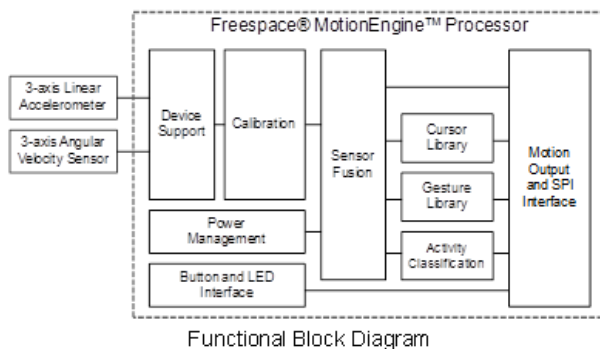


## Freespace® Sensor Module (FSM) with Serial Interface

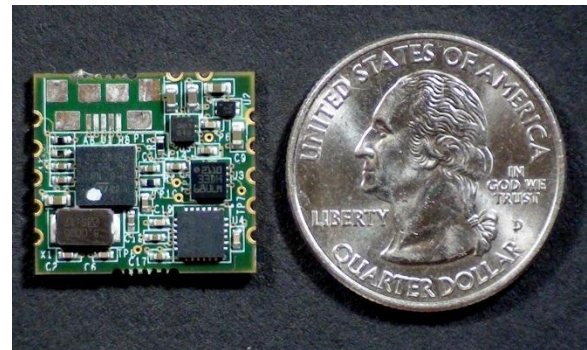
The FSM-SI-2 is a low cost, battery operable, thumbnail sized, fully calibrated Inertial Measurement Unit (IMU). The FSM provides a simple, highly cost effective solution for integrating accurate, multi-axis inertial sensing into a wide range of consumer and industrial applications, eliminating the complexity and investment associated with a discrete design. This compact module contains state of the art MEMS technology comprised of a tri-axial gyroscope, and a tri-axial accelerometer. Combining these sensors with the onboard Hillcrest Freespace MotionEngine™ Processor, the FSM-SI-2 provides precise real-time 3D orientation, calibrated acceleration, and calibrated angular position, as well as more advanced outputs such as cursor position and gesture recognition.

### Complete Inertial Motion Tracking System



- Tri-axial accelerometer and tri-axial gyroscope enable complete motion tracking
- Individually and dynamically calibrated for misalignment, temperature, and sensitivity
- Patented real time signal processing algorithms produces 6-axis sensor fusion via on board processor

### Compact Design



- Small form factor PCA module ideal for embedded application (0.68" x 0.75" x 0.11")
- Solder cups (castellations) enable integration into custom application for prototyping and production
- Communicates with an external system via a Serial Peripheral Interface (SPI)

### Sophisticated Power Management for Max Battery Life

- Multiple low-power sleep modes provide optimized power up speed
- Wake-on-Motion feature allows greater use of low power modes
- Activity state detection such as 'on-table' or 'in-hand' enables intelligent use of low power modes

### Flexible SDK

- Freespace MotionStudio - PC-based evaluation and configuration tool
- Libfreespace - Open source C I/O library with Java bindings
- In-field software upgradable - Allows ongoing performance tuning and cost effective support

### Extensive Data Modes

- Linear acceleration ( $\text{mm/s}^2$ )
- Angular velocity ( $\text{mrad/s}$ )
- Angular position (quaternion)
- Accurate, low-latency X-Y pointer data for cursor control applications

### Advanced Processing Options

- Adaptive tremor removal - Ensures smooth, steady motion when held in a human hand
- Orientation compensation – Compensates for tilt by translating motion from the FSM's frame of reference to the user's
- Button motion suppression – Minimizes inadvertent cursor movement caused by button and scroll events

## Potential Uses

### Vehicle Dynamics



Freespace® technology incorporated in the FSM-SI-2 facilitates a wide range of vehicle dynamics applications. Vehicle usage, braking, acceleration, forward and backward tilt, lane changes, cornering and swerving can be monitored and rated. Crash recording applications can utilize the FSM-SI-2 to act as a “black box”, providing vital data to fleet managers, insurance providers, vehicle manufacturers and law enforcement officials.

### Industrial Monitoring

Hillcrest's precision motion tracking and dynamic calibration are ideally suited to industrial monitoring applications. The motion trending performance of mechanical equipment can easily be monitored to determine maintenance needs well ahead of failure. The FSM-SI-2's advanced power saving features allow for applications where power is difficult to obtain. Dynamic temperature calibration ensures accurate monitoring in mobile, as well as stationary equipment.



### Home Medical Monitoring



Because of its compact size, advanced power saving features, and accurate motion tracking, the FSM-SI-2 is ideal for wearable medical monitors. The FSM-SI-2 provides simple interfaces for fall detection, orientation, activity, and sleep cycle tracking. Orientation compensation allows for proper monitoring whether the device is worn around the neck or kept in a pocket. 'Is-worn' detection lets caregivers know when the device is not in use.

### Sports & Fitness

Freespace® motion tracking allows athletes and fitness enthusiasts to be coached and trained by wearable devices small enough not to impede their movement. While in the gym, form and repetition count can be precisely monitored, and the patented tremor detection algorithms can track muscle fatigue. Dynamic calibration means the athlete never has to stop training to reset the device.



### Head Mounted Displays



The high sensitivity of the FSM-SI-2 enables precise pointer control from small movements, a necessity for military-grade Head Mounted Displays (HMD). From targeting applications to desktop applications, soldiers in the field require the best-in-class precision, power savings, and compact form of the FSM-SI-2.

### Virtual Reality

From 3D audio to totally immersive visual worlds, today's virtual reality applications are powered by Freespace® technology. The FSM-SI-2 meets gamers' demands for high precision and rapid response. And research teams worldwide are making use of the FSM-SI-2's highly-accurate motion tracking and flexible SDK.



Overall Performance	
Update Rate	125 Hz
Bandwidth (-3 dB point)	42 Hz
Pointer Performance	
Sensitivity	35 mickeys / °
Biased Angle Error	< 2° typical
Unbiased Angle Error	< 1° typical
Ripple	1 mickey typical
Hysteresis (>12°/s motion)	3%
Drift	< 100 mickeys / hr
Tremor Cancellation	70%
Linear Acceleration	
Range	± 2 g
Bias (zero-g offset)	< 20 mg typical
Sensitivity Accuracy	2%
Non-linearity (% full-scale)	3%
Resolution	< 5 mg
Angular Velocity	
Range	± 2000 °/s
Bias (zero-rate offset)	< 0.5 °/s
Sensitivity Accuracy	1%
Non-linearity (% full-scale)	0.2% typical
Resolution	0.06 °/s
Angular Position	
Range	Any orientation
Bias	< 5°
Resolution	< 0.3°

Physical Specifications	
Dimensions (length x width x height)	0.68" x 0.75" x 0.11" 17.3 x 19 x 2.8 mm
Weight	1.0 grams (0.035 oz)
Operating Temperature Range	0°C to 50°C
Storage Temperature Range	-30°C to 70°C
Supply Voltage	3.0 V
Supply Current @3.0V (active)	20 mA
Supply Current @3.0V (sleep)	0.10 mA

### System Integration

The FSM-SI-2 communicates with an external system via a Serial Peripheral Interface (SPI). The FSM runs Hillcrest Labs' HCOMM protocol over SPI. HCOMM is a message based protocol allowing the system to configure the module and receive calibrated motion data, fused sensor data or mouse data. Data is presented in HID like messages to allow simple integration with the host software.

### Additional Information

Product information, white papers, and tools are available at <http://www.hillcrestlabs.com>

Hillcrest Laboratories (a.k.a. Hillcrest Labs) sells products to enable a new class of motion and interactive applications. Hillcrest Labs offers its Freespace motion technology as a turnkey solution for motion sensing, motion control, and motion tracking applications including in-air pointing remote controls, motion-sensing game controllers, wireless presenters, mobile handsets, and gesture recognition systems. Freespace motion technology is also used in Hillcrest's Loop™ pointer, a direct-to-consumer in-air mouse for TV that lets users control an on-screen cursor with a flick of the wrist and navigate the Web or their home media content on TV. Hillcrest's products have received numerous awards and recognitions including two CES Innovations Awards, PC World's 100 Best Products and Greatest Tech Designs, ECN's Reader's Choice Tech, Popular Mechanics' Editors Choice, and others.

Hillcrest Labs has a worldwide portfolio of over 200 patents and patents pending including foundational patents for Freespace motion technology and the HōME® application creation platform. Freespace and HōME are registered trademarks of Hillcrest Laboratories, Inc. Loop pointer and the Hillcrest Labs logo are trademarks of Hillcrest Laboratories, Inc. All other trademarks and copyrights are the property of their respective owners.