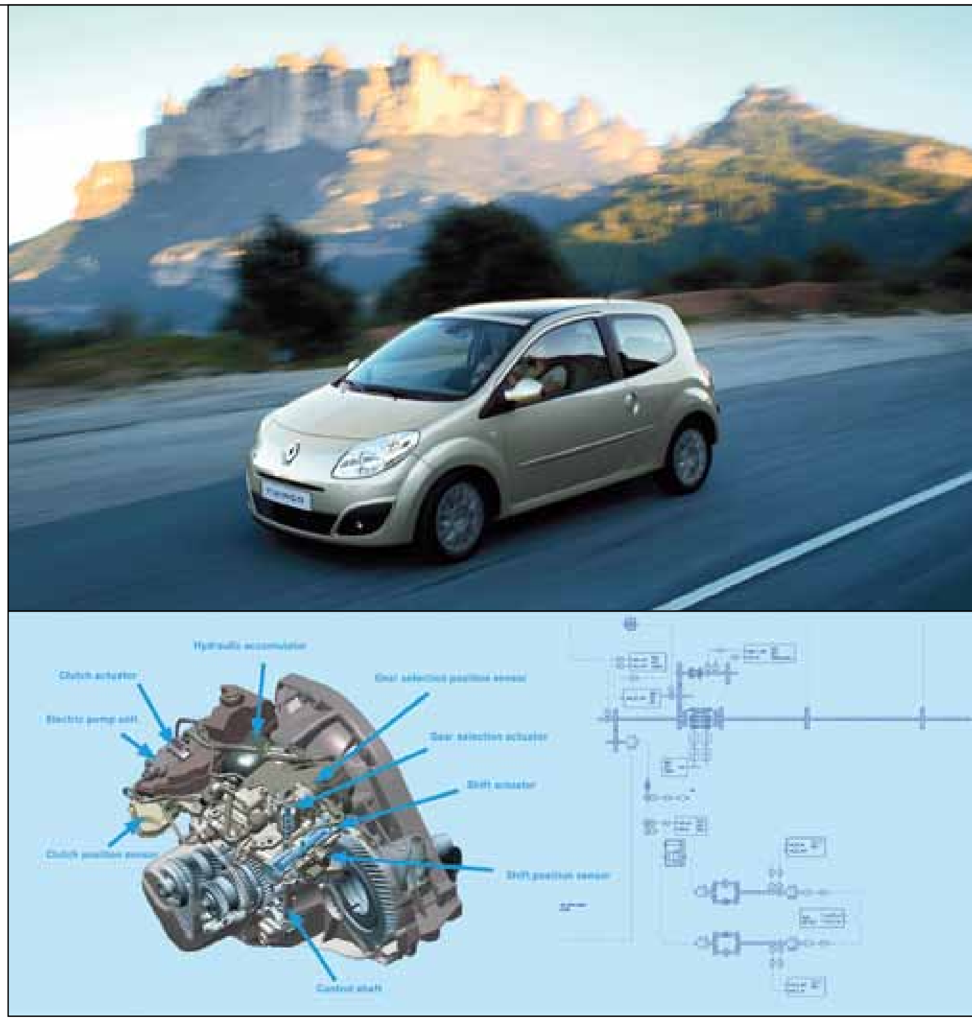

The Renault Twingo (top) and a schematic of Renault's automated manual transmission (bottom).

Designing the Brains for Automated Manual Transmissions

MECHATRONICS BRIDGES GAPS IN RENAULT'S AMT SYSTEMS

One of the features consumers worldwide increasingly look for in a new car is an automated manual transmission (AMT)—a system that behaves like an automatic, but also allows drivers to shift gears electronically using a push-button command without a clutch pedal. AMTs combine the fuel efficiency, performance and control of manual systems with the convenience of automatics—an especially handy feature in stop-and-go traffic. With the ease and convenience appreciated by many drivers facing daily traffic congestion, automakers are equipping a growing number of new vehicle models with these types of transmissions. Indeed, a report from market research firm Frost and Sullivan predicts 15 percent of small cars will likely feature AMTs by 2012.

These complex mechatronic systems are difficult to design, however, since their performance depends on the operation of three different subsystems all working together in perfect synchronization: an electromechanical actuator that shifts the gears, electronic sensors that monitor vehicle status and software embedded in the transmission control unit (TCU)—the "brains" that control the powertrain.

Ordinarily, up to a year is required to define overall functional requirements, design the actuator mechanics, develop and calibrate TCU software and validate the complete system. Software development and calibration are particularly troublesome bottlenecks, since these tasks typically require extensive trial-and-error physical testing cycles that cannot be performed until hardware prototypes are built. By then, mechanical and electronics designs are nearly finalized and cannot be changed appreciably to improve powertrain performance. Considerable time is spent troubleshooting problems near the end of design rather than refining TCU control strategies.

French automaker Renault S.A. is streamlining the AMT development process with a simulation-based approach using *LMS Imagine.Lab AMESim* 1-D simulation software to predict the performance and real functionality of complex multi-domain systems using a single unified physics-based model. Engineers drag, drop and interconnect simple icons to graphically create the model, displayed on the screen with a working sketch showing relationships of all the various elements to predict the behavior of an entire AMT system.

"Using the multi-domain simulation approach based on *LMS Imagine. Lab AMESim*, we can see early in development how all the various parts of the complex AMT system will operate together—mechanics, electronics and control software," explains Edouard Négre, senior design engineer in the Renault Powertrain Control Engineering Division. "With this understanding of the complete mechatronics system, we can readily optimize the entire design up front in development and avoid many late-stage problems and delays."

Throughout the process, the *AMESim* model evolves as the design progresses and system requirements are defined in greater detail. Renault most recently used the method to develop a new actuator for one of their existing AMT models, redefine the existing TCU control strategy and evaluate the entire AMT performance.

A simplified model was initially created to define overall powertrain load constraints and size the major mechanical components including hydraulics, electrical generator and gear reductions. Next, parameters from design drawings and technical data from engineering specifications were added to plot overall performance curves, define basic control commands and determine the overall response of the complete mechatronics system. In these conceptual phases, engineers explored the behavior of various alternative mechatronics configurations—in particular various actuator designs to provide for smooth gear shifting—until the best powertrain performance was achieved.

Based on these simulation results, the model was then used to develop control algorithms used as a basis for co-simulation between *AMESim* and the real-time software development and integration platform to develop first-order TCU logic software. In this "Software in the Loop" (SiL) approach *AMESim* was used to simulate the powertrain hardware—essentially providing a virtual engine and transmission as stand-ins while the actual hardware was still in development.

Finally, the TCU software performance was validated and calibrated using a "Hardware in the Loop" (HiL) approach to exercise the system model in real time. On a test rig, a TCU with control code embedded in the electrics sent signals to operate a physical prototype of an AMT actuator based on simulated load and sensor signals generated by *AMESim* for the rest of the powertrain. In this way, engineers fine-tuned the TCU software to achieve optimal powertrain performance according to fuel efficiency, dynamic response and other operational factors.

"Simulation-based development using *LMS Imagine.Lab AMESim* enabled Renault to shorten AMT development time considerably," Négre noted. "Refining the performance of the mechatronics system early in development avoids problems that take considerable time to resolve later in the development cycle. Moreover, using SiL and HiL approaches to develop, calibrate and validate TCU software in parallel with hardware development and fabrication constitutes an immense time savings."

"The models developed and lessons learned with this project will be used as a basis for further time and devel-

continued

opment savings in the future," Négre adds. "With this process, Renault will be launching more new vehicle models with AMTs months sooner than would otherwise be possible."

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Zero-Max ServoClass Couplings

OFFER
ROBUST DESIGN FEATURES

Design engineers looking to increase speeds in electronic assembly systems will find ServoClass Couplings from Zero-Max a viable design option. ServoClass Couplings provide high torsional stiffness, zero backlash and low hysteresis to ensure repeatable precise positioning at speeds up to 10,000 rpm. Their robust design ensures precise system operation in automated 24/7 applications. That is especially true where stresses occur at increased speeds in a servo system. Designed with 304 stainless steel disc packs and 7075-T6 aluminum hubs, ServoClass couplings are inherently strong, durable and precisely balanced. To ensure precise alignment of the assembled components, ISO 4762 CL12.9 corrosion resistant socket head cap screws are utilized with a carefully controlled assembly process. (Competitor couplings are assembled utilizing brazing, gluing and otherwise less precise methods with more variability.)

"ServoClass couplings are designed to handle the specific sensitivities of servo systems," reports Robert Mainz, Zero-Max sales manager. "The design of the coupling takes into account the mechanical as well as the electrical attributes of the system with the mechanical components keeping up with the electronic commands of the controller. The design specifications of the ServoClass coupling aid in making these two entities work far better together than other couplings when used in servomotor applications."

In addition to electronic assembly systems, ServoClass couplings are suitable for all types of automation, packaging and other types of automated assembly including most systems using ball screws and servomotors. ServoClass couplings are available in single and double flex models in inch and metric bore sizes from 0.157 inch (4 mm) to 1.750 inch (45 mm). All models and sizes feature clamp style hubs and operate in temperatures from –22 to +212 degrees F (–30 to +100 degrees C).

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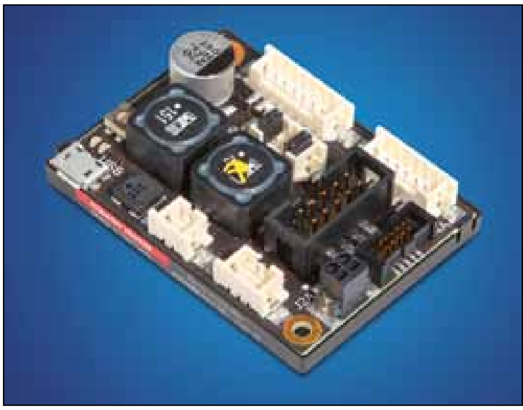
Maxon

RELEASES COMPACT
FOUR-QUADRANT SERVO
CONTROLLER



Maxon's Escon 36/2 DC is a four-quadrant PWM servo controller for use with DC motors up to 72 W. The Escon 36/2 DC is a very fast digital current controller with enormous bandwidth for optimal motor current/torque control. The drift-free yet extremely dynamic speed behavior enables a speed range of 1 to 150,000 rpm. It provides a wide range of functions, with fully configurable digital and analog inputs and outputs. When matched up with Maxon's range of motors, high demanding and dynamic drive solutions are possible. Additionally, it can be run in various operating modes speed controller (closed loop), speed controller (open loop)and current controller. This ultra-compact servo controller is controlled by means of an analog set value. The value can be specified by means of analog voltage, an external or internal potentiometer, a defined value or by means of a PWM signal with variable duty cycle. Other functions include the ability to enable or disable the power stage depending on the direction of rotation, or to use speed ramps for acceleration and deceleration. The speed can be regulated by means of a digital incremental encoder (2-channel, with/without line driver), DC tacho or without encoder (IxR compensation).

Designed to be user-friendly with an easy start-up, no in-depth knowledge of drive technology is required. When the servo controller is connected to a PC via a USB port, it can easily and efficiently be configured with the *Escon Studio* graphical user interface. During startup and configuration of the inputs and outputs, monitoring, data recording and diagnostics, the user has access to a large variety of functions and is assisted by user-friendly software wizards, as well as an automatic procedure for fine-tuning the controller. It comes fully equipped with everything that is needed. No additional external filters or motor chokes are required, and pre-assembled cables for the startup are available as accessories.

The Escon 36/2 DC has protective circuits against over-current, excess temperature, under- and over-voltage, against voltage transients and against short-circuits in the motor cable. It is equipped with protected digital inputs and outputs and an adjustable current limitation for protecting the motor and the load. The motor current and the actual speed of the motor shaft can be monitored by means of the analog output voltage. The large range for the input voltage and the operating temperature allow flexible use in a variety of drive applications. With its exceptional 95 percent efficiency, the inexpensive Escon 36/2 DC is a first-class choice for mobile, highly efficient yet consumption-optimized applications.

For more information:

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101 Waldron Road,
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Ameridrives Couplings

AVAILABLE
WITH TORSI-LOCK HUBS

Developed for API 610 service, Torsiflex-i flexible disc couplings feature a robust disc pack design, allowing for greater torque load in a smaller size which results in lower weight. The couplings' lower weight and longer bearing life yield a lower cost-per-application. Max bores matched to NEMA motor shafts provide up to 60 percent weight savings. A plug-in spacer design allows installation and removal without disturbing the hubs. All models are ATEX-compliant and come standard with a zinc phosphate coating, a built-in anti-flail feature and inch series hub attachment screws (metric available).

Torsiflex-i couplings are now available with Torsi-Lock hubs. Torsi-Lock offers the ease of a slip fit with the power of a shrink fit. Ameridrives Couplings has responded to industry demand for a cold-install hub that provides the secure torque transmission and balance repeatability of an interference fit. Ameridrives combined their Ameriloc shaft-locking devices with Torsiflex-i to provide a fully pre-engineered solution that meets the balance requirements of API 610.

Cold installation of Torsiflex-i couplings with Torsi-Lock hubs means "No hot work permits," providing added safety and productivity in hazardous environments. Torsi-Lock hubs provide easy, repeatable removal and installation, and eliminate fretting of hub to shaft. The hubs compensate for variances in shaft spacing—units can be slipped on and fixed in the needed location. The hub and locking device are balanced and match-marked to assure optimum balance performance.

For more information:

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Motoman

RELEASES CONTROLLER AND
MATERIAL HANDLING ROBOTS

Introduced at Pack Expo in September, the high-performance FS100 controller from Motoman Robotics is designed for open software connectivity and supports *PCI Express*. The FS100 controller supports *C*, *C#*, *INFORM III* and other high-level programming environments. "To meet the growing needs of our customers, it is often necessary to create custom functionality for the robot controller. The FS100 design leverages hardware standards and open software to allow easy extensibility of the controls," says Erik Nieves, technology director at Motoman Robotics. "It is now possible for users or system integrators to easily integrate off-the-shelf hardware or write value-added functions to the robot controller."

Designed for packaging, assembly and material handling applications, the FS100 controller is compatible with Motoman robots with payloads up to 20 kg, including the high-speed MPP3 delta-style robot also introduced at Pack Expo.

In addition, the powerful, high-speed MH80 robot has an extremely flexible design, allowing it to be used for a variety of material handling applications. The long reach of the MH80 model makes it ideal for handling large parts. Fast axial speeds and acceleration reduce cycle times and increase production output. Internally routed cables and hoses maximize system reliability, minimize interference and facilitate programming. The MH80 features an 80 kg (176.4 lb) payload, 2,061 mm (81.1") horizontal reach, 3,578 mm (140.9") vertical reach and ± 0.07 mm (0.003") repeatability. Its wide work envelope and small interference zones allow the MH80 to be placed in close proximity to workpieces and equipment, reducing floor space requirements. The robots have brakes on all axes and can be floor-, wall- or ceiling-mounted for

layout flexibility.

The MH80 robot is also suitable for dispensing and material cutting applications. The MH80 robot uses Motoman Robotics' dynamic, next-generation DX100 controller that includes patented multiple robot control technology to easily handle multiple tasks and control up to eight robots (72 axes), I/O devices and communication protocols. Featuring a robust PC architecture, the DX100 uses a Windows CE programming pendant with color touch screen. The energy-saving DX100 controller features faster processing speeds for smoother interpolation, advanced robot arm motion, built-in collision avoidance, quicker I/O response and accelerated Ethernet communication. Its extensive I/O suite includes integral PLC and HMI pendant displays, 2,048 I/O and a graphical ladder editor that can provide system level control. The DX100 controller supports all major fieldbus networks. It is compliant to ANSI/RIA R15.06-1999 and other relevant ISO and CSA safety standards.

For more information:

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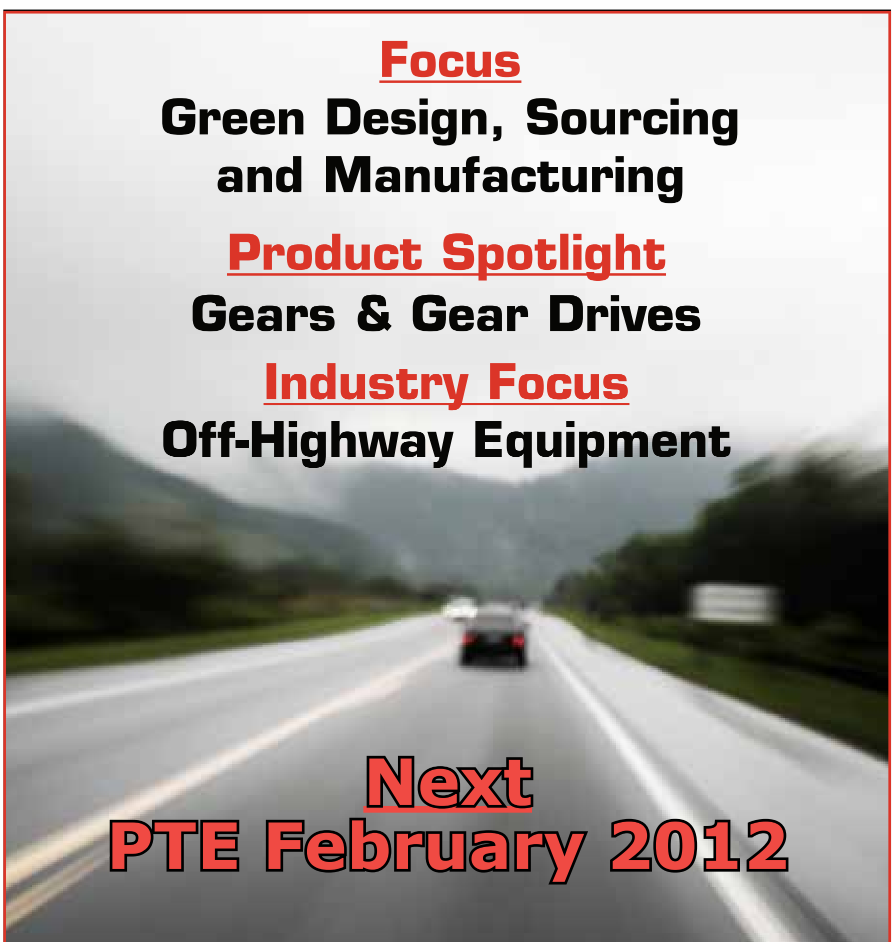

HC/CH Clutch

OFFERS PERFORMANCE ADVANTAGES IN MARINE APPLICATIONS

Industrial Clutch, located in Waukesha, Wisconsin, has introduced the Model HC/CH clutch designed for use in marine applications including drawworks, winches and propulsion. HC/CH models are drop-in replacements to competitive clutches. The HC/CH clutch features a unique, patent-pending key seal that allows for the use of standard o-rings and improves the ease of installation in current configurations using a double keyway and single drilled actuation hole. Hubs are manufactured from high quality alloy steel and include induction-hardened teeth for maximum spline life. The HC/CH is available in two styles: the EWA model for oil immersed application and EDA units designed to run as dry friction clutches. All friction materials utilized are designed to provide high thermal and smooth engagement performance. Wet friction material used in the EWA style oil immersed units allows for the use of both EP (extended pressure) and vegetable-based oils.

For more information:

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