HID Report Definitions

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1 Introduction

1.1 Intended Audience

This document is intended for engineers involved with the evaluation, design, and implementation of products using Freespace® motion control.

1.2 Scope

This document describes the format of USB Human Interface Device (HID) messages supported by the Freespace® system. The format of these messages complies with Reference 1 and Reference 2.

1.3 Revision History

Edition	Date	Description
1.0	04/03/2009	Release for FSRK 3.1 and firmware 1.0.0

Figure 1: Revision History

1.4 HID In Reports

This section covers HID reports that are sent from a Freespace system to a USB host. When sending reports, reserved bits must be set to 0. When receiving report, reserved bits must be ignored.

1.4.1 Mouse Movement Report

This report implements a HID Mouse with 8 buttons and a scroll wheel. The mouse report conforms to the HID boot protocol format. No report ID is used because it has its own USB interface.

Delta X and Delta Y return changes in pointer location in dimensionless units called mickeys. X positive moves the pointer right and Y positive moves the cursor down. Delta Wheel returns scroll wheel motion in detents (up is positive).

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Button 8	Button 7	Button 6	Button 5	Button 4	Button 3	Button 2	Button 1
1	Delta X							
2	Delta Y							
3	Delta Wheel							

Figure 2: Mouse Movement Report

1.4.2 Consumer Page Report (ID 3)

The consumer page report indicates buttons that operate a consumer electronics product. The Usage ID is a 12-bit field that carries a consumer page usage code. Refer to the Consumer Page (0x0C) section of Reference 2 for more information. The Numeric Key Pad field indicates keypad numbers 0 to 9. The Function Buttons field indicates up to 255 different functions.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 3							
1	Usage ID (bits 7-0)							
2	Numeric Key Pad				Usage ID (bits 11-8)			
3	Function Buttons							

Figure 3: Consumer Page Report

1.4.3 Keyboard Report (ID 4)

The keyboard report indicates buttons from a computer keyboard or keypad. Refer to the Keyboard/Keypad Page (0x07) section of Reference 2 for more information. This report carries one key press plus 8 modifier bits for keys such as Control and Shift.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 4							
1	RGui	RAlt	RShift	RCtrl	LGui	LAlt	LShift	LCtrl
2	Reserved							
3	Key ID							

Figure 4: Keyboard Report

1.4.4 Coprocessor Pass-through In Report (ID 6)

Report ID 6 is reserved for passing messages through from the Freespace® coprocessor interface to the USB host.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 6							
1	Payload length							
2-15	14 bytes of payload							

Figure 5: Coprocessor Pass-through In Report

1.4.5 Vendor-defined Generic In Report (ID 8)

Report ID 8 is reserved for proprietary diagnostics, testing, and debugging use. The report contains a message Sub ID. All Sub ID values are reserved with the exception of those described in this section.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 8							
1	Message Sub ID							
2-26	25 bytes of payload							

Figure 6: Vendor-defined Generic In Report

1.4.5.1 Generic In Pairing Response (Sub ID 13)

Sub ID 13 is used to either respond to pairing requests from the host or to send pairing status updates to the host that describe events during the pairing process.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 8							
1	Sub ID (13)							
2	Reserved					Success	Auto-pairing	Pairing
3-26	Reserved							

Figure 7: Generic In Pairing Response Report

Pairing: 0 - not pairing
1 - pairing
Auto-pairing: 0 - dongle is not auto-pairing
1 - dongle is in auto-pairing
Success: 0 - pairing was either not successful (Pairing == 0) or has not yet completed (Pairing == 1)
1 - pairing was successful; will not see if Pairing == 1

1.4.6 Battery Level (ID 10)

The Battery Level report indicates the battery strength of the handheld unit. This is reported as percentage of the operating voltage range (0 to 100%).

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 10							
1	Battery Strength (0 – 100)							
2	Reserved							
3	Reserved							

Figure 8: Battery Level Report

1.4.7 Body Frame Motion (ID 32)

This report conveys the motion relative to the body frame of the Freespace® handheld device.

The Sequence Number is a monotonically increasing integer generated by the Freespace® sensor board at a nominal rate of 125 Hz. The Sequence Number can be used to correlate the body frame messages with the user frame messages. Sequence gaps are normal and could be due to these reasons:

- Sensor board power management
- Button motion suppression
- RF packet loss

Linear Acceleration is reported in millimeters / second². X positive is forward, Y positive is to the right, and Z positive is down with respect to the handheld device frame of reference.

Angular Velocity is reported in milliradians / second. X positive is tilt right (roll), Y positive is tilt up (pitch), and Z positive is turn right (yaw), with respect to the handheld device frame of reference.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 32							
1	Button8	Button7	Button6	Button5	Button4	Button3	Button2	Button1
2	Pointer Delta X							
3	Pointer Delta Y							
4	Delta Wheel							
5	Sequence Number (bits 7-0)							
6	Sequence Number (bits 15-8)							
7	Sequence Number (bits 23-16)							
8	Sequence Number (bits 31-24)							
9	Linear Acceleration X (bits 7-0)							
10	Linear Acceleration X (bits 15-8)							
11	Linear Acceleration Y (bits 7-0)							
12	Linear Acceleration Y (bits 15-8)							
13	Linear Acceleration Z (bits 7-0)							
14	Linear Acceleration Z (bits 15-8)							
15	Angular Velocity X (bits 7-0)							
16	Angular Velocity X (bits 15-8)							
17	Angular Velocity Y (bits 7-0)							
18	Angular Velocity Y (bits 15-8)							
19	Angular Velocity Z (bits 7-0)							
20	Angular Velocity Z (bits 15-8)							

Figure 9: Body Frame Motion Report

1.4.8 User Frame Motion (ID 33)

This report conveys the handheld device position and orientation with respect to a user frame of reference. The gravity acceleration vector points up along the negative Z axis.

The Sequence Number is a monotonically increasing integer generated by the Freespace® sensor board at a nominal rate of 125 Hz. The Sequence Number can be used to correlate the user frame messages with the body frame messages. Sequence gaps are normal and could be due to these reasons:

- Sensor board power management
- Button motion suppression
- RF packet loss

Linear Position is in units of millimeters. X positive is right, Y positive is near, and Z positive is down, with respect to the user frame of reference.

Angular Position is in dimensionless units scaled by 2^{14}. The axes are given in quaternion form where A, B, C, D represent the real, i, j, and k coefficients.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 33							
1	Button8	Button7	Button6	Button5	Button4	Button3	Button2	Button1
2	Pointer Delta X							
3	Pointer Delta Y							
4	Delta Wheel							
5	Sequence Number (bits 7-0)							
6	Sequence Number (bits 15-8)							
7	Sequence Number (bits 23-16)							
8	Sequence Number (bits 31-24)							
9	Linear Position X (bits 7-0)							
10	Linear Position X (bits 15-8)							
11	Linear Position Y (bits 7-0)							
12	Linear Position Y (bits 15-8)							
13	Linear Position Z (bits 7-0)							
14	Linear Position Z (bits 15-8)							
15	Angular Position A (bits 7-0)							
16	Angular Position A (bits 15-8)							
17	Angular Position B (bits 7-0)							
18	Angular Position B (bits 15-8)							
19	Angular Position C (bits 7-0)							
20	Angular Position C (bits 15-8)							
21	Angular Position D (bits 7-0)							
22	Angular Position D (bits 15-8)							

Figure 10: User Frame Motion Report

1.5 HID Out Reports

This section describes the HID reports that are sent from the USB host to the Freespace® system. Bits marked as “Reserved” must be set to zero.

1.5.1 Coprocessor Pass-through Out Report (ID 5)

Report ID 5 is used for passing messages through from the USB host to the Freespace coprocessor interface.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 5							
1	Payload length							
2-15	14 bytes of payload							

Figure 11: Coprocessor Pass-through Out Report

1.5.2 Vendor-defined Generic Out Report (ID 7)

This report is used for proprietary configuration, diagnostics, testing, and debugging commands sent from the USB host to the Freespace system. All Sub ID values are reserved with the exception of those described in this section.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 7							
1	Message Sub ID							
2-7	6 bytes of payload							

Figure 12: Vendor-defined Generic Out Report

1.5.2.1 Generic Out Pairing (Sub ID 13)

The generic out report with Sub ID 13 is used by the host to put the dongle into RF pairing mode.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID(7)							
1	Sub ID (13)							
2-7	Reserved							

Figure 13: Generic Out Pairing Report

1.5.3 Battery Level Request (ID 9)

The Battery Level Request report is sent by the host to request the battery status of the handheld unit.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 9							
1	Reserved							

Figure 14: Battery Level Request Report

1.5.4 Vendor-defined Extended Out (ID 15)

The Extended Out report is used for sending vendor-specific messages that are too long for a generic out report (ID 7). The message Sub ID in byte 1 defines the usage. This report is used for diagnostics, debugging, and testing. This report is reserved for Hillcrest use only. Sending messages of this type produces undefined behavior.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 15							
1	Message Sub ID							
2-30	29 bytes of payload							

Figure 15: Vendor-defined Extended Out Report

1.5.5 Freespace® Data Mode Control (ID 34)

This report controls generation of the Freespace motion reports.

	Bit							
Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	Report ID = 34							
1	Reserved		Reserved	Disable Freespace	Enable Mouse Movement	Inhibit Power Manager	Enable User Frame Motion	Enable Body Frame Motion
2	Reserved							
3	Reserved							
4	Reserved							

Figure 16: Freespace Data Mode Control Report

Enable Body Frame Motion:

0 – disable Body Frame Motion Reports

1 – enable Body Frame Motion Reports

Enable User Frame Motion:

0 – disable User Frame Motion Reports

1 – enable User Frame Motion Reports

Inhibit Power Manager:

0 – enable the wake on motion power management feature

1 – disable the wake on motion power management feature. Overrides the Disable Freespace bit and enables the Freespace® motion sensing system.

Enable Mouse Movement:

0 – disable Mouse Movement Reports

1 – enable Mouse Movement Reports

Disable Freespace:

0 – enable the Freespace motion sensing system.

1 – disable the Freespace motion sensing system if Inhibit Power Manager == 0. No motion reports are sent regardless of the value of the Enable Body Frame Motion, Enable User Frame Motion or Enable Mouse Movement bits.

Default configuration: 0x08.

1.6 Usages

The Hillcrest USB report descriptor supports multiple top-level usages. This table associates the report IDs to the HID application usages.

Usage Page		Usage		Reports	
Description	**ID**	**Description**	**ID**	**Name**	**ID**
Generic Desktop	0x01	Mouse	0x02	Mouse Movement	None
Consumer Devices	0x0C	Consumer Control	0x01	Consumer Control	3
Generic Desktop	0x01	Keyboard	0x06	Keyboard	4
Vendor-defined	0xFF01	Vendor usage	0x04	Pass-through Out Pass-through In Generic Out Generic In Battery Out Battery In Extended Out	5 6 7 8 9 10 15
Generic Desktop	0x01	Multi-axis Controller	0x08	Body Frame Motion User Frame Motion Data Mode Control	32 33 34

Figure 17: HID Usage to Report ID Map

1.7 USB Interfaces

A Hillcrest HID device is a USB composite device with multiple interfaces. Different interfaces are used for different input functions, as shown in Figure 18.

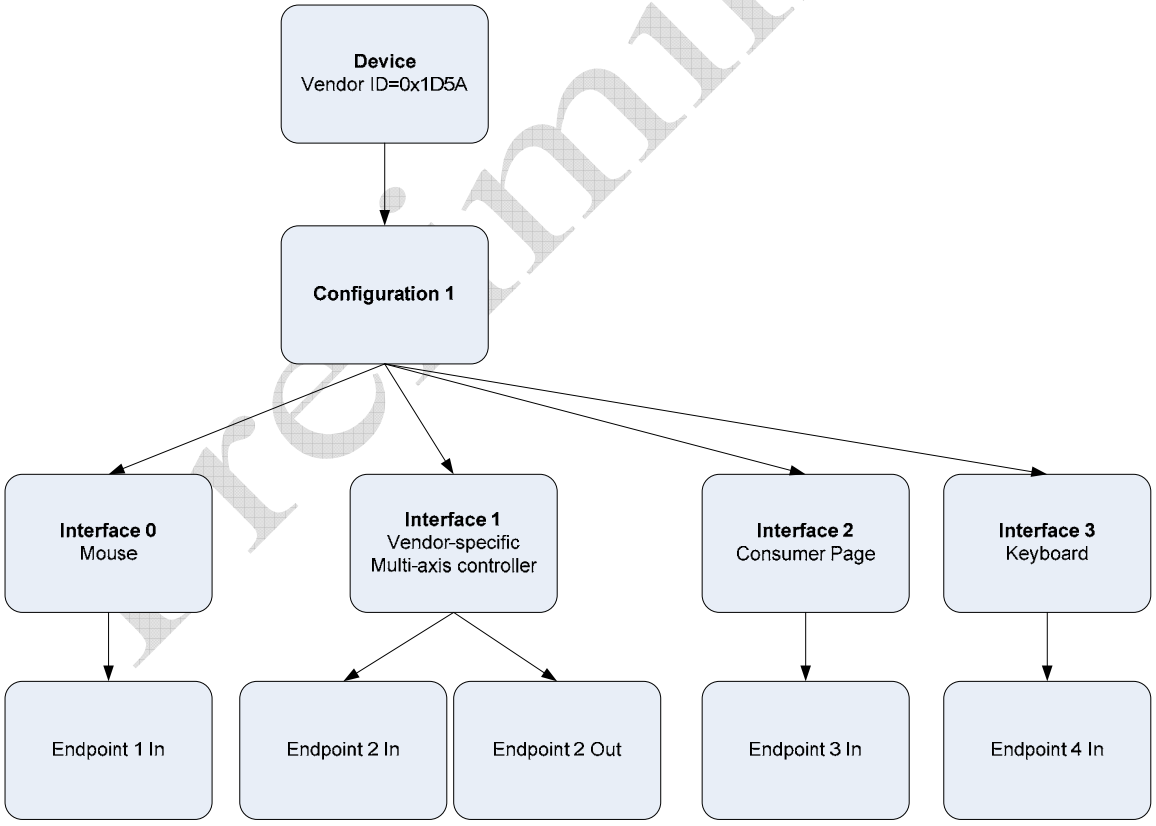

Figure 18: HID Interface and Descriptor Structure

2 References

1. USB Device Class Definition for Human Interface Devices (HID) Version 1.11: http://www.usb.org/developers/devclass_docs/HID1_11.pdf.
2. USB HID Usage Tables Version 1.12: http://www.usb.org/developers/devclass_docs/Hut1_12.pdf.

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