Automotive Electronics

Product Information
Angular Rate Sensor for Roll-over Applications – SMG040

BOSCH
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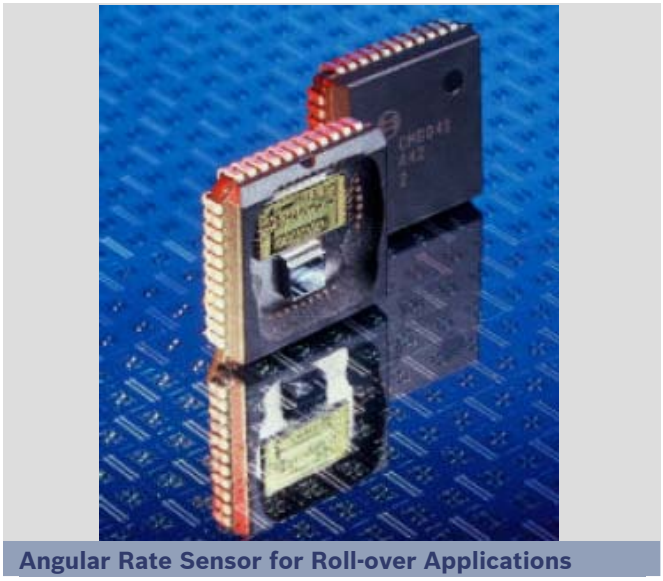
preliminary



Angular Rate Sensor for Roll-over Applications

The Robert Bosch Angular Rate Sensor SMG040 is a micromachined angular rate sensor especially designed for roll-over applications. The sensor bases upon a two-chip concept – the micromachined sensing element and a separate evaluation ASIC. The sensing element is an oscillating polysilicon mass with the sensitive axis lying in the chip plane. The micromachined structure is sealed under vacuum on wafer level. Sensor chip and read-out ASIC are packaged in a standard PLCC44 package.

The sensing element has a symmetrical layout with only one suspension at the pivot point. By applying electrostatic forces to comb structures, the mass is forced to a rotational oscillation around this pivot point in the center of the mass. This oscillation (in-plane movement, drive movement) is stabilised by an electronic control loop (drive control loop) in the evaluation ASIC of the sensor.

Due to the conservation of the angular momentum an angular rate around an axis in the chip plane will cause a rocking motion of the mass in the out-of plane direction. Electrodes in the substrate (detection counterelectrodes) under the mass allow a capacitive detection of this motion.

Features

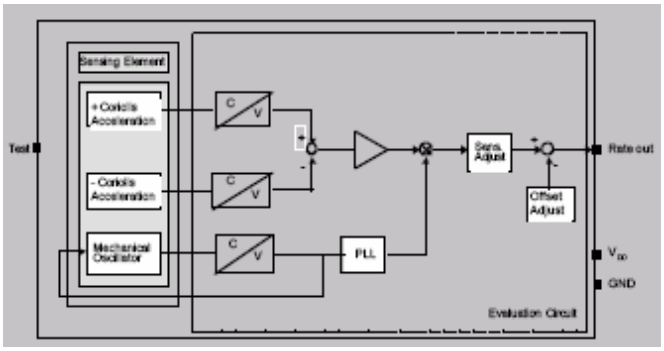
- Sensing element: rotational oscillator
- Surface micromachining technology
- Sensitive axis: in-plane
- Ratiometrical analog output
- Low parameter drifts
- Low sensitivity
- Low cost
- Linear acceleration
- Full Self-test Capability (electronics and mechanics)
- Bandwidth adjustable by external capacitor
- Small size (SMD: PLCC44)

Block diagram

Figure 1 shows the general block diagram of the sensor. The mechanical oscillator symbolises the sensing mass and its in-plane movement. The “± Coriolis acceleration” comprises the deflection of the two capacitors formed by the sensing mass and the counter-electrodes in the substrate. The signals at those detection electrodes are modulated onto the frequency of the drive oscillation. After amplification and subtraction the signal proportional to the angular rate is discriminated by a synchronous demodulation. A PLL derives the correct demodulation phase.

The sensor provides an analog output ratiometric to half of the power supply (4,8 V nominal value). Sensitivity and offset of the device are calibrated to nominal values at the end of the assembly line. Mechanics and electronics are testable by applying a logic level to a test pin (also called BITE = Build In Test Equipment). A voltage at test electrodes is then induced and causes an out-of-plane movement of the polysilicon mass. This voltage imitates the effect of an angular rate in the sensitive axis. A correctly working sensor will then show a defined rate response.

Fig.1: Block diagram



Self test

The self-test of the sensor is twofold. First the mechanics are tested by deflecting the sensing mass on command and secondly by an ASIC-internal monitoring system.

Testing of the mechanics

The self-test of the sensor is triggered by applying a logic low level at the BITE pin. A correct working sensor will respond with a nominal value of 30 % fullscale (FS) rate signal at the RATE OUT pin. All other signals indicate a defect of either the sensing element or the evaluation circuit.

Testing of the electronics

In case the mechanical self-test is not activated, there is still a continuous test of the electronic components within the ASIC: all important information concerning the driving stage, the phase-locked loop and the detection circuit are constantly monitored.

Technical data

Operating conditions

Measurement range	±250°/s
Supply voltage	4.8V
Supply current	< 30mA
Operating temperature	-40 ... +85°C
Bandwidth (-3 dB)	21 ... 33 Hz
Cross- sensitivity	< 5%
Lifetime	> 7500 hrs

Measurement and functional characteristics

Sensitivity	6.75mV/°/s
Sensitivity tolerance	± 7%
Non- linearity	± 1%
Offset	2.4V
Bandwidth (-3 dB)	27 ± 6 Hz
Noise	< 2.0°/s rms
Self- test response	504 ± 20%

Absolute maximum ratings

Supply voltage	0.3 ... 0.6V
Power- on time	< 1.0s
Storage temperature	-55 ... +105°C
ESD (any pin)	1.5kV
Shock impact	0.5m
Temperature gradient	20K/min

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