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# TECHNOLOGIES

Home » Technologies » Inertial Technology » GNSS/INS Position and Attitude Systems

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## GNSS/INS Position and Attitude Systems

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### Introduction

GNSS faces one significant limitation, the requirement for line-of-sight visibility to at least four satellites in the sky. Not only does this limitation render GNSS ineffective in tunnels, in mountainous terrain and in urban canyons, but even low-rise buildings and trees can obstruct the signals. Because of the number of variables that affect GNSS performance (reflected signals, satellite constellation, etc), it is difficult to predict just how well GNSS will perform in a particular type of environment. For some applications, interrupted availability is not a significant disadvantage. For cross-country vehicle tracking, for example, occasional position updates to base are more than sufficient to know where the

vehicle is in its route. However, there are several applications that require more robust positioning – positioning data that can be relied upon to be always there, always accurate, always trustworthy. Combining GNSS and inertial technology is an ideal way to address this.

## **Development**

For almost 30 years Trimble has been providing GNSS-Inertial solutions to the Geospatial market. Initially focused on the position and orientation requirements for the airborne, land and marine mapping industry, today Trimble utilizes GNSS-INS technology across many divisions. The key to this expansion has been the development of in-house IMU technology and its integration directly onto the GNSS circuit board. This IMU sensor data is tightly coupled with the GNSS observations in the RTK/RTX positioning and orientation engine. Dynamic models based on real world application data further assist the engine in providing continuous high rate low latency output to guidance and control systems even in GNSS denied environments. Dual GNSS antenna systems allow robust alignment of gyro sensors while the platform is static. The technology allows customers to be more productive, efficient, and profitable. Trimble GNSS OEM receivers deliver centimeter-level positions and orientations to OEM and system integrator customers for a variety of autonomous applications. All GNSS-Inertial receivers support Trimble RTX delivering high accuracy without the constraints of a local base station.

## **GNSS/INS Single Antenna Systems**

GNSS/INS systems generally utilize a single or dual antenna GNSS architecture. While single antenna systems have the advantage of being easier to install they require vehicle movement to align the gyros and are better suited to more dynamic applications (> 5 kph). Applications suitable for single antenna GNSS/INS systems include:

- ▶ Automotive
- ▶ Agriculture
- ▶ Fixed wing airborne

In addition to separated GNSS/INS receiver and antenna, Trimble also offers Smart Antenna systems where the GNSS antenna, GNSS receiver and IMU sensors are all packaged into a single mechanical housing. This makes integration and installation much easier and also reduces the chances of interference with a single piece of electronics as opposed to a separate antenna, cable and receiver.

## GNSS/INS Dual Antenna Systems

In the case of dual antenna GNSS/INS systems the Moving Base RTK technique is used to align the gyros. This allows for 3D orientation of the platform when powering up in a stationary position. Overall this is a more robust solution for slow moving vehicles that will regularly lose line-of-sight to the satellites. Applications include:

- ▶ Construction
- ▶ Marine
- ▶ Multi-rotor airborne
- ▶ Mapping vehicles
- ▶ Autonomous vehicles


### Benefits

There are many benefits to tightly combining the robustness of inertial measurements with the absolute accuracy of GNSS. These include:

- ▶ High output rates
- ▶ Continuous position and orientation in difficult environments
- ▶ GNSS and IMU integrated in one housing
- ▶ Tightly integrated into RTK,RTX,DGPS,SBAS and autonomous positioning engine

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