Active Suspension Control Systems - ASCS

For many years vehicle dynamics engineers have struggled to achieve a compromise between vehicle handling, ride comfort and stability. The results of this are clear in the vehicles we see today. In general, at one extreme are large sedan and luxury cars with excellent ride qualities but only adequate handling behavior. At the other end of the spectrum are sports cars with very good handling but very firm ride quality. In between are any number of variations dictated by the vehicle manufacturer and target customer needs.

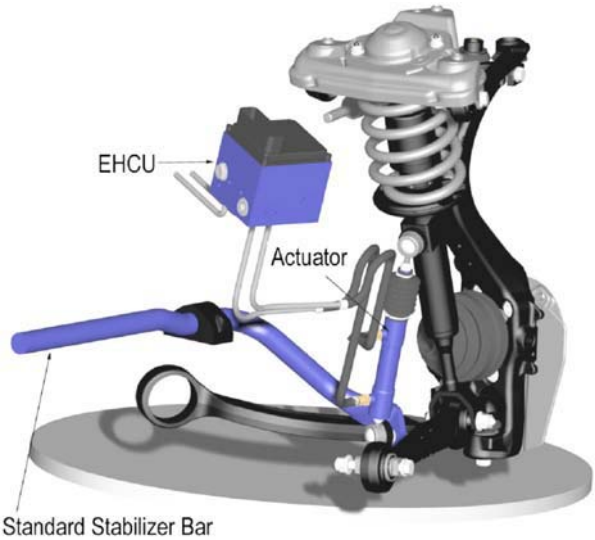
TRW's Active Suspension Control Systems ASCS helps to resolve the conflict between ride comfort and handling by replacing the rigid drop links of one stabilizer bar end against an hydraulic actuator (active stabilizer bar). These actuators are controlled by an Electro-Hydraulic-Control-Unit (EHCU) depending on the sensed driving conditions. That gives vehicle dynamics engineers new possibilities of suspension tuning. The TRW ASCS architecture is divided into three different systems:

Active Dynamic Control 1 (ADC1)

- **Setup:** Active stabilizer bar at front or rear axle
- **Sensor signals:** controlled by sensor signals lateral acceleration, steering angle, vehicle speed and yaw rate
- **Control Goal:** agile if possible, stable if necessary
- **Benefits:** improved, controlled neutral handling and agile steer response, improved roll comfort

Active Roll Control (ARC)

- **Setup:** Active stabilizer bar at front and rear axle, controlled by a common hydraulic circuit
- **Sensor signals:** lateral acceleration, steering angle and vehicle speed
- **Control Goal:** Body roll compensation



Standard Stabilizer Bar

Benefits: flat body while cornering, improved roll comfort, roll over mitigation

Active Dynamic Control 2 (ADC2)
Setup: Active stabilizer bar at front and rear axle, controlled by two separate hydraulic circuits
Sensor signals: lateral acceleration, steering angle, vehicle speed and yaw rate
Control Goal: agile if possible, stable if necessary and body roll compensation
Benefits: ADC2 combines ADC1 and ARC benefits in one system

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ACC Adaptive Cruise Control
DAS Driver Assistance Systems

ACC System Operation
TRW´s ACC System is similar to conventional cruise controls. However, in addition to maintaining the vehicle's pre-set road speed, the TRW system automatically adjusts the vehicle's speed when there is an impeding vehicle by keeping an appropriate following distance between the two vehicles. This is achieved through a radar headway sensor (AC20 for future applications), digital processor and longitudinal controller. The radar sensor senses the distance to the nearest vehicle in front. If that vehicle is travelling slower, the ACC sends a signal to the engine and braking system to decelerate until there is an appropriate following distance.
The max. deceleration demand is limited to 0.3g. If higher deceleration is required to avoid an accident it is the drivers responsibility to take action.
Brake force can be provided by an Electronic Booster, VSC/ESP, etc.

Extension to DAS:
With additional Short Range Sensors (< 50m) the speed range can be extended to 0kph if they cover the whole width of the lane in front of the car. As a result functions like Follow Stop and Stop & Go can be provided. Follow Stop means that in traffic jam situations the car follows the impeding vehicle until this comes to a standstill. To drive off afterwards the driver has to take action (e. g. press a button). Stop & Go means that also drive off is done automatically. For safety reasons additional sensors are required.
With the addition of vision systems (video camera) detection of lane marking is possible.
This allows functions like Lane Keeping Support and Lane Departure Warning.
Short Range Sensors can also be used for Blind Spot Detection, Pedestrian Protection Systems, improved Restraint Systems, improved ACC and Parking Aid.
Combination of several sensors will allow very reliable obstacle detection. Together with high dynamic automatic brake actuation automatic Emergency Braking is possible.

Radar Sensor AC 20

Specifications:
Dimensions 95mm x 95mm x 63mm
76 GHz Digital FSK Waveform
TR Module MMIC Design
CAN Interface
Distance measurement:
range 1m ... 200m
accuracy ± 5% or 1m
Speed measurement:
range ± 250kph
accuracy ± 0.1kph
Lateral position measurement
range ± 6°
accuracy ± 0.3°

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Chassis Systems

LDW Lane Departure Warning
DAS Driver Assistance Systems

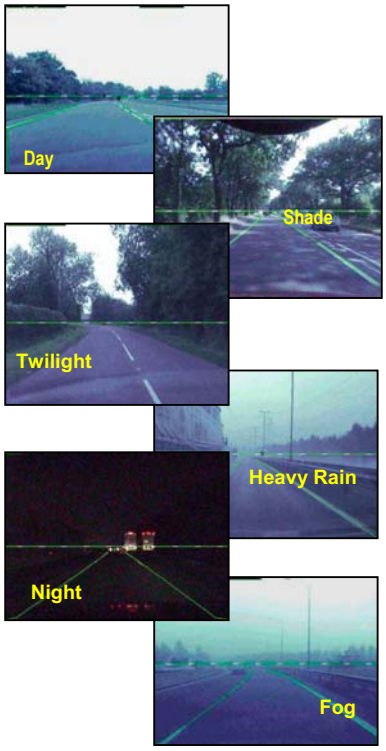
LDW System Operation
Lane Departure Warning (LDW) systems are video based detection systems which track the road features (edges or lane markings) to determine if the vehicle is in the process of leaving its designated lane.
The LDW System can be configured to inform the driver when he is about to leave the lane by sounding warning buzzers or 'gongs' or can deliver 'haptic' feedback via the steering system or steering wheel. This makes the driver feel like he is driving in a virtual camber. TRW's LDW demonstration vehicle has been configured with TRW's Electric Power Steering (EPAS) to provide 'haptic' feedback with actual steering correction. The system gently informs the driver by 'tugging' on the steering wheel to prompt him to make a steering correction.

As with all DAS systems the driver always maintains control of the vehicle but is assisted by the technology in the task of driving.

Extension to DAS:

- **Haptic Feedback** - for driver alertness. Using TRW's 'haptic' feedback system located in the steering wheel TRW can simulate the 'rumblestrip' effect to warn the driver that he is leaving the lane. Another 'haptic' feedback can be realized by activating the Active Control Retractor (ACR).
- Using data fusion techniques TRW's radar **based Adaptive Cruise Contro**l (ACC) System can be 'fused' with LDW to offer enhanced driver support systems. Such a system would regulate both longitudinal and lateral parameters to assist the driver.
- Via intervention with the steering system **basic Lane Departure Warning** can be transformed into **Lane Guidance** or **Lane Keeping Support**. Should the car drift towards the lane edges TRW's EPAS electric steering system can add 'weight' to the steering to give the feeling of 'road camber' . This is called 'virtual camber'.

TRW's Lane Departure Warning System functions in all weather and light conditions.



LDW keeps the vehicle in the lane

LDW keeps the vehicle in the lane


Camera module in rear mirror unit


Steering wheel


Active Control Retractor


EPAS Steering column

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