inception in 2013. (www.contitech.us)

Smalley Steel Ring

RECEIVES GM SUPPLIER QUALITY AWARD

For the fourth year in a row, Smalley has received the prestigious GM Supplier Quality Excellence Award. Smalley is one of only 80 powertrain suppliers to receive the award four years in a row.



“Smalley’s commitment to quality, service and deliverability are what drives the organization to produce the best retaining rings and wave springs in the world,” states Gina Dolan, Smalley’s quality assurance manager. “Receiving this award again is a testament to our employees’ total engagement and commitment to ensuring complete customer satisfaction.”

For over 50 years, Smalley has remained committed to quality. As Smalley continues to push the envelope of coiling technologies to expand its product range, the company remains focused on delivering engineered solutions to its customers. (www.smalley.com)

Dana

ANNOUNCES AGREEMENT TO ACQUIRE POWER TRANSMISSION AND FLUID POWER BUSINESS OF BREVINI GROUP

Dana Incorporated has announced a definitive agreement to purchase the power-transmission and fluid power businesses of Brevini Group, S.p.A.

Under terms of the agreement, Dana plans to initially purchase an 80 percent share in the Brevini businesses, with an option to purchase the remaining 20 percent by 2020. Dana has valued 100 percent of the Brevini businesses at €325 million, including the assumption of approximately €100 million of net debt.

The acquisition will immediately expand Dana’s product portfolio with adjacent technologies and establish Dana as the only off-highway solutions provider that can manage the power to both move the equipment and perform its critical work functions. It adds technologies for tracked vehicles, doubling Dana’s addressable market for off-highway driveline systems. It also provides a platform of proven technologies that can be leveraged in Dana’s light- and commercial-vehicle end markets, helping to accelerate the company’s hybridization and electrification initiatives.

“Brevini is a strong, well-run business that shares Dana’s commitment to serving customers with advanced technologies that deliver exceptional performance and durability,” said James Kamsickas, president and chief executive officer of Dana. “We have long admired Brevini’s exceptional products, customer focus, and company culture, which are some of the most pertinent reasons we specifically targeted this acquisition — at this opportune time in the off-highway business cycle.”

The transaction will be funded with cash on hand, with existing Brevini debt to be refinanced in the future. Subject to customary regulatory approvals, the acquisition is expected to close in early 2017. Dana expects the purchase to be accretive to earnings in 2017.

The acquisition of Brevini aligns with Dana’s enterprise strategy, which includes leveraging core expertise, strengthening customer centricity, expanding global markets, commercializing new technologies, and accelerating hybridization and electrification. (www.dana.com)

GKN

SELLS STROMAG BUSINESS TO ALTRA

GKN recently announced that it has agreed to sell its Stromag business (part of the GKN Land Systems division) to Altra Industrial Motion Corp. Completion of the transaction is expected to take place in the first quarter of 2017. Stromag supplies brakes, clutches and highly flexible couplings to the agricultural, construction, industrial and renewable energy markets.

Nigel Stein, chief executive of GKN, said: “I would like to thank the Stromag team for their dedication over the past five years. Stromag has been a good investment for GKN despite challenging end markets and I am confident that Altra is an excellent home for the business. Altra is well positioned to invest in the business to meet the future growth opportunities in its markets. For GKN this sale helps sharpen our focus and allows us to redeploy capital into our core aerospace and automotive businesses.”

January 9-13—SciTech 2017 Grapevine, TX. From its creation in 1963, the American Institute of Aeronautics and Astronautics (AIAA) has organized conferences to serve the aerospace profession as part of its core mission. Spanning over 70 technical discipline areas, AIAA's conferences provide scientists, engineers, and technologists the opportunity to present and disseminate their work in structured technical paper and poster sessions, learn about new technologies and advances from other presenters, further their professional development, and expand their professional networks that furthers their work. The AIAA Science and Technology Forum and Exposition (AIAA SciTech) has continued to grow in each succeeding year, drawing participants from around the globe. SciTech participants tackle the most pressing issues impacting the future of aerospace, while the technical program presents innovative research and technologies that offer solutions. For more information, visit www.aiaa-scitech.org.

January 18-20—A3 Business Forum Lake Buena Vista, FL. The A3 Business Forum is the world's leading annual networking event for robotics, vision & imaging, motors, and motion control professionals. Over 525 global automation leaders are expected to attend this largest Annual Forum to date. Topics include a global and economic outlook for 2017, robotics in Mexico, game plan for success and more. Speakers include Alan Beaulieu (ITR Economics), Lou Holtz (football coach), Kevin Viner (comedian), Sam Richter (sales intelligence thought leader) and Christina McKenna (Bluestone Executive Communications). The event is organized by the Association for Advancing Automation. For more information, visit a3.a3automate.org/a3/BusinessForum.

February 7-9—MD&M West 2017 Anaheim, CA. For 32 years, MD&M West has helped take medical devices from concept to market by uniting cutting-edge technology with the industry's foremost minds. Keynote presentations and activities focus on business development, improving patient outcomes, value engineering, design thinking, speed to market, 3D printing and the IoT. The MD&M West educational conference is a resource for accessing the ever-shifting medical tech marketplace. In its 32nd year, the program will deliver three days and three tracks of product development strategy, design technique, and in-depth workshop learning. Engage with over 20,000 industry professionals from leading companies such as Boston Scientific, St. Jude Medical, 3M, and Medtronic. Admission includes ATX West, Electronics West, Plastec West, WestPack and the Advanced Manufacturing Expo. For more information, visit mdmwest.mddionline.com.

February 22-24—AGMA 2017 Gear Materials Clearwater Beach, FL. Learn what is required for the design of an optimum gear set and the importance of the coordinated effort of the gear design engineer, the gear metallurgist and the bearing system engineer. Investigate gear-related problems, failures and improved processing procedures. Gear design engineers, management involved with the design and manufacture of gearing type components, metallurgists and materials engineers, laboratory technicians, quality assurance technicians,

furnace design engineers and equipment suppliers should attend. The course is instructed by Ray Drago and Roy Cunningham. For more information, visit www.agma.org.

March 7-11—IFPE 2017 Las Vegas, NV. IFPE returns every three years to showcase the latest innovations and expertise in the fluid power, power transmission and motion control industries. Educational opportunities provide crucial information on new fluid power, power transmission and motion control technologies to engineers and others involved in the design and manufacturing process. One highlight of the show is Project AME (Additive Manufactured Excavator), an excavator that is being 3D printed using various machines at the Oak Ridge National Laboratory's Manufacturing Demonstration Facility (MDF). Project AME will be on display at IFPE and CONEXPO-CON/AGG 2017 as part of the new Tech Experience. Co-located with CONEXPO-CON/AGG 2017, the largest international gathering place for the construction industries, attendees will have access to the latest products and innovations from over 400 exhibitors. For more information, visit www.ifpe.com.

March 21-23—AGMA 2017 Gearbox CSI Concordville, PA. Gain a better understanding of various types of gears and bearings. Learn about the limitation and capabilities of rolling element bearings and the gears that they support. Grasp an understanding of how to properly apply the best gear-bearing combination to any gearbox from simple to complex. Gear design engineers; management involved with design, maintenance, customer service, and sales should attend. Instructors include Ray Drago and Joseph W. Lenski, Jr. For more information, visit www.agma.org.

March 22-24—PTDA Leadership Development Conference 2017 Hyatt Centric French Quarter New Orleans, New Orleans, LA. Step up your leadership game while networking with your power transmission/motion control industry peers in an intimate and relaxed setting. Educational sessions are designed for emerging and seasoned executives who want to build executive leadership skills. Open to all employees of PTDA member companies. No other program provides the industry-specific networking so essential for success in the power transmission/motion control distribution industry. Because the Leadership Development Conference is incorporated into the Association's Spring Meetings, participants can also attend the dinner and talk on Thursday evening along with the industry's top executives who volunteer on PTDA committees and the board of directors. For more information, visit www.ptda.org.

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For publication guidelines and more information, please contact Jack McGuinn at jmguinn@powertransmission.com.

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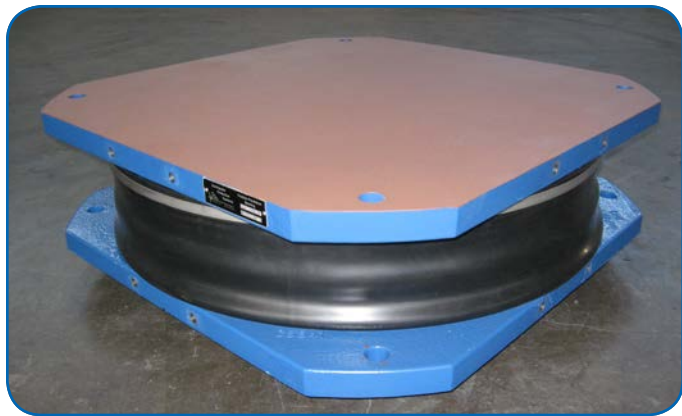
BEARING THE BRUNT OF EARTHQUAKES

Earthquake Protection Systems is using giant bearings to make buildings more resilient to earthquake damage.

Alex Cannella, News Editor

According to a FEMA study back in 2000, America suffers \$4.4 billion in losses due to earthquakes every year. While that's a drop in the bucket for our \$16 trillion plus GDP, it's still a substantial amount of money, and some people are working to lessen those losses. One group is Earthquake Protection Systems (EPS), a company that is designing bearings to better protect buildings from earthquake damage.

According to EPS Vice President, Dr. Anoop Mokha, standard building regulations are inherently flawed, as they insist that a building be capable of remaining standing during an earthquake, but say little about what state the building needs to be in beyond that. This means that while we've gotten pretty good at making sure buildings don't collapse and hurt people during earthquakes, there's still a high number of buildings that are being crippled and rendered derelict by them. As an example, Mokha pointed to an earthquake that happened in New Zealand in 2010. Only two buildings collapsed during the quake, but the event still left 70 percent of affected buildings so badly damaged that they had to be torn down.



Ever since the company first opened its doors in 1985, EPS has been working to reverse that trend with a product they call a friction pendulum bearing, which is designed to not only keep buildings standing after an earthquake, but to keep them operable and livable.

"What we are doing is allowing engineers and owners to have sustainable structures they can walk in after an earthquake, and they have no damage," Mokha said.

The bearings are designed to absorb excess energy when the force of an earthquake exceeds a building's acceptable horizontal load and safely dissipate it in the form of motion. This means that when an earthquake's force would otherwise



damage a building, the bearings allow the building's foundation to physically move back and forth like a pendulum, finding an outlet to expend otherwise damaging levels of force.

EPS's newest product, the Triple Pendulum Bearing, takes it a step further, with three different bearings in a single product all designed to resist different magnitudes of earthquakes. The bearings activate sequentially, so that only one bearing is active at any given time, but each bearing is ideally suited to different magnitude earthquakes, and when one bearing's ability to resist the earthquake is overloaded, the next bearing immediately takes over.

"If the earthquake is weak, the bearing is weak," Mokha said. "If the earthquake gets stronger, the bearing gets stronger."

According to Mokha, products like the Triple Pendulum Bearing are fairly standard in Japan, where earthquakes are a constant hazard, but are still only just catching on worldwide as an effective countermeasure for earthquakes. Mokha estimates that previously, only about 10 percent of buildings in the U.S. used a pendulum bearing or equivalent product, but that in recent years, that number may have risen as high as 15 or 20 percent and is still growing.

"What Elon Musk did with the electric car in the automotive industry, and now everyone is realizing the benefits...I believe we have crossed that threshold now, where people are realizing the benefits," Mokha said.

EPS' bearings protect over \$20 billion worth of construction today and are installed in 30 countries. They are present in high-profile buildings such as the San Francisco Airport Terminal, the Cathedral of Christ the Light in Oakland, Calif. and Pasadena's city hall and are used in many infrastructure projects such as bridges and viaducts. **PTE**

For more information:

Earthquake Protection Systems (EPS)
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Dear Santa,

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All my engineering friends are specifying it and saying it's the hottest electronic product this year. It should make me look really good, so hold off on that coal for my boss's stocking (wink).

Thanks, Santa... you rock, dude!
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