

ASC Inertial Sensor Technology

**Enhancing railway capacity,
safety and productivity**

ANALOG • DIGITAL • SMART



Gyroscopes



MEMS
accelerometers



IMUs



IEPE
accelerometers



Smart
sensor systems



Characterization of track geometry (EN 13348)

ASC accelerometers and gyroscopes are integrated in total-body measurement systems to service trains in structure monitoring from regular in-service trains. Based on accurate results, deviations in longitudinal height, dynamic direction or distortion of tracks are calculated.

Bridging navigation and ATO (automated train operation)

Knowing the exact positioning of trains is critical for rail traffic safety. ASC's inertial measurement units (IMUs) track train positions precisely, even when other locating systems are disrupted or unavailable.

Specifying structural requirements for bogie frames (EN 13749)

Wheeler sets and bogies are subject to challenging loads. These loads vary and depend on the speed of the train. The ASC OS series is the most advanced standard solution for demanding railway engineering, as the capacitive accelerometers are based on hermetically sealed stainless-steel housings that withstand the harshest environmental conditions.

Infrastructure monitoring

Continuous and accurate measurements of the structural health of railway assets like track bed, sleepers, and rails are essential for improved availability and safety. Thanks to our digital monitoring technology, the ASC EO series offers very high resolutions. With their ability to register amplitudes of a millimeth of the earth's gravitational acceleration, the sensors are often used in seismological monitoring applications.

MEMS capacitive accelerometers

ASC's capacitive accelerometers are based on high-quality sensor elements (MEMS) of impressive long-term stability and reliability. This technology makes it possible to measure static (DC) as well as constant and dynamic (AC) accelerations, with 0.7 Hz range and amplitudes of up to 1,400 g. Due to the design of the micro mechanical structures the sensors feature an extremely short recovery time, with a shock resistance of up to 6,000 g.

IEPE accelerometers

ASC's IEPE (Integrated Electronics Piezo Electric) piezoelectric accelerometers are based on both shear and compression principles. This technology offers a high pass characteristic, meaning no static DC components are detected. However, highly dynamic measurements with a very wide bandwidth of up to 10 kHz and amplitudes up to 3000 g are feasible. These sensors are available with integrated flame retardant HFR cable material or railway certified cable compliant with the protection standard EN 45545.

Inertial sensors for strong rail

analog – digital – smart

TRACK GEOMETRY



ASC OS-1150LHPG



ASC Z71



ASC P31x

NAVIGATION



ASC IMU 7 / IMU 8

WHEELSETS AND BOGIES



ASC OS series

INFRASTRUCTURE



ASC EO



ASC DiSense EO

PANTOGRAPH



ASC 4421MF

RIDE COMFORT



ASC IM series

RUNNING CHARACTERISTICS



ASC DiSense EDO RAIL



ASC DiAIL series

BRIDGE MONITORING



ASC CS series



ASC EEO CS series



ASC AISys EDO

Dynamic interaction between pantograph and overhead contact line (EN 50317)
Measurements of the contact force and dynamic response are performed in challenging environmental conditions with electromagnetic interferences present, as the sensors are installed very close to the catenary. The uniaxial accelerometers ASC 4421MF are ideally suited due to their flat design and a low mass, which is of special importance to avoid aerodynamic interferences.

Passenger ride comfort (EN 12299)

Analyzing the effects of train motions on passenger ride comfort is necessary because human perception of mechanical vibrations varies greatly, depending on their direction, frequency and amplitude. Passenger inconveniences, however, occur primarily below 10 Hz, so that precise measurements of minimal linear motions, low-frequency vibrations and impacts are essential to optimizing ride comfort.

Running characteristics of railway vehicles (EN 14563)

For the safe and economical operation of railway systems, running behavior tests are essential. The goal is to quantify vehicles under known, representative operating and infrastructure conditions. Using various inertial ASC sensors at the axle box, bogie frame and diverse positions in the vehicle body, significant accelerations are accurately measured.

Bridge monitoring

ASC CS and ASC EEO CS accelerometers offer a current output signal and are, therefore, intended for loss-free signal transmission of structural health monitoring of railway bridges. In addition, smart sensor systems of the ASC AISys EEO series make the monitoring and proactive maintenance of critical railroad bridges even simpler, safer and more cost-effective in the long term.

Digital and smart sensor solutions

ASC DiSense® accelerometers are also based on proven MEMS technology and capacitive operating principle. In addition, configurable filter settings and sampling rates are already integrated and various application-specific options for digital interfaces, like USB, CAN or RS232, are available.

ASC AISys® combine the user-friendly configurations of digital accelerometers with implemented algorithms for extracting the application-specific information. For example, frequency analysis through Fast Fourier Transform (FFT) or calculating dynamic velocity and displacement are already basic in-built features. As a result, smart sensor systems of the ASC AISys® series provide information via standardized, digital interfaces.

Inertial measurement units (IMUs)

ASC's analog IMUs are based on a modular concept. By combining three accelerometers and three gyroscopes, an integrated sensor system featuring up to 6-DOF with individually adjustable measurement ranges can be achieved. For example, the TriAxisfree ASC IMU 8 features accelerometers with measurement ranges from ±2 to ±30 g and an in- or bias stability of $\pm 45 \mu\text{g}$, as well as angular rate sensors of measurement ranges from ±10 to ±400°/s, an angular random walk <math>< 0.1^\circ/\text{hr}</math> and a bias stability of <math>< 0.1^\circ/\text{hr}</math>, leading to tactical grade performance.

Gyroscopes

ASC's analog gyroscopes are based on proven MEMS vibrating ring technology. The design of micro mechanical silicon structures makes these gyroscopes extremely insensitive to external impacts and vibrations. In terms of maximum accuracy, the uniaxial and triaxial gyroscopes are available for both industrial grade (bias stability <math>< 1.2^\circ/\text{hr}</math>, measurement range ±75 to ±500 °/s) and tactical grade (bias stability <math>< 0.1^\circ/\text{hr}</math>, measurement range ±10 to ±400 °/s) performance.



Find out more!
www.asc-sensor.de/en/
applications/rail-transport

ASC RAIL sensors to improve railway performance

ASC's RAIL sensor series provides high-precision, robust yet flexible inertial sensor technologies. The tailored solutions support railway customers in improving the safety, capacity and overall productivity of their rolling stock.

Robust solutions ready for stable long-term performance

In addition, all components of the ASC RAIL series have been confirmed to meet the latest fire protection standards including EN 45545 for electronic equipment on rolling stock. This includes a robust, non-flammable, laser-welded stainless-steel housing featuring protection class IP68 as well as rail-certified cables and cable glands.

Accelerometers and gyroscopes

The standard accelerometers ASC RAIL-x152LN are available in uniaxial, biaxial and triaxial configuration. The newly developed, even more compact housing option is used for uniaxial and biaxial accelerometers ASC RAIL-x151LN, to fit into narrower spaces.

Both accelerometer models are based on proven MEMS technology and capacitive operating principle. This technology enables the measurement of DC and AC accelerations up to ± 400 g and within frequency response range of up to 1 kHz. The integrated electronic circuits enable differential analog voltage output (± 4 V FSO) and an outstanding noise performance of 7 to 400 $\mu\text{g}/\sqrt{\text{Hz}}$.

The uniaxial, biaxial or triaxial gyroscopes ASC RAIL-27x1 are based on established MEMS vibrating ring sensor elements. This technology enables the measurement of angular rates up to ± 900 $^{\circ}/\text{s}$, featuring bias stability of 12 $^{\circ}/\text{hr}$ and an angular random walk of 0.2 $^{\circ}/\sqrt{\text{hr}}$. The design of the micro-mechanical silicon structures makes these gyroscopes extremely insensitive to external impacts and vibrations.

Digital accelerometers

The ASC DiSens[®] ECO-RAIL digital accelerometers are based on proven MEMS technology and capacitive operating principle. In addition, their integrated electronic circuitry features enhanced protection through galvanically isolated main parts for power supply, sensing and the digital CAN interface. The devices provide integrated filter settings enabling a sampling rate of up to 4 kHz at a 3dB-corner frequency of 1 kHz as well as configurable measurement range settings of $\pm 2/4/8$ g or $\pm 10/20/40$ g.

Smart sensor solutions

The smart sensor systems ASC AiSys[®] ECO-RAIL combine the user-friendly configurations of digital accelerometers with complex, integrated algorithms, for example:

- Frequency analysis through FFT
- Calculating dynamic velocity and displacement

Accelerometers



Gyroscopes



Digital and smart accelerometers



Inertial sensor of the ASC RAIL series meet applicable EN 50155 standards

The following tests have been performed according to railway standard EN 50155, to confirm climatic resistance and dynamic-mechanical robustness:

- Low temperature storage test – test A
- Low temperature start-up test – test A
- Dry heat test – test B (OT6)
- Damp heat, cyclic – test Db
- Insulation tests (before and after damp heat, cyclic)
- Vibration, broad-band random – long time test Fh
- Shock testing – test Ea

Further, interference emission and interference immunity tests have been conducted according to standard EN 50121, confirming electromagnetic compatibility:

- Conducted continuous disturbance at battery port
- Radiated disturbance, electrical field
- Immunity radiated electromagnetic fields
- Conducted immunity, injected currents
- EFT / Burst
- Electrostatic discharge test / ESD