USB HID Learning Record

版本：v0.6

Crifan Li

摘要

本文主要介绍了USB HID的基本知识，以及举例说明如何解析HID Report

本文提供多种格式供：

在线阅读	HTML [1]	HTMLs [2]	PDF [3]	CHM [4]	TXT [5]	RTF [6]	WEBHELP [7]
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HTML版本的在线地址为：

http://www.crifan.com/files/doc/docbook/usb_hid/release/html/usb_hid.html

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http://www.crifan.com/bbs/categories/usb_hid/

修订历史		
修订 0.4	2011-06-16	crl
1. 写好了USB HID基本内容		
修订 0.6	2013-09-05	crl
1. 通过Docbook发布 2. 更新了所有xml:id		

[1] http://www.crifan.com/files/doc/docbook/usb_hid/release/html/usb_hid.html
[2] http://www.crifan.com/files/doc/docbook/usb_hid/release/htmls/index.html
[3] http://www.crifan.com/files/doc/docbook/usb_hid/release/pdf/usb_hid.pdf
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[13] http://www.crifan.com/files/doc/docbook/usb_hid/release/rtf/usb_hid.rtf.7z
[14] http://www.crifan.com/files/doc/docbook/usb_hid/release/webhelp/usb_hid.webhelp.7z

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[15] http://www.crifan.com/files/doc/docbook/soft_dev_basic/release/html/soft_dev_basic.html#cc_by_nc

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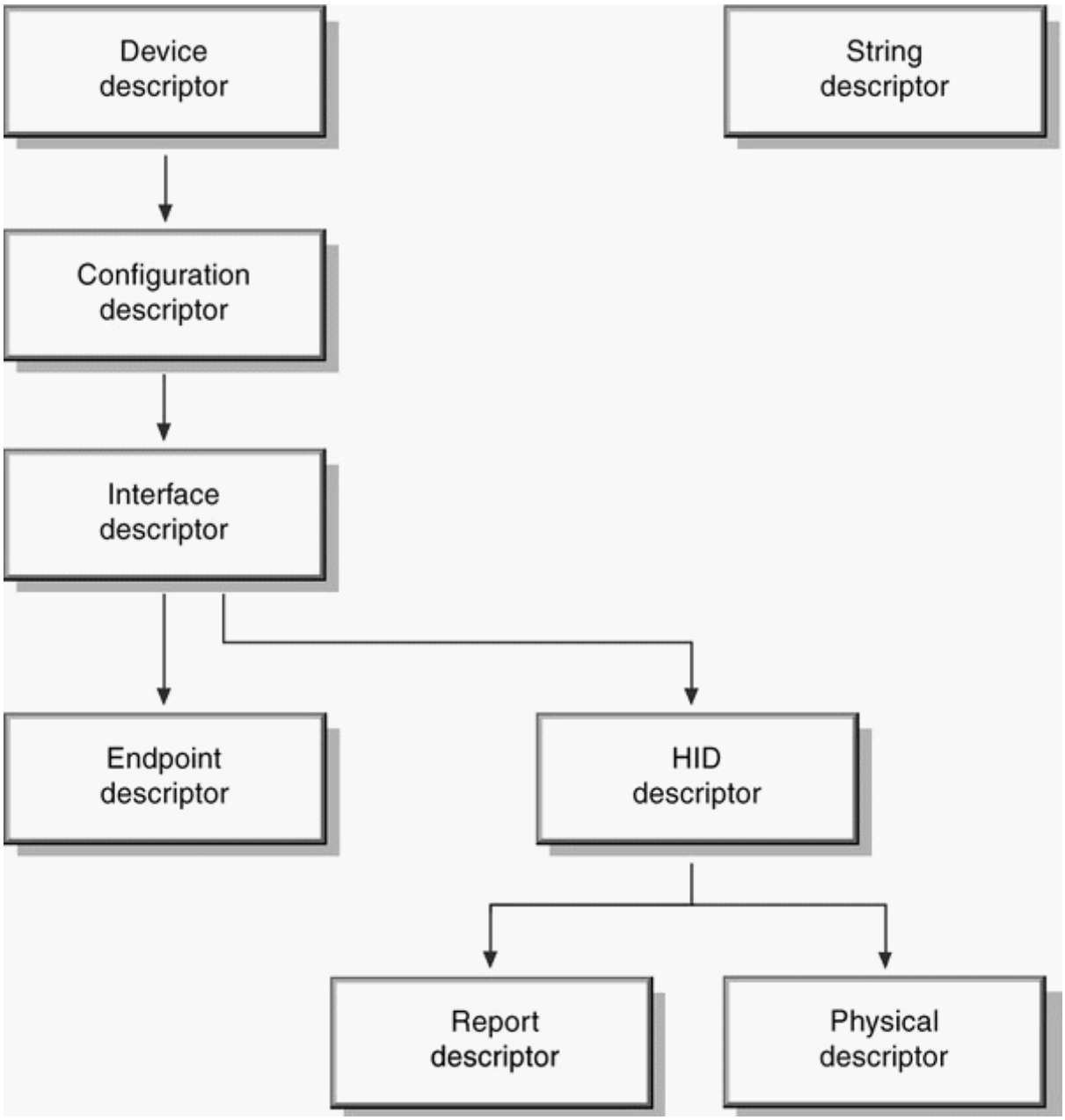
第 1 章 USB HID基础知识

1.1. USB HID Structure

图 1.1. USB HID Structure



1.2. HID descriptor

图 1.2. HID descriptor

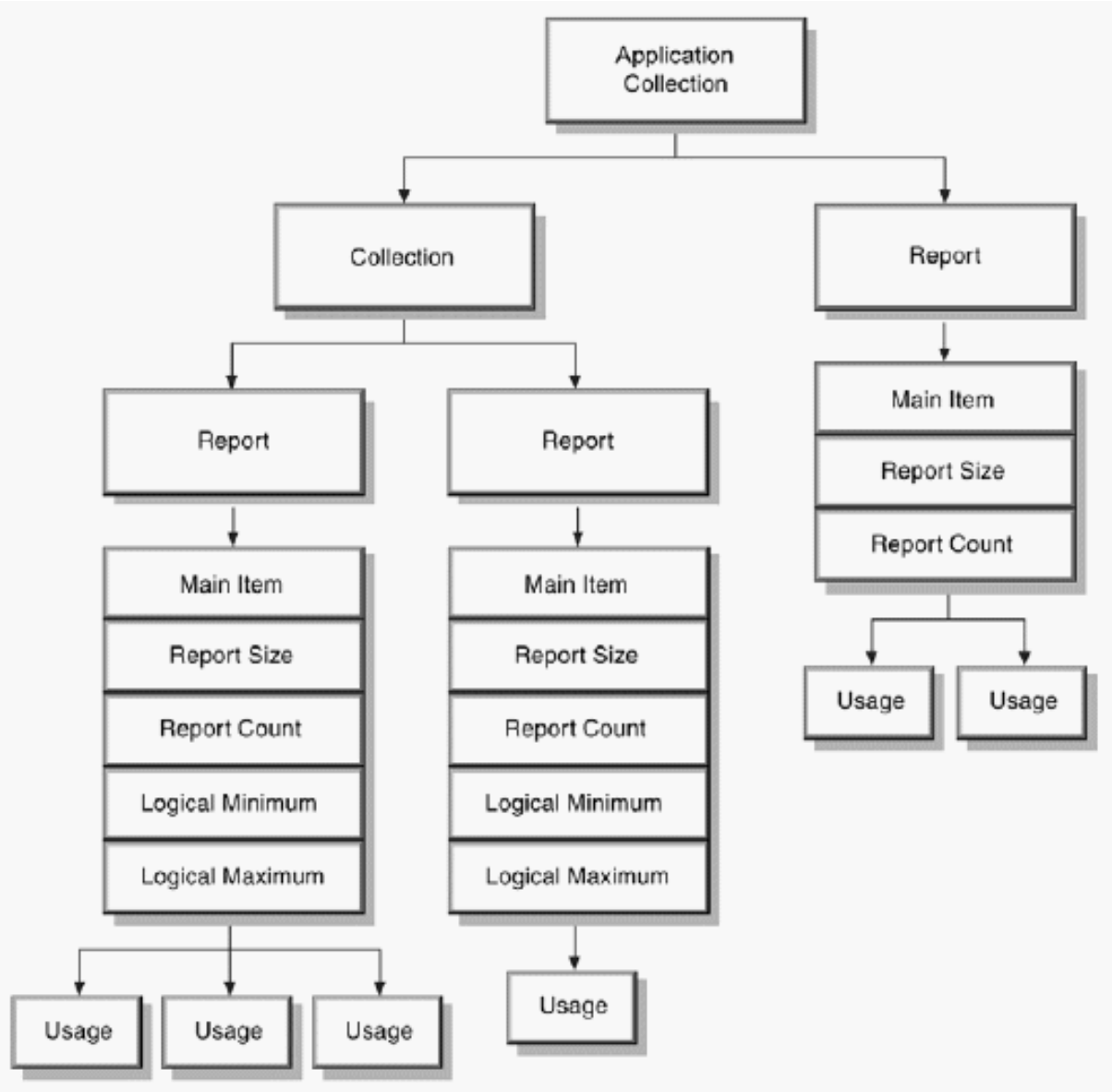
6.2.1 HID Descriptor

The **HID** descriptor identifies the length and type of subordinate descriptors for a device.

Part	Offset/Size (Bytes)	Description
bLength	0/1	Numeric expression that is the total size of the HID descriptor.
bDescriptorType	1/1	Constant name specifying type of HID descriptor.
bcdHID	2/2	Numeric expression identifying the HID Class Specification release.
bCountryCode	4/1	Numeric expression identifying country code of the localized hardware.
bNumDescriptors	5/1	Numeric expression specifying the number of class descriptors (always at least one i.e. Report descriptor.)
bDescriptorType	6/1	Constant name identifying type of class descriptor. See Section 7.1.2: Set_Descriptor Request for a table of class descriptor constants.
wDescriptorLength	7/2	Numeric expression that is the total size of the Report descriptor.
[*bDescriptorType*]...	9/1	Constant name specifying type of optional descriptor.
[*wDescriptorLength*]...	10/2	Numeric expression that is the total size of the optional descriptor.

1.2.1. HID Class Structure

图 1.3. HID Class Structure

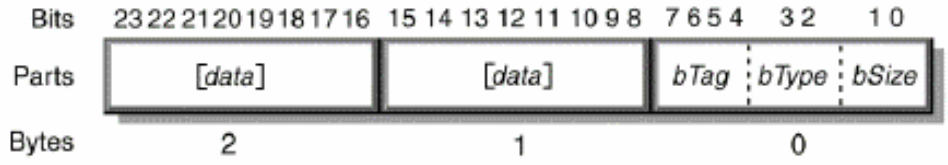


1.2.2. Short Items

图 1.4. HID Short Items

6.2.2.2 Short Items

The short item format packs the item size, type, and tag into the first byte. The first byte may be followed by 0, 1, 2, or 4 optional data bytes depending on the size of the data.



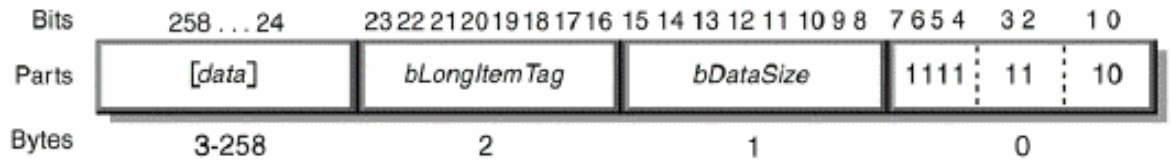
Part	Description
bSize	Numeric expression specifying size of data: 0 = 0 bytes 1 = 1 byte 2 = 2 bytes 3 = 4 bytes
bType	Numeric expression identifying type of item where: 0 = Main 1 = Global 2 = Local 3 = Reserved
bTag	Numeric expression specifying the function of the item.
[*data*]	Optional data.

1.2.3. Long Items

图 1.5. HID Long Items

6.2.2.3 Long items

Like the short item format, the long item format packs the item size, type, and tag into the first byte. The long item format uses a special item tag value to indicate that it is a long item. The long item size and long item tag are each 8-bit quantities. The item data may contain up to 255 bytes of data.



Part	Description
bSize	Numeric expression specifying total size of item where size is 10 (2 bytes); denotes item type as long.
bType	Numeric expression identifying type of item where 3 = Reserved
bTag	Numeric expression specifying the function of the item; always 1111.
[*bDataSize*]	Size of long item data.
[*bLongItemTag*]	Long item tag.
[*data*]	Optional data items.

1.2.4. Main Items

图 1.6. HID Main Items

Main item tag	One-Byte Prefix (*nn* represents size value)	Valid Data	
Input	1000 00 *nn*	Bit 0	{Data (0) | Constant (1)}
		Bit 1	{Array (0) | Variable (1)}
		Bit 2	{Absolute (0) | Relative (1)}
		Bit 3	{No Wrap (0) | Wrap (1)}
		Bit 4	{Linear (0) | Non Linear (1)}
		Bit 5	{Preferred State (0) | No Preferred (1)}
		Bit 6	{No Null position (0) | Null state(1)}
		Bit 7	Reserved (0)
		Bit 8	{Bit Field (0) | Buffered Bytes (1)}
		Bit 31-9	Reserved (0)
Output	1001 00 *nn*	Bit 0	{Data (0) | Constant (1)}
		Bit 1	{Array (0) | Variable (1)}
		Bit 2	{Absolute (0) | Relative (1)}
		Bit 3	{No Wrap (0) | Wrap (1)}
		Bit 4	{Linear (0) | Non Linear (1)}
		Bit 5	{Preferred State (0) | No Preferred (1)}
		Bit 6	{No Null position (0) | Null state(1)}
		Bit 7	{Non Volatile (0) | Volatile (1)}
		Bit 8	{Bit Field (0) | Buffered Bytes (1)}
		Bit 31-9	Reserved (0)
Feature	1011 00 *nn*	Bit 0	{Data (0) | Constant (1)}
		Bit 1	{Array (0) | Variable (1)}
		Bit 2	{Absolute (0) | Relative (1)}
		Bit 3	{No Wrap (0) | Wrap (1)}
		Bit 4	{Linear (0) | Non Linear (1)}
		Bit 5	{Preferred State (0) | No Preferred (1)}
		Bit 6	{No Null position (0) | Null state(1)}
		Bit 7	{Non Volatile (0) | Volatile (1)}
		Bit 8	{Bit Field (0) | Buffered Bytes (1)}
		Bit 31-9	Reserved (0)
Collection	1010 00 *nn*	0x00	Physical (group of axes)
		0x01	Application (mouse, keyboard)
		0x02	Logical (interrelated data)
		0x03	Report
		0x04	Named Array
		0x05	Usage Switch
		0x06	Usage Modifier
		0x07-0x7F	Reserved
		0x80-0xFF	Vendor-defined
End Collection	1100 00 *nn*	Not applicable. Closes an item collection.	
Reserved	1101 00 *nn* to 1111 00 *nn*	Not applicable. Reserved for future items.	

1.2.5. Global Items

图 1.7. HID Global Items

Global item tag	One-Byte Prefix (*nn* represents size value)	Description
Usage Page	0000 01 *nn*	Unsigned integer specifying the current Usage Page. Since a usage are 32 bit values, Usage Page items can be used to conserve space in a report descriptor by setting the high order 16 bits of a subsequent usages. Any usage that follows which is defines 16 bits or less is interpreted as a Usage ID and concatenated with the Usage Page to form a 32 bit Usage.
Logical Minimum	0001 01 *nn*	Extent value in logical units. This is the minimum value that a variable or array item will report. For example, a mouse reporting x position values from 0 to 128 would have a Logical Minimum of 0 and a Logical Maximum of 128.
Logical Maximum	0010 01 *nn*	Extent value in logical units. This is the maximum value that a variable or array item will report.
Physical Minimum	0011 01 *nn*	Minimum value for the physical extent of a variable item. This represents the Logical Minimum with units applied to it.
Physical Maximum	0100 01 *nn*	Maximum value for the physical extent of a variable item.
Unit Exponent	0101 01 *nn*	Value of the unit exponent in base 10. See the table later in this section for more information.
Unit	0110 01 *nn*	Unit values.
Report Size	0111 01 *nn*	Unsigned integer specifying the size of the report fields in bits. This allows the parser to build an item map for the report handler to use. For more information, see Section 8: Report Protocol.
Report ID	1000 01 *nn*	Unsigned value that specifies the Report ID. If a Report ID tag is used anywhere in Report descriptor, all data reports for the device are preceded by a single byte ID field. All items succeeding the first Report ID tag but preceding a second Report ID tag are included in a report prefixed by a 1-byte ID. All items succeeding the second but preceding a third Report ID tag are included in a second report prefixed by a second ID, and so on. This Report ID value indicates the prefix added to a particular report. For example, a Report descriptor could define a 3-byte report with a Report ID of 01. This device would generate a 4-byte data report in which the first byte is 01. The device may also generate other reports, each with a unique ID. This allows the host to distinguish different types of reports arriving over a single interrupt in pipe. And allows the device to distinguish different types of reports arriving over a single interrupt out pipe. Report ID zero is reserved and should not be used.
Report Count	1001 01 *nn*	Unsigned integer specifying the number of data fields for the item; determines how many fields are included in the report for this particular item (and consequently how many bits are added to the report).
Push	1010 01 *nn*	Places a copy of the global item state table on the stack.
Pop	1011 01 *nn*	Replaces the item state table with the top structure from the stack.
Reserved	1100 01 *nn* to 1111 01 *nn*	Range reserved for future use.

1.2.6. Local Items

图 1.8. HID Local Items

Tag	One-Byte Prefix (*nn* represents size value)	Description
Usage	0000 10 *nn*	Usage index for an item usage; represents a suggested usage for the item or collection. In the case where an item represents multiple controls, a Usage tag may suggest a usage for every variable or element in an array.
Usage Minimum	0001 10 *nn*	Defines the starting usage associated with an array or bitmap.
Usage Maximum	0010 10 *nn*	Defines the ending usage associated with an array or bitmap.
Designator Index	0011 10 *nn*	Determines the body part used for a control. Index points to a designator in the Physical descriptor.
Designator Minimum	0100 10 *nn*	Defines the index of the starting designator associated with an array or bitmap.
Designator Maximum	0101 10 *nn*	Defines the index of the ending designator associated with an array or bitmap.
String Index	0111 10 *nn*	String index for a String descriptor; allows a string to be associated with a particular item or control.
String Minimum	1000 10 *nn*	Specifies the first string index when assigning a group of sequential strings to controls in an array or bitmap.
String Maximum	1001 10 *nn*	Specifies the last string index when assigning a group of sequential strings to controls in an array or bitmap.
Delimiter	1010 10 *nn*	Defines the beginning or end of a set of local items (1 = open set, 0 = close set).
Reserved	1010 10 *nn* to 1111 10 *nn*	Reserved.

Table 1: Usage Page Summary

Page ID	Page Name	Section or Document
00	Undefined	
01	Generic Desktop Controls	4
02	Simulation Controls	5
03	VR Controls	0
04	Sport Controls	7
05	Game Controls	8
06	Generic Device Controls	9
07	Keyboard/Keypad	10
08	LEDs	11
09	Button	12
0A	Ordinal	13
0B	Telephony	14
0C	Consumer	15
0D	Digitizer	16
0E	Reserved	
0F	PID Page	*USB Physical Interface Device definitions for force feedback and related devices.*
10	Unicode	17
11-13	Reserved	
14	Alphanumeric Display	18
15-3f	Reserved	
40	Medical Instruments	19
41-7F	Reserved	
80-83	Monitor pages	*USB Device Class Definition for Monitor Devices*
84-87	Power pages	*USB Device Class Definition for Power Devices*
88-8B	Reserved	
8C	Bar Code Scanner page	*USB Device Class Definition for Point of Sale Devices*
8D	Scale page	
8E	Magnetic Stripe Reading (MSR) Devices	
8F	Reserved Point of Sale pages	
90	Camera Control Page	*USB Device Class Definition for Image Class Devices*
91	Arcade Page	*OAAF Definitions for arcade and coinop related Devices*
92-FEFF	Reserved	
FF00-FFFF	Vendor-defined	

第 2 章 HID Report Example

2.1. Normal examples

2.1.1. Generic mouse

3-button mouse:

图 2.1. HID Report Example - 3 button mouse

E.10 Report Descriptor (Mouse)

Item		Value (Hex)
Usage Page (Generic Desktop),		05 01
Usage (Mouse),		09 02
Collection (Application),		A1 01
Usage (Pointer),		09 01
Collection (Physical),		A1 00
Usage Page (Buttons),		05 09
Usage Minimum (01),		19 01
Usage Maximun (03),		29 03
Logical Minimum (0),		15 00
Logical Maximum (1),		25 01
Report Count (3),		95 03
Report Size (1),		75 01
Input (Data, Variable, Absolute),	;3 button bits	81 02
Report Count (1),		95 01
Report Size (5),		75 05
Input (Constant),	;5 bit padding	81 01
Usage Page (Generic Desktop),		05 01
Usage (X),		09 30
Usage (Y),		09 31
Logical Minimum (-127),		15 81
Logical Maximum (127),		25 7F
Report Size (8),		75 08
Report Count (2),		95 02
Input (Data, Variable, Relative),	;2 position bytes (X & Y)	81 06
End Collection,		C0
End Collection		C0

Note: above data’ s format is:

05 01 = 0x 01 05

09 02 = 0x 02 09

2.1.2. Keyboard

图 2.2. HID Report Example - keyboard - 1/2

表 10　報告描述元範例	
鍵盤	
項目	編碼
Usage Page (Generic Desktop),	0x0105
Usage (**Keyboard**),	0x0609
Collection (Application),	0x01A1
Usage Page (Keyboard),	0x0705
Usage Minimum (224),	0xE019
Usage Maximum (231),	0xE729
Logical Minimum (0),	0x0015
Logical Maximum (1),	0x0125
Report Size (1),	0x0175
Report Count (8),	0x0895
Input (Data, Variable, Absolute),	0x0281
Report Size (8),	0x0875
Report Count (1),	0x0195
Input (Constant),	0x0181
Usage Minimum (0),	0x0019

图 2.3. HID Report Example - keyboard - 2/2

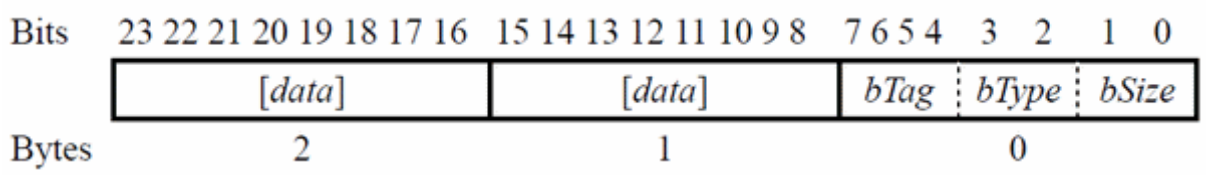
Usage Maximum (101),	0x6529
Logical Minimum (0),	0x0015
Logical Maximum (101),	0x6525
Report Size (8),	0x0875
Report Count (6),	0x0695
Input (Data, Array),	0x0081
Usage Page (LEDs),	0x0805
Usage Minimum (1),	0x0119
Usage Maximum (5),	0x0529
Logical Minimum (0),	0x0015
Logical Maximum (1),	0x0125
Report Size (1),	0x0175
Report Count (5),	0x0595
Output (Data, Variable, Absolute),	0x0291
Report Size (3),	0x0375
Report Count (1),	0x0195
Output (Constant),	0x0191
End Collection	0xC0

2.2. An HID Report Example analysis

Follow is the example.

According to the format, defined in specification:

图 2.4. HID Data Format



Now to analysis the corresponding meaning for every group bytes:

Data send by LSB

The data is send by LSB, so when "0x45, 0xFF' is sent, first send is "0x45", second send "0xFF", the LSB is "0x45" located in low address, the MSB "0xFF" located in high address, so the hex value is " 0xFF45 "

```
0x06, 0x45, 0xFF,❶
0x0A, 0x00, 0xA0,❷
0xA1, 0x01,❸
0x75, 0x08,❹
0x96, 0x07, 0x01,❺
0x15, 0x00,❻
0x26, 0xFF, 0x00,❼
0x0A, 0x01, 0xA0,❽
0x91, 0x02,❾
0x75, 0x08,❿
0x95, 0x08,⓫
0x0A, 0x02, 0xA0,⓬
0x81, 0x02,⓭
0xC0⓮
```

❶

[Data]	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x06
0xFF	0x45	0000	01	10	0000 0110
0xFF45 -> 0xFF00 -0xFFFF = Vendor defined		Usage Page	Global item	2 bytes	

❷

[Data]	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x0A
0xA0	0x00	0000	10	10	0000 1010
Usage=0xA000		Usage	Local item	2 bytes	

here Usage=0xA000 is just self defined, just need not confict with self's others, no other special meaning

❸

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0xA1
	0x01	1010	00	01	1010 0001
	Application (mouse, keyboard)	Collection	Main item	1 bytes	

❹

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x75
	0x08	0111	01	01	0111 0101
	Report Size = 0x08 bits	Report Size	Global item	1 bytes	

❺

[Data]	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x96
0x01	0x07	1001	01	10	1001 0110
Report Count = 0x0107=263		Report Count	Global item	2 bytes	

❻

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x15
	0x00	0001	01	01	0001 0101
	Logical Minimum = 0x00	Logical Minimum	Global item	1 bytes	

❼

[Data]	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x26
0x00	0xFF	0010	01	10	0010 0110
Logical Maximum =x00FF=255		Logical Maximum	Global item	2 bytes	

❽

[Data]	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x0A
0xA0	0x01	0000	10	10	0000 1010
Usage = 0xA001		Usage	Local item	2 bytes	

here Usage=0xA001 is just self defined, just need not confict with self's others, no other special meaning

❾

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x91
	0x02	1001	00	01	1001 0001
	0x02=0000 0010 Bit 1 { Variable (1)} All other bits are Reserved (0)	Output	Main item	1 bytes	

❿

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x75
	0x08	0111	01	01	0111 0101
	Report Size = 0x08 bits	Report Size	Global item	1 bytes	

⓫

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x95
	0x08	1001	01	01	1001 0101
	Report Count= 0x08 = 8	Report Count	Global item	1 bytes	

⓬

[Data]	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x0A
0xA0	0x02	0000	10	10	0000 1010
Usage = 0xA002		Usage	Local item	2 bytes	

⓭

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x81
	0x02	1000	00	01	1000 0001
	0x02=0000 0010 Bit 1 { Variable (1)}	Input	Main item	1 bytes	

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0x81
	All other bits are Reserved (0)				

⓮

	[Data]	bTag=7:4	bType=3:2	bSize=1:0	0xC0
		1100	00	00	1100 0000
Closes an item collection		End Collection	Main item	0 bytes	

After analyze following data, the summary is:

Usage Page (0xFF45)	=Vendor-Specific	0xFF45 06	Global
Usage (0xA000)		0xA000 0A	Local
Collection (Application)		0x01 A1	Main
	Report Size (8)	0x08 75	Global
	Report Count (263)	0x0107 96	Global
	Logical Minimum (0)	0x00 15	Global
	Logical Maximum (255)	0x00FF 26	Global
	Usage (0xA001)	0xA0001 0A	Local
	Output (Variable)	0x02 91	Main
	Report Size (8)	0x08 75	Global
	Report Count (8)	0x08 95	Global
	Usage (0xA002)	0xA002 0A	Local
	Input (Variable)	0x02 81	Main
End Collection		0xC0	Main

Report (Usage=0xA0000)	
	Output Report (Usage=0xA001)
263 bytes	Byte 0
	Byte 1
	...
	...
	Byte 261
	Byte 262
	Input Report (Usage=0xA002)
8 bytes	Byte 0
	Byte 1
	...
	Byte 7

All of above means:

1. This is a vendor-specific HID device

2. input or output is relative to Host side:
   - Output = Host ⇒ Device = host send 263 bytes to device
   - Input = Host ⇐ Device = device send 8 bytes to host
3. Every bytes value range is 0~255