Magneto-Rheological (MR) Suspension Systems

FOR INDUSTRIAL APPLICATIONS
Operators of heavy machinery spend a lot of time in harsh and unpleasant vibration environments. As industrial equipment becomes increasingly automated, operators are more aware of annoying vibrations and noise which influence their perception of comfort and quality. In parallel, government agencies around the globe are evaluating new laws that require OEMs to protect operators from the harmful effects of whole body vibration.

To satisfy the changing market expectations for improved comfort, health and safety, OEMs must consider new suspension technologies to maintain a leading market position.
FROM PASSIVE TO ADAPTIVE SUSPENSION SYSTEMS

Suspension systems in today’s industrial equipment are evolving. Traditional passive spring and damper systems react to load inputs from the wheels and body, and exhibit relatively constant spring rates and damping forces regardless of the road and load conditions. In contrast, adaptive suspension systems continuously alter their suspension settings in real time to suit different driving or road surface conditions providing improved dynamic stability.

LORD Corporation offers unique adaptive suspensions that leverage our proprietary Magneto-Rheological (MR) fluid technology, which support different suspension applications including primary (axle), cab, seating and more.
WHAT ARE LORD MR FLUIDS?

MR Fluids consist of magnetic (typically iron) particles in a carrier fluid. In the presence of a magnetic field, the micron-sized particles link and change the fluid to a semi-solid in milliseconds. When the magnetic field is removed, the fluid just as quickly reverts back to its natural free-flowing state. Furthermore, the degree to which the fluid changes to a semi-solid is proportional to the strength of the magnetic field, giving the fluid infinite controllability and precision.

HOW DOES AN MR DAMPER WORK?

Similar to passive hydraulic dampers, an MR damper consists of a fluid that moves between different chambers via small orifices in the piston, converting “shock” energy into heat. However in an MR damper, an electrical circuit is introduced in the piston assembly. As electrical current is supplied to the damper, a coil inside the piston creates a magnetic field and instantaneously changes the properties of the MR Fluid in the piston. Consequently, the resistance of the damper can be continuously changed in real time by modulating electrical current to the damper.
MR CONTROL SYSTEMS

Adaptive suspension systems rely on quick detection of a disturbance and precise control of the damper for optimal suspension performance. Our control systems leverage a network of sensors that continuously monitor the driving situation in a vehicle and send data to the control unit via the CAN bus. The control unit interprets these signals and regulates electrical current to the damper using sophisticated proprietary control algorithms. This process occurs continually thousands of times per second during vehicle operation to ensure the ideal suspension characteristics for the specific driving condition. LORD has spent decades developing proprietary control algorithms that optimize the unique capabilities of MR Fluid technology.

Typical performance characteristics of various suspension technologies are displayed in Figure 5 using a force-velocity curve. The speed at which MR technology changes damper forces enables more use of the damper stroke to control motion, improving the ride and handling for the operator.

Figure 4: Block diagram of a typical control system

Figure 5: Performance comparison of various suspension types
A Broad Performance Capability

During our long history, LORD has developed more than 100 MR Damper designs with varying capability. Our systems are incredibly flexible and well-suited to a wide range of applications with damper forces ranging from 1,700 N to 38,000 N (and higher).

**SEAT SUSPENSIONS**
LORD Corporation has produced more than 250,000 MR Seat Suspension systems since 1998 for various Agricultural, Construction and Commercial Vehicles. Our system includes a MR damper, a control unit with an integrated position sensor, and an optional ride mode switch for the driver to select between different suspension settings. LORD MR Seat Suspensions have proven to dramatically improve driver comfort, fatigue and safety by damping harsh shock events using our proprietary control algorithms.

**CAB SUSPENSIONS**
Traditional cab suspension systems typically compromise between ride comfort and stability, but LORD MR cab suspensions offer a solution to manage these conflicting goals. Our solution integrates the air spring, MR damper, controls, sensors and leveling valves into a single unit. The air spring provides a soft suspension for low-frequency vibrations, while the MR damper is used only when needed to provide stability and shock protection. The leveling valves help keep the cab level during operation to provide optimal suspension performance during most driving conditions.

**PRIMARY SUSPENSIONS**
LORD invests in the research and development of MR primary suspensions. Although our initial products were developed for military vehicles, we have since demonstrated the technology on other industrial vehicles and verified the benefits of improved comfort, stability, safety, speed, productivity, and durability.

**CUSTOMIZED SOLUTIONS**
LORD can also develop new solutions with unique product requirements for applications requiring instantaneous and precise control of variable force.
LORD MR Suspension Systems – A Proven Technology

LORD Corporation has been working with controllable fluids since the 1980s, and is presently the largest global supplier of commercial MR Fluids.

As the exclusive supplier of MR Fluid to BWI for Magneride™ automotive primary suspensions, LORD has demonstrated the ability to meet the quality and reliability expectations of the world's leading automotive companies. With hundreds of thousands of systems in the field and over 110 patents related to fluid formulations, device design, control algorithms and manufacturing methods, LORD Corporation remains a market leader for adaptive suspensions … Ask Us How.

BENEFITS OF LORD MR SUSPENSION SYSTEMS

Customized controllable damping significantly improves vehicle ride comfort, handling and safety

• Improved driver responsiveness, efficiency and pleasure
• Reduced operator fatigue and risk of injury
• Improved vehicle stability for safe maneuverability at higher speeds
• Easily integrated with other vehicle electronic systems (braking, steering) to enable sophisticated vehicle dynamic control capability
• Fail-safe (becomes a passive damper) or fail-firm (becomes rigid) design options if electrical power is lost
• Better protection for cargo or goods

Simple electro-mechanical design is easy to integrate, improves reliability and reduces total cost

• No additional packaging space required versus conventional passive dampers
• No maintenance required
• Reduced wear on suspension and drivetrain components
• Low power requirements (typically less than 5A)
• Broad operating temperature range (-40°C to 120°C)
LORD provides valuable expertise in adhesives and coatings, vibration and motion control, and magnetically responsive technologies. Our people work in collaboration with our customers to help them increase the value of their products. Innovative and responsive in an ever-changing marketplace, we are focused on providing solutions for our customers worldwide ... Ask Us How.

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