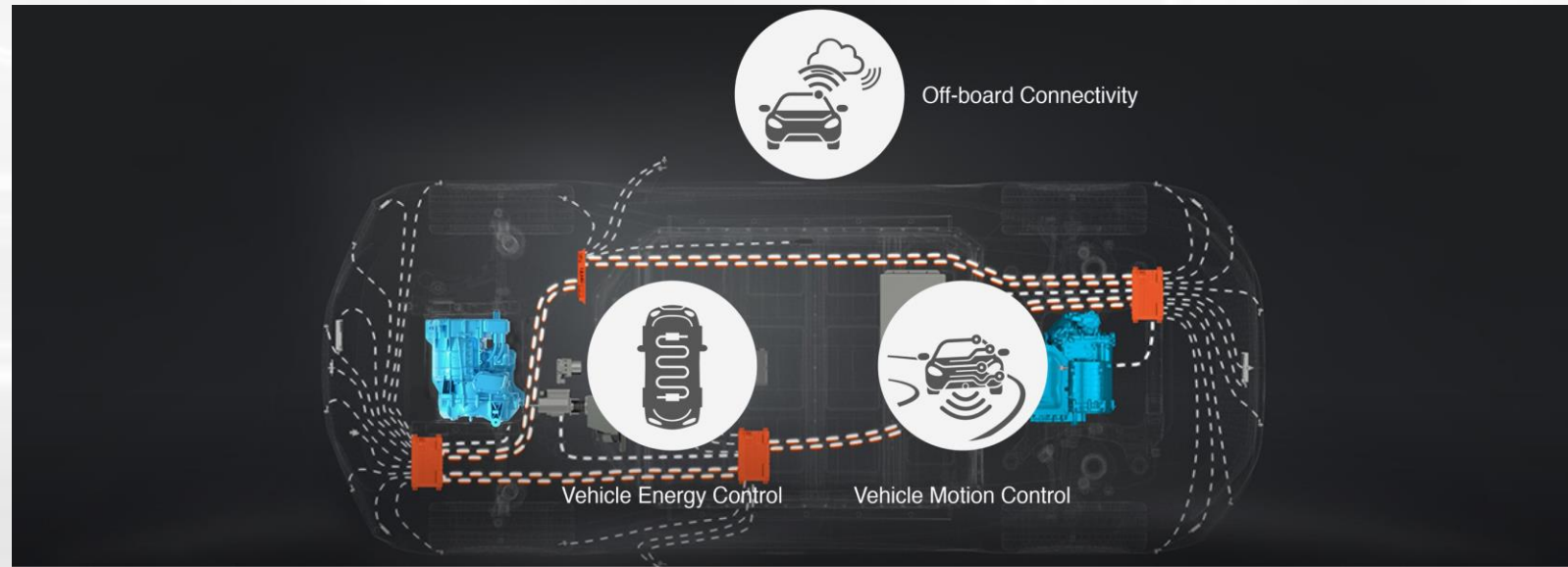


Powertrain Cross Domain Display

Energy & Motion Control

Functional modular software platform for BEV and (P)HEV. Magna delivers an operating strategy including advanced and predictive vehicle functions for energy & motion control independent of the powertrain layout and E/E architecture. Delivery of software as a product (SaaS).



Features and Specifications

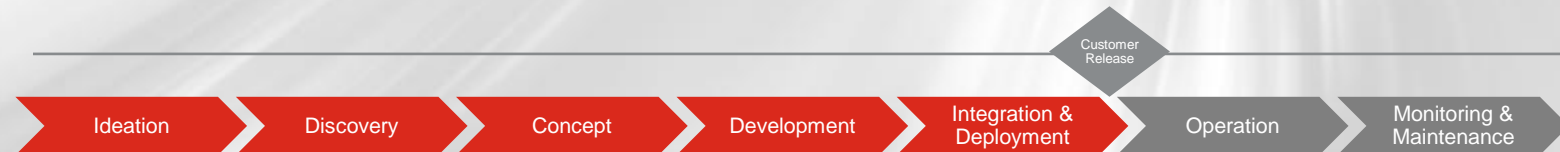
- Vehicle physics model incl. active sideslip angle calculation
- Longitudinal torque vectoring
- Lateral torque vectoring by EMs, clutches and brakes (incl. integrated eDrive and brake controls)
- Disconnect strategy
- Traction Predictor incl. Road State Observer
- Energy management by using route information
- Powertrain and battery conditioning
- Charging Control
- Specific calibration of platform functionalities ensures differentiation and supports individual brands image

Core Technologies

- Service oriented architecture
- Distributed Data Services (DDS)
- Containerization based on e.g., WebAssembly
- Fully functional safety ISO 26262 compliant
- Cyber security ISO 21434
- Over-the-air updates / continuous deployment to support Always New Vehicle (ANV)

Additional Takeaways

- Connectivity to off-board information enables predictive features e.g., friction data, route information (online digital twins)
- Full-scale energy management supports max range – for hybrids and BEVs
- Highly adaptable to various vehicle characteristics/driver modes
- In production for torque vectoring and disconnect strategy
- Multiple software licensing models

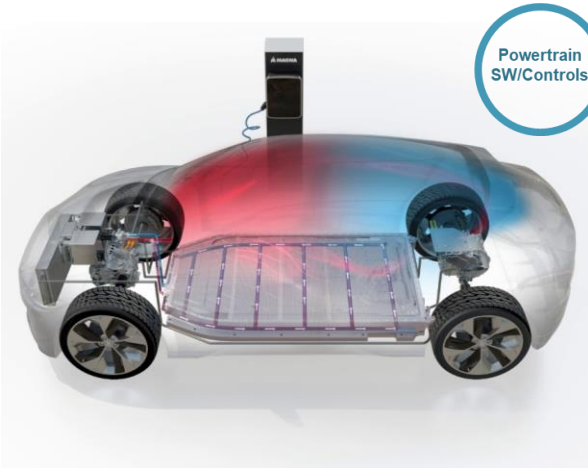


Magna SmartBridge™ – Software Energy & Motion Control



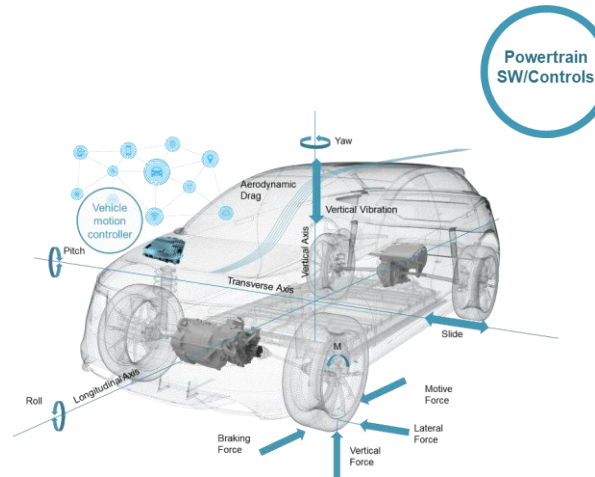
Platform for Application Software

Battery conditioning	Vehicle Energy Control
Energy management by using route information	
Powertrain conditioning	
Charging control	
Predictive cabin cooling / heating	
Vehicle Thermal Management (incl. ThermalCore control)	
Torque split control for best efficiency	
Decoupling strategy of secondary axle	



Magna's energy management control ensures highest possible efficiency for future vehicles systems. The waste heat recovery and smart heat distribution between heat sources are linked with the energy demand and generation of the eDrive system to ensure an optimum real-life efficiency.

Driver Torque Request	Vehicle Motion Control
Vehicle physics model incl. active sideslip angle calculation	
Longitudinal Torque Vectoring	
Lateral Torque Vectoring	
Lateral torque vectoring (e.g., by EM + 2 clutches or by 2 EM, ...)	
Lateral torque vectoring by EM + brakes	
Lateral torque vectoring by EMs, clutches and brakes (incl. integrated eDrive and brake controls)	
Brake torque request incl. regeneration and brake blending	
Active sideslip angle control (part of longitudinal TV and lateral TV)	
Traction control by inverter-based speed controller	
Traction Predictor incl. Road State Observer	
Vehicle State Predictor	

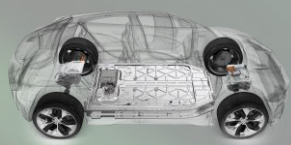


Magna's vehicle motion control functions allow for superior drivability attributes of future BEVs and Hybrids. The centralized control approach optimizes the end-consumer values safety, dynamics, convenience. This holistic approach reduces system complexity and cost and enables ADAS level >3.

Operating Strategy Standard Core
USP and first to market

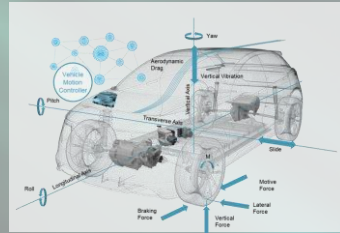
Tailored OEM
application

Real Vehicle Input



- Driver input (steering wheel, throttle/brake pedal)
- Vehicle mode setting
- Actual vehicle movement via vehicle sensor (lateral/longitudinal acceleration, wheel speeds, yaw rate)
- ADAS system input

Vehicle Physics Model



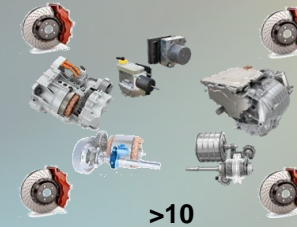
- Calculation of "Non-Sensor" values needed for Vehicle Motion Control Strategy (**side slip angle per wheel**, vehicle side slip angle, vehicle speeds in different directions)

Vehicle Motion Control Strategy

Powertrain
SW/Controls

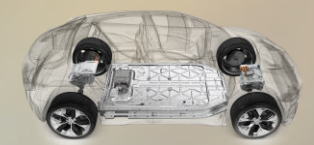
- Targeted trajectory based on driver or ADAS input
- Targeted torques/speed per wheel for smart actuators
- Open loop torque/speed
- Closed loop torque/speed
- Closed loop vehicle

Smart Actuators



- eDrive front/rear
- Torque vectoring
- Service brakes
- Brake booster
- ABS/ESP controller
- Decoupling
- Steering front/rear
- Damping

Real Vehicle Behavior



- Real vehicle movement
- Real driver reaction

- Technology level at OEM
- 3+ redundant physical models not matching with each other (eDrive, Brake, Steering)
- USP by Magna

- Functional differentiation, attribute design at OEM level
- Scalability across vehicle brands
- Tailored application by Magna

- Physical differentiation attribute at OEM level
- Tailored OEM application
- MPT agnostic to all kind of physical vehicle architectures

eDS – electric Drive System Mid+

This eDrive with next-gen technologies provides up to 205 kW for 10 seconds and up to 4,000 Nm at the wheels. It can be applied to both hybrid and battery electric vehicles as primary and secondary drive. Next-gen technology options in the e-motor, inverter, gearbox and intelligent software strategy contribute to best-in-class efficiency, drivability and safety. Up to -24% less weight, +7% more power and -22% less volume in packaging compared to other available products in the market.



Features and Specifications

- Scalable from 150 to 205 kWp and 400 to 800 V while providing affordable cost via building block approach
- PSM e-motor, highly-optimized bearing concept, smart lubrication concept
- Inverter attached or axially integrated with optional SiC power module
- Advanced e-motor speed control interface enables intelligent launch vehicle function

Competitive advantage/differentiators

- Optimized and scalable to best-in-class efficiency (aiming > 95% peak efficiency)
- Best-in-class drivability, performance, and safety with TV option
- Optimized and flexible package
- Affordable cost

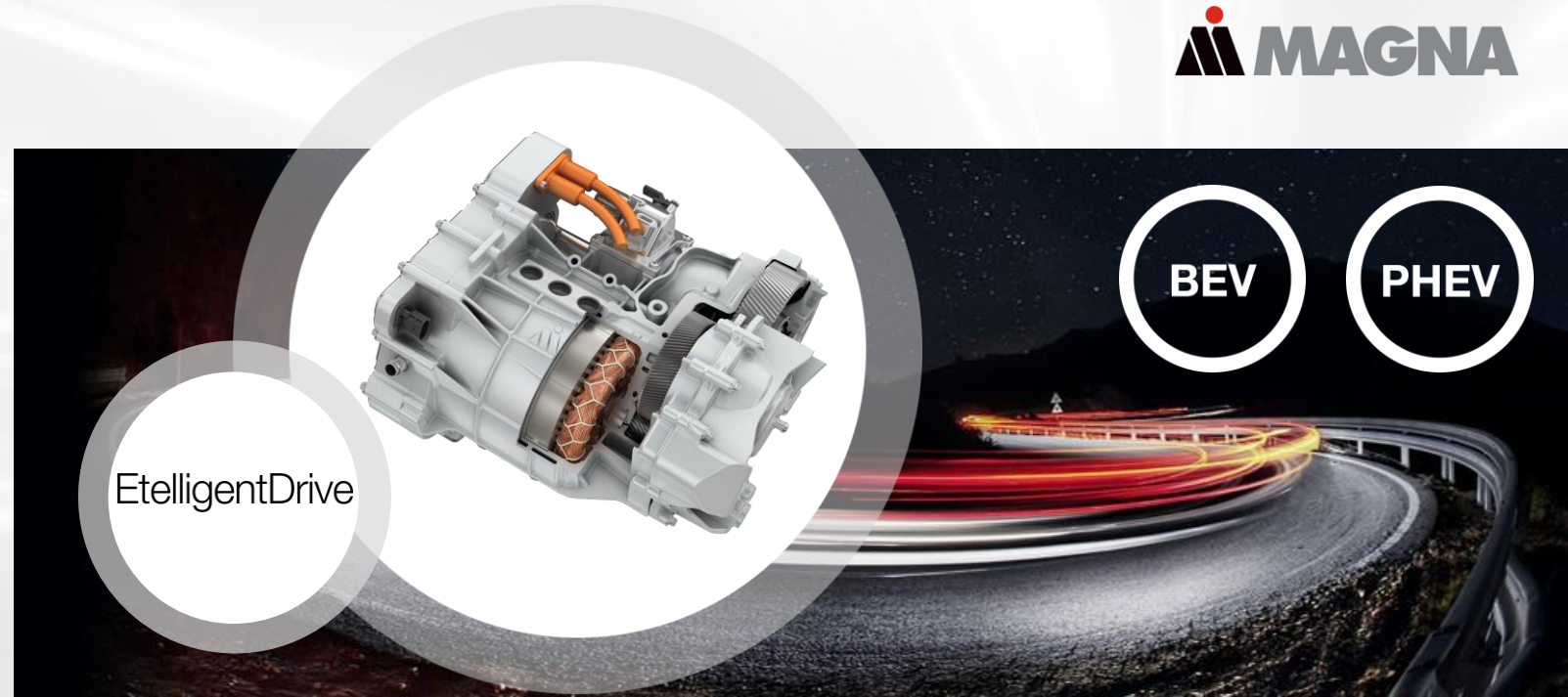
Applications/benefits

- C, D, E Segment BEVs / PHEVs
- Advanced direct stator cooling concept enabling increased continuous power performance
- Safety integrity level ASiL “D”
- Optional park lock or disconnect, and small packaged twin-clutch torque vectoring



eDS – electric Drive System Mid+ w/ Decoupling+

The eDrive system is equipped with Decoupling+ a combination of an integrated decoupling unit and a predictive controls strategy. Together with next-gen technology options in the e-motor, inverter, gearbox and intelligent software strategy it contributes to best-in-class efficiency, safety, convenience and dynamics.



Features and Specifications

- Peak axle power: 160 kW for 30 s*
- Boost axle power: 204 kW for 7 s**
- Peak axle torque: 4,000 Nm
- Cont. axle torque: 2,000 Nm
- Output speed: 1,400 rpm
- Feature: Decoupling+

*Nominal battery voltage 350 V

**Nominal battery voltage 400V

Competitive advantage/differentiators

- **Efficiency**
35 W drag loss at 50 kph or
94 % max. efficiency
91.6 % avg. efficiency WLTC
- **Safety**
< 200 ms fast reconnect time
- **Convenience**
1 ms control loop of native speed interface
- **Dynamics**
+ 8 % torque boost (7 sec.)
+ 22 % power boost (7 sec.)

Applications/benefits

- C, D, E, VAN Segment BEVs / PHEVs

SOP



eDecoupling

Magna's electromagnetic eDecoupling acts as a stand alone or integrated power flow decoupler for EV applications. With quick activation times, superior NVH behaviour via integrated powertrain controls and compact packaging, the Magna eDecoupling increases EV range by reducing drag torque of e-motor and gearbox in primary and secondary eDrive systems.



Features and Specifications

- Activation time: <100 msec (design dependent)
- Improves EV travel range up to 9% by reducing drag-torque losses
- Components scalable in size to meet torque requirements
- Low input current
- Minimal power consumption (<6 W)
- Integrated position sensors included in design as required
- Available with monostable or bistable configurations

Competitive advantage/differentiators

- eDecoupling integrates into differential or EV link shaft as a complete module
- Compact design minimizes added package space and weight in axial or radial direction
- In-house coil design assures quick activation times to maximize performance and efficiency
- Seamless integration via powertrain controls to ensure best NVH

Applications/benefits

- Decouple rotating power of e-motor and gearbox in primary (HEV) or secondary eDrive systems
- Improve electric vehicle travel range by reducing e-motor and gearbox drag-torque loss
- Modular design can be scaled for use in electric vehicles from B segment up to SUV and LCV

