
Electrification

ADVANCED

ALTERNATIVE POWERTRAIN SOLUTIONS
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YOUR ENGINEERING DEVELOPMENT PARTNER

Hybrid and E-mobility concept development by FEV
FEV is an internationally recognized leader in design and development of powertrain and vehicle systems. Professor Stefan Pischinger, President and CEO of the FEV Group, maintains the company’s focus towards sustainable and significant contributions to the design and development of advanced gasoline and diesel as well as alternative hybrid and pure electric powertrains.

FEV is a premium partner for hybrid and electric vehicle development. The scope of services and experiences includes every single step and every single part of vehicle development. We realize solutions for electric vehicles, plug-in hybrid vehicles and hybrid electric vehicles. Furthermore, we offer full turn-key responsibility gained during more than 60 hybrid/ EV projects.

Think global, act local
Our global customer support is essential to the mutual success of both FEV and its customers. With its World Headquarters and European Technical Center in Aachen, Germany as well as the durability test center in Brehna, the FEV Group operates globally with its local Technical Centers in suburban Detroit in the USA, and our Asian facilities in Dalian, China and in Pune, India.

Partner for professionalism
FEV is committed to keeping its position as a technology leader, and to maintaining that leadership. The company continually reinvests in internal R&D programs, developing value-orientated solutions to meet tomorrow’s mobility and transportation demands. These activities are strictly aligned to customer demands through focus on the individual definition and adaptation of development and business processes, while observing the highest standards of confidentiality.
FEV AT A GLANCE

» Worldwide at your side to meet the future challenges «

> Leader in design and development of powertrain and vehicle systems
> Founded in 1978
> Privately-owned global enterprise
> More than 35 subsidiaries on four continents
HYBRIDS AND E-MOBILITY

» The predominant majority of new vehicles in 2020 will have at least Start/Stop functionality and intelligent generator control «

To meet future CO₂ emission legislation targets worldwide, electrification of vehicle propulsion systems is the most probable technology. It offers high CO₂ reduction potential combined with increasing performance and passenger comfort. FEV expects that the predominant majority of new vehicles in 2020 will have at least Start/Stop and intelligent generator control and approx. one third will have a higher degree of electrification like Mild-, Full or Plug-In hybridization. Beyond 2025 we expect additionally a recognizable number of battery electric and fuel cell vehicles.

FEV’S CAPABILITIES AT A GLANCE

» Concept evaluation with respect to fuel consumption and performance, target markets, manufacturers vehicle portfolio as well as supplier availability

» Benchmarking, system simulation and buildup of demonstrators

» Integration of all disciplines from engine, transmission, electric components, vehicle and electronics to develop optimized powertrains

» Full responsibility in turn key projects from concept to production or dedicated support with our experts in your hybrid program on-site
FEV has been responsible for a large number of development programs for hybrid and all-electric powertrains as a turn-key development partner for international customers. Starting with Start/Stop systems, our experience comprises micro, mild, full and plug-in hybrids as well as battery electric vehicles (with and without range extender modules). FEV also engages in internal R&D projects to evaluate fuel cell technology for our clients.

In combination with our transmission system experts, FEV has contributed a considerable number of advantageous hybridized transmission solutions. In all of our global development centers, we have employed rapidly growing teams and continuously extended our test facilities to meet these needs.
COMPONENT DEVELOPMENT

More than 25 years of experience in customized hardware solutions

With competences in engineering support of series production projects, FEV develops hardware components ranging from sensors, actuators and controllers to complete hybrid drivetrains. Our design teams are familiar with all common CAD/CAE tools to design electric and electronic hardware for demonstrator purpose as well as for production.

Examples include:

- Battery management systems (BMS)
- High-Voltage Li-ion battery packs
- Electric motor layout and optimization
- Power electronics and DC/DC converter
- Complete Range Extender modules
- Fuel cell systems

For component validation FEV has state-of-the-art test benches for development, calibration and durability tests of printed circuit boards (PCB), motor/generators, batteries and complete drivetrains.

**Our experience and tools include:**

- More than 20 battery projects
- R&D project: optimization of e-motor power
- Development of our own battery management system (BMS) for prototyping and production
- Power electronics for combination of power and energy batteries

Our experts are involved in many series production projects as technical contacts for component suppliers to specify the requirements and validate the delivered hardware at the system level.
FEV'S CAPABILITIES AT A GLANCE

- Specification of electric components for hybrid and electric vehicles
- Technical supplier management
- Design and optimization of components based on CAE, simulation and testing
- Interdisciplinary teams with electrical, mechanical and control engineers
- Component validation and durability testing
- Technical consulting and EMC/EMI troubleshooting
E-TRACTIVE BATTERIES

» Full service battery development from one source «

FEV has several cell and battery test benches worldwide for the testing and validation of developed battery packs as well as experience with series production testing for several well-known manufacturers, allowing FEV to be recognized as an internationally-operating engineering company that can guarantee a high degree of quality and series production readiness in its engineering developments. Our additional test benches for hybrid powertrains are important tools for not only powertrain development, but also for the evaluation of battery performance in the overall drive system.

The quality of battery management system algorithms has as much influence on performance as the selection of suitable battery cells and an optimized layout of the overall battery. The core system for the battery development is our own mature battery management system – BMS – now in its third generation, that together with optimized algorithms allows a very reliable and stable control of the battery. Thanks to its use in a variety of projects, the system is highly mature and very flexible with the capability to accommodate any battery concept.
FEV’S CAPABILITIES AT A GLANCE

> Electrical layout and cell selection, appropriate to your application
> Mechanical design and structural optimization
> Simulation and layout of thermal management
> Battery management, hardware and software development and calibration
> Functional and electrical safety
> Validation on cell, module and pack level
POWERTRAIN AND VEHICLE E/E-INTEGRATION

» The whole is greater than the sum of all parts «

E/E-integration is all about bringing the components together in the vehicle and to make them work as a whole. FEV has the overall knowledge to do this, from conventional and hybrid powertrain and transmission control units to body, chassis, vehicle and driver assistance systems including its actuators and sensors. To integrate them in the growing complexity of the individualized vehicle architectures and data streams is today's challenge.

E/E-integration projects not only become successful by interconnecting control units in either data buses (LIN, CAN, MOST, FlexRay) or hardwired, FEV’s global presence also assures that people are optimally communicating. To realize it, FEV is a full service provider in both supplier management and project management and offers complete communication network and wiring harness development from rapid control prototyping to series production development.

Diagnostics by embedded software and by off-board testers is completed by drive-by-wire development and calibration to support the latest OBD and safety standards like 3-level EGAS safety according to FMVSS124. Extensive climate controlled test facilities, E/E-laboratories and the direct proximity to a test track complete the service portfolio of FEV’s E/E-competence.
FEV’S CAPABILITIES AT A GLANCE

> Integration competence covering powertrain and transmission control units, body, chassis, vehicle and driver assistance systems
> Full service provider in both supplier management and project management
> Complete communication network and wiring harness development from rapid control prototyping to series production development
> Support of latest OBD and safety standards
> Cutting-edge test facilities
FUNCTIONAL SAFETY

» Solutions for functional safety based on outstanding automotive engineering expertise «

State-of-the-art vehicles are controlled by electronic components and software. From active safety systems like ABS/ESP, driver assistance like adaptive cruise control or park pilot up to torque monitoring of conventional and hybrid drivetrains, reliability and accuracy of hardware and software is essential for product maturity.

The introduction of ISO 26262 standardizes on one hand the requirements and the understanding of how to achieve a safe system. On the other hand OEMs, system and component suppliers are forced to adapt their quality processes to comply with the standard. FEV has a long experience in the development of components and systems following standards related to functional safety.

Our competence center for functional safety consists of technical experts with long-term experience in the development of electronic hardware and software, who:

> combine know how of safety standards like ISO 26262 and practical engineering background
> are able to discuss safety measures in detail with your technical experts to find the most suitable solution
> develop processes and tools to support the development and validation activities around the entire product life cycle
> perform functional safety management during the whole product development lifecycle
FEV CAPABILITIES AT A GLANCE:

- Provide training and consultancy related to functional safety audits and ISO 26262
- Act as an independent third party for audits and reviews
- Develop customized solutions for all kinds of tools and templates related to functional safety
- Support development projects with functional safety managers to assure conformity to the relevant standards
HYBRID AND ELECTRIC VEHICLE CONTROL

» The intelligent powertrain uses topology data, connectivity and advanced driver assist systems «

The complexity of hybrid powertrains requires advanced control algorithms to achieve maximum benefit in terms of fuel consumption, performance and comfort. FEV uses its experience with all types of hybrid topologies as well as know-how of advanced vehicle electronics to improve the hybrid strategy of your powertrain. Essential functionalities like comfortable engine restart, recuperation strategies for different hybrid modes and adaptation of torque split accordant to battery performance capability are proven in several serial production development projects. With our hybrid control library FEV is able to produce high quality hybrid and electric vehicle control software with outstanding performance.

Our calibration engineers are working with in-house developed tools to reduce the calibration effort and achieve high quality at the same time. Connectivity and data aggregation will allow a new level of hybrid strategy in the near future. By using topology data from navigation systems, traffic information and near field data from driver assist systems the hybrid strategy can be adapted online. FEV is working on such solutions for passenger cars and commercial vehicles.

FEV CAPABILITIES AT A GLANCE:

» Proven series project competence
» Rich vehicle control library
» Experience with third party software and control unit suppliers
» Powerful in-house developed tools reduce calibration effort and increase quality
» Consistent architecture by common design principles
» Integrated tool support for the entire development
» Automated software documentation for high quality and customer transparency
SOFTWARE DEVELOPMENT AND EMBEDDED SYSTEM TEST CENTER

Expertise meets excellence

FEV PERSIST provides a standard approach to establish a stable and yet flexible software architecture to maximize maintainability and reuse. All activities are continuously and automatically monitored by a Continuous Integration approach which enables FEV to realize agile development for model-based control software in combination with flexible development and quality gates at the same time. Mature and customer proven processes improved by agile concepts are accompanied by systematic verification and validation in our FEST (FEV Embedded System Test Center) right from the start.

Decades of control development experiences converge to software meeting your needs in series production as well as bringing to life thrilling new functionalities on demonstrator level.

From initial concept and rapid prototyping to production code: Our system know-how covers:

- combustion engines
- hybrid-electric powertrains
- battery packs
- transmissions
- gear sets
- control software applications for rail, marine and wind energy

FEVs

YOUR ADVANTAGES:

- Less time and costs through reuse
- Flexible software configuration for any system
- Frontloading through early simulation
- High degree for entire software lifecycle
- Proven functions from many series projects
YOUR ADVANTAGES:
> Cost and time reduction
> Early detection of quality defects
> Reuse of simulation models
> On-site support at required location
> Efficient testing within project boundaries
> Quality focus “working customer system”