



Revolution™ AV+

The Revolution AV+ (TNT4700) is a unique combination IMU and magnetic compass with advanced vibration detection and sensor fault detection. It features 11 sensors aligned, calibrated, and compensated over a temperature range of -50°C to 110°C. There are two independent serial channels (RS232 or RS485) to transfer either compass or IMU data in industry-standard formats: a simple-to-decipher ASCII string for compass data (NMEA 0183*) or an efficient binary packet format for IMU data.

The sensor suite consists of 3D rate gyros, a 3D MEMS accelerometer, a 3D MEMS magnetometer, and a dual axis electrolytic tilt (eTilt) sensor. Accelerometer sensors have a selectable range of ± 2 , 4, 8, or 16G. Rate gyros operate in the range of $\pm 250^\circ/\text{sec}$. Magnetometer and electrolytic sensors are the same used in all Revolution products. Output measurement data rates of up to 27.5 or 50Hz – depending on operating mode – can be selected.

The AV+ operates in either Compass or IMU mode. In compass mode, easy-to-tune complementary filters blend accelerometer, gyro, and magnetometer data to produce accurate estimates of attitude in dynamic ambient conditions. Trigonometric 3D gimbal equations are incorporated in the firmware to produce azimuth, pitch, and roll relative to the earth's North-East-Down (NED) frame of reference. An optional GPS (NMEA) RMC sentence can be input to correct for continuous circling and magnetic variation between true and magnetic north. The electrolytic tilt sensor can be configured to automatically correct bias drift in the MEMS accelerometer. Diagnostic measurements include magnetic dip angle and horizontal field strength that can be verified with online geomagnetic model data to ensure that interfering magnetic sources are correctly compensated.

* National Marine Electronics Association

In IMU mode, the measurement and diagnostic packet can either be requested or automatically streamed. The packet contents include:

- Accelerometer X, Y, Z in mg
- RMS X, Y, Z vibration in mg
- Gyro X, Y, and Z - 0.01°/sec resolution
- Magnetic field X, Y, Z - 0.1 mOe resolution
- eTilt angles - 0.01° degree resolution
- Ambient temperature - 0.1°C
- Input voltage in mV
- 16-bit sensor error flags
- 16-bit serial error indicators

Inertial sensor measurements are normalized for ambient temperature variation and calibrated to be coaxial at room temperature. Magnetic field measurements are compensated using hard and soft iron coefficients. RMS vibration measurements are produced by high-pass filtering raw accelerometer data. Corner frequency and sample size can be configured through the serial interface.



For more information, pricing, and availability, please call or e-mail sales@tntc.com.

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IMU Packet Description

Byte Offset	Name	Description	Value / Range	Units
0	Header	Packet header	0x5AA5	
2	Length	Packet length	46	
3	Type	Packet ID	0	
4	Count	Packet counter	0-65535	
6	Data1	Accel X	±16,000	1 mG/count
8	Data2	Accel Y		
10	Data3	Accel Z		
12	Data4	Mag X	±32,000	0.1 mOe/count
14	Data5	Mag Y		
16	Data6	Mag Z		
18	Data7	Gyro X	±30,000	1 count = 0.01 °/sec
20	Data8	Gyro Y		
22	Data9	Gyro Z		
24	Data10	eTiltX	±4500	0.01 °/count
26	Data11	eTiltY		
28	Data12	Vibration X	±16,000	1 mG/count
30	Data13	Vibration Y		
32	Data14	Vibration Z		
34	Data15	Ambient Temp	-500 to 1200	0.1 °C/count
36	Data16	Input Volts	0 to 45000	milliVolts
38	Data17	Startup Test Status	0 to 65535	flags
40	Data18	Operating Status	0 to 65535	flags
42	Data19	Serial Status	0 to 65535	flags & code
44	Chksm	16-bit checksum		

Software Support

The advanced capabilities of the AV+ are supported by updated Revolution PC software that simplifies engineering verification and integration tasks. The software allows a user to

- Monitor and change settings
- Save and restore configuration data
- Perform magnetic calibration
- Capture and record selected measurement data in CSV file format
- Maintain communication transaction logs and a setting change log

For users who need to write communication software, the NMEA 0183 protocol is widely used in GPS receivers and marine equipment and is easily adapted for sending commands to the Revolution. A technical guide with the protocol details is available.

Diagnostics

The AV+ can be configured to run a comprehensive test routine either on power up (POST), or when a software reset command is issued, or in both cases. It performs a few measurement cycles with electrostatic activation of offsets for MEMS sensors, and tests voltage, temperature, and electrolytic impedance values required for proper operation. Failure flags are cleared or set when the diagnostic run completes and normal operation resumes. Additional start-up time is roughly half a second.

Sensor Specifications

Device Specification	eTilt	Accelerometer	Gyro	Magnetometer
Manufacturer	Spectron	Kionix	Analog Devices	Honeywell
Mfr Part Number	SP5000	KX132-1211	ADXRS642	HMC 1001/1002
Range	±40°	±16g	±250°/sec	±1.6 Oersted
Bias drift*		0.25 mg/°C	<0.01°/sec/°C	
Scale factor drift	0.1%/°C	0.03%/°C	0.1%/°C	
Noise Density		130 µg√Hz	0.02°/sec√Hz	<29nV/√Hz
Axis misalignment*		1%		±1% FS
Resolution	.02°	60 µg	<0.1°/sec	250 µOe
Bandwidth		2900 Hz	2000 Hz	5 MHz
Nonlinearity	3%	0.5%	.01% FS	.05%

*Bias drift and axis misalignment are compensated by calibration at True North. Sensors are aligned coaxial and orthogonal within 0.1° or better. Bias drift is compensated over the full operating temperature range of -50 to 110°C.

General Specifications

Heading Performance

<u>Parameter</u>	<u>Value</u>	<u>Conditions</u>
Accuracy ¹	± 0.5° rms ± 4.0° rms	Static, Tilt < 35° Dip < 60° Dynamic, rate < 150°/sec
Repeatability	± 0.3°	Static, no filter
Response time	36 msec	Minimum, no filter
Dip Angle Range	± 80°	
Tilt Range	± 90° Pitch / ±180° Roll	With accelerometers
Output update rate	27.5 Hz	Compass mode

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

Pitch and Roll Performance

Accuracy	± 0.25°	Factory calibrated
Repeatability	± 0.1°	Typical
Range	± 90° Pitch/± 180° Roll	

Electrical

Supply Voltage (V _{DD})	5.5 – 45 Vdc unregulated	
Supply Current	40 mA operating 10 mA idle	Typical Typical

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General Specifications continued

Sensor Sampling Rates (IMU mode)

<u>Parameter</u>	<u>Value</u>	<u>Conditions</u>
Accelerometers	25,600 Hz	KX132 internal
Gyros	800 Hz	Each component
Magnetometer	800 Hz	Each component
Electrolytic	400 Hz	Both pitch and roll

Environmental

Operating Temp	-50 to 110°C	
Storage Temperature	-55 to 150°C	
Humidity	0 to 90%	Non-condensing
Shock	200g 5000g	Max horizontal with electrostatic tilt sensor Without eTilt sensor

Mechanical

Enclosure	Hammond Mfg1591MFL (optional water-tight enclosure available)
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 – RS-232 and RS-485 6 pin RJ12 modular jack or 9-pin D-Sub – RS-232
Weight	3 oz. in box

Interface

Signal type	RS-232 and RS-485
Baud rate	4800, 9600, 19200, 38400, 57600, and 115,200 bps
Character Format	8 data, no parity, 1 stop
Input Buffer Size	100 characters
Output Buffer Size	100 characters
Output Format	NMEA 0183 and binary
Output Data Rate	Up to 27.5 Hz compass mode, 50Hz IMU mode
Operating Modes	Compass Continuous or Sample, IMU Streaming or request
Angle Units	Degrees, mils, radians, 16-bit integer (1 LSB = 0.0055°)