AN993: BLUETOOTH HID PROFILE

iWRAP APPLICATION NOTE

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Version 1.11

SILICON LABS

VERSION HISTORY

Version	Comment
1.0	First version
1.1	iWRAP4 updates
1.2	Minor changes
1.3	Consumer page descriptions added
1.4	Multimedia key examples added
1.5	Complete revamp for iWRAP5
1.6	Restructured example descriptors
1.7	Improved examples
1.8	Updated Known issues chapter for iWRAP 5.0.2
1.9	Divided Known issues chapter for iWRAP 5.0.1 and 5.0.2
1.10	Added chapter: Receiving HID control requests Updated chapter: Sending and receiving HID reports
1.11	Updated contact information and chapter 2

Contents

1 Introduction

This application note discusses Bluetooth Human Interface Device (HID) Profile its advantages and how this profiles can be utilized. Also practical examples are given how the HID is used with the iWRAP firmware.

1.1 Human Interface Device Profile

The HID profile defines the protocols, procedures and features to be used by Bluetooth HID such as keyboards, pointing devices, gaming devices and remote monitoring devices.

The HID defines two roles, that of a Human Interface Device (HID) and a Host:

- Human Interface Device (HID) – The device providing the service of human data input and output to and from the host.
- Host – The device using or requesting the services of a Human Interface Device.

The HID profile uses the universal serial bus (USB) definition of a HID device in order to leverage the existing class drivers for USB HID devices. The HID profile describes how to use the USB HID protocol to discover a HID class device's feature set and how a Bluetooth enabled device can support HID services using the L2CAP layer. The HID profile is designed to enable initialization and control self-describing devices as well as provide a low latency link with low power requirements.

The Bluetooth HID profile is built upon the Generic Access Profile (GAP), specified in the Bluetooth Profiles Document; see Referenced Documents [1]. In order to provide the simplest possible implementation, the HID protocol runs natively on L2CAP and does not reuse Bluetooth protocols other than the Service Discovery Protocol.

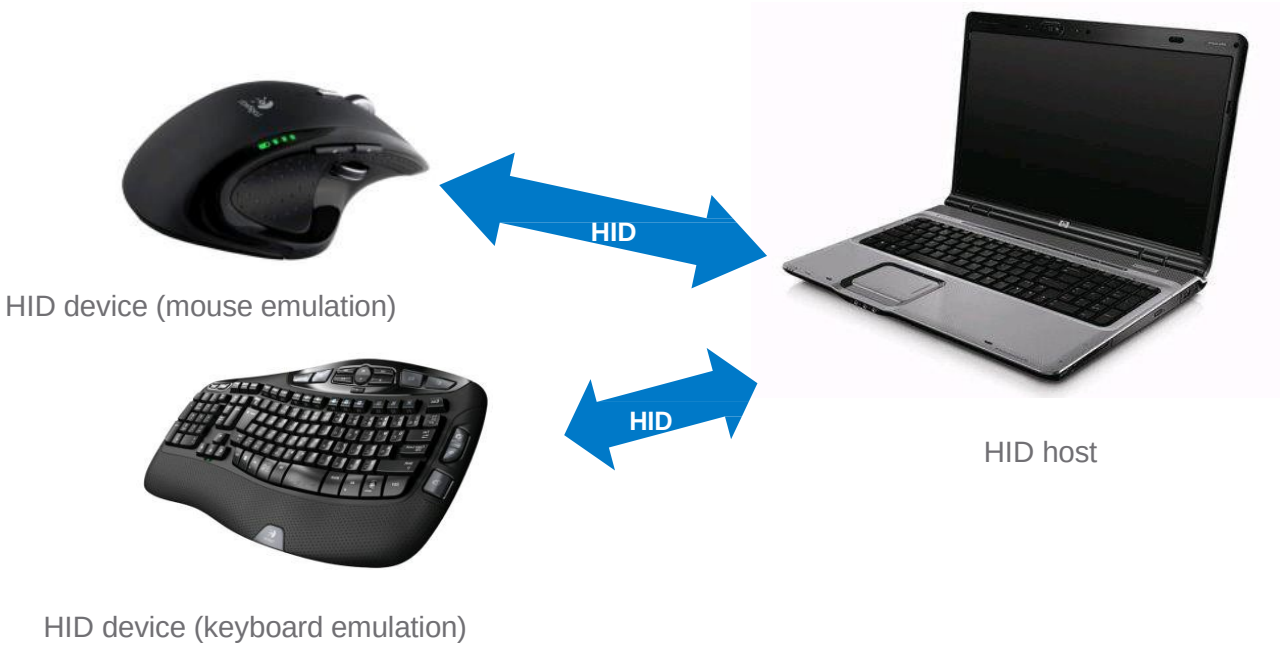


Figure 1: Typical HID use case

2 iWRAP firmware overview

iWRAP is an embedded firmware running entirely on the RISC processor of WT11, WT12, WT32(i) and WT41 modules. It implements the full *Bluetooth* protocol stack and many *Bluetooth* profiles as well. All software layers, including application software, run on the internal RISC processor in a protected user software execution environment known as a Virtual Machine (VM).

The host system can interface to iWRAP firmware through one or more physical interfaces, which are also shown in the figure below. The most common interfacing is done through the UART interface by using the ASCII commands that iWRAP firmware supports. With these ASCII commands, the host can access *Bluetooth* functionality without paying any attention to the complexity, which lies in the *Bluetooth* protocol stack. GPIO interface can be used for event monitoring and command execution. PCM, SPDIF, I2S or analog interfaces are available for audio. The available interfaces depend on the used hardware.

The user can write application code to the host processor to control iWRAP firmware using ASCII commands or GPIO events. In this way, it is easy to develop *Bluetooth* enabled applications.

On WT32(i) there is an extra DSP processor available for data/audio processing.

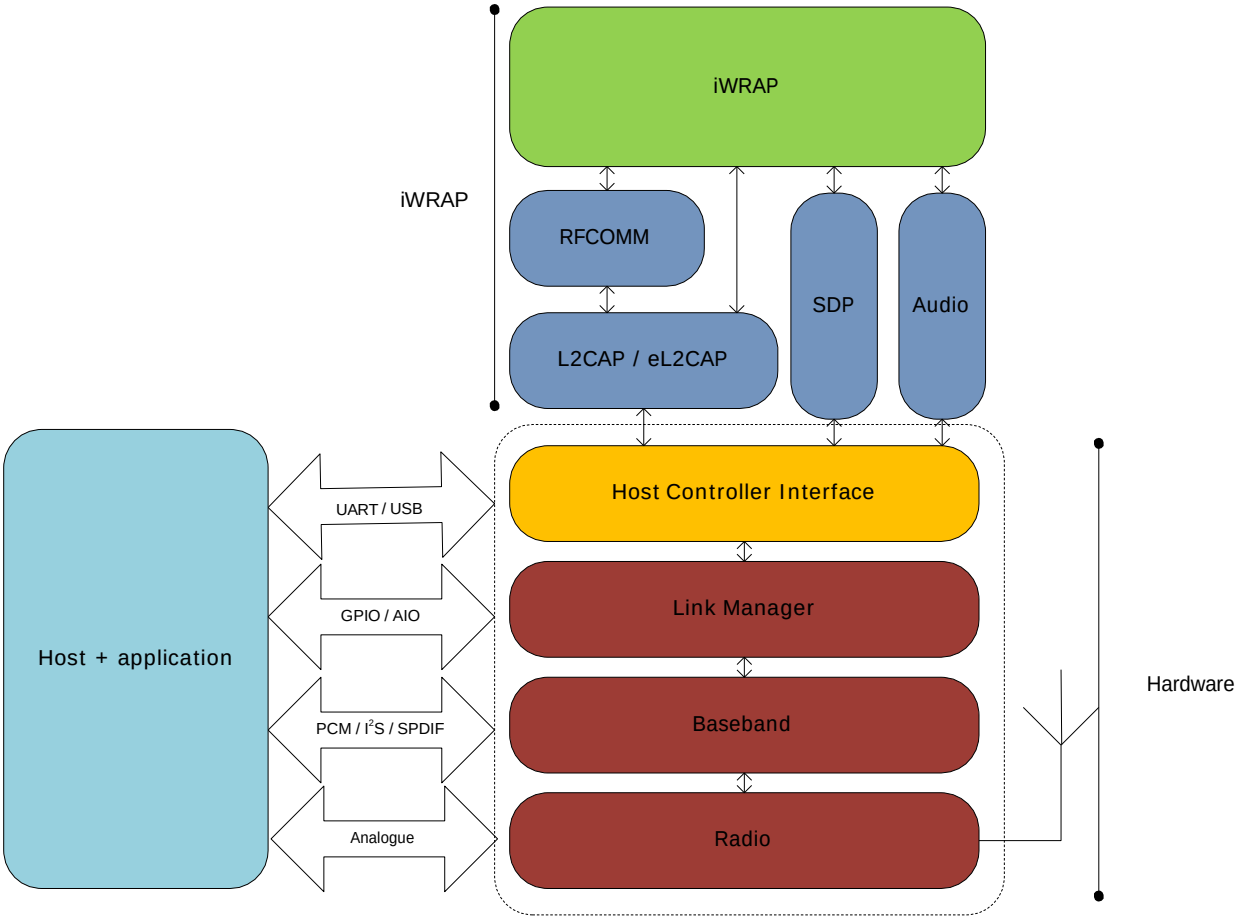


Figure 2: iWRAP Bluetooth stack

In the figure above, a Bluegiga *Bluetooth* module with iWRAP firmware could be connected to a host system for example through the UART interface. The options are:

- If the host system has a processor, software can be used to control iWRAP by using ASCII based commands or GPIO events.
- If there is no need to control iWRAP, or the host system does not need a processor, iWRAP can be configured to be totally transparent and autonomous, in which case it only accepts connections or automatically opens them.
- GPIO lines that WRAP THOR modules offer can also be used together with iWRAP to achieve additional functionality, such as Carrier Detect or DTR signaling.
- Audio interfaces can be used to transmit audio over a *Bluetooth* link.

3 Using HID with iWRAP

This chapter instructs the HID usage and configuration with the iWRAP firmware. ***Please note that the HID profile API has changed radically since iWRAP4.***

3.1 Profile configuration

HID is enabled and configured with

SET PROFILE HID {features} {subclass} {version} {country_code} {BTlang} {USBlang} {service_name} where the fields are as follows:

Field	Description
features (uint8)	This bitmask indicates which optional features the HID device supports. **Bit 0**: Virtual Cable support. This essentially means saving generated link keys so pairing does not have to be done upon each connection setup, unless the Virtual Cable Unplug procedure is done. **Bit 1**: Reconnection Initiation support. This indicates to the HID Host that this device is capable of reconnecting to the Host. The Host shall not initiate reconnection if this is set. **Bit 2**: Normally Connectable. This means that the device can be connected to without any user intervention when it is powered on. **Bit 3**: Boot Device support. Setting this bit indicates that the device supports HID Boot Reports. ***Mandatory for keyboards and mice.*** **Bit 4:** Receive raw Output Reports. iWRAP will output all report data from the HID Host instead of parsing them into “HID {link_id} OUTPUT” events. **Bit 5:** Double size data channel MTU. Increases the L2CAP MTU from 48 bytes to 96 bytes, which enables iWRAP to receive very large output reports from the HID Host. Note that to achieve minimum latency, HID reports should be kept as small as possible. The rest of the bits are reserved and shall be set to zero.
subclass (uint8)	Identifies the type of device. It should be set identical to the lowest 8 bits of the Class of Device, unless the device is a composite device that supports other profiles than just HID. Bits 0-1 must be set to zero.
version (uint16)	The version number of your device in binary-coded decimal (BCD) format. Example: 1203 = 12.0.3.
country_code (uint8)	Country code for localization information, for example the language of the key caps of a keyboard. Set to zero if not localized.
Btlang (char[2])	Language code in Bluetooth SDP format. Two ASCII characters as described by ISO 639:1988. Example: "en" is English.
USBlang (uint16)	Language code in USB HID format, as specified in Universal Serial Bus Language Identifiers (LANGIDs). 0409 is English.
service_name (string)	The service name the HID profile will advertise. The maximum length is 114 characters.

Because iWRAP registers its SDP entries at boot time, a reset is needed before changes made with SET PROFILE HID become effective.

To disable HID, issue **SET PROFILE HID** without any parameters.

3.2 HID descriptors configuration

In addition to the high-level information provided here, the HID descriptors themselves must be defined. Because of memory limitations, **the maximum length for the HID SET command is 320 bytes for the WT32, 512 bytes for other modules**. Descriptors for multiple logical HID devices can be entered in a single HID SET command, provided they don't exceed the maximum length constraint, for example a keyboard descriptor and a consumer control descriptor – the very common keyboard with volume control and application launch buttons. The following command is used to set the HID descriptors:

HID SET {*length*} {*descriptor*}

length	parameter is a uint16 in hexadecimal format.
descriptor	is the entire USB HID report descriptor in hexadecimal format.

To read the current HID descriptor the following command can be used:

HID GET

The response to the command is:

HID GET {*length*} {*descriptor*}

length	parameter is a uint16 in hexadecimal format.
descriptor	is the entire USB HID report descriptor in hexadecimal format.

3.3 Class-of-Device configuration

The Bluetooth class-of-device also needs to be configured properly. This can be done with the iWRAP command "**SET BT CLASS**". Usually, the Major Device Class must be set to Peripheral (0x000500).

The Minor Device Class field depends on which type of HID device your device is. 0x40 is a keyboard of any sort, 0x80 is a pointing device. If your device includes both types, the field is 0xc0.

Note that the SET PROFILE HID subclass must match the low 8 bits of the CoD (with bits 0-1 set to zero), unless it is a composite device that supports other profiles, which may add their own bits into the low 8 CoD bits.

Some examples:

SET BT CLASS 00540	: A keyboard device
SET BT CLASS 00580	: A pointing device
SET BT CLASS 005C0	: A combined keyboard + pointing device
SET BT CLASS 00500	: Not keyboard / not pointing device

3.4 Security configuration

The third configuration is related to pairing and security. iWRAP5 has Secure Simple Pairing enabled by default, as it is a mandatory feature for all Bluetooth 2.1 (and upwards) devices. iWRAP3 and older do not support SSP and legacy paring needs to be used.

To enable SSP two possible configurations can be used depending on the device type. The configuration is done with iWRAP command "**SET BT SSP**".

For a keyboard one should use setting:

SET BT SSP 2 0 **:** Enables SSP pairing for keyboard device, Man-in-the-Middle protection not required but can be used

For a mouse or any other device without a keyboard one should use setting:

SET BT SSP 3 0 : Enables SSP just works mode

To support pairing with older devices that do not implement SSP. Two other configurations should also be made. The Bluetooth PIN code should be enabled with "**SET BT AUTH * <pin>**" command and a so called interactive pairing mode should also be enabled with "**SET CONTROL CONFIG**" command.

Below is an example how to configure the security for a keyboard device supporting SSP.

```
SET BT AUTH * 0000
SET BT SSP 2 0
SET CONTROL CONFIG 800
RESET
```

Below is an example how to configure the security for a keyboard device without SSP support.

```
SET BT AUTH * 0000
SET CONTROL CONFIG 800
RESET
```

3.5 *Bluetooth* mouse example

Suppose our device is a Bluetooth mouse. It is capable of storing pairing information and can initiate connections on its own. It also supports Boot Reports, as is mandatory for all keyboards and mice. We do not want to bypass iWRAP parsing, so bits 4 and 5 of the first field are zero.

Its Class of Device must have the Peripheral Major Device Class (0x500) and Pointing Device Minor Device Class (0x80). The whole CoD is then 0x000580, and the HID Device Subclass must duplicate the CoD's Minor Device Class bits, 0x80.

This is the first release, so its product version is 1.0.0. It does not have any specific localization, as it is a mouse.

Our mouse has three buttons and a wheel. The buttons are either up or down, so they have a binary state. The range of the X- and Y-axis relative displacement is between -127 and 127. For the wheel it is between -15 and 15.

For a detailed explanation of the HID descriptor, please see Appendix A.

```
SET BT CLASS 000580
SET BT SSP 3 0
SET PROFILE HID b 80 100 0 en 409 Bluetooth Mouse
HID SET 3c
05010902a1010901a1008501050919012903150025019503750181020501093815f1250f950175058106050
1093009311581257f750895028106c0c0
RESET
```

3.6 Service discovery

Bluetooth technology enables wireless service discovery, so you can find out the capabilities the remote device supports. Wireless service discovery uses the Bluetooth Service Discovery Profile (SDP).

With iWRAP the service discovery is performed with command: "**SDP {*bd_addr*} {*uuid*}**".

bd_addr	Bluetooth device address of the remote device.
uuid	Universally unique identifier. Refers to the Bluetooth profile to be discovered. For HID the ***uuid*** is 1124.

Below is an example how to perform a service discovery for HID device.

SDP 00:07:80:FF:FF:FF 1124

SDP 00:07:80:ff:ff:ff < I SERVICENAME S "**HID**" > < I PROTOCOLDESCRIPTORLIST < < U L2CAP I **11** > < U 0011 > > >

SDP

HID	= Service name
11	= L2CAP psm for HID profile

3.7 Pairing

The pairing must be initiated by the HID Host device such as a PC or a mobile phone, because the Host must read the HID Device's SDP entry in order to be able to parse its HID reports. The pairing may need actions on iWRAP, depending on which paring mode is used. If SSP pairing is used, no actions are needed on iWRAP, but with the legacy Bluetooth pairing also the interactive pairing mode needs to be enabled, and this requires user interaction.

When a device like a PC starts pairing with a keyboard it usually automatically displays a pin code that the user needs to type with a keyboard. This is the reason why interactive pairing is needed in iWRAP. The following example shows how the pairing procedure is made.

Interactive pairing example:

AUTH 00:21:86:35:c9:c8?	(Pairing is initiated from a PC and iWRAP shows **AUTH** event)
AUTH 00:21:86:35:c9:c8 12476505	(This is responded with AUTH command)

Pairing can also be initiated from iWRAP using the iWRAP command "**PAIR {*bd_addr*}**".

When using SSP, it is recommended to use **SET BT SSP 2 0** for keyboard-like devices (keypad capability, Man-in-the-Middle protection not required, but will be complied to if the remote end requests it), and **SET BT SSP 3 0** (no capabilities, no MITM) for mice, joysticks and similar devices with no display and yes/no button capability.

Note that almost all HID Hosts cache HID Device SDP entries, so if you change a HID-related setting on your module, you will have to delete the pairing on the HID Host and pair again; otherwise the changes will have no effect.

3.8 Connection establishment

Usually the HID connection is opened by the PC right after pairing. This can be seen by an incoming **RING** event generated by iWRAP.

Below is an example how a HID connection is received

```
RING 0 00:21:86:35:c9:c8 11 HID
RING 1 00:21:86:35:c9:c8 13 HID
```

However if a HID connection needs to be opened from iWRAP it can be done with a **CALL** command:

"**CALL {*bd_addr*} 11 HID**"

bd_addr Bluetooth device address of the remote device.

Below is an example how to set up a HID from iWRAP to a HID host device.

```
CALL 00:07:80:aa:bb:cc 11 HID
CALL 0
CONNECT 0 HID 11
CONNECT 1 HID 13
```

Two separate connections are established: the first is the control channel and the second is the data channel. Note that unlike with Serial Port Profile connections, HID connections will not automatically go into data mode.

3.9 Connection termination

The HID data and control channels should be terminated on iWRAP using the "**DISCONNECT**" or "**CLOSE {link_id}**" command.

If the Virtual Cable Unplug procedure needs to be done, the command "**UNPLUG**" can be issued. It instructs the Host to delete all pairing information of the Device. iWRAP will delete its corresponding pairing information automatically.

HID connection termination:

CLOSE 0

NO CARRIER 1 ERROR 0

NO CARRIER 0 ERROR 0

3.10 Sending and receiving HID reports

HID can be used in either command/data mode or MUX mode. In command mode, HID commands can be issued to either of the HID links as long as they're selected as the active receiver of commands with **SET {*link_id*} SELECT**. In MUX mode, the link ID must be set to 0xff and either of the HID links must be the active receiver.

To send HID reports in command/data mode, either of the links must be selected with **SELECT {*link_id*}**. In MUX mode, HID reports can be sent to either of the links.

The escape character is disabled when the HID profile is used and a GPIO pin needs to be used for mode switching. This is because a user might want to transmit the escape (three '+' characters by default) sequence over the HID connection and this might lead to an unwanted iWRAP mode switch.

HID Output Reports sent by the Host will be presented in **HID {*link_id*} OUTPUT {*data_length*} {*data*}** events, unless the Raw Output bit is set in the HID configuration; in that case iWRAP will simply give a raw dump of the data received if print are not disabled in data mode (Bit 13 of *optional_block_2* for command SET CONTROL CONFIG).

For backwards compatibility and ease of testing, iWRAP has built-in support for the example keyboard (see Appendix). The keyboard support requires that iWRAP's HID descriptor entry contains the example keyboard or a keyboard with a similar report format, or that Boot Reports are supported. The example keyboard reports are identical to Boot Reports, so they can be used even in the case the Host indicates that it wants to use Boot Reports.

Example:

```
RING 0 00:21:86:35:c9:c8 11 HID
RING 1 00:21:86:35:c9:c8 13 HID
HID 1 OUTPUT 01 00 (Host indicates that Caps Lock, Num Lock etc. are off)
SELECT 0
abcdefg
```

Below is an example with raw data:

```
RING 0 00:21:86:35:c9:c8 11 HID
RING 1 00:21:86:35:c9:c8 13 HID
bf 01 00 03 a2 01 00 fe (Host indicates that Caps Lock, Num Lock etc. are off)
```

3.11 Receiving HID control requests

The HID_CONTROL requests are used to inform about major state in Bluetooth HID device.

HID {*link_id*} UNPLUG event informs that it was received a HID_CONTROL message with a parameter of VIRTUAL_CABLE_UNPLUG. It can be received by HID Host or by Hid device. The recipient will send back an L2CAP Disconnect Request signal for the Interrupt channel. After closed Interrupt channel it send an L2CAP Disconnect Request signal for the Control channel. This event inform that Virtual Cable was “unplugged” from the device.

Example:

```
RING 0 00:21:86:35:c9:c8 11 HID
RING 1 00:21:86:35:c9:c8 13 HID
HID 0 UNPLUG
```

HID {*link_id*} SUSPEND event inform that normal performance is no longer required by Host. It can be used to e.g. turn off LEDs to save power, reduce button scanning for keyboard, enter to sniff mode or disconnect from the Bluetooth HID Host if the Bluetooth HID device declares the HIDReconnectInitiate attribute with a value of TRUE (set Bit 1 in features HID configuration).

Example:

```
RING 0 00:21:86:35:c9:c8 11 HID
RING 1 00:21:86:35:c9:c8 13 HID
HID 0 SUSPEND
```

HID {*link_id*} EXIT_SUSPEND event inform that Host wants to return to normal performance mode.

Example:

```
RING 0 00:21:86:35:c9:c8 11 HID
RING 1 00:21:86:35:c9:c8 13 HID
HID 0 EXIT_SUSPEND
```

3.12 HID raw reports

All HID functionality outside of the example/Boot keyboard must be implemented with raw reports. All raw reports begin with the hexadecimal byte 0x9f followed by the length byte (length excluding the 0x9f and the length byte themselves).

Example keyboard report:

0x9f	0x0a	0xa1	report ID	modifier	0x00	key code 1	key code 2	key code 3	key code 4	key code 5	key code 6

Figure 3: Raw HID keyboard report

Example mouse report:

0x9f	0x05	0xa1	report ID	buttons	x-step	y-step

Figure 4: Raw HID mouse report

Example consumer page report:

0x9f	0x05	0xa1	report ID	bitfield 1	bitfield 2	bitfield 3

Figure 5: Raw HID consumer report (iWRAP 4.1.0 and later)

Bitfield 1:

0x01 Volume Increment
0x02 Volume Decrement
0x04 Mute
0x08 Play/Pause
0x10 Scan Next Track
0x20 Scan Previous Track
0x40 Stop
0x80 Eject

Bitfield 2:

0x01 Email Reader
0x02 Application Control Search
0x04 AC Bookmarks
0x08 AC Home
0x10 AC Back
0x20 AC Forward
0x40 AC Stop
0x80 AC Refresh

Bitfield 3:

0x01 Application Launch Generic Consumer Control
0x02 AL Internet Browser
0x04 AL Calculator
0x08 AL Terminal Lock / Screensaver
0x10 AL Local Machine Browser 0x20
AC Minimize
0x40 Record
0x80 Rewind

Full key codes can be found from document USB HID Usage Tables:

http://www.usb.org/developers/devclass_docs/Hut1_11.pdf

Modifier key codes can be found from document HID1_11.pdf (page 56)

http://www.usb.org/developers/devclass_docs/HID1_11.pdf

Example of transmitting a key press-then-release sequence for '=' key:

0x9f 0x0a 0xa1 0x01 0x00 0x00 0x2e 0x00 0x00 0x00 0x00 0x00

0x9f 0x0a 0xa1 0x01 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00

Notice above that, according to the USB HID Usage Tables, 0x2e corresponds to US keyboard's key '=' which is found at AT-101 key position 13. But the character '=' might be re-mapped by a host localized to other than US (see footnote 4 at page 59 of Hut1_12v2.pdf and see the note on top of page 54 – from http://www.usb.org/developers/hidpage/ as of 26 March 2013). For example, an Italian-localized host will treat the above raw report as character "ì" which is also found at AT-101 key position 13 but of the Italian keyboard.

Example of transmitting a key press-release sequence for 'a' key while holding left shift down

0x9f 0x0a 0xa1 0x01 0x02 0x00 0x04 0x00 0x00 0x00 0x00 0x00

0x9f 0x0a 0xa1 0x01 0x02 0x00 0x00 0x00 0x00 0x00 0x00 0x00

0x9f is used to indicate that a raw HID report is sent. Then **0x0a** indicates the length of the data to follow (10 bytes) and then the next 10 bytes are the raw report as described in the Keyboard descriptor. Note that the example Keyboard descriptor format is identical to the Boot Keyboard in the USB HID specification.

To indicate a user has simultaneously pressed multiple keys (up to six different keys) you can use the rest of the key codes. **Note:** to send key combinations which include modifier keys (ctrl, alt, shift, GUI), the corresponding modifier bit must be used, not the key code for the modifier key. For example, Left Alt + Tab:

0x9f 0x0a 0xa1 0x01 0x04 0x00 0x2b 0x00 0x00 0x00 0x00 0x00

Launching the calculator application using the Consumer Report descriptor:

0x9f 0x05 0xa1 0x02 0x00 0x00 0x04

0x9f 0x05 0xa1 0x02 0x00 0x00 0x00

The first raw frame indicates that the calculator button is pushed down and the second frame indicates that it is released.

Play/pause report:

0x9f 0x05 0xa1 0x02 0x08 0x00 0x00

0x9f 0x05 0xa1 0x02 0x00 0x00 0x00

Next track:

0x9f 0x05 0xa1 0x02 0x10 0x00 0x00

0x9f 0x05 0xa1 0x02 0x00 0x00 0x00

Mouse movement examples

\x9f\x05\xa1\x01\x00\x05\x00 move 5px right

\x9f\x05\xa1\x01\x00\xff\x00 move 1px left

The above uses the following report:

9f 05 a1 01 [buttons+wheel] [x] [y]

X and Y steps:

00-7F correspond to: +0…+127

FF-80 correspond to: -1…-127

3.13 Power saving

iWRAP offers two power saving options. Sniff mode, which can be used to save power for active Bluetooth connections and deep sleep more which puts the internal processor into a reduced duty cycle mode. Please refer to iWRAP user guide for more information about sniff and deep sleep modes.

One should also know that when Bluetooth connections are in active mode i.e. no power saving in use the master device uses 3-4 times less power then a slave device. Therefore for battery powered applications it might be useful to configure the device as a master rather then a slave, eventually considering role switching.

For HID devices the Bluetooth 2.1 + EDR introduced a new sniff mode called sniff sub rating. In brief the sniff sub rate mode increases the sniff interval after a certain period of inactivity and therefore reduces the current consumption. iWRAP4 supports sniff sub rating mode. Please refer into iWRAP4 user guide for more information.

4 Example connection diagram

An example of HID configuration and a simple HID connection setup is illustrated below.

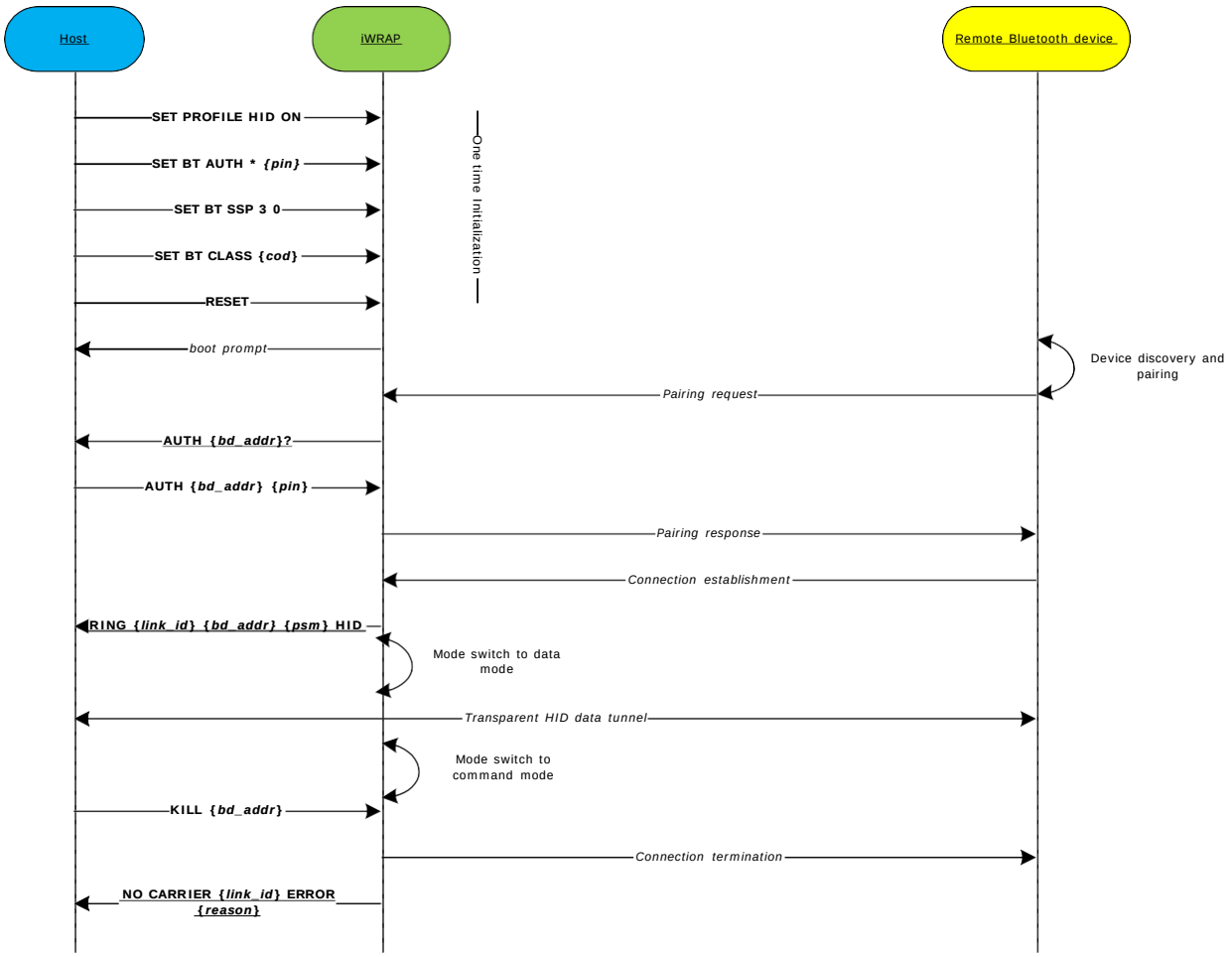


Figure 6: HID connection example

In the above example the **AUTH** event is only seen if a legacy pairing with pin code and interactive paring is made. If the legacy pairing does not take place and SSP pairing is used instead then **AUTH** event is not seen and there is no need to reply to it with the **AUTH** command. With SSP pairing, depending on the SSP mode, however SPP events may be displayed and then need to be responded with correct SSP pairing commands.

Also depending on the remote Bluetooth device one or two **RING** events may been seen during the connection establishment.

Please refer to iWRAP user guide for more information about the iWRAP command and events.

5 Known issues

5.1 Release 5.0.1

Certain proprietary Bluetooth stacks for Windows XP, such as the Qualcomm / Atheros stacks, do not recognize iWRAP's HID service record, and refuse to connect. This has been addressed in 5.0.2 release.

5.2 Release 5.0.2

No known issues at the time of releasing.

6 Appendix

6.1 Example keyboard layout

The example HID keyboard layout is US and the following key codes are supported. These codes are transmitted over the HID data channel to the HID host device such as a PC.

Code	Description
00	Left control + space
01	Left control + a
02	Left control + b
03	Left control + c
04	Left control + d
05	Left control + e
06	Left control + f
07	Left control + g
08	Backspace
09	Tab
0a	Enter
0b	Left control + k
0c	Left control + l
0d	Enter
e0	Left control + n
0f	Left control + o
10	Left control + p

11	Left control + q
12	Left control + r
13	Left control + s
14	Left control + t
15	Left control + u
16	Left control + v
17	Left control + w
18	Left control + x
19	Left control + y
1a	Left control + z
1b	Left control + space
1c	Esc
1d-1f	N/A
20-7e	Corresponding ASCII character
7f	backspace
80	Cursor up
81	Cursor right
82	Cursor down
83	Cursor left
84	Insert
85	Delete
86	Home

87	End
88	Page up
89	Page down
8a-9e	-
9f	raw mode*
a0-ff	-

Table 1: Available HID key codes

6.2 Example descriptors

6.2.1 Example keyboard descriptor

iWRAP command string: HID SET 43
05010906a1010507850119e029e715002501750195088102950175088101950575010508850119012905910
2950175039103950675081500256505071900296581 00c0

C code:

```
static const uint8 hid_descriptor_keyboard[] = {
  /****/ 0x05, 0x01,     /* USAGE_PAGE (Generic Desktop) */
  /****/ 0x09, 0x06,     /* USAGE (Keyboard) */
  /****/ 0xa1, 0x01,     /* COLLECTION (Application) */
  /******/ 0x05, 0x07,   /*   USAGE_PAGE (Keyboard) */
  /******/ 0x85, 0x01,   /*   REPORT_ID (1) */

  /* Ctrl, Shift and other modifier keys, 8 in total */
  /******/ 0x19, 0xe0,   /*   USAGE_MINIMUM (kbd LeftControl) */
  /******/ 0x29, 0xe7,   /*   USAGE_MAXIMUM (kbd Right GUI) */
  /******/ 0x15, 0x00,   /*   LOGICAL_MINIMUM (0) */
  /******/ 0x25, 0x01,   /*   LOGICAL_MAXIMUM (1) */
  /******/ 0x75, 0x01,   /*   REPORT_SIZE (1) */
  /******/ 0x95, 0x08,   /*   REPORT_COUNT (8) */
  /******/ 0x81, 0x02,   /*   INPUT (Data,Var,Abs) */

  /* Reserved byte */
  /******/ 0x95, 0x01,   /*   REPORT_COUNT (1) */
  /******/ 0x75, 0x08,   /*   REPORT_SIZE (8) */
  /******/ 0x81, 0x01,   /*   INPUT (Cnst,Ary,Abs) */

  /* LEDs for num lock etc */
  /******/ 0x95, 0x05,   /*   REPORT_COUNT (5) */
  /******/ 0x75, 0x01,   /*   REPORT_SIZE (1) */
  /******/ 0x05, 0x08,   /*   USAGE_PAGE (LEDs) */
  /******/ 0x85, 0x01,   /*   REPORT_ID (1) */
  /******/ 0x19, 0x01,   /*   USAGE_MINIMUM (Num Lock) */
  /******/ 0x29, 0x05,   /*   USAGE_MAXIMUM (Kana) */
  /******/ 0x91, 0x02,   /*   OUTPUT (Data,Var,Abs) */

  /* Reserved 3 bits */
  /******/ 0x95, 0x01,   /*   REPORT_COUNT (1) */
  /******/ 0x75, 0x03,   /*   REPORT_SIZE (3) */
  /******/ 0x91, 0x03,   /*   OUTPUT (Cnst,Var,Abs) */

  /* Slots for 6 keys that can be pressed down at the same time */
```

```
  /******/ 0x95, 0x06,    /*   REPORT_COUNT (6) */
  /******/ 0x75, 0x08,    /*   REPORT_SIZE (8) */
  /******/ 0x15, 0x00,    /*   LOGICAL_MINIMUM (0) */
  /******/ 0x25, 0x65,    /*   LOGICAL_MAXIMUM (101) */
  /******/ 0x05, 0x07,    /*   USAGE_PAGE (Keyboard) */
  /******/ 0x19, 0x00,    /*   USAGE_MINIMUM (Reserved (no event indicated)) */
  /******/ 0x29, 0x65,    /*   USAGE_MAXIMUM (Keyboard Application) */
  /******/ 0x81, 0x00,    /*   INPUT (Data,Ary,Abs) */
  /****/ 0xc0,            /* END_COLLECTION */
};
```

6.2.2 Example mouse descriptor

iWRAP command string: HID SET 3c
05010902a1010901a1008501050919012903150025019503750181020501093815f1250f9501750581060501
0930093115812 57f750895028106c0c0

C code:

```
static const uint8 hid_descriptor_mouse\[\] = {
/****/ 0x05, 0x01,     /\* USAGE_PAGE (Generic Desktop) \*/
/****/ 0x09, 0x02,     /\* USAGE (Mouse) \*/
/****/ 0xa1, 0x01,     /\* COLLECTION (Application) \*/
/******/ 0x09, 0x01,   /\*   USAGE (Pointer) \*/
/******/ 0xa1, 0x00,   /\*   COLLECTION (Physical) \*/
/********/ 0x85, 0x01, /\*     REPORT_ID (1) \*/
/********/ 0x05, 0x09, /\*     USAGE_PAGE (Button) \*/
/********/ 0x19, 0x01, /\*     USAGE_MINIMUM (Button 1) \*/
/********/ 0x29, 0x03, /\*     USAGE_MAXIMUM (Button 3) \*/
/********/ 0x15, 0x00, /\*     LOGICAL_MINIMUM (0) \*/
/********/ 0x25, 0x01, /\*     LOGICAL_MAXIMUM (1) \*/
/********/ 0x95, 0x03, /\*     REPORT_COUNT (3) \*/
/********/ 0x75, 0x01, /\*     REPORT_SIZE (1) \*/
/********/ 0x81, 0x02, /\*     INPUT (Data,Var,Abs) \*/
/********/ 0x05, 0x01, /\*     USAGE_PAGE (Generic Desktop) \*/
/********/ 0x09, 0x38, /\* USAGE (Wheel) \*/
/********/ 0x15, 0xf1, /\*               LOGICAL_MINIMUM (-15) \*/
/********/ 0x25, 0x0f, /\* LOGICAL_MAXIMUM (15) \*/
/********/ 0x95, 0x01, /\*     REPORT_COUNT (1) \*/
/********/ 0x75, 0x05, /\*     REPORT_SIZE (5) \*/
/********/ 0x81, 0x06, /\*     INPUT (Data,Var,Rel) \*/
/********/ 0x05, 0x01, /\*     USAGE_PAGE (Generic Desktop) \*/
/********/ 0x09, 0x30, /\*     USAGE (X) \*/
/********/ 0x09, 0x31, /\*     USAGE (Y) \*/
/********/ 0x15, 0x81, /\*     LOGICAL_MINIMUM (-127) \*/
/********/ 0x25, 0x7f, /\*     LOGICAL_MAXIMUM (127) \*/
/********/ 0x75, 0x08, /\*     REPORT_SIZE (8) \*/
/********/ 0x95, 0x02, /\*     REPORT_COUNT (2) \*/
/********/ 0x81, 0x06, /\*     INPUT (Data,Var,Rel) \*/
/******/ 0xc0,          /\*   END_COLLECTION \*/
/****/ 0xc0,           /\* END_COLLECTION \*/
};
```

6.2.3 Example consumer page descriptor

```
static const uint8 hid_descriptor_consumer_page[] = {
  /****/ 0x05, 0x0c,                    /* USAGE_PAGE (Consumer) */
  /****/ 0x09, 0x01,                    /* USAGE (Consumer Control) */
  /****/ 0xa1, 0x01,                    /* COLLECTION (Application) */
  /******/ 0x85, 0x02,                  /* Report ID 2 */
  /******/ 0x05, 0x0c,                  /* USAGE_PAGE (Consumer) */

  /* 8 media player related keys */
  /******/ 0x15, 0x00,     /* Logical Min 0 */
  /******/ 0x25, 0x01,     /* Logical Max 1 */
  /******/ 0x09, 0xe9,     /* Usage (8-bit), Volume Increment */
  /******/ 0x09, 0xea,     /* Usage (8-bit), Volume Decrement */
  /******/ 0x09, 0xe2,     /* Usage (8-bit), Mute */
  /******/ 0x09, 0xcd,     /* Usage (8-bit), Play/Pause */
  /******/ 0x19, 0xb5,     /* Usage Min (Scan Next Track, Scan Previous Track, Stop, Eject) */
  /******/ 0x29, 0xb8,     /* Usage Max */
  /******/ 0x75, 0x01,     /* Report Size */
  /******/ 0x95, 0x08,     /* Report Count */
  /******/ 0x81, 0x02,     /* Input type 2 */

  /* 8 application control keys */
  /******/ 0x0a, 0x8a, 0x01,/* Usage (16-bit), LSB first, e.g. this is 0x018a Email Reader */
  /******/ 0x0a, 0x21, 0x02,/* Usage (16-bit), Generic GUI Application Control Search */
  /******/ 0x0a, 0x2a, 0x02,/* Usage (16-bit), Application Control Bookmarks */
  /******/ 0x1a, 0x23, 0x02,/* Usage Min (16-bit), AC Home, Back, Forward, Stop, Refresh */
  /******/ 0x2a, 0x27, 0x02,/* Usage Max (16-bit) */
  /******/ 0x75, 0x01,     /* Report Size */
  /******/ 0x95, 0x08,     /* Report Count */
  /******/ 0x81, 0x02,                  /* Input type 2 */

  /* Application launch keys + record & rewind */
  /******/ 0x0a, 0x83, 0x01,/* Usage (16-bit), Application Launch Generic Consumer Control */
  /******/ 0x0a, 0x96, 0x01,/* Usage (16-bit), AL Internet Browser */
  /******/ 0x0a, 0x92, 0x01,/* Usage (16-bit), AL Calculator */
  /******/ 0x0a, 0x9e, 0x01,/* Usage (16-bit), AL Terminal Lock / Screensaver */
  /******/ 0x0a, 0x94, 0x01,/* Usage (16-bit), AL Local Machine Browser */
  /******/ 0x0a, 0x06, 0x02,/* Usage (16-bit), AC Minimize */
  /******/ 0x09, 0xb2,     /* Usage (8-bit), Record */
  /******/ 0x09, 0xb4,     /* Usage (8-bit), Rewind */
  /******/ 0x75, 0x01,     /* Report Size */
  /******/ 0x95, 0x08,     /* Report Count */
  /******/ 0x81, 0x02,     /* Input type 2 */
```

```
  /******/ 0xc0,                                    /* End Collection */
};
```

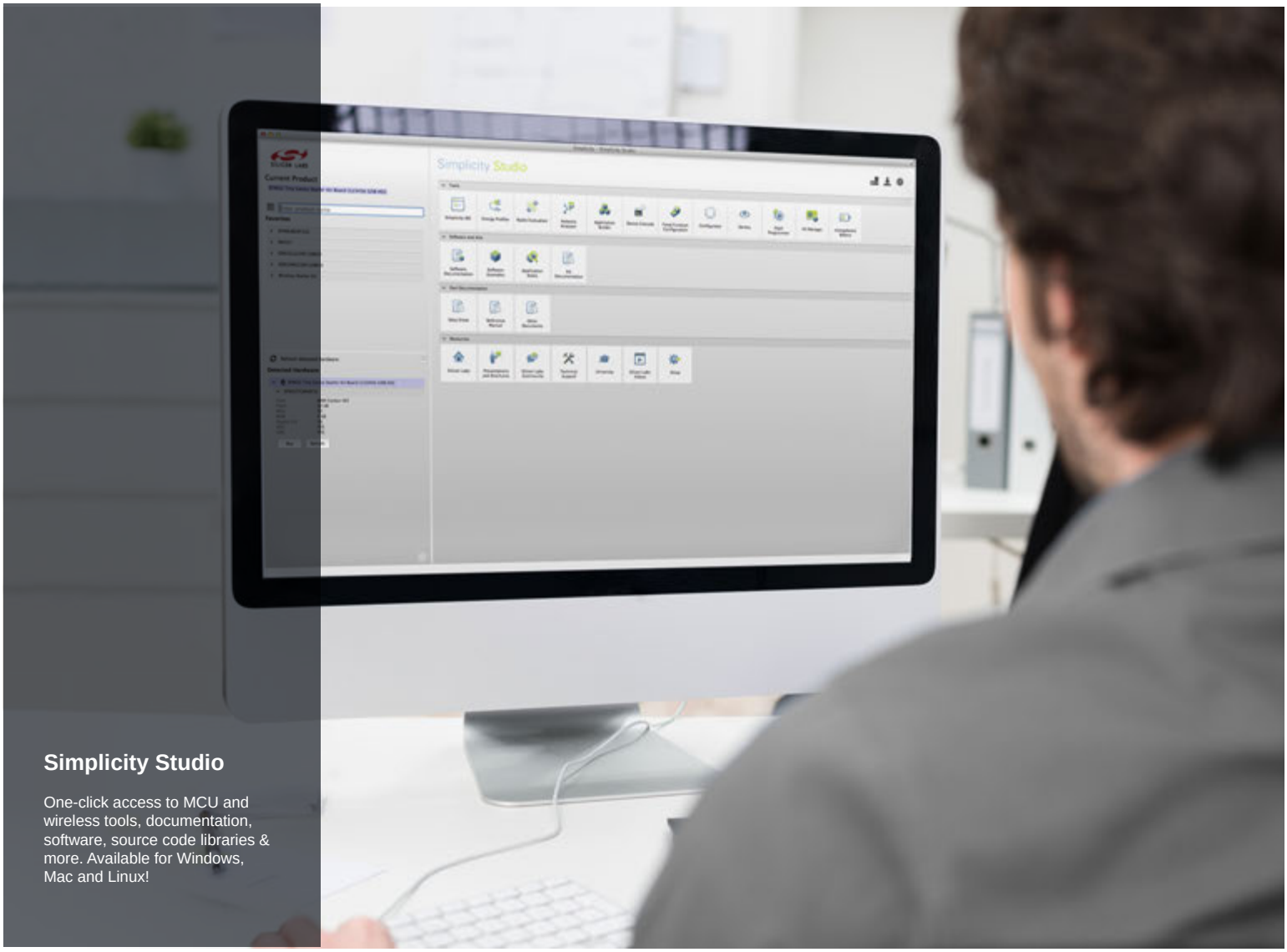
6.2.4 Example joystick descriptor

```
static const uint8 hid_descriptor_joystick[] = {
  0x05, 0x01,                    /* USAGE_PAGE (Generic Desktop) */
     0x09, 0x04,                    /* USAGE (Joystick) */
     0x85, 0x01,                            /* Report ID 1 */
     0xa1, 0x01,                    /* COLLECTION (Application) */
     0x05, 0x01,                    /*   USAGE_PAGE (Generic Desktop) */
     0x09, 0x01,                    /*   USAGE (Pointer) */
     0xa1, 0x00,                    /*   COLLECTION (Physical)*/
     0x15, 0x81,                    /*     LOGICAL_MINIMUM (-127)*/
     0x25, 0x7f,                    /*     LOGICAL_MAXIMUM (127)*/
     0x75, 0x08,                    /*     REPORT_SIZE (8)*/
     0x95, 0x02,                    /*     REPORT_COUNT (2)*/
     0x09, 0x30,                    /*     USAGE (X)*/
     0x09, 0x31,                    /*     USAGE (Y)*/
     0x81, 0x02,                    /*     INPUT (Data,Var,Abs)*/
     0x09, 0x39,                    /*     USAGE (Hat switch)*/
     0x15, 0x00,                    /*     LOGICAL_MINIMUM (0)*/
     0x25, 0x03,                    /*     LOGICAL_MAXIMUM (3)*/
     0x35, 0x00,                    /*     PHYSICAL_MINIMUM (0)*/
     0x46, 0x0e, 0x01,              /*     PHYSICAL_MAXIMUM (270)*/
     0x65, 0x14,                    /*     UNIT (Eng Rot:Angular Pos)*/
     0x95, 0x01,                    /*     REPORT_COUNT (1)*/
     0x75, 0x04,                    /*     REPORT_SIZE (4)*/
     0x81, 0x42,                    /*     INPUT (Data,Var,Abs,Null)*/
     0x15, 0x00,                    /*     LOGICAL_MINIMUM (0)*/
     0x25, 0x01,                    /*     LOGICAL_MAXIMUM (1)*/
     0x95, 0x02,                    /*     REPORT_COUNT (2)*/
     0x75, 0x01,                    /*     REPORT_SIZE (1)*/
     0x05, 0x09,                    /*     USAGE_PAGE (Button)*/
     0x19, 0x01,                    /*     USAGE_MINIMUM (Button 1)*/
     0x29, 0x02,                    /*     USAGE_MAXIMUM (Button 2)*/
     0x65, 0x00,                    /*     UNIT (None)*/
     0x81, 0x02,                    /*     INPUT (Data,Var,Abs)*/
     0xc0,                          /*     END_COLLECTION*/
     0x19, 0x03,                    /*   USAGE_MINIMUM (Button 3)*/
     0x29, 0x04,                    /*   USAGE_MAXIMUM (Button 4)*/
     0x81, 0x02,                    /*   INPUT (Data,Var,Abs)*/
     0x05, 0x02,                    /*   USAGE_PAGE (Simulation Controls)*/
     0x09, 0xbb,                    /*   USAGE (Throttle)*/
     0x15, 0x81,                    /*   LOGICAL_MINIMUM (-127)*/
     0x25, 0x7f,                    /*   LOGICAL_MAXIMUM (127)*/
     0x75, 0x08,                    /*   REPORT_SIZE (8)*/
```

```
    0x95, 0x01,                    /*   REPORT_COUNT (1)*/
    0x81, 0x02,                    /*   INPUT (Data,Var,Abs)*/
    0xc0,                          /* END_COLLECTION*/
};
```

7 References

[1] The Bluetooth SIG, Human Interface Device Profile overview, URL: http://www.bluetooth.com/Bluetooth/Technology/Works/HID.htm



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