



Multimatic



Formula SAE Formula Student Multimatic DSSV™ Damper Program

Multimatic's Innovative Spool Valve damper technology is now available for teams competing in Formula SAE and Formula Student.



Using the same Multimatic spool valve damping technology that has had great success in Formula One, CART, IMSA, global endurance sportscar racing, Porsche Carrera Cup, Touring Car, WEC and even off-road racing, Multimatic is now making available DSSV™ dampers specifically engineered for Formula SAE and Formula Student competition.



From Formula One to Formula SAE

Background

Multimatic has been involved with Formula SAE and Formula Student for over 25 years, with full appreciation of the personal and technical skills that these programs develop in participating students. We have over 50 engineers at our technical centres who were introduced to Multimatic through Formula SAE and Formula Student.

We have also actively engaged with both programs through judging, sponsorship and the presentation of awards and trophies, all intended to promote interest and achievement in the field of vehicle dynamics.

It was only natural, then, for Multimatic to become more involved and develop specific dampers for Formula SAE and Formula Student competition in order to:

- Expose talented young engineers to our DSSV damper technology and development tools
- Contribute to the advancement of technology in the student Formula programs

This damper development program was led by students while on work-terms at Multimatic Technical Centres in Canada and the UK.



Overview of the Technology

Unlike any other, Multimatic DSSV dampers use spool valves to precisely regulate oil flow and deliver the highest possible level of damper predictability, accuracy and repeatability. This unique design also reduces the sensitivity to temperature and frequency.

- Multimatic DSSV dampers enable accurate off-line and driver-in-the loop (DIL) simulations

The valves used in the student Formula dampers offer:

- Valve-to-valve repeatability of +/-3% of total damping +/- 30N
- Extremely low mass of ~30g

The dampers are available in two configurations:

- A conventional four-corner damper setup
- A mode-decoupled four-damper setup having two heave and two roll dampers



For the first time ever, Formula SAE and Formula Student teams can purchase either a conventional four-corner damper system, or a mode-decoupled suspension with separate heave and roll dampers from a renowned damper manufacturer.

The car shown here was developed by Western University in Ontario, Canada, and features a mode-decoupled suspension.

Conventional vs. Mode-Decoupled Systems

Benefits of a Mode-Decoupled Suspension

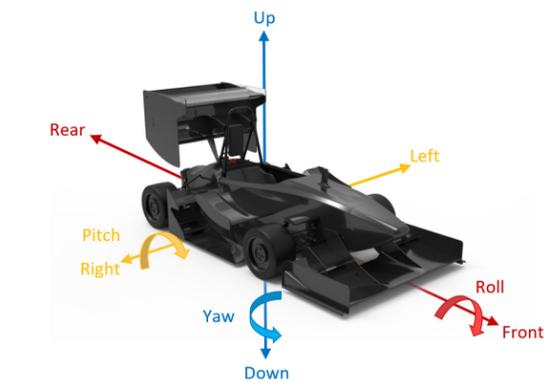
In a conventional independent suspension, springs and dampers are simultaneously actuated in all four modes shown at right, making independent control of each mode impossible.

A mode-decoupled suspension enables discrete control of stiffness and damping for each chassis mode. Each can then be tuned individually.

High spring rates help control chassis attitude while softer rates help maximize tire grip. A mode-decoupled suspension provides flexibility with regard to this compromise. Improved ride height control also reduces aerodynamic center of pressure migration, improving vehicle balance and high-speed stability.

Other benefits include:

- Minimized contact patch load variation through independent modal damping helps improve overall grip
- Greater control of lateral and longitudinal load transfer through all vehicle maneuvers provides improved transient response and drivability



Suspension motion can be described by four individual modes:

- Heave (four wheels move in unison relative to chassis)
- Pitch (front wheels move opposite to rear wheels relative to chassis)
- Roll (left wheels move opposite to right wheels relative to chassis)
- Warp (twist of the front axle relative to the rear axle)

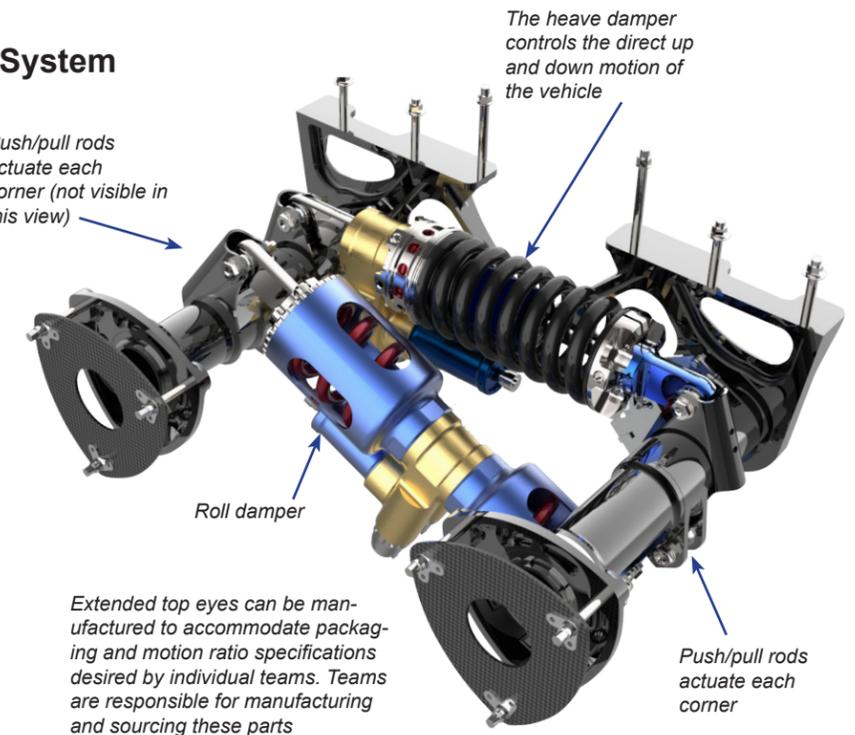
A Mode-Decoupled Suspension System

This underslung front suspension module shows the separate heave and roll dampers, which act on the wheels through push-pull control rods.



Example on this page provided by the Ecole de Technologie Supérieure (ÉTS)

Push/pull rods actuate each corner (not visible in this view)



Extended top eyes can be manufactured to accommodate packaging and motion ratio specifications desired by individual teams. Teams are responsible for manufacturing and sourcing these parts

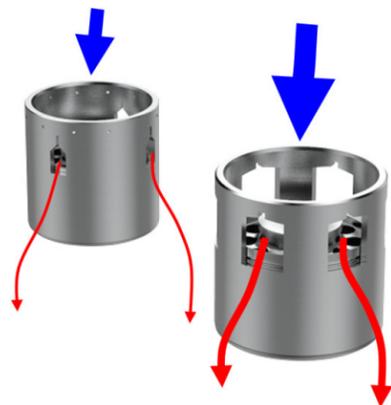
The Ford GT and Ford GT Mk II, both built by Multimatic, have dampers that rely on the exact same technology implemented in our Formula SAE and Formula Student dampers.

Predictable. Precise. Adjustable.

Damper Architecture

Multimatic dampers use proprietary spool valve technology to precisely regulate oil flow through a series of profiled port windows within the damper.

The laser-cut port window shapes, together with the configuration of other elements within the valves, enable a wide range of mathematically predictable damper force-velocity curves.



Traditional dampers rely on a stack of flexible shims to regulate oil flow through a series of piston orifices.



Benefits

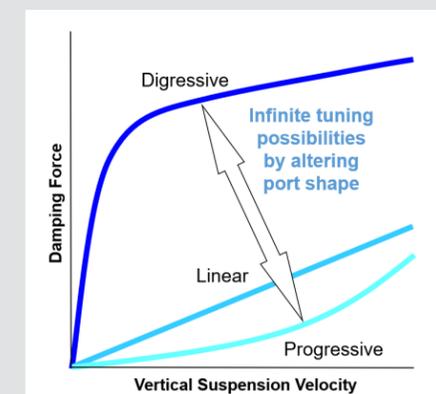
Multimatic dampers are analytically determinant, which simply means they can be modeled and predicted.

The shape of any given damper's force/velocity curve can be precisely created and tuned:

- The laser-cut shape of the port windows controls the overall shape of the dampers force/velocity curve:
- The narrow portion of the window restricts oil flow, requiring more oil pressure to achieve a given flow rate

- The wider portion of the window allows oil to flow more easily, requiring less pressure to achieve a given flow rate
- The angle of transition between the narrow and wider portions of the port window determines the shape of the transition between the two gradients of the force-velocity curve
- Multimatic dampers use self-piloted valves. Changing the diameter of the pilot orifice controls the amount of force on the valve spring for a given pressure, which results in a different area of the port window being exposed to flow
- Changing the valve spring rate controls the exposed port window area for a given pressure. A stiffer spring results in less spool travel and therefore a stiffer damper curve

Holding extremely tight machining and laser-cutting tolerances when producing the dampers makes it possible to achieve valve-to-valve repeatability of +/-3% of total damping +/- 30N.



Supported by the global engineering resources of Multimatic, these dampers were designed and engineered by Formula SAE students specifically for Formula SAE and Formula Student competition.

Specifications

Corner Dampers

Multimatic's Formula SAE and Formula Student corner dampers are used for a conventional four-corner setup. Four dampers are supplied as a set, without springs, and can accommodate a wide range of off-the-shelf springs that teams currently use.

For better part interchangeability, corner dampers have the same race valves, reservoir architecture and valve bodies as the heave and roll dampers.

Corner damper specs:

- Eye-to-eye Length: 189.3 mm
- Stroke: 55 mm
- Mass: 397 g (w/o spring)



Corner damper

Common Specs

All dampers provide:

- 2-way adjustability with minimized weight and packaging architecture
- 12 settings (0-11) per valve with position indexing and position limit stops
- Desired force-velocity curves and adjustability ranges achieved through Multimatic Specfinder™ software

Note: accelerated durability tests were performed to validate the reliability of the dampers. Worst-case testing conditions were generated by compiling data from several Formula SAE teams through in-car data acquisition and simulations. All dampers survived ten simulated Formula SAE seasons.

Heave and Roll Dampers

Multimatic's Formula SAE and Formula Student heave and roll dampers come as a set and are used in mode-decoupled suspension. Both incorporate a dual spool-valve and adjuster arrangement similar to the corner damper.

The heave dampers are similar to corner dampers but can accommodate a sliding collar if teams deem helper springs are necessary for their system. Springs are not included, but most of the popular springs currently used by teams can be accommodated.

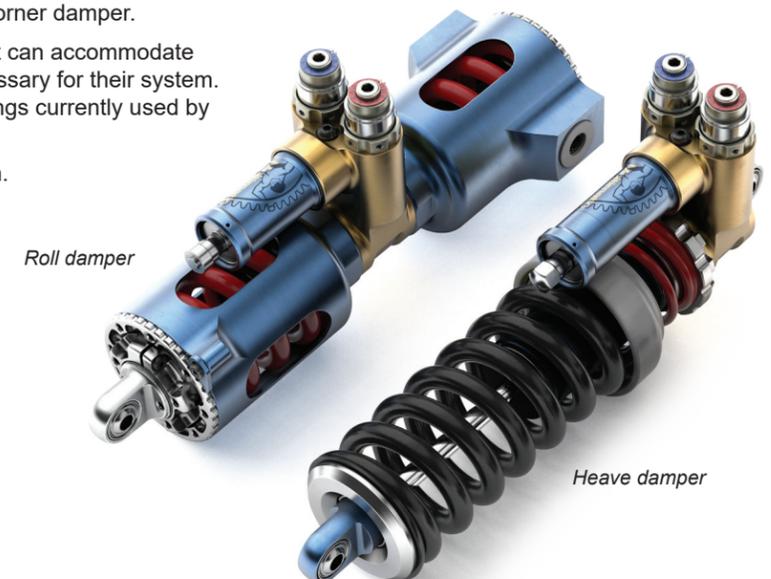
The roll damper requires two bump springs to function. One spring is used per direction of roll, removing the need for high-friction sliding mechanisms currently used by some student Formula teams. The system eliminates the need for an anti-roll bar.

Roll damper specs:

- Eye-to-Trunnion Length: 211 mm
- Stroke: ± 37 mm
- Mass: 784 g (w/o springs)
- Designed specifically to allow for rapid spring changes and damping adjustments on track
- Spring changes only require three steps, with the same procedure on both sides

Heave damper specs:

- Eye-to-Eye Length (Extended): 229.3 mm
- Stroke: 75 mm
- Mass: 459 g (w/o springs)



Roll damper

Heave damper

Multimatic provides multi-post rig testing services at its Technical Centres in the U.K. and Canada.



Supporting Services

More Than Dampers

Multimatic is a leading provider of multi-post vehicle development services, and is making them available to Formula SAE and Formula Student teams, at a discounted rate, through our Thetford, U.K. and Markham, Ontario, Canada facilities.

The multi-post rigs can be used to:

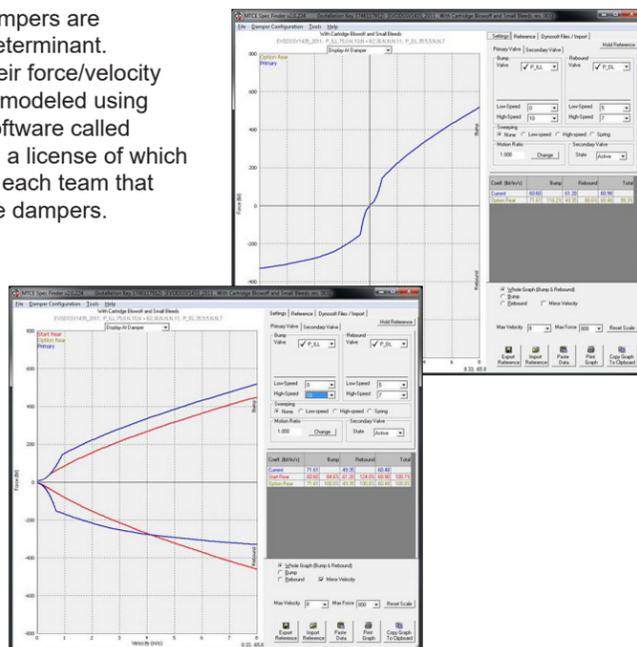
- Determine vehicle properties
- Identify sources of vehicle deficiencies
- Quantify effects on suspension performance
- Optimize dampers, tires and springs
- Characterize different suspension systems
- Review previous/existing vehicle set-ups

If you are interested in scheduling time on one of our multi-post rigs, please email:

fsaedampers@multimatic.com

Specfinder™ Software

Multimatic dampers are analytically determinant. As a result their force/velocity curve can be modeled using proprietary software called Specfinder™, a license of which is supplied to each team that purchases the dampers.



Springs

Although springs are not included, Multimatic's corner and heave dampers can accommodate the standard 36mm ID springs used by most Formula SAE and Formula Student teams. The spring must have the following specifications:

- Maximum protected compression load (combined spring and jounce bumper) is 5.16 kN
- Maximum protected extension load is 4.09 kN
- Maximum allowable free-length for corner springs is 119.3 mm
- Maximum allowable free-length for heave springs is 159.3 mm

For those teams selecting the mode-decoupled damper system, two bump springs that meet the following specifications are required per damper:

- Internal and external allowable roll spring diameters are 34 mm and 49.5 mm, respectively
- Maximum allowable free-length for roll bump springs is 59.3 mm. Springs with free lengths less than the maximum allowable can be shimmed to remove any free play in the system or to add pre-load.

Jounce bumpers are required for corner, heave and roll dampers and are not included with the dampers. The rod external diameter on all the dampers is 8 mm.

Spare Parts

Spare dampers and consumables will be available for purchase from both Multimatic Technical Centre and Multimatic Technical Centre Europe.

Teams can request spare parts/support from the Technical Centre that is established as their point of contact.

Tools for changing springs will be included with each vehicle set of dampers.

Multimatic is committed to supporting the professional development of teams and individual engineers participating in Formula SAE and Formula Student programs.



Next Steps

Purchasing

Multimatic is starting to make these dampers available to select teams.

- 25 vehicle sets of dampers will ultimately be available in the first year
- Initially, they will be available only to teams located in North America and Europe. This is to ensure suitable support can be provided to each team.

The dampers cost \$7,500 CDN per vehicle set (decoupled or corner configuration).

- Please email fsaedampers@multimatic.com if you are interested

Formula teams can purchase highly discounted 4-post rig testing time, at a cost of \$1,500 CDN for a half-day at either our Thetford, UK, or Markham, Ontario, Canada facilities.

We ask that teams using Multimatic Formula SAE or Formula Student dampers display the Multimatic logo on their race vehicle. We will provide a set of logos with the dampers.

Who to Contact

For all inquiries related to Multimatic's Formula SAE and Formula Student dampers, please contact:

fsaedampers@multimatic.com

Awards

At select events, Multimatic provides a "Vehicle Dynamics Performance Excellence Award" to the team that demonstrates the greatest understanding and optimization of their vehicle's handling performance.





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