New Generation of Inertial Sensor Cluster for ESP- and Future Vehicle Stabilizing Systems in Automotive Applications

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Abstract

In 1995 Robert Bosch GmbH (RB) started the mass production of the first VDC-System (Vehicle Dynamics Control system) for vehicles, today called ESP (Electronic Stability Program). This ESP-System went beyond ABS and Traction Control Systems and offered consumers unsurpassed driving confidence and safety. The key part of this system was a first generation Yaw Rate Sensor DRS 50/100, based on a metal vibrating cylinder. The second generation DRS MM1, introduced in 1998, based on silicon micromachining and included an integrated linear acceleration sensor element. For new additional functions of ESP and of future high dynamic and high performance vehicle stabilizing systems, like Hill Hold Control (HHC) or Steer by Wire (SbW) BOSCH develops the third generation, a flexible and cost-effective Inertial Sensor Cluster with a modular concept for hard- and software, called DRS MM 3.x. Design, basic functions, modular concept, safety features and system requirements of the new Inertial Sensor Cluster DRS MM 3.x are presented.

1 Introduction

In 1995 Robert Bosch GmbH (RB) started the mass production of the first VDC-System (Vehicle Dynamics Control system) for vehicles, today called ESP (Electronic Stability Program). The key part of this system was a first generation Yaw Rate Sensor DRS 50/100, based on a metal vibrating cylinder with piezo-electric transducers (figure 1) [12].

The second generation DRS MM1, introduced in 1998, based on a combination of silicon bulk and surface micromachining with an electromagnetic drive and capacitive detection and included an integrated linear acceleration sensor element for measuring the lateral acceleration of the vehicle. (figure 1) [13].
ESP is a safety system for road vehicles which controls the dynamic vehicle motion in emergency situations. Vehicle handling at the physical limit of adhesion between the tires and the road is extremely difficult. In such situations the driver may be supported by controlling the longitudinal and lateral forces on the tires. The ESP-system of Bosch does that by controlled braking of individual wheels which makes the vehicle motion approach the nominal motion intended by the driver. It uses signals to determine the driver’s intent, like steering wheel angle, brake pressure, engine torque and other signals to derive the actual motion of the vehicle, like angular velocity of the car around its vertical axis (Yaw Rate) and lateral acceleration. The support of the driver is not limited to coasting conditions. Also during full braking, partial braking, engine drag, free rolling and acceleration of the vehicle the system supports the driver in all safety critical situations, within the physical limits.

For new additional functions of ESP and of future high dynamic and high performance vehicle stabilizing systems or comfort systems, like Hill Hold Control (HHC), Navigation (Navi, Travel Pilot), Adaptive Cruise Control (ACC), Four Wheel Drive (4w), Roll over Mitigation (ROM), Electronic Active Steering (EAS), Roll Over Sensing (ROSE), Active Suspension Control (ASC) and Steer by Wire (SbW) BOSCH develops the third generation, a flexible and cost-effective Inertial Sensor Cluster called DRS MM 3.x.

These new system-functions require additional inertial measuring data of the dynamic behaviour of the vehicle like angular acceleration, longitudinal acceleration, tilt angle, acceleration of the z-axis, angular velocity of the x-axis and redundancy of the inertial data in the case of high safety relevant systems.