# Revolution™ AV Electronic Compass

Technical Brief

The Revolution AV (TNT4000) provides stable azimuth, pitch, and roll measurements in dynamic conditions. An enhanced version of our Revolution GS, the AV includes a full suite of precision, 3-axis, MEMS sensors and a dual-axis electrolytic tilt sensor for the ultimate in near-level accuracy.

The recommended applications for the AV are manned and unmanned aerial and underwater vehicles, but it can also be appropriate for robotics, weather buoys, antenna positioning, platform stabilization, excavation machinery, and irrigation equipment. For cost sensitive applications, the rate gyros and eTilt are optional sensors that can be eliminated if not needed.

All 11 sensor measurements are calibrated over a -50° to 110°C temperature range and aligned in three dimensions. In addition to azimuth output, all raw and calibrated measurements are available at up to 28 readings per second.

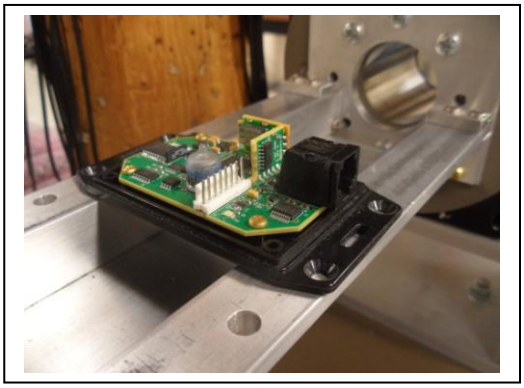
The AV's sensor suite consists of the following:

- 3-axis angular rate gyros
- 3-axis accelerometer
- 3-axis magnetometer
- 2-axis eTilt sensor

Each sensor is sampled at over 200 readings per second using a 12-bit SAR A/D converter with multiplexed inputs. The readings are averaged to produce eleven, 27.5 Hz, raw signal streams. The raw measurements are calibrated and combined to provide azimuth, pitch, roll, inclination, acceleration, and other outputs. Calibrated measurements are available as outputs to be used by external navigation algorithms. Serial outputs from the AV are compatible with earlier True North Revolution models. Advanced binary messages are available at fast data rates (up to 57.6K baud) for applications requiring additional outputs. Examples of available binary data include inclination, input voltage level, ambient temperature, and both raw and calibrated sensor measurements. There are more than 50 measurements available in binary output form.

The advanced capabilities of the AV are supported by updated Revolution PC software that simplifies engineering verification and integration tasks. The software provides the following functionality:

- Monitor and change settings
- Perform magnetic calibration
- Capture selected measurement data (spreadsheet-compatible file format)
- Maintain communication and setting logs



*For more information, pricing, and availability, please call True North Technologies or e-mail bpowell@tntc.com.*

**Features**

- ***Static Accuracy***
  - ⇒ Azimuth within 0.5° typical (0.1° resolution)
  - ⇒ Pitch and roll within 0.2°
- ***Dynamic Performance***
  - ⇒ Gyro gimbal equations performed in firmware
  - ⇒ Azimuth within 3° typ, rates < 150°/sec
  - ⇒ Pitch and roll within 1° typical for rates < 150°/sec
- ***Wide Operating Range***
  - ⇒ Ambient temperature -40° to 105°C (-40° to 220°F)
  - ⇒ ±300°/sec angular rate
  - ⇒ Total magnetic field (earth + hard-iron) to ±1.5 Gauss
  - ⇒ ±80° dip angle range
  - ⇒ Total acceleration field to 1.3g (gravity = 1g)
  - ⇒ ±40° eTilt pitch & roll range (±60°optional)
- ***Fast Response***
  - ⇒ Up to 27.5 calibrated measurements per second
  - ⇒ Wake from standby in 50 msec
- ***Single Supply Operation***
  - ⇒ 7 to 45V unregulated DC
  - ⇒ Thermal overload and reverse polarity protection
- ***Low Power***
  - ⇒ 40 mA operating
  - ⇒ 15 mA idle
  - ⇒ 5 mA standby
- ***Wide Selection of ASCII or Binary Output Data***
  - ⇒ Heading, pitch, and roll
  - ⇒ Temperature, input voltage, and dip angle
  - ⇒ Magnetometer X, Y, and Z
  - ⇒ Total, horizontal, and vertical magnetic field strength
  - ⇒ Raw and conditioned gyro data
- ***Two independent Serial Channels***
  - ⇒ Full-duplex RS-232 for the external RJ12
  - ⇒ Either RS-232 or full-duplex RS-485 for the internal connector
- ***In-System Configuration and Test***
  - ⇒ Laptop can be connected while unit operates in situ
  - ⇒ Perform hard and soft iron calibration
  - ⇒ Monitor outputs and change user-definable settings

The rate gyros are high stability, low noise, and vibration rejecting components. A unique, interlocking PCB design creates a rigid 3D configuration to maintain positional stability over temperature. Each gyro is sampled at over 200 Hz using a 12-bit, SAR-type A/D converter.

Inertial sensors include both a Kionix KX94 tri-axis accelerometer and a Spectron dual-axis electrolytic tilt (eTilt) sensor. Either the eTilt sensor or the accelerometer can be used for long-term pitch and roll measurements. Both sensors are calibrated over their full tilt and operating temperature range to eliminate bias, sensitivity, and cross-axis effects.

The Revolution AV is plug compatible with all of True North's Revolution models: standard, low power (LP), 2X, and GS. The AV board is the same size as the GS and it fits in the same enclosure with the same mounting hole pattern. Identical NMEA sentences are available in all devices.

Tuning the AV is as easy as setting a time constant. There are 3 separate values that control pitch, roll, and azimuth complementary filters. Like the GS, the AV has separate serial channels for the external RJ12 and internal J2 connector; there are independent baud rates and separate on/off options for automatic data. If binary data is desired additional parameters are available to select which items to transmit.

The Revolution AV comes with an upgraded version of True North's PC software that is backward compatible with the entire Revolution electronic compass line. The magnetic calibration procedure required upon installation is identical. Cabling and power requirements are similar, but the AV requires an input voltage greater than 6V to accommodate the high precision rate gyros.

## Specifications

### *Heading Performance*

| Parameter | Value | Conditions |
|---|---|---|
| Accuracy[1] | ± 0.5° rms | Static, Tilt < 35° Dip < 60° |
| | ± 3.0° rms | Dynamic, rate < 150°/sec |
| Repeatability | ± 0.3° | Static, no filter |
| Response time | 36 msec | Minimum, no filter |
| Dip Angle Range | ± 80° | |
| Tilt Range | ± 80° (with accelerometer) | |
| Update rate | 27.5 measurements per second | |

[1] May require calibration after installation to eliminate effect of local magnetic field

### *Pitch and Roll Performance*

| | | |
|---|---|---|
| Accuracy | ± 0.3° | Factory calibrated |
| Repeatability | ± 0.2° | No filter |
| Range | ± 80° | (± 40° eTilt) |
| Settling time | 50 msec | Gyros enabled |

### *Electrical*

| | | |
|---|---|---|
| Supply Voltage ($V_{DD}$) | 7 - 45Vdc unregulated | |
| Supply Current | 40 mA operating | typical |
| | 15 mA idle | typical |
| | 5 mA standby | typical |

### *Environmental*

| | | |
|---|---|---|
| Operating Temp | -40 to 105°C | (-20°C with eTilt) |
| Storage Temperature | -50 to 150°C | |
| Humidity | 0 to 90% | Non-condensing |
| Shock | 200g | Max horizontal (with eTilt) |

### *Mechanical*

| | |
|---|---|
| Box (optional) | Hammond Mfg1591MFL |
| PCB Size | 1.8"W x 3.0"L x 0.6"H |
| PCB Mounting | 4 #4 screws, 1.4" x 2.6" spacing |
| Connectors | 8 pin, single-row, 0.1" friction header |
| | 6 pin RJ12 modular jack |
| Weight | 3 oz. in box |

### *Interface*

| | |
|---|---|
| Signal type | RS-232 and RS-485 |
| Baud rate | 2400, 4800, 9600, 19200, 38400, or 57600 bps |
| Character Format | 8 data, no parity, 1 stop |
| Input Buffer Size | 110 characters |
| Output Buffer Size | 110 characters |
| Output Format | NMEA 0183 and binary |
| Output Data Rate | 1 to 1650 sentences per minute |
| Operating Modes | Continuous or sample |
| Angle Units | Degrees, mils, radians, 16-bit integer |