

## **Abstract**

The trend of reducing the emissions in automotive sector leads to the development of electrification of vehicle powertrain and chassis. Those vehicles equipped with regenerative shock absorbers can transfer the vibrational energy coming through the road irregularities into electricity which can be further used for other purpose, i.e. to charge the battery. To realize the regeneration target, the developed device should be able to vary their damping behaviors while converting part of the dissipated power into electricity. Therefore, an electric machine together with a suitable transmission system need to be integrated to the vehicle. Several types of solutions have been investigated during the last two decades. In the present thesis, one prototype of regenerative damper with controllable damping and energy harvesting features is developed. The regenerative shock absorber employs the electro-hydrostatic actuation principle, uses a hydraulic actuator directly interfaced with a motor-pump group by means of hydraulic circuit to convert the linear motion of the piston into rotation. To maximize the energy regeneration as well as to guarantee the damping features, the hydraulic, mechanical and electric subsystems must be integrated and optimized as an entire system. The thesis establishes a system-level approach during the design phase while complying with important constraints such as envelop volume and supply voltage limitation. Different aspects that will affect the final conversion efficiency are analyzed individually, a prototype is also produced and fully characterized with experimental tests. Furthermore, this approach can be extended to any motor-pump unit for hydraulic regenerative dampers. The significance of the present work can be seen also from its integration with the electric powertrain. Since the shock absorber is electrical, it can easily transfer the power to the vehicle battery which is also electrical, in this case, a single system can be used to handle the energy. Another important aspect is about the autonomous driving technology, since systems and devices nowadays are getting towards having more controlled damping properties to enhance the driving comfort experience.