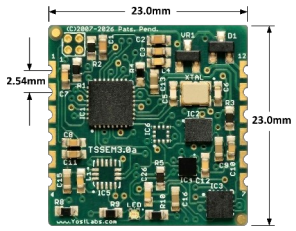
Technical Brief

Yost Labs 3-Space™ Sensor

Embedded TSS-EM3-v3.1 Series

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



Product Overview

The 3-SpaceTM Sensor Embedded EM3-v3.1 are a series of ultra-miniature, high-precision, high-reliability, 10-DOF SMT Attitude and Heading Reference System (AHRS) / Inertial Measurement Unit (IMU) devices which are available with two orderable auto-selecting accelerometer configuration options:

Part:	Accel1	Accel2
TSS-EM3-v3.1	±2g / ±4g / ±8g / ±16g	
TSS-EM3-H-v3.1	±2g / ±4g / ±8g / ±16g	±32g / ±64g / ±128g / ±256g / ±320g

All TSS-EM3 devices use triaxial gyroscope, auto-selecting accelerometers, magnetometers, and barometric pressure sensors in conjunction with patented advanced processing and on-board quaternion-based orientation filtering algorithms to determine orientation relative to an absolute or relative reference in real-time.

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.

The 3-Space™ Sensor Embedded module features are accessible via a well-documented open communication protocol that allows access to all available sensor data and configuration parameters. Versatile commands allow access to 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).

The 3-Space™ Sensor Embedded module also offers a range of communication interface options which include SPI, I2C, full-speed USB 2.0, and asynchronous serial.

Applications

- Robotics
- Positioning and stabilization
- Aeronautical and defense systems
- GPS-denied personnel / pedestrian navigation and tracking
- Unmanned air/land/water vehicle navigation
- Down-hole applications
- Sports performance analysis and healthcare monitoring
- Equipment monitoring and preventative maintenance
- Industrial motion and vibration analysis
- Education and performing arts
- Gaming and motion control
- Motion capture, virtual reality, and human interfaces

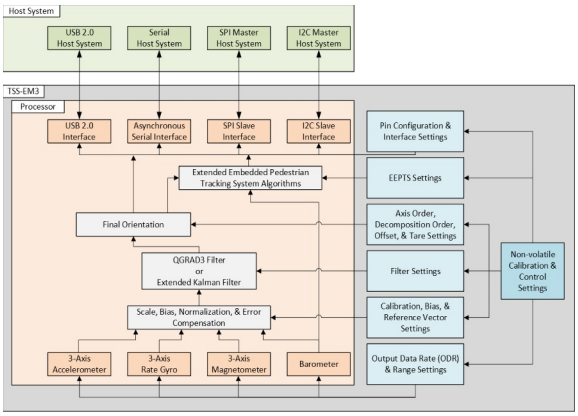
Key Features

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

- Ultra-small high-performance 10-DOF AHRS available at 23mm x 23mm x 1.95mm and only 1.3 grams
- Ultra-fast sensor update and filter rates of 2000Hz allow use in real-time applications, including stabilization, virtual reality, real-time immersive simulation, and dynamic robotics
- Highly customizable orientation sensing with 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.
- Auto-selecting accelerometer range options that handle acceleration ranges from ±2 to ±320G
- Robust open protocol allows commands to be sent in human readable form, or more quickly in machine readable binary
- Orientation output format available in absolute or relative terms in multiple formats (quaternion, rotation matrix, axis angle, two-vector)
- Absolute or custom reference axes
- Access to fully-calibrated or raw sensor data
- Flexible communication options: SPI, I2C, full-speed USB 2.0, or asynchronous serial
- USB communication through a virtual COM port
- Castellated SMT edge pads provide secure SMT mounting and allow optional through-hole mounting
- Upgradeable firmware
- RGB status LED
- Programmable interrupt capability
- 3-Space™ Sensor Suite application allows for quick experimentation and evaluation
- Python and C APIs available
- Development kit available (Part: TSS-EVK-EM)

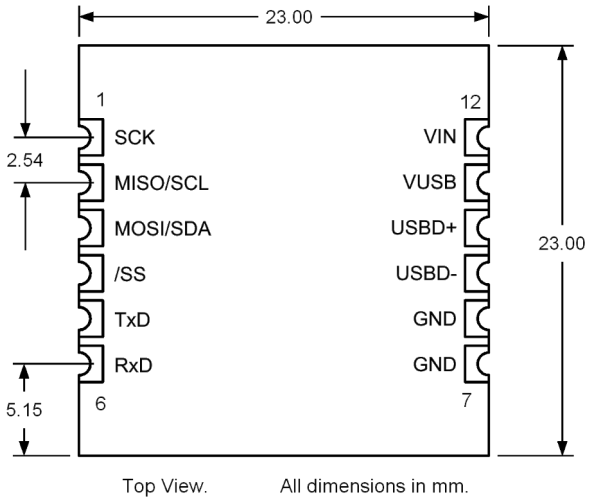
High-reliability MEMS technology combined with advanced processing and multiple quaternion-based filtering algorithms allows for accurate orientation outputs across a wide range of performance conditions.

Block Diagram



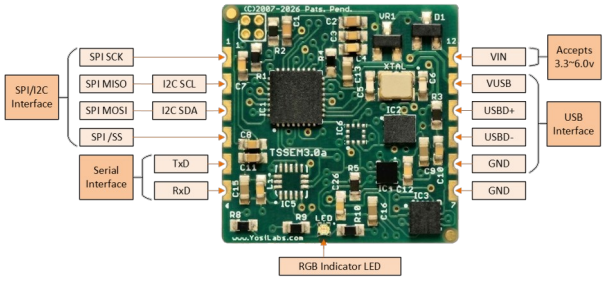
Dimensions / Pinout

TSS-EM3



Top View. All dimensions in mm.

Hardware / Pinout



Specifications

General	
Part numbers	TSS-EM3-v3.1 (Base Range Accel) TSS-EM3-H-v3.1 (Base+High Range Accel option)
Dimensions	23mm x 23mm x 1.95mm (0.9 x 0.9 x 0.0768 in.)
Weight	1.3 grams (0.0458 oz)
Supply voltage	+3.3v ~ +6.0v
Power consumption	Minimum: 10mA in low-power modes. Maximum: 55mA at full-performance
Communication interfaces	USB FS 2.0, SPI, I2C, Asynchronous Serial
Filter update rate[1]	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
SPI/I2C clock rate	SPI: 10 MHz max / I2C: 4 MHz max
Serial baud rate	4,800~4,000,000 selectable, default: 115,200
Shock survivability	5000*g*
Temperature range	-40C ~ 85C (-40F ~ 185F)
MSL Classification	Level 3 (168 hours ≤ 30°C / 60% RH)
Sensor	
Orientation range	360º about all axes
Orientation accuracy[2]	±1º for dynamic conditions & all orientations
Orientation resolution	<0.08º
Orientation repeatability	0.085º for all orientations
Accelerometer scale	Accelerometer Options - Auto-Selecting ±2*g* / ±4*g* / ±8*g* / ±16*g* selectable (Base range – all models) ±32*g* / ±64*g* / ±128*g* / ±256*g* / ±320*g* selectable (H option)
Accelerometer resolution	16-bit (Base – all models), 16-bit (H option)
Accelerometer noise density	60µg/√Hz(Base range – all models), 1000µg/√Hz(H option)
Accelerometer sensitivity	0.0000610352g/digit-0.00048828g/digit (Base - all models) 0.00097656g/digit-0.010417g/digit (H option accel)
Accelerometer temperature sensitivity	±0.01%/°C (-40°C to +85°C) (Base - all models) ±0.01%/°C (-40°C to +85°C) (H Option accel)
Gyro scale	±250/±500/±1000/±2000/±4000 °/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

1. Depends upon communication mode and filter mode.
2. Average value when calibrated.

Specifications are subject to change.
Version: 3.1.1

YOST LABS
630 Second Street
Portsmouth, Ohio 45662 USA

www.YostLabs.com
Phone: +1 (740) 876-4936
Email: information@yostlabs.com

©2017-2026 Yost Labs, Inc.