

# RT3000

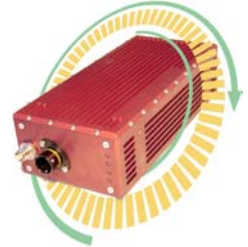
## Inertial and GPS Measurement System

### Features

- 0.03° Pitch/Roll
- No Pitch/Roll Drift
- 0.05 km/h Velocity
- 0.15° Slip Angle
- Lateral Acceleration
- Yaw Rate
- Other Measurements
- 100Hz
- Real-Time
- Low Latency
- 5 minute Installation
- RS232, Ethernet
- Optional CAN
- Replaces dozens of sensors
- No aerodynamic changes to vehicle
- Wet/Dry Surface
- Compact Size

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# Pitch & Roll Measurement System for Ride & Handling Development



## Introduction

Accurate Pitch and Roll measurements are required to improve the ride and handling of vehicles. Vehicle stability and comfort are closely related to the Pitch and Roll behaviour of vehicles. Automotive engineers are putting considerable effort into the development of safer, more stable, comfortable vehicles. They are also demanding accurate and reliable tools to make their measurements repeatable.

Figure 1. RT3002 System



One classical way to measure Pitch and Roll is using a six-axis Inertial Navigation System. Inertial Navigation Systems must achieve very high Pitch and Roll performance as these affect the quality of the navigation. Measurements better than 0.1° are essential for successful navigation. The RT3000 products can deliver accuracies of 0.03°, with resolutions better than 0.005°.

Figure 2. Vehicle Pitch

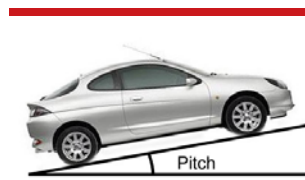


Figure 3. Vehicle Roll



## Installation

The RT3000 products are very compact and can usually be installed very close to the vehicle's Centre of Gravity. Installation can take less than 5 minutes using an optional stiff mounting strut. The GPS antenna clips on to the roof of the vehicle. No specialised survey equipment is required to install the system.

The RT3000 uses standard 12V vehicle power and consumes as little as 15W.

## Stability, Repeatability

The algorithm in the RT3000 is very different to that of Vertical Reference Systems. The Pitch and Roll angles measured by the RT3000 do not

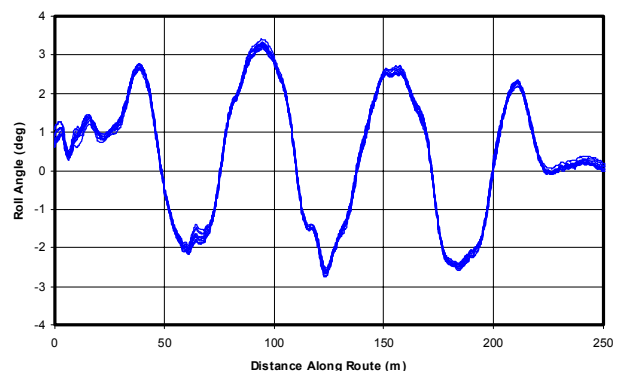
drift with time. Sophisticated algorithms in the RT3000 use GPS to continuously correct Pitch and Roll for any drift or errors, leading to very stable measurements.

The RT3000 can be used indefinitely without the need to realign. It can perform continuous circles or very dynamic ride and handling circuits without any performance degradation.

## Outputs

The RT3000 has a fast, 100Hz output rate. Clever manipulation of the data allows the output to have a very low latency (3.9ms). The outputs are suitable for connection to real-time data acquisition systems, immediate comparison to other sensors and control applications.

Figure 5. Roll Angle for 9 Repeated Tests



**Table 1. RT3002 Specification**

Parameter	RT3002
Positioning	L1/L2 RTK
Position Accuracy	2cm 1σ
Velocity Accuracy	0.05 km/h RMS
Acceleration	
– Bias	10 mm/s <sup>2</sup> 1σ
– Linearity	0.01%
– Scale Factor	0.1% 1σ
– Range	100 m/s <sup>2</sup>
Roll/Pitch	0.03° 1σ
Heading	0.1° 1σ
Angular Rate	
– Bias	0.01°/s 1σ
– Scale Factor	0.1% 1σ
– Range	100°/s
Track (50km/h)	0.07° RMS
Slip Angle (50 km/h)	0.15° RMS
Lateral Velocity	0.2%
Update Rate	100 Hz
Calculation Latency	3.9 ms

Outputs are presented over RS232, Ethernet or CAN (optional). Connection to laptop computers (using RS232 or Ethernet) or Data Acquisition Systems (using CAN) is simple. A CAN DBC file is provided to simplify the configuration of the Data Acquisition System software.

The system has a high (50Hz) bandwidth, with very little in-band gain or phase error. The bandwidth is constant and not speed dependent. Outputs are valid at all speeds from zero up to

the GPS export restriction (>1000 mph). Steady-state, time series and Fourier analysis measurements can be made from the outputs.

**Other Outputs**

The RT3000 makes a whole load of additional measurements besides Pitch and Roll. These include:

- Slip Angle
- Forward/Lateral Velocity
- Lateral Acceleration (Roll-corrected)
- Body-Frame Accelerations
- Yaw Rate

and many others besides. The single, comprehensive package can take care of nearly all measurement needs, replacing dozens of sensors, improving

accuracy and drastically cutting installation times.

**Testing**

Classical tests, such as sine-tests, flick tests, J-tests are easily measured using the RT3000. Other tests typically include elk or roll-over tests.

Using the Pitch measurement the dive of the bonnet during severe braking and the recovery once stationary can be accurately plotted. The rise of the bonnet during hard acceleration can also be plotted from stationary.

The RT3000 is also ideal for collecting data for simulation systems. Road mapping to find the camber and gradient of the road is simple and quick.

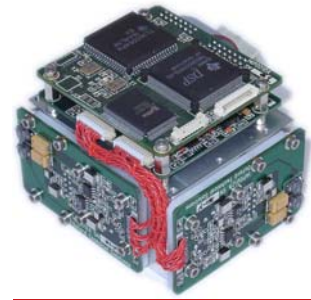
For dynamics simulations the low gain/phase error allows the engineer to make more accurate comparisons to dynamics simulations.

**Technology**

The heart of the RT3000 is a state-of-the-art six-axis Inertial Measurement Unit (IMU). A powerful Pentium-class micro-processor is used to compute the mathematically intensive algorithms. Survey-grade GPS is used to update the system through a 23-state Kalman filter.

The accelerometers are tactical-grade components from missile programs. Using servo technology they can resolve accelerations below 0.1mG and have linearity better than 0.01%.

**Figure 7. RT3000 IMU**



Angular Rate is measured using high-performance MEMS rate sensors. These give excellent bias stabilities, allowing bias to be estimated to 0.01°/s or better.

Over-sampling, coning and sculling motion compensation algorithms used in the Inertial Measurement Unit lead to a very high tolerance to vibration.

The navigation system uses a complex WGS-84 earth model that compensates for earth

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rotation, Coriolis acceleration effects, transport rate and other anomalies that affect measurement systems on an elliptical, rotating earth.

**Conclusion**

The RT3000 products are ideal for Pitch and Roll measurements. They offer an abundance of other important measurements in a compact, easy to use package.

**Figure 6. RT3000 Connectivity**

