

APPLICATION NOTE

Accelerometers for railway applications

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The VS9030.D is highly used as vibration sensor

Features

- Wide range of products from $\pm 1g$ to $\pm 200g$
- Inertial, Vibration and Seismic sensors
- Extended bandwidth (DC to $>1kHz$ @ -5%)
- Excellent long term stability
- Harsh environment (shock, vibration, temperature)
- Qualified for safety critical applications

Introduction

Future train systems are integrating more and more high tech technologies to guide and control the vehicles but also looking to reduce maintenance costs and facilitate repair planning whilst at the same time improving passenger and driver safety and comfort. Therefore, a large variety of sensors are required and incorporated into modern trains.

One large branch of these sensors is the family of accelerometers that can detect and measure various form of mechanical motions, including inertial force (acceleration), tilt, vibration or shock.

Various technologies such as capacitive, piezoelectric or piezoresistive compete to provide the best solution. However these different sensing technologies do not offer the same level of performances and the best specifications in term of long term stability, temperature stability and precision are clearly offered by the capacitive products.



Close view of a Colibrys capacitive accelerometer.

Colibrys accelerometers are based on silicon MEMS capacitive sensors. MEMS manufacturing processes provide an alternative to conventional macro-scale machining and assembly techniques. This technology derives from the microelectronics industry and combines the conventional techniques developed for integrated circuit (IC) processing with specific MEMS processes, to produce microscopic mechanical structures.

For low to medium frequency measurements (typ. up to $1kHz$ @ 5%), the capacitive approach offers higher performances than the other technologies in term of reliability, long term stability, signal to noise, robustness, size and power.

Motion sensors for railway technology

Motion sensors find a variety of applications in the areas of railway technologies. Typical examples are:

- Bogie monitoring and diagnostics system for security and comfort
- High-speed train tilt control system for improved passenger comfort
- Position monitoring of magnetic levitation train
- Control system
- Health and Usage Monitoring System (HUMS)
- Shock monitoring during transportation
- Precise train positioning
- Railway track monitoring system for safety and maintenance.



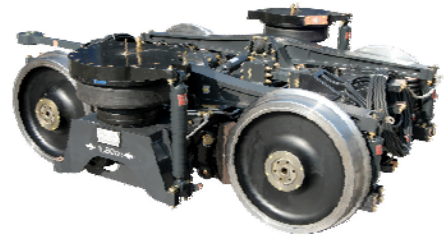
German Maglev train

APPLICATION NOTE

Colibrys accelerometers for railway technology

As presented, there are many opportunities for motion sensors products to be used in the railway technology market. Colibrys MEMS capacitive accelerometers are already well recognized for their high reliability in harsh environment and have already been successfully qualified for safety critical railway applications.

One of the latest and most important qualifications of MEMS capacitive accelerometers in trains has been for the tilt monitoring system in the latest generation of German ICE high-speed trains. Siemens has developed a bogie monitoring system that detects wear within bearings, shafts, brakes or wheels and identifies any potential bogie instability that could provoke an accident. This is the first bogie monitoring system designed and manufactured ever by Siemens Mobility. This highly innovative bogie monitoring system uses 24 Colibrys sensors per wagon and some 200 sensors per train. The first three trains have been produced in 2010 and final system qualification will take place in 2011.



Tilting trains are another well established application, in service since years in many countries where capacitive accelerometers are successfully integrated.

Colibrys offers different types of accelerometers dedicated to the railway applications:

- VS9000 Colibrys product is designed for vibration sensing which requires wide bandwidth, extended g range, small size and dedicated signal conditioning. Typically this product family covers the full range from $\pm 2g$ to $\pm 200g$ and offers a constant frequency response ($<5\%$ variation) from DC up to 1 kHz.
- MS9000 product family is designed for inertial sensing which requires long term stability.
- SiFlexTM are world best in class seismic sensors widely used to assess vibration in structures such as bridges or rail tracks.



Principle of operation

VS9000 and MS9000 sensors operate from a single power supply voltage (between 2.5V and 5.5V) with low current consumption ($<0.5mA$ at 5V). The output is a ratiometric analog voltage that varies between 0.5V and 4.5V for the full-scale acceleration range at a voltage supply of 5V. It is essential to have a stable power supply since any instability is directly transferred to the output.

The sensor is fully self-contained and packaged in a 20-pin LCC standard ceramic housing LCC20, thus insuring full hermeticity. It operates over the temperature range of $-55^{\circ}C$ to $+125^{\circ}C$ and can withstand shocks up to $6'000g$ without performance degradation. For further technical information please refer to the related product files and specifications.

Conclusion

MEMS capacitive accelerometers are the best candidates for the fast growing railway market of high speed-lines in most countries and the deployment of new generation of high-speed trains which will be more and more equipped with onboard safety control equipment requiring reliable and high specification accelerometers.

Colibrys is the right partner to provide the best and adequate accelerometers for your railway applications.

