

# RT4000

## Inertial and GPS Measurement System

### Features

- 250Hz Update Rate
- 2cm Positioning
- 0.05km/h Velocity
- 10mm/s<sup>2</sup> Acceleration
- Lateral Acceleration
- 0.03° Roll, Pitch
- 0.15° Slip Angle
- 0.01°/s Angular Rates
- Real-Time
- Low Latency
- CAN Output
- Wheel speed input
- 500MB Logging
- 5 min Installation
- Compact Size

### Vehicle Applications

- Vehicle dynamics
- Autonomous vehicles
- Roll-over testing
- Lane change
- NHTSA ESC
- ITS testing
- Simulation verification
- Acceleration/braking
- Lap timing, racing

### Other Applications

- AHRS
- Video Correction
- Road Survey

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# RT4000 High-Speed Inertial and GPS Navigation System

The RT4000 Inertial and GPS Navigation Systems are advanced six-axis inertial navigation systems, blended with precision GPS, to give high speed 250Hz, robust outputs of position, orientation and velocity.

The RT4000 Inertial and GPS Navigation System includes three angular rate sensors (gyros), three servo-grade accelerometers, a GPS receiver and all the required processing in one very compact box.

Six models in the RT4000 family allow us to offer very competitively priced products. The difference between the products is the positioning performance of the GPS receiver, with our most accurate model offering 2cm accuracy.



The RT4000 works as a stand-alone, autonomous unit and requires no user input before it starts operating.

The outputs from the RT4000 Inertial and GPS Navigation System are derived from the measurements of the accelerometers and gyros. Using the inertial sensors for the main outputs gives the RT4000 sys-

tem a fast update rate (250Hz) and a wide bandwidth. All the outputs are computed in real-time with a very low latency.

The RT4000 Inertial and GPS Navigation System outputs its real-time measurements over RS232, Ethernet and CANbus.

The CAN bus output can be combined into a vehicle's CAN bus or captured using any CAN data acquisition system. The real-time nature allows the RT4000 to be used for *hardware in the loop* and controller development. Connection to powerful tools like dSPACE is easy. CAN DBC files are provided.

The precision ADC in the RT4000 gives more than 19 bits of resolution. The resolution of the acceleration measurements is 0.24mm/s<sup>2</sup> (24μg). The ADC oversamples the analogue sensors and uses coning/sculling motion compensation algorithms to avoid aliasing of the signals.

The internal processing includes the strapdown algorithms (using a WGS-84 earth model), Kalman filtering and in-flight alignment algorithms.

Parameter	RT4200	RT4100	RT4020	RT4002	RT4050	RT4040
Position Accuracy	3.0mCEP SPS	1.8mCEP SPS	1.8mCEP SPS	1.5mCEP SPS	1.8mCEP SPS	1.5mCEP SPS
	1.4mCEP SBAS	1.2mCEP SBAS	1.2mCEP SBAS	0.8mCEP SBAS	1.2mCEP SBAS	0.8mCEP SBAS
	1.0mCEP DGPS	0.4mCEP DGPS	0.2m 1 $\sigma$ DGPS	0.02m 1 $\sigma$ DGPS	0.5mCEP VBS <sup>2</sup>	0.1mCEP HP <sup>2</sup>
Velocity Accuracy	0.2 km/h RMS	0.1 km/h RMS	0.08km/h RMS	0.05km/h RMS	0.08km/h RMS	0.07km/h RMS
Acceleration						
– Bias	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$	10 mm/s <sup>2</sup> 1 $\sigma$
– Linearity	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
– Scale Factor	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$
– Range <sup>1</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>	100 m/s <sup>2</sup>
Roll/Pitch	0.1° 1 $\sigma$	0.05° 1 $\sigma$	0.04° 1 $\sigma$	0.03° 1 $\sigma$	0.04° 1 $\sigma$	0.03° 1 $\sigma$
Heading	0.2° 1 $\sigma$	0.1° 1 $\sigma$	0.1° 1 $\sigma$	0.1° 1 $\sigma$	0.1° 1 $\sigma$	0.1° 1 $\sigma$
Angular Rate						
– Bias	0.02°/s 1 $\sigma$	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$	0.01°/s 1 $\sigma$
– Scale Factor	0.2% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$	0.1% 1 $\sigma$
– Range <sup>1</sup>	100°/s	100°/s	100°/s	100°/s	100°/s	100°/s
Track (at 50km/h)	0.2° RMS	0.15° RMS	0.1° RMS	0.07° RMS	0.1° RMS	0.08° RMS
Slip Angle (at 50km/h)	0.3° RMS	0.2° RMS	0.15° RMS	0.15° RMS	0.15° RMS	0.15° RMS
Lateral Velocity	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%
Update Rate	250 Hz	250Hz	250Hz	250Hz	250Hz	250Hz
Calculation Latency	3.9 ms	3.9ms	3.9 ms	3.9 ms	3.9 ms	3.9 ms

Note 1. 300m/s<sup>2</sup> and 300°/s options are available. Note 2. A subscription is required to use OmniStar VBS and OmniStar HP Services.



*Inertial Sensors in RT4000 include servo-grade accelerometers and precision MEMS angular rate sensors. Powerful 40MHz floating point DSP takes care of coning, sculling and aliasing.*



*GPS antenna for RT4200, RT4100 and RT4020 systems*

The internal Pentium-class processor runs QNX real-time operating system to ensure that the outputs are always delivered on time.

The Kalman filter monitors the performance of the system and updates the measurements using GPS and wheel speed. By using the measurements from GPS, the RT4000 system is able to maintain highly accurate measurements and correct its inertial sensor errors.

The RT4000 comes with acquisition software that displays the data on a PC or on Pocket PC devices. The PC software can be used to save tests in files, display real-time results and monitor the performance.

The internal logging enables the RT4000 to work stand-alone. Post-mission, data can be output in ASCII text format and loaded in to the software of your choice.

Simple configuration software allows the user to change the mounting angle; displace the measurement point to a virtual location; change the differential GPS options, etc.

#### Models

To choose the best model for your application, think about the positioning accuracy you require and what differential GPS corrections you can supply. OmniStar systems give excellent results over a wide area. The RT4002 can give

more accurate positioning in a local area where licence-free radios can be used to transmit the corrections.

The RT4000 products are also available as dual antenna models. Where accurate heading in low dynamics is required, the dual-antenna model may be more suitable

For further information please contact Oxford Technical Solutions or your nearest local agent.

Parameter	RT4000
Power	9-18 V d.c. 15W
Dimensions (mm)	234 x 120 x 80
Weight	2.2 kg
Operating Temperature	-10 to 50°C
Vibration	0.1 g <sup>2</sup> /Hz 5-500 Hz
Shock Survival	100G, 11ms
Internal Storage	500 MB
Dual Antenna	No