Chassis
Technology Workshop Cayenne
Driving dynamic properties of all Porsche models

Optimum **driving dynamics** and **steering precision** from high-performance chassis, steering and all-wheel drive systems.

Performance **brakes** and efficient **high-performance tyres**

Highest level of functional **spread** between performance and fuel consumption, as well as driving dynamics and comfort.

Optimal efficiency with the specific target parameters and framework conditions.
Three-stage Porsche chassis development for superior performance

**Total vehicle concept**
- Systematic attention to driving dynamic requirements in total vehicle concept
- Driver-oriented operating concept (seat position, steering wheel, pedals)

**Chassis mechanics**
- Precision suspensions
- High-performance fixed-calliper brakes
- High-performance tyres
- Lightweight design

**Mechatronic chassis systems**
- Further boost to performance potential
- Increased spread between driving dynamics and comfort
Use of intelligent modular technologies within the Group

<table>
<thead>
<tr>
<th>Group platform</th>
<th>Taken from the toolkit</th>
<th>Application</th>
<th>New features</th>
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<tr>
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<td>Front axle concept</td>
<td>Steering/steering ratio</td>
<td>Hang-on all-wheel drive</td>
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<td></td>
<td>Rear axle concept</td>
<td>Specific chassis tuning</td>
<td>Three-chamber air suspension</td>
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<td>Body stiffness</td>
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<td>Mixed tyres</td>
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<tr>
<td></td>
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<td>Porsche brake construction kit</td>
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<tr>
<td></td>
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<td>Porsche Torque Vectoring</td>
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</tbody>
</table>

New features include:
- Porsche brake construction kit
- Porsche Torque Vectoring
### Total vehicle concept

<table>
<thead>
<tr>
<th></th>
<th>Cayenne S (previous model)</th>
<th>Cayenne S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheelbase (mm)</td>
<td>2,895</td>
<td>2,895</td>
</tr>
<tr>
<td>Track width front/rear (mm)</td>
<td>1,655/1,669</td>
<td>1,680/1,673</td>
</tr>
<tr>
<td>Axle load distribution front/rear (%)</td>
<td>54.2/45.8</td>
<td>56.4/43.6</td>
</tr>
<tr>
<td>Power (kW/hp)</td>
<td>309/420</td>
<td>324/440</td>
</tr>
<tr>
<td>Drive system (-)</td>
<td>Hang-on all wheel drive</td>
<td>Hang-on all wheel drive</td>
</tr>
<tr>
<td>Tyre size front</td>
<td>255/55 R 18</td>
<td>255/55 R 19</td>
</tr>
<tr>
<td>Tyre size rear</td>
<td>255/55 R 18</td>
<td>275/50 R 19</td>
</tr>
</tbody>
</table>
Three-stage Porsche chassis development for superior performance

**Total vehicle concept**
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Driver-oriented operating concept (seat position, steering wheel, pedals)

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Chassis mechanics – Axles

- Newly developed front axle
- Multi-link suspension instead of double wishbone at the front
- Responsiveness, precision and straight-line steering further optimized
## Chassis mechanics – Brakes

<table>
<thead>
<tr>
<th></th>
<th>Cayenne</th>
<th>Cayenne S</th>
<th>Cayenne Turbo</th>
<th>PSCB</th>
<th>PCCB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Front axle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td>350 mm x 34 mm</td>
<td>390 mm x 38 mm</td>
<td>415 mm x 40 mm</td>
<td>440 mm x 40 mm</td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td>0 mm/0 mm</td>
<td>+30 mm/+2 mm</td>
<td>+25 mm/+2 mm</td>
<td>+20 mm/0 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Rear axle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td>330 mm x 26 mm</td>
<td>330 mm x 28 mm</td>
<td>365 mm x 28 mm</td>
<td>410 mm x 32 mm</td>
<td></td>
</tr>
<tr>
<td>Delta</td>
<td>0 mm/-2 mm</td>
<td>0 mm/0 mm</td>
<td>+7 mm/0 mm</td>
<td>+40 mm/+2 mm</td>
<td></td>
</tr>
</tbody>
</table>

- New Porsche Surface Coated Brake (PSCB) standard in the Cayenne Turbo
- New PCCB with bigger brake discs
- New lightweight brake with aluminium pan (so-called pin disc) in Cayenne S
- Optimised pedal feel
Chassis mechanics – The world first Porsche Surface Coated Brake PSCB
Brake disc with tungsten carbide coating

Performance
- Improved responsiveness and higher fading stability

Resolution of conflict between performance and brake dust
- Reduced brake dust without compromising performance, no comfort pads required

Reduction in wear
- Increased durability by 30 per cent and reduced fine dust

Look/corrosion
- Lasting optimal appearance due to corrosion-free friction surfaces, robust friction behaviour
Chassis mechanics – Porsche Surface Coated Brake PSCB

Structure of the PSCB

**Brake disc and calliper**
- Grey cast brake disk in lightweight construction with ten piston fixed calliper and large surface area

**Thermally treated surface:**
- Procedure:
  - Roughen and clean laser-structured surface

**Ductile intermediate layer:**
- Galvanically applied intermediate layer to optimize layer adhesion

**Hard metal layer** (Hardness > 1000 HV):
- Tungsten carbide (W₂C);
- Coated with high velocity oxygen fuel (HVOF)

**PSCB brake pads**
- Special material composition
Chassis mechanics – Porsche Surface Coated Brake PSCB
Structure of the PSCB

Hard metal layer (Hardness > 1000 HV):
- Tungsten carbide (W₂C);
- Coated with high velocity oxygen fuel (HVOF)
Chassis mechanics – Performance of the PSCB
Fading stability of PSCB brake at 0.8 g braking

![Graph showing change in pedal force vs. number of fading braking manoeuvres.](image)

- **Approx. 330°C** Disc temperature
- **Approx. 640°C** Disc temperature

**Axes:**
- **Y-axis:** Change in pedal force [%]
- **X-axis:** Number of fading braking manoeuvres

**Legend:**
- **Black line:** Pedal force grey cast iron brake (%)
- **Red line:** Pedal force PSCB (%)

*Note: The graph illustrates the relative change in pedal force for grey cast iron and PSCB brakes under fading braking conditions.*
Chassis mechanics – PSCB brake features
Conflict of objectives between performance and brake dust

Grey cast iron brakes + “Performance” pads

No premium segment

PSCB

Grey cast iron brakes + “Comfort” pads
Chassis mechanics – Porsche brake philosophy

The PSCB closes the gap between the high-performance grey cast iron brakes and the PCCB ceramic brakes suitable for racing.

PSCB is available as an option for Cayenne and Cayenne S.
Chassis mechanics – Extensive range of wheels

<table>
<thead>
<tr>
<th>Front axle tyre size</th>
<th>19 inch</th>
<th>20 inch</th>
<th>21 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>tyre size</td>
<td>255/55 ZR19 (8.5J)</td>
<td>275/45 ZR20 (9.0J)</td>
<td>285/40 ZR21 (9.5J)</td>
</tr>
<tr>
<td></td>
<td>275/50 ZR19 (9.5J)</td>
<td>305/40 ZR20 (10.5J)</td>
<td>315/35 ZR21 (11.0J)</td>
</tr>
</tbody>
</table>

For the first time mixed tyres with different sizes at the front and rear wheels for the Cayenne

19” basic and S-wheel designed as a forged wheel
Chassis mechanics – High-performance tyres

Wide-ranging requirements for high-performance tyres
- Steering precision and agility
- High level of driving stability and driving pleasure
- Maximum driving performance
- Best possible ride comfort
- Best-in-class braking distances
- Low rolling resistance coefficients

Implemented in the new Cayenne through
- Typical Porsche mixed tyres
- Larger wheel diameter
- Systematic tyre development with respect to driving dynamics and driving quality
- Confirmation of the typical Porsche tyre properties with the N-marking
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Mechatronic chassis systems

- Adaptive three-chamber air suspension with PASM
- Rear-axle steering
- Controlled differential lock/PTV+
- Electromechanical roll stabilisation
- Hang-on all-wheel drive
- Electromechanical steering
Chassis systems – Electromechanical steering with a special controller

- More direct steering ratio for a sporty driving style
- Stiff system design for optimum steering precision
- Porsche specific controller with force-feedback for a Porsche-typical steering feel with optimised steering response
**Chassis systems – Electromechanical steering with a special controller**

**Graph:**

- **Sprocket angle [°]**
- **Steering ratio**

**Table:****

<table>
<thead>
<tr>
<th>Model</th>
<th>Platform with rear axle steering</th>
<th>New Cayenne with rear axle steering</th>
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<tbody>
<tr>
<td>Steering ratio</td>
<td>15.8:1</td>
<td>13.3:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.3:1</td>
</tr>
</tbody>
</table>

- Steering ratio is 10 to 15 per cent more direct compared with the platform and previous model
- Performance-oriented system layout with increased stiffness including aluminium tie
- Increased rotary vane stiffness in the Cayenne with rear axle steering (3.3 Nm/° instead of 2.0 Nm/°)
- Further optimised system weight of 15.0 kg at maximum boost force of 16.0 kN

- More direct steering behaviour and increased agility
- Optimum steering precision and typical Porsche feedback
Chassis systems – Adaptive air suspension with PASM

Three-chamber air suspension in conjunction with regulated twin-tube damper

Spring rate switching according to the driving situation and the selected driving mode

Maximum spread between driving dynamics and ride comfort

Reduces rolling and pitching movements

Effects of driving dynamic properties

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*One-chamber air suspension of the previous model E2 II

- Front axle:
  - 21 N/mm
  - 26 N/mm*
  - 31 N/mm

- Rear axle:
  - 17 N/mm
  - 25 N/mm*
  - 37 N/mm
Chassis systems – Rear axle steering

At low driving speeds
- Reduces the steering angle required
  - Makes steering more manageable
- Virtual shortening of wheelbase
  - Increased manoeuvrability

At higher driving speeds
- Improved damping of yaw movements
  - Increased vehicle stability
- Faster build-up of lateral acceleration for more spontaneous vehicle response
  - Enhanced agility
- Virtual elongation of wheelbase
  - Improved stability at high driving speeds
Chassis systems – Electromechanical roll stabilisation

- Active roll stabilisation based on a 48 V energy supply
- 1,200 Nm actuator torque to compensate for the rolling motion
- High adjustment dynamics to optimise the steering behaviour
- Offroad stabiliser activation
- Variable roll torque distribution between front axle/rear axle to provide vehicle agility
- High efficiency to prevent loss of performance
Chassis systems – Porsche Traction Management

- Electronically controlled hang-on all-wheel drive
- Torque distribution to front axle as required
- Optimum steering behaviour and lateral support to the front axle
- Maximum traction
- Clear and predictable handling
- Optimum agility
- Optimised all-wheel drive distribution for offroad scenarios
Chassis systems – Porsche Torque Vectoring Plus

- Controlled rear differential lock depending on driving situation
- Dynamic brake intervention on the rear axle
- Increased traction
- Increase in lateral dynamics
- Increase in driving stability
- Improved steering precision
- Improved steering behaviour
- Optimised for offroad scenarios
4D Chassis Control – Electronic chassis platform
Foundation for the intelligent chassis

Benefits
- Intelligent networking of all software controllers on a computer platform in real time
- Central driving status coordination for all chassis controllers
- Maximum utilisation of system performance
- Ensuring and optimising typical Porsche handling characteristics
- Differentiation from competition

Functions included
- Adaptive damper control
- Vehicle state observer
- Offroad scenes/modes
- Roll stabilisation
- Controlled all-wheel drive and differential lock
- Offroad displays
- Adaptive three-chamber air suspension
- Offroad displays
4D Chassis Control – Electronic chassis platform

New offroad modes for the ideal chassis setup

4D-Chassis Control enables central control of all chassis systems

Automatic adjustment, among other things, of diff locks, ride height, spring rates and dampers, PDCC, RWS and powertrain

Four offroad modes
1. GRAVEL (mild offroad)
2. MUD (muddy dirt roads)
3. SAND (deep sand, dunes)
4. ROCKS (hard surfaces)

Option to individually select special levels suitable for the selected terrain
Chassis of the new Cayenne

- Hang-on all-wheel drive
- Rear-axle steering
- Porsche high-performance brakes incl. PSCB und PCCB
- Porsche 4D Chassis Control
- Adaptive three-chamber air suspension with PASM
- Use of intelligent modular technologies in the Group
- Electromechanical roll stabilization PDCC
- New generation of tyres mixed tyres, new wheels
- Porsche Torque Vectoring Plus
Development of Cayenne from the platform with respect to performance and ride comfort

Three-chamber air suspension: Spring rate switching according to the driving situation

PASM: Porsche sensor and control concept for maximum spread between ride comfort and driving dynamics

PTM and PTV+: Controlled longitudinal and transverse torque distribution according to the driving situation

→ Agility and traction

Mixed tyres: Increased performance, driving stability and agility

Platform best setup

Ride comfort

Performance

Cayenne Turbo

New Cayenne

Adaptive roof spoiler

Three-chamber air suspension

Engine power

Mixed tyres

PTM

PTV+

PASM