

# Position Excavator Shovels Precisely along Three Axes

Inertial Measurement Unit F99  
Supplies Angle, Acceleration,  
and Rotation Rate Data

## At a Glance

- Precise positioning of excavator shovels for accurate excavation work
- Rugged design for outdoor use in harsh conditions
- Resistant to dust, dirt, moisture, and extreme temperatures
- Inclination, acceleration, and rotation rate measurement along three axes
- Adjustable compensation range for adjusting angular accuracy



## The Application

The excavator's GPS-enabled software controller receives all of the necessary data about a hole to be excavated: the exact location and dimensions including the depth. The excavator operator is shown a virtual excavator on their display, illustrating the actual movements of the machine and the relevant landscape points. The operator moves the shovel following these instructions. By its nature, this type of work takes place outside and in all weather conditions. Dust, dirt, extreme temperatures, and humidity, including the immersion of vehicle parts in standing water, are all considered normal working conditions.

## The Goal

The excavator shovel must be positioned with an accuracy of  $\pm 2$  cm. The sensor technology and control systems on board the vehicle will ensure this—so there is no need for a separate measuring device outside the excavator. Using an external device would require time-consuming iterative measurement during excavation work. The devices on the excavator must permanently withstand the environmental influences and typical mechanical impacts associated with excavation work. At the same time, accurate position measurement using angle outputs on the arm and shovel of the machine is required during movement.

## The Solution

The inertial measurement unit F99 is mounted on the moving parts of the articulated arm, the shovel, and the chassis. The devices measure acceleration and rotation rate, and use this to calculate the dynamic angle of the moving component. In addition, the position of the shovel tip in absolute relation to the center of the earth is also recorded during the machine's movement. The integration of external GPS data enables absolute position measurement of the excavator shovel. In a deployment without GPS data, the additional information on the geographical position is missing, but the absolute orientation to the earth's center is still recorded.

## The Benefits

The sensor's fusion algorithm reliably compensates for external accelerations by intelligently linking the acceleration sensor and gyroscope. Unlike comparable devices, the compensation range can be adjusted. This allows the angular accuracy to be customized to the specific movement profile of the excavator. The sensor has been especially developed for outdoor use, has a degree of protection of IP68/IP69K, and can also be used in public traffic due to E1 approval.

### Technical Features

- Inclination, acceleration, and rotation rate measurement along three axes
- Adjustable compensation range
- Degree of protection: IP68/IP69K
- Temperature range of  $-40$  °C to  $+85$  °C
- Housing withstands mechanical impact up to 100 g
- Interface for parameterization
- Output formats and values can be selected
- Suitable for dynamic applications
- E1 approval

