

## Freespace® Reference Design with USB

Hillcrest Labs' patented Freespace motion solution interfaces with low-cost, commercially available MEMS accelerometers and gyroscopes to sense motion in three dimensions and precisely translate movements to control a cursor for use in pointing remote controls and computer peripherals. The solution also enables motion control and tracking for use in immersive video game systems, gestural interfaces and many more applications. This reference design contains the Freespace Sensor Module which includes the Freespace MotionEngine and microprocessor together with MEMS inertial sensors in a complete six-axis motion control solution configuration. In addition to a standard micro-B USB connector, the module includes solder cups that allow installation directly into prototypes and products.

### Core Motion Sensing Features

- Produces accurate, low-latency X-Y pointer data for use by a host to control cursor motion
- Produces linear acceleration ( $\text{mm/s}^2$ ) and angular velocity ( $\text{mrad/s}$ )
- Produces angular position (quaternion)
- Provides six-axis sensor configuration
- Includes an embedded processor

### Advanced Motion Processing Features

- Orientation compensation – Compensates for tilt by translating motion from the body frame of reference to the user frame of reference
- Button motion suppression – Compensates for inadvertent movement caused by button and scroll events
- Adaptive tremor removal – Cancels the effects of unintended motion caused by user tremor
- Power management – Performs wake-on-motion and on-table detection

### USB Host Interface Features

- Includes USB interface with micro-B USB connector (cable not included)
- Produces HCOMM (Hillcrest Communication Protocol) USB HID report
- Appears as a standard USB HID mouse

### SPI Host Interface Features

- Implements the HCOMM-SPI slave interface
- Implements the HCOMM LCP service
- Produces HCOMM HID reports

### User Interface Features

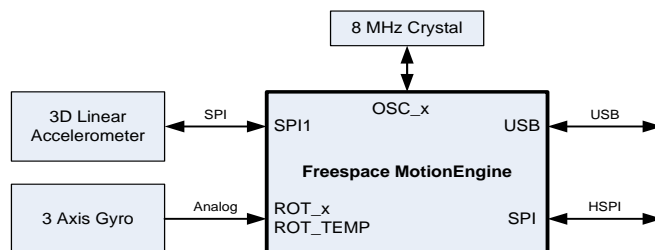
- Includes 2 mouse button inputs (left and right)
- Includes 2 GPIO (LED) outputs

### General Features

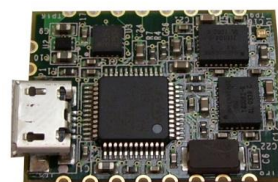
- Small form factor PCA module
- Solder cups enable integration into custom application for prototyping and production
- Powered by USB or custom application
- Intelligent, automatic power management
- Host interface selectable at reset
- Device firmware upgradeable through USB
- Supported by Hillcrest's Freespace MotionStudio
- Supported by Hillcrest's libfreespace open source library

### Applications

- TV remote controls
- Game Controllers
- Computer mice
- Wireless presenter
- Mobile handsets
- Head trackers
- Virtual reality systems
- Robotics



Module Block Diagram



Freespace Sensor Module

General Specifications	Value
Dimensions (length x width x height)	1.0" x 0.75" x 0.16" 25.4 x 19 x 4 mm
Weight	1.8 grams (0.064 oz)
Operating Temperature Range	0°C to 50°C
Storage Temperature Range	-30°C to 70°C
Latency (motion to HID report)	10 milliseconds
Supply Voltage	3.0 V to 5.5 V
Supply Current @5.0V (active)	21.5 mA (USB)
Supply Current @5.0V (sleep)	8.3 mA (USB)
Supply Current @3.0V (active)	19.6 mA (SPI)
Supply Current @3.0V (sleep)	0.10 mA (SPI)

Performance Specifications	Value
<b>Overall</b>	
Update Rate	125 Hz
Bandwidth (-3 dB point)	40 Hz
<b>Pointer</b>	
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%
<b>Linear Acceleration</b>	
Range	± 2 g
Bias (zero-g offset)	< 100 mg
Sensitivity Accuracy	2%
Non-linearity (% full-scale)	3%
Resolution	< 5 mg
<b>Angular Velocity</b>	
Range	± 500 °/s
Bias (zero-rate offset)	< 0.5 °/s
Sensitivity Accuracy	3%
Non-linearity (% full-scale)	1%
Resolution	0.5 °/s
<b>Angular Position</b>	
Range	Any orientation
Bias	< 5°
Resolution	< 0.3°

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.

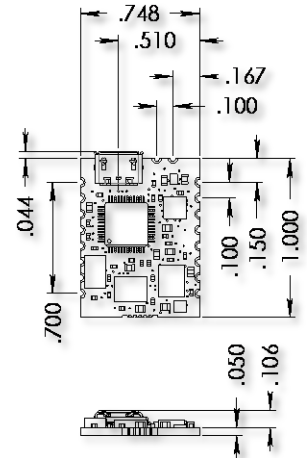
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## Host System

The FSRK-USB-1 contains a USB HID device that works with any host that supports a traditional 2D mouse. Plug the FSRK-USB-1 into an available USB slot, and the module in the FSRK-USB-1 will control the cursor. The module can also be connected to the host system through SPI.

## Module

The FSRK-USB-1 includes the printed circuit assembly module. The module can be embedded in a custom prototype to demonstrate Freespace motion sensing with any USB host system. The module supports all features of the processor including 2 buttons and 2 LEDs. Solder cups on the module allow access to the processor signals. See the detailed engineering documents.



## Additional Information

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

## Patent Protection

Hillcrest Labs has a worldwide portfolio of over 200 patents and patents pending including foundational patents for Freespace motion technology and the HöME® application creation platform.

This product is a reference kit intended only for evaluation in a research and development environment, not for use in a residential environment. It has not been tested for compliance with FCC or CE EMC regulations regarding interference with radio frequency energy. It might cause harmful interference with radio communications. The user assumes responsibility for any interference caused by this device.