Future Powertrain Solutions for BMW Characteristic Driving Dynamics

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FUTURE POWERTRAIN SOLUTIONS FOR BMW CHARACTERISTIC DRIVING DYNAMICS.

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BMW GROUP
BMW CHARACTERISTIC DRIVING DYNAMICS. BMW i CONCEPT VEHICLES.

BMW i3 Concept

BMW i8 Concept

BMW CHARACTERISTIC DRIVING DYNAMICS. GENERAL CONCEPT.

Driving dynamics and energetic operating strategy.

Powertrain functions.

Characteristics of the powertrain components.

Vehicle- and powertrain architecture.
BMW CHARACTERISTIC DRIVING DYNAMICS. VEHICLE- AND POWERTRAIN ARCHITECTURE.

Driving dynamics and energetic operating strategy.

Powertrain functions.

Characteristics of the powertrain components.

Vehicle- and powertrain architecture.

BMW CHARACTERISTIC DRIVING DYNAMICS. BMW i8 CONCEPT CAR - POWERTRAIN DESIGN.

<table>
<thead>
<tr>
<th>Static</th>
<th>FA Load*</th>
<th>RA Load*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration</td>
<td>50 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Deceleration</td>
<td>40 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Static</td>
<td>60 %</td>
<td>40 %</td>
</tr>
</tbody>
</table>

For the maximum acceleration approx. 2/3 of the power should drive the rear axle. For the maximum deceleration approx. 2/3 of the power should drive the front axle. To achieve an optimal recuperation the front axle should be electric.

FA: Front axle
RA: Rear axle

* Approximate values.
BMW CHARACTERISTIC DRIVING DYNAMICS.
LIFE DRIVE - ARCHITECTURE.

Life-module with carbon fibre-reinforced plastic passenger compartment.

Body surfaces
Drive module

Electric motor with power electronics
Lithium-ion battery
Fuel tank
Internal combustion engine with transmission

BMW CHARACTERISTIC DRIVING DYNAMICS.
CHARACTERISTICS OF THE POWERTRAIN COMPONENTS.

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### BMW Characteristic Driving Dynamics

**Main Electric Components**

<table>
<thead>
<tr>
<th>High-voltage battery</th>
<th>Electric motor</th>
<th>Power electronics</th>
</tr>
</thead>
</table>

### BMW Characteristic Driving Dynamics

**Electric Motor**

- High power density ➔ 2.5 kW/kg
- High efficiency ➔ approx. 92%
### BMW CHARACTERISTIC DRIVING DYNAMICS. COMPARISON OF ELECTRIC MOTOR CONCEPTS.

<table>
<thead>
<tr>
<th></th>
<th>HSM Hybrid Synchronous Machine</th>
<th>PSM Permanent Energised SM (Surface Magnetism)</th>
<th>ASM Asynchronous Machine</th>
<th>ESM Electrically Energised Synchronous Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical values</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnet mass</td>
<td>50 %</td>
<td>100 %</td>
<td>0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous torque</td>
<td>40 - 50 Nm/l</td>
<td>40 - 50 Nm/l</td>
<td>20 - 30 Nm/l</td>
<td>40 - 50 Nm/l</td>
</tr>
<tr>
<td>per active rotor volume</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase current ( I_{AC} ) Costs PE</td>
<td>75 %</td>
<td>100% reference</td>
<td>110%</td>
<td>75%</td>
</tr>
<tr>
<td>Average efficiency</td>
<td>approx. 92%</td>
<td>88%</td>
<td>86%</td>
<td>92%</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamics</td>
<td>a few 10 ms</td>
<td>approx. 10 ms REFERENCE</td>
<td>a few 100 ms</td>
<td>&lt; 250 ms</td>
</tr>
<tr>
<td>Braking/ Acceleration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BMW CHARACTERISTIC DRIVING DYNAMICS. EFFICIENCY AND TORQUE OF ELECTRIC MOTOR.

![Efficiency and Torque Diagram](image-url)
BMW CHARACTERISTIC DRIVING DYNAMICS. RESPONSE OF BMW TWIN POWER TURBO 3-CYLINDER ENGINE.

Load step at steady 1,500 rpm

BMW CHARACTERISTIC DRIVING DYNAMICS. SOUND CHARACTERISTICS OF 3-CYLINDER ENGINE.

Predominant frequency of engine sound

Hz

Engine speed [rpm]
BMW CHARACTERISTIC DRIVING DYNAMICS.
POWERTRAIN FUNCTIONS.

Driving dynamics and energetic operating strategy.

Powertrain functions.

Characteristics of the powertrain components.

Vehicle- and powertrain architecture.

BMW CHARACTERISTIC DRIVING DYNAMICS.
FUNCTIONAL ARCHITECTURE FOR ALL-WHEEL DRIVE VEHICLES.

<table>
<thead>
<tr>
<th>Torque distribution mechanically coupled</th>
<th>MINI and future BMW offers</th>
<th>BMW xDrive BMW X3 (current)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual torque distribution</td>
<td>BMW Concept Active Tourer</td>
<td>BMW i8 Concept</td>
</tr>
</tbody>
</table>

Primary axle: front

Primary axle: rear
BMW CHARACTERISTIC DRIVING DYNAMICS.
DRIVING DYNAMICS AND ENERGETIC OPERATING STRATEGY.

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BMW CHARACTERISTIC DRIVING DYNAMICS.
DRIVING DYNAMICS AND TARGET CONFLICTS.

Electrical range

Driving Dynamics and Driving Performance

Consumption and emissions

Acoustics and comfort
BMW CHARACTERISTIC DRIVING DYNAMICS. DRIVING DYNAMICAL ALLOCATION OF DRIVING TORQUE.

Foresight of the driving situation and of the route profile.

Optimal use of the electric energy to support the driving dynamics.

Strong focus on the driver’s operating strategy.

Use Driving Experience Control.

Sport  | Prio driving performance
Comfort | Balanced
ECO PRO | Consumption optimal
EV | Prio electric driving
BMW CHARACTERISTIC DRIVING DYNAMICS. FORESIGHT FUNCTIONS IN CURRENT PRODUCTS.

Data reception and processing from navigation data.
Situation detection identifying the route ahead and the driving situation.
Optimisation of vehicle behaviour through predictive driving functions for enhanced efficiency and dynamics.

BMW CHARACTERISTIC DRIVING DYNAMICS. BMW i8 CONCEPT VEHICLE DATA.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>4632 mm</td>
</tr>
<tr>
<td>Height</td>
<td>1280 mm</td>
</tr>
<tr>
<td>Width</td>
<td>1955 mm</td>
</tr>
<tr>
<td>Wheelbase</td>
<td>2800 mm</td>
</tr>
<tr>
<td>No. of seats</td>
<td>2 + (2)</td>
</tr>
<tr>
<td>Kerb weight</td>
<td>1480 kg</td>
</tr>
<tr>
<td>Top speed (limited)</td>
<td>250 km/h / 155 mph</td>
</tr>
<tr>
<td>Acceleration (0-100 km/h 0-62 mph)</td>
<td>4.6 s</td>
</tr>
<tr>
<td>Fuel consumption (EU cycle)</td>
<td>2.7 l/100 km / 104 mpg imp (66 g CO₂)</td>
</tr>
<tr>
<td>Luggage compartment</td>
<td>approx. 150 litres</td>
</tr>
</tbody>
</table>
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