Taking Advantage of a Certified Platform

Microsoft's Windows® 8 Sensor Interface

freescale™

Windows 8 Compatible

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In addition to simplifying system design and reducing time to market, a certified platform provides low power consumption capabilities and ease of updating.

1. Introduction

With its standardized approach to a sensor interface for the Windows 8 operating system (OS), Microsoft has provided designers the means to quickly and easily develop smarter, more accurate portable devices. However, utilizing the full capability of the interface standard, especially for more complex processes such as high-level sensor fusion, still poses significant challenges. A certified platform such as the 12-axis approach designed by Freescale Semiconductor's hardware and software experts simplifies the system designer's task even further. This white paper discusses the standardized interface, technical issues associated with sensor integration in Windows 8, and the advantages of using a certified platform for designing innovative portable computing products.

Microsoft's **Windows Sensor and Location platform** for the Windows 8 OS provides a standardized approach to implementing sensor technology which users have come to expect in tablets, slates, laptops and other mobile devices. Market research firms, such as Yole Développement, expect the **annual demand** for micro-electromechanical system (MEMS) motion sensors for mobile phones and tablets to grow from slightly less than 1.5 billion units in 2011 to over 4 billion units by 2017. Combination inertial sensors that include 3-axis accelerometers, gyroscopes and/or magnetometers could provide the basis for cost reduction and as much as 40 percent of the value for the consumer market **according to Yole Développement**.

Microsoft's standardized interface specifies both physical interface and communications protocols. The standard hardware (HW) interface allows original equipment manufacturers (OEMs) and independent hardware vendors (IHVs) to create and own anything below this layer. However, all vendors must comply with the same communication protocols.

Unlike Google's **Android™** platform that specifies the physical interface and framework for sensors, Microsoft has defined both a physical interface and a communications protocol for conveying the results of sensor fusion to the OS. The physical interfaces are either USB or I^2C. The communications protocol is the human interface device (HID). Through this partitioning, Microsoft has greatly increased the likelihood that sensor fusion is performed on a logical subsystem. The partitioning provides PC manufacturers options regarding how they implement their sensor subsystems. These options can significantly impact power consumption, product performance, and ultimately, the user experience.

For the first time, Microsoft has mandated that portable mobile computing products must have an accelerometer, gyroscope and magnetometer. Though a sensor interface was defined in previous Windows products, it was a secondary consideration. Now, sensing is a primary feature. As a result, in portable computing systems, Windows 8 has upgraded sensors from optional to mandatory.

A Certified Platform Solution

As a leading supplier of MEMS sensors and embedded MCUs, Freescale was among the first to certify a reference design that conforms to the Windows 8 sensor interface requirements. The **12-axis Xtrinsic Sensor Reference Platform for Windows 8** provides sensor data collection, computational capability and host interface functionality for sensor fusion aligned to the Windows 8 specification.

The HID over USB solution implements algorithms on an external MCU. The application advantages of MCU-based sensor hub instead of a PC-based approach include the ability to offload computations from the host processor to lower system power consumption and reduce system interrupts for higher throughput.

While some system designers consider a traditional PC-driver approach acceptable because of their familiarity with this approach and, if power consumption is not an issue, it may appear to be more cost effective to let the PC's processor perform sensor fusion directly. However, the advantages of

12-Axis Xtrinsic Sensor Platform for Windows® 8

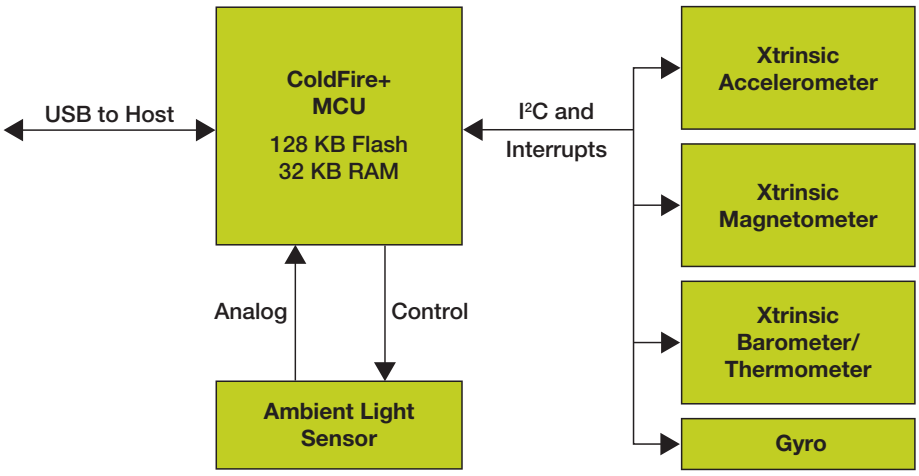

Figure 1. Block diagram of certified 12-axis platform solution for Windows 8.

an embedded system design normally favor system designers seeking to minimize power consumption and offload the computations performed by the main processor. This is because the primary computing system power consumption can be hundreds or even 1000 times higher than the embedded MCU.

The sensor platform design includes a 3-axis accelerometer, 3-axis magnetometer, precision altimeter pressure and temperature sensor, an analog ambient light sensor and selection of compatible gyroscopes. Figure 1 shows a high-level block diagram for this design. While this appears rather straightforward, as is often said, the devil is in the details.

The platform takes the strengths of the individual sensors into consideration to synthesize data such as motion, orientation and ambient light at the subsystem level. This results in more accurate, reliable and sensitive device performance.

In addition to dynamically trimming and calibrating the outputs, the platform provides sensor fusion of the 3-axis inertial measurements unit (IMU)—the accelerometer, magnetometer and gyroscope beyond that required by the Windows 8 specification. Figure 2 shows the inputs and outputs for a full motion/orientation 12-axis sensor fusion capable of implementation of Windows 8 motion and orientation sensing.

Certification Difficulties and Lessons Learned

To verify conformance to the Windows 8 sensor interface specification, Microsoft established a regression suite for HID over USB implementations within the **Windows Hardware Certification Kit (WHCK)**. The Freescale Windows 8 reference design has passed the regression suite, but not before engineers resolved a few specification issues. Problems were discovered in the Microsoft tests as they were being performed on this design and subsequently Microsoft made several changes based on these inputs.

Freescale's involvement helped Microsoft to revise requirements to make them applicable to a broad range of suppliers and, subsequently, Freescale was among the first suppliers to **certify a 12-axis design.** Figure 3 shows the reference design platform that is available as the result of these efforts.

With first-hand experience in dealing with sensor fusion and Windows integration issues including the HID protocol itself, Freescale engineers went beyond the Windows 8 requirements to deliver additional application-specific, high-level sensor fusion and power

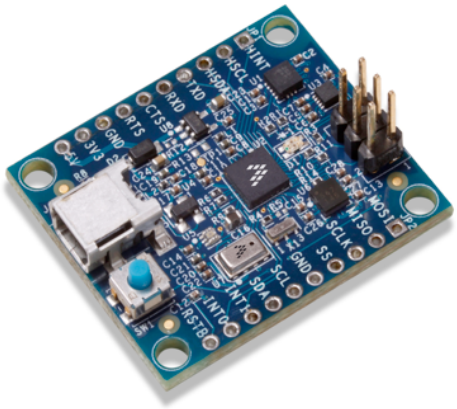

Figure 3. The 12-axis sensor fusion development board. (Note: More recent versions may be slightly larger.)

12-Axis Xtrinsic Sensor Data Flow for Windows® 8

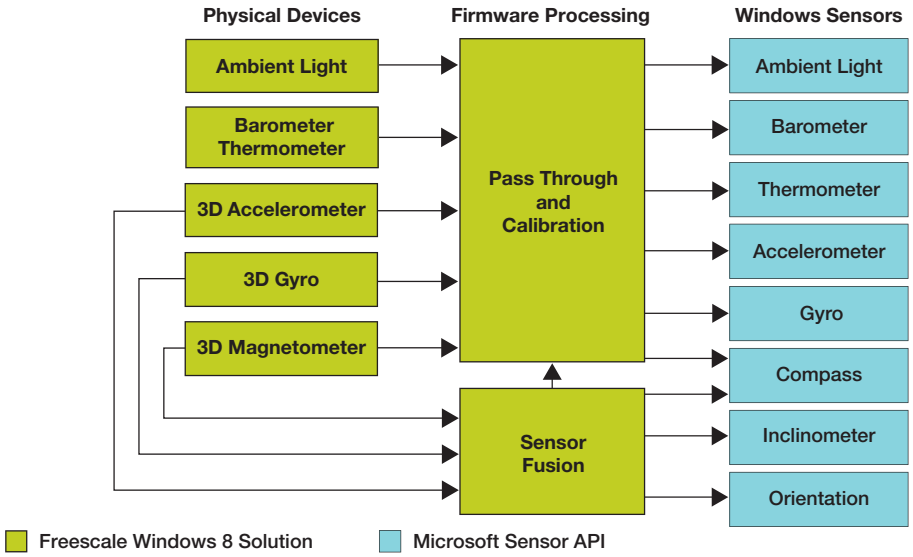

Figure 2. Data flow diagram for 12-axis sensor fusion.

Tablet Connected to Freescale's Sensor Reference Platform

Figure 4. The display/user interface for the gyroscope and magnetometer in the sensor reference platform on a tablet running Microsoft Windows 8.

management for lowering power consumption in their platform. As a result, they feel confident they can offer users a truly useful design tool.

The development of the sensor fusion and the Windows 8 integration obviously simplifies and reduces time to market for users who can avoid dealing with many time-consuming issues that have already been addressed.

In addition, there are minimal issues involved with using this platform because no additional drivers are required. Since Windows 8 comes with an inbox driver, by adhering to the HID over USB spec, the plug-n-play analogy and ease of use is extended to sensors. Users simply connect the reference design platform and it works.

User Implementation

Using a reference design within a user's design is quite easy from a hardware design perspective. System designers simply drop the provided schematics (Gerber files) into their printed circuit board (PCB) design and connect power and ground. However, flexibility was a major consideration in the reference design, so it is easily configurable.

The system has designed-in capability to change the PCB orientation and rotate the physical device layout by 90 degrees if required. If OEMs follow the same orientation as the reference design, no changes are necessary. If they require a different orientation, the reference design can accommodate those changes.

To build the manufacturing file for configurability, platform designers considered several different users' configuration issues.

Customization examples of changes confined to manufacturing file in the sensor platform.

- Three-axis sensor device orientation (accelerometer, magnetometer, gyroscope)
- MCU package selection
- Peripheral instance selection (I^2C0 vs. I^2C1, UART0 vs. UART1) and baud rate
- Pin configurations (MUX, pull-up resistors, direction)
- Pin connections (i.e., accelerometer interrupt attached to MCU pin 42)
- Logging detail (print debug statements for accelerometer, USB, fusion, etc.)

One of the features built into the reference design is the ability to perform in-field updates. This makes it easy for OEMs to upgrade the firmware similar to updating a driver on a PC. To do this, the design conforms to the standard **USB device firmware upgrade (DFU)** part of USB specification. Conformance to the Windows 8 and USB specification standards allows easy implementation of firmware updates. The USB DFU bootloader in the MCU in the platform requires only a PC and a USB cable. Figure 5 shows the functional blocks of the USB DFU bootloader architecture. Figure 6 shows a flow chart showing the use of the firmware updater and the basic flow of revised information/data to the embedded MCU.

Conformance to the Windows 8 specification makes the user's implementation quite easy.

USB DFU Bootloader Architecture

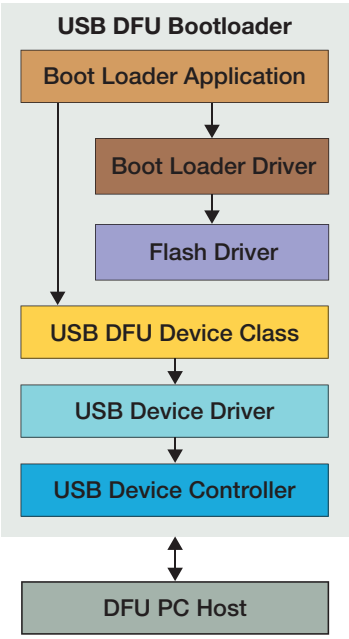

Figure 5. USB DFU bootloader architecture in the 12-axis sensor platform.

Programming Flow Chart

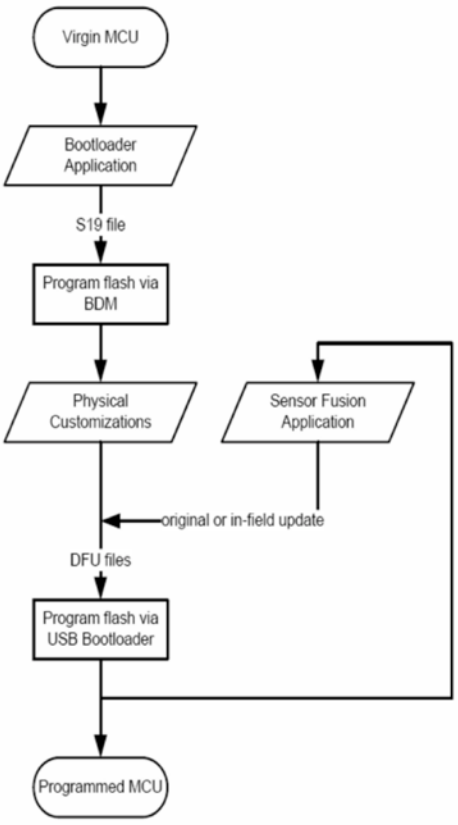

Figure 6. Simplified programming flow on Windows 8 with the 12-axis sensor platform.

Success has been demonstrated when people not involved with the development who have simply plugged the design into a Windows 8 computer and used it. Convertible PCs utilizing this solution are already on the market.

Future Improvements

The timely availability of a certified 12-axis platform solution for Windows 8 further demonstrates Freescale's commitment to sensor-based solutions in mobile computing devices. Ongoing developments that are not included in the Microsoft specification will impact systems and system aspects that have not been addressed as well as provide even greater power-saving techniques for targeted applications.

An example is the additional effort required for swivel-hinge convertible PCs, where the back becomes front and front becomes the back. This changes the sensor configuration. As indicated in Microsoft's white paper **"Integrating Motion and Orientation Sensors,"** swivel-hinge PCs require adjustments to fusion outputs in the slate mode beyond the motion detection and device orientation in slate PCs with detachable keyboards and tablets, slide-out keyboard and convertible flipper PCs.

In addition, changes that will further reduce power consumption for the system by taking advantage of the hardware and software capabilities of the MCU-based sensor hub are among the future improvements that are being investigated. The Microsoft specification has allowed these options but not defined how they are accomplished. Freescale is actively seeking the answers.

Conclusion: Simply Plug It In

Microsoft's standardized Windows Sensor and Location platform for Windows 8 has taken the application of sensors in portable computing to a higher level. While this has simplified many of the application issues, there are still many challenges that system designers face if they want to develop their approach from a clean sheet of paper.

In contrast, with its considerable and unique expertise in MCUs, sensors, software, power management and system solutions, Freescale's certified 12-axis platform solution for Windows 8 essentially solves all these challenges. The reference design, user guides and other materials allow users to take advantage of this expertise to expedite their design-in process. Through this approach, the complex integration issues and conformance testing issues are eliminated from the user's design cycle.

The certified 12-axis platform provides a demonstrated plug-and-play design tool. Recognizing the system-level benefits from using this architecture, major manufacturers have integrated this solution into their next-generation Windows 8 OS-based ultra books and hybrid PCs.

References

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Supporting Sensors in Windows 8 Blog by Steven Sinofsky at Microsoft

Freescale 12-axis Xtrinsic Sensor Platform Certified for Windows® 8 Sensor Fusion Requirements Press Release

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Microsoft Dev Center for Windows, Devices, Sensors

Microsoft Windows Sensor and Location Platform

Microsoft Dev Center for Accelerometers

Microsoft Dev Center for Integrating Motion and Orientation Sensors

The growth of the MEMS Market - SEMI Networking Day Italy, 20 Sept 2012

MEMS: Inertial Combo Sensors for Consumer and Automotive

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