Revolution™ AV+ Family

The Revolution AV+ family is a set of four devices that share common hardware components and firmware. They combine IMU and magnetic compass operation with advanced vibration detection and sensor fault detection. The top-line member is the AV+ (TNT4700-AV). It features 11 sensors aligned and calibrated to identical, orthogonal axes 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. The GS+ family member eliminates the Z-axis gyro, XT+ has no gyros, and the NG+ has the same sensors as our legacy Revolution compass: 3D magnetometer and electrolytic sensor.

All family members are RoHS compliant, which requires an immersion silver (iAG) PCB finish. A protective conformal coating is applied to the finished assemblies to allow operation in challenging environments. Several non-magnetic enclosure options are available depending on the level of protection needed.

IMU/Compass operating mode can be changed on the fly. In Compass mode, easy-to-tune complementary filters blend accelerometer, gyro, and magnetometer data to produce accurate estimates of attitude in dynamic ambient conditions. Diagnostic measurements include magnetic dip angle and horizontal field strength that can be verified with online geomagnetic model data to ensure that interfering magnetic signals are correctly compensated.

* National Marine Electronics Association

In IMU mode, the binary 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 and orthogonal 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.

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

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Configurations

Four hardware configurations available:

1. The fully loaded Revolution AV+ (P/N TNT4700-AV) is an enhanced upgrade of the discontinued AV model (TNT4000).
2. With no Z-axis gyro, the Revolution GS+ (TNT4700-GS) is a compatible upgrade for the previous GS. The 3-axis accelerometer yields improved dynamic performance .
3. The Revolution NG+ (TNT4700-NG) is a RoHS upgrade to our standard Revolution compass. This is our most economical 4700 model without gyros or accels.
4. The Revolution XT+ (TNT4700-XT) is the NG with the addition of a 3-axis accelerometer. It gives extended tilt range and improved vibration performance.

All configurations share the same firmware. Non-volatile settings indicate which sensors are installed. This allows the AV+ to be modified in-situ to operate as any of the other variations, a simple way to evaluate a cost effective solution for the application.

Software Support

The advanced capabilities of the AV+ family 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 a spreadsheet-compatible file format
- Maintain communication transaction and setting change logs

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 impedance values required for proper operation. Additional start-up time is less than half a second.

Sensor Specifications

Device Specification	eTilt	Accelerometer	Gyro	Magnetometer
Manufacturer	Spectron	Kionix	Analog Devices	Honeywell
Mfr. Part Number	SP5000	KX132-1211	ADXRS642	HMC1001/1002
Range	±40°	±16g	±250 °/sec	±1.6 Oersted
Bias drift*		0.25 mg/°C	<0.01 °/sec/°C	
Scale factor drift	.1 %/°C	0.03 %/°C		
Noise Density		130 µg√Hz	<0.02 °/sec√Hz	29 nV/√Hz
Axis misalignment*		1%		±1 %FS
Resolution	.02°	60ug	<0.1 °/sec	27 µ gauss
Bandwidth		2.9KHz	2 KHz	5 MHz
Nonlinearity	3%	0.5%	.01 %FS	.05 %

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

General Specifications

Heading Performance

Parameter	Value	Conditions
Accuracy[1]	0.1° rms	Static, Level, default filtering
	3.0° rms	Dynamic, rate < 200°/sec
Repeatability	± 0.1°	Static, default filtering
Response time	36 msec	Minimum
Dip Angle Range	± 80°	
Tilt Range	± 90° Pitch, ± 180° Roll	With accelerometers
Update rate	27.5 measurements/second	Compass mode
	50 packets/second	IMU mode

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

Pitch and Roll Performance

Accuracy	± 0.3°	Factory calibrated
Repeatability	± 0.1°	Typical
Range	± 90° Pitch, ± 180° Roll	With accelerometers

Electrical

Supply Voltage (V_{DD})	6 – 45 Vdc unregulated	
Supply Current	50 mA	AV+ Run state, IMU mode
	40 mA	Run state, Compass mode
	25 mA	Idle state, either mode

Environmental

Parameter	Value	Conditions
Operating Temp	-50 to 110°C	
Storage Temperature	-55 to 150°C	
Humidity	0 to 90%	
Shock	200g	Max horizontal with electrostatic tilt sensor
Compliance	RoHS compliant	Made in USA

Mechanical

ABS 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 – RS232 (optional 9-pin D-Sub available)
Weight	3 oz. / 90 grams in ABS box

Interface

Signal type	RS-232 and RS-485
Baud rate	4800, 9600, 19200, 38400, 57600, 76800, 115200 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, 50 Hz IMU mode
Operating Modes	Compass Continuous or Sample, IMU Streaming or Single
Angle Units	Degrees, mils, radians, 16-bit integer

IMU Mode Packet Data

Byte Offset	Name	Description	Value / Range	Units
0	Header	Packet header	Hex 5AA5	
2	Length	Packet length	46	
3	Type	Packet ID	0	
4	Count	Packet counter	0-65535	
6	Data1	Accel X	± 16000	1.0 mg/count
8	Data2	Accel Y		
10	Data3	Accel Z		
12	Data4	Mag X	± 32000	0.1 mOe/count
14	Data5	Mag Y		
16	Data6	Mag Z		
18	Data7	Gyro X	± 30000	0.01°/sec/count
20	Data8	Gyro Y		
22	Data9	Gyro Z		
24	Data10	eTiltX	± 4500	0.01°/count
26	Data11	eTiltY		
28	Data12	Vibration X	± 16000	Approx. 1.0 mg/count
30	Data13	Vibration Y		
32	Data14	Vibration Z		
34	Data15	PC Board Temp	-500 to 1200	0.1 °C/count
36	Data16	Input Volts	0 to 45000+	milli-Volts
38	Data17	Startup Status	Hex 0 to FFFF	flags
40	Data18	Operating Status	Hex 0 to FFFF	flags
42	Data19	Serial Status	Hex 0 to FFFF	flags & code
44	Checksum	16-bit checksum	0 to 65535	

