Technical Brief

Yost Labs 3-Space™ Sensor
Data-logging 3.1



Miniature High-Performance Attitude & Heading Reference Systems / Inertial Measurement Units

Product Overview

The 3-Space™ Sensor Data-logging integrates a miniature, high-precision, high-reliability, Attitude and Heading Reference System (AHRS) / Inertial Measurement Unit (IMU) / Vertical Reference Unit (VRU) with a micro-SD card storage device, Bluetooth LE wireless interface, high-speed USB-C interface, GPS/GNSS solution, and a rechargeable lithium-polymer battery solution into a single end-use-ready unit. The Attitude and Heading Reference System (AHRS) uses triaxial gyroscope, auto-selecting dual accelerometers, and magnetometer sensors in conjunction with patented advanced processing and on-board quaternion-based orientation filtering algorithms to determine orientation relative to an absolute reference in real-time. The system also offers GPS tracking capability that operates in conjunction with Yost Labs Extended Embedded Pedestrian Tracking System™ (EEPTS™)

Orientation can be returned in absolute terms or relative to a designated reference orientation. The gradient descent calibration process and high update rates increase accuracy and greatly reduce and compensate for sensor error. The 3-Space Sensor system also utilizes a dynamic sensor confidence algorithm that ensures optimal accuracy and precision across a wide range of operating conditions.

When attached to a USB host, the 3-Space™ Data-logging unit uses high-speed USB to enumerate as both a virtual COM port and a USB mass-storage device. The virtual COM port allows access to real-time sensor data and configuration parameters and the mass-storage device allows access to logging & config options and captured sensor data. Both real-time and logged data can also be accessed via wireless BLE or via the removable micro-SD card. Versatile commands provide for GPS/EEPTS coordinates, raw sensor data, normalized sensor data, and filtered absolute and relative orientation outputs in multiple formats including: quaternion, Euler angles (pitch/roll/yaw), rotation matrix, axis angle, two vector (forward/up).

Applications

- Kinematics and performance analysis, motion capture and data gathering
- High-fidelity motion data for research and analytics
- Personnel / pedestrian / asset tracking
- Unmanned air/land/water vehicle tracking
- Healthcare monitoring
- Vibration analysis and monitoring
- Event detection and monitoring
- Navigation & Compassing
- Education and performing arts

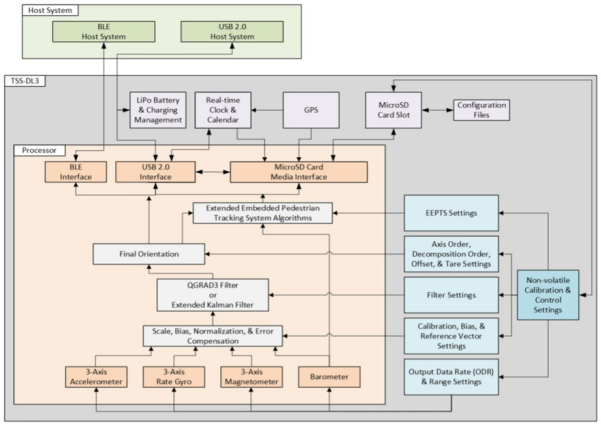
Key Features

The 3-Space™ Sensor Data-logging has many features that allow it to be a flexible all-in-one solution for your orientation sensing and data-logging needs. Below are some of the key features:

- Small self-contained high-performance data-logging AHRS at 40.0mm x 40.9mm x 14.2mm and 20 grams
- Ultra-fast sensor update and filter rates of 2000Hz allows use in highly dynamic applications, including motion capture, motion & kinematic performance analysis, and navigation
- Integrated GNSS/GPS and 700mAh battery options
- Integrated Lithium-Polymer battery and charge control allows battery life up to 11+ hours at full performance, 20+ hours with 700mAh option.
- Highly customizable orientation sensing with accessible options such as tunable filtering, oversampling, and orientation error correction
- Embedded high-performance EEPTS™ pedestrian tracking system allows for real-time motion path extraction from body-worn devices or hand-carried equipment without GPS or other external infrastructure
- Selectable advanced integrated filter modes, including Extended Kalman Filtering, and our proprietary high-performance QGRAD3, allows sensor to automatically reduce the effects of sensor noise and sensor error
- Integrated World Magnetic Model (WMM) with simple commands for heading and bearing referenced to true north, magnetic north, or grid north.
- Robust open protocol allows commands to be sent in human readable form, or more quickly in machine readable form
- Orientation output format available in absolute or relative terms in multiple formats (quaternion, rotation matrix, axis angle, two-vector), Access to raw/corrected sensor data. Absolute or custom reference axes
- MicroSD card allows for data-logging applications, USB allows for real-time applications
- Flexible data logging configuration allows customization of logged data and allows event-based and time-based logging options
- Built-in real-time clock/calendar provides for fully time-stamped event logging at high resolution
- USB communication through a virtual COM port
- Enumeration as USB mass-storage device makes access to configuration settings and logged data easy
- Bluetooth Low Energy (BLE5.4) access to real-time and logged data
- RGB status LED, Upgradeable firmware

High-reliability MEMS technology combined with advanced processing and multiple quaternion-based filtering algorithms allows for accurate orientation outputs across a wide range of performance conditions.

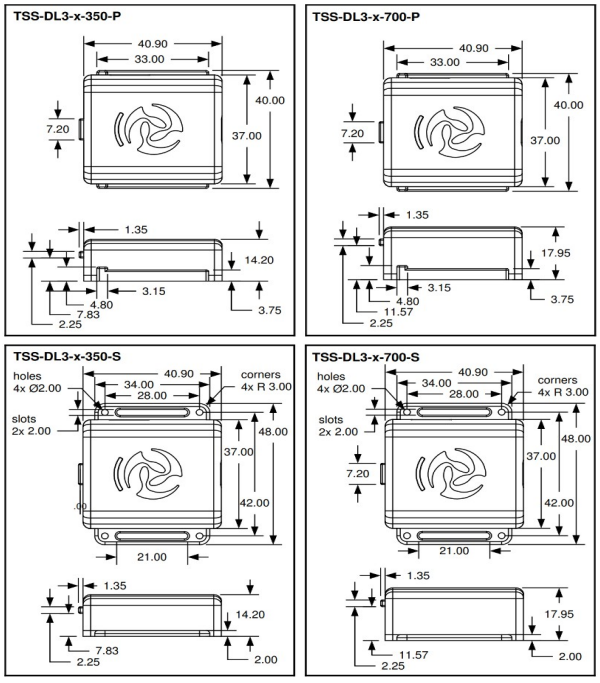
Block Diagram



Hardware Overview



Case Dimensions



Specifications

General	
Part numbers	TSS-DL3-HB-350-P-v3.1 (350mAh battery, BLE, Portable Case) TSS-DL3-HB-700-P-v3.1 (700mAh battery, BLE, Portable Case) TSS-DL3-HBG-700-P-v3.1 (700mAh battery, BLE+GPS, Portable Case) TSS-DL3-HB-350-S-v3.1 (350mAh battery, BLE, Screw-down Case) TSS-DL3-HB-700-S-v3.1 (700mAh battery, BLE, Screw-down Case) TSS-DL3-HBG-700-S-v3.1 (700mAh battery, BLE+GPS, Screw-down Case)
Dimensions	40.0 x 40.9 x 14.2mm (1.575 x 1.61 x 0.563 in.) (350mAh, Portable Case) 40.0 x 40.9 x 17.95mm (1.575 x 1.61 x 0.71 in.) (700mAh, Portable Case) 48.0 x 40.9 x 14.2mm (1.575 x 1.89 x 0.563 in.) (350mAh, Screw-down Case) 48.0 x 40.9 x 17.95mm (1.575 x 1.89 x 0.71 in.) (700mAh, Screw-down Case)
Weight	20 grams (0.70 oz) (350mAh option) 33 grams (1.16 oz) (700mAh options)
Supply voltage	+5v USB Type-C for power and charging
Battery technology	Rechargeable Lithium-Polymer
Battery lifetime[1]	TSS-DL3-HB-350: 5.5 to 10 hours TSS-DL3-HB-700: 11 to 20 hours TSS-DL3-HBG-700: 7.5 to 20 hours
Communication interfaces	High-Speed USB 2.0, BLE5.4 (Host: 4.0+, 5.2+ recommended)
Storage media	MicroSD card
Filter update rate[2]	up to 2000Hz with Kalman AHRS up to 2000Hz with QGRAD3™ AHRS up to 2000Hz in IMU mode
Orientation output	absolute & relative quaternion, Euler angles, axis angle, rotation matrix, two vector
Other output	corrected sensor data, normalized sensor data, temperature, pedestrian motion-path (longitude / latitude) offsets, heading (true, magnetic, grid north ref.)
Shock survivability	5000g
Temperature range	-40C ~ 85C (-40F ~ 185F)
Sensor	
Orientation range	360º about all axes
Orientation accuracy[3]	±1º for dynamic conditions & all orientations
Orientation resolution	<0.08º
Orientation repeatability	0.085º for all orientations
Accelerometer scale	Dual Accelerometer - Auto-Selecting ±2*g* / ±4*g* / ±8*g* / ±16*g* selectable for Accel1 ±32*g* / ±64*g* / ±128*g* / ±256*g* / ±320*g* selectable for Accel2
Accelerometer resolution	16-bit(Accel1), 16-bit(Accel2)
Accelerometer noise density	60µg/√Hz(Accel1), 1000µg/√Hz(Accel2)
Accelerometer sensitivity	0.0000610352g/digit-0.00048828g/digit (Accel1) 0.00097656g/digit-0.010417g/digit(Accel2)
Accelerometer temperature sensitivity	±0.01%/°C (-40°C to +85°C) (Accel1) ±0.01%/°C (-40°C to +85°C) (Accel2)
Gyro scale	±250/±500/±1000/±2000/±4000 º/sec selectable
Gyro resolution	16 bit
Gyro noise density	0.005º/sec/√Hz
Gyro bias stability @ 25°C	1.5º/hr average for all axes
Gyro sensitivity	0.008750º/sec/digit for ±250º/sec 0.140016º/sec/digit for ±4000º/sec
Gyro non-linearity	0.01% full-scale
Gyro temperature sensitivity	±0.007%/°C (-40°C to +85°C)
Magnetometer scale	±8.0 Ga
Magnetometer resolution	18-bit
Magnetometer sensitivity	0.06 mGa/digit
Magnetometer non-linearity	0.1% full-scale
GPS/GNSS Channels[4]	33 Tracking, 99 Acquisition, 210 PRN
GPS/GNSS Bands[4]	GPS/Gallileo L1 C/A, GLONASS L1 C/A, BD2 B1 C/A
GPS/GNSS Accuracy[4]	Position: <2.5m CEP, Velocity<0.1m/s, Acccel<0.1m/s^2, Timing≤10ns
GPS/GNSS TTFF[4]	Cold Start:<15s, Warm Start: <5s, Hot Start: <1s

1. Dependent upon logging frequency and performance settings.
2. Depends upon model, communication mode, and filter mode.
3. Average value when calibrated.
4. GPS/GNSS Available on TSS-DL3-HBG-700-v3.1 model.

Specifications are subject to change.
Version: 3.1.0

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