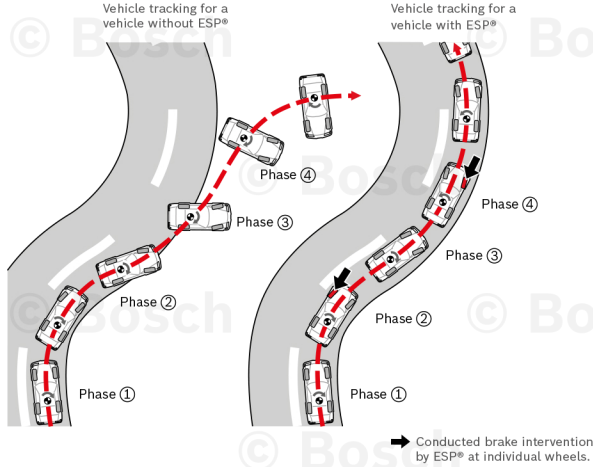# Electronic Stability Program (ESP®)

Right-left cornering sequence

Vehicle tracking for a vehicle without ESP®

Vehicle tracking for a vehicle with ESP®

Phase ④
Phase ③
Phase ②
Phase ①

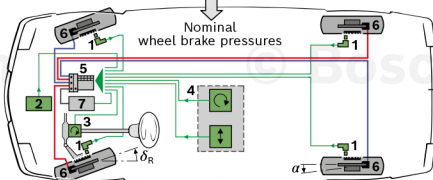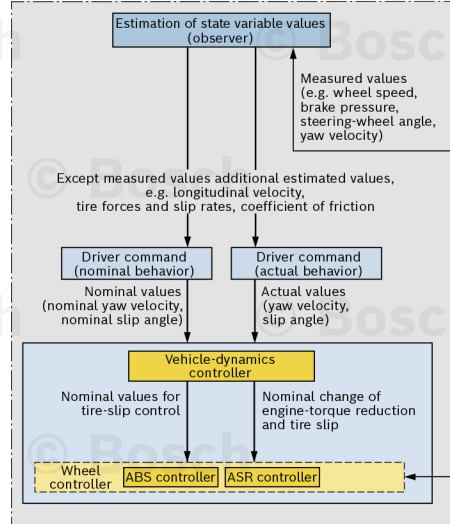➤ Conducted brake intervention by ESP® at individual wheels.

Curves for dynamic response parameters

Steering-wheel angle: +180°, 0, −180°
Lateral acceleration: +10 m/s², 0, −10
Yaw velocity: +45 °/s, 0, −45
Slip angle: +22°, 0, −22°

Phase ① ② ③ ④
Time 0 — s 11
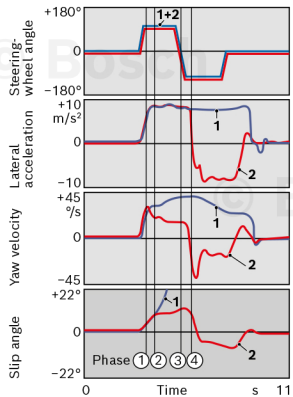
Phase 1
Driver steers, lateral-force buildup

Phase 2
Incipient instability,
ESP® intervention at left front.

Phase 3
Countersteer;
Vehicle without ESP®: Driver loses control of vehicle.
Vehicle with ESP® remains under control.

Phase 4
Vehicle without ESP® becomes uncontrollable.
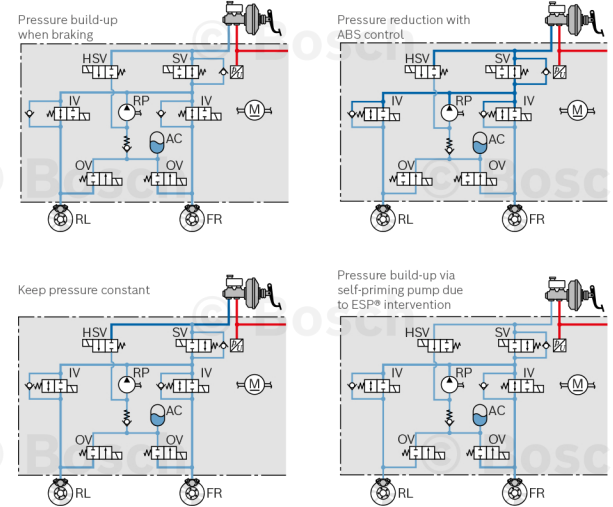ESP® intervention at right front, complete stabilization.

1 Vehicle without ESP®
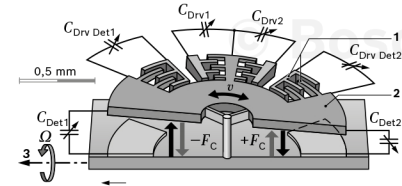2 Vehicle with ESP®

ESP® control loop in vehicle

Estimation of state variable values (observer)

Measured values (e.g. wheel speed, brake pressure, steering-wheel angle, yaw velocity)

Except measured values additional estimated values, e.g. longitudinal velocity, tire forces and slip rates, coefficient of friction

Driver command (nominal behavior)
Nominal values (nominal yaw velocity, nominal slip angle)

Driver command (actual behavior)
Actual values (yaw velocity, slip angle)

Vehicle-dynamics controller

Nominal values for tire-slip control

Nominal change of engine-torque reduction and tire slip

Wheel controller | ABS controller | ASR controller

Nominal wheel brake pressures

1 Wheel-speed sensors
2 Brake-pressure sensor (integrated in the hydraulic unit)
3 Steering-wheel-angle sensor
4 Yaw-rate sensor with integrated lateral-acceleration sensor
5 ESP® hydraulic unit (hydraulic modulator) with mounted ECU
6 Wheel brakes
7 Engine ECU

Hydraulic unit of an ESP® systems

Pressure build-up when braking

Pressure reduction with ABS control

Keep pressure constant

Pressure build-up via self-priming pump due to ESP® intervention

IV	Inlet valve	AC	Low-pressure reservoir
OV	Outlet valve	M	Pump motor
SV	Switchover valve	RP	Return pump
HSV	High-pressure switching valve		
		F	Front
		R	Rear
		R	Right
		L	Left

Surface micromechanics yaw-rate sensor (design)

1 Comb structure
2 Rotary oscillator
3 Measurement axis

C_{Drv} Capacitance of drive electrodes

C_{Det} Capacitive rotary-oscillation tap

$C_{Drv\,Det}$ Capacitance of drive tap (measurement of drive oscillation)

F_C Coriolis force
v Oscillation velocity
Ω Yaw rate to be measured ($\Omega = \text{const} \cdot \Delta C_{Det}$)

0,5 mm

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