TB057

USB Combination Devices
Demonstrated by a Combination Mouse and Gamepad Device

Author: Reston Condit

Company: Microchip Technology Inc.

OVERVIEW

This Technical Brief describes a USB combination device consisting of a mouse and a gamepad implemented on a PIC16C765. Previous technical briefs describe the translation of a PS/2® mouse to a USB mouse (TB055) and the translation of a gameport gamepad to a USB gamepad (TB054). These two devices were combined to form the USB combination device described in this brief. Details about the translation and implementation of the mouse and the gamepad are not covered. Refer to the earlier briefs for this information as well as their circuit diagrams. This brief focuses on setting up the descriptors appropriately for a combination device.

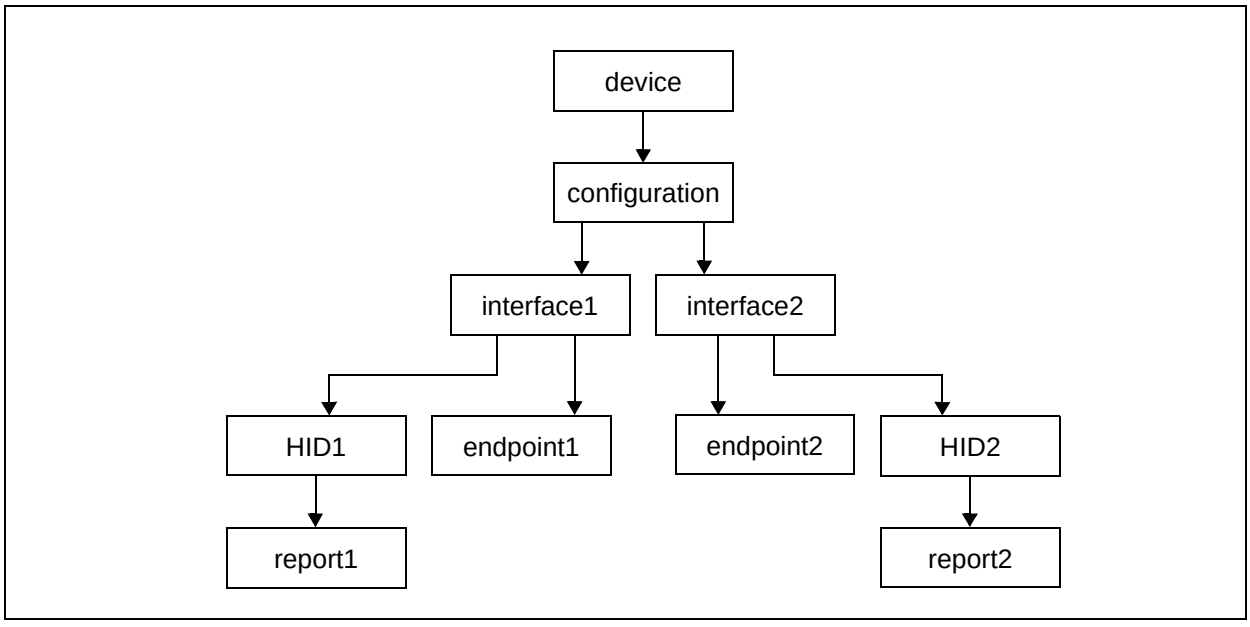
Note: This Technical Brief is the fourth in a series of five technical briefs. This series is meant to familiarize developers with USB. For the best understanding of USB, read the briefs in order: TB054, TB055, TB056, TB057, TB058

DESCRIPTORS

A combination device, from the USB standpoint, is a device with multiple interfaces. An interface is an endpoint or a group of endpoints that perform(s) a certain function. Since only two endpoints are available in low speed USB devices, low speed combination devices will always consist of two interfaces, one endpoint each. Two interfaces require two interface descriptors. In this case, interface one is a mouse and interface two is a gamepad. Figure 1 shows the descriptors needed for the implementation of the combination mouse and gamepad USB device. Both the mouse and gamepad are part of the *Human Interface Device (HID)* class - this means each device has a report and HID descriptor associated with it.

Note 1: See the complete descriptor listing in file `descript.asm`

FIGURE 1: USB COMBINATION DEVICE DESCRIPTORS



The descriptors are sent to the host in response to the following requests:

- `Get_Device_Descriptor`
- `Get_Configuration_Descriptor`
- `Get_Report_Descriptor`
- `Get_String_Descriptor`

The DEVICE descriptor is the first descriptor to be sent to the host during enumeration. It is sent in response to the `Get_Device_Descriptor` request. The CONFIGURATION, INTERFACE, HID, and ENDPOINT descriptors are all sent to the host in response to the `Get_Configuration_Descriptor` request. They are sent in the following order (refer to Figure 1):

- CONFIGURATION
- INTERFACE1
- HID1
- ENDPOINT1
- INTERFACE2
- HID2
- ENDPOINT2.

Report descriptors are sent in response to the `Get_Report_Descriptor` request and finally STRING descriptors in response to the `Get_String_Descriptor` request. Depending on the operating system, the string descriptors may be requested before the report descriptors.

How report descriptors are associated with endpoints is not entirely intuitive or easily understood from the *HID Class Definitions*. Report descriptors are not like other descriptors in that they do not have a field that identifies them as a report descriptor. Nor do report descriptors have an index number that distinguishes one from another. Report descriptors are composed entirely of report format data. The host associates a report descriptor with the appropriate endpoint using the following information:

1. The order report descriptors are mentioned by HID descriptors
2. The descriptor tree (contains the descriptors found on a particular branch)

From Figure 1 it is seen that HID1 is associated with ENDPOINT1 because it is on the same branch of the descriptor tree as ENDPOINT1. Also seen in the figure, HID1 specifies that it has a report descriptor, REPORT1. The host assigns this report descriptor an index value of 0 (this is a zero based array) simply because HID1 is the first descriptor sent to the host that specifies a report descriptor. Similarly, the host assigns the report descriptor specified by HID2 and index value of 1. The host keeps track of which descriptors branch off a particular interface. Therefore, the host is able to deduce that report descriptors with indexes 0 and 1 are describing communication that will take place over the endpoints described by ENDPOINT1 and ENDPOINT2, respectively. The host will obtain these report descriptors from the device with the `Get_Report_Descriptor` request. As part of this request, the host specifies the index number of the descriptor it desires. It is up to the developer to make sure that REPORT1 is sent to the host when index 0 is specified in the request and REPORT2 is sent to the host when index 1 is specified. The REPORT DESCRIPTOR INDEX, in file `descript.asm`, makes this process possible. In this index, the labels for the report descriptors are listed in the order that the corresponding HID descriptors are sent to the host. Example 1 is a listing of the report descriptor index for the USB mouse/gamepad combination device:

EXAMPLE 1: REPORT DESCRIPTOR INDEX

```
Report_desc_index                       ;this function is called with the index number
                                        ; of the report descriptor in W
movwf   temp
movlw   HIGH RDI_start
movwf   PCLATH
movlw   low  RDI_start
addwf   temp,w
btfsc   STATUS,C
incf    PCLATH,f
movwf   PCL
RDI_start                               ; this table calculates the offsets for each
                                          report
retlw   low  ReportDescriptorLen1       ; descriptor with index of zero
retlw   high ReportDescriptorLen1
retlw   low  ReportDescriptorLen2       ; descriptor with index of one
```

The REPORT DESCRIPTOR INDEX is called in order for the firmware to obtain the starting address of a specific report descriptor. Another jump table is responsible for feeding the descriptor to the host once it has this information.

Note:	Similar descriptor indexes are included in Microchip's USB firmware for multiple string and configuration descriptors. See file `descript.asm` for their listings

Table 1 specifies the fields within descriptors that are affected by a combination device.

TABLE 1: AFFECTED FIELDS WITHIN DESCRIPTORS

Descriptor	Offset	Field	Why Affected?
Configuration	4	*bNumInterfaces*	Specifies number of interface descriptors to follow.
Interface	2	*bInterfaceNumber*	Multiple interfaces mean interface descriptors with different interface numbers (IDs).
Interface	4	*bNumEndpoints*	There will always be one endpoint per interface in a low speed combination device.
Endpoint	2	*bEndpointAddress*	This is the endpoint number and direction. Two endpoints must be used for a low speed combination device.

MEMORY USAGE

In the PIC16C765, the following memory was used

Data Memory: 50 bytes

Program Memory: 2K bytes

REFERENCES

1. *USB Specification*, Version 1.1: Chapter 9 (located at www.usb.org)
2. *Device Class Definition for Human Interface Devices* (located at www.usb.org)
3. *HID Usage Tables* (located at www.usb.org)
4. *USB Firmware User's Guide* (located in USB Support Firmware zip file at www.microchip.com)
5. *USB Complete, Second Edition,* Jan Axelson; Lakeview Research, 2001 (www.lvr.com)
6. *PS/2 Mouse/Keyboard Protocol*, Adam Chapweske,

   http://panda.cs.ndsu.nodak.edu/~achapwes/PICmicro/PS2/ps2.htm
7. TB054: *An Introduction to USB Descriptors with a Gameport to USB Gamepad Translator*
8. TB055: *PS/2 to USB Mouse Translator*
9. TB056: *Demonstrating the Set_Report Request with a PS/2 to USB Keyboard Translator Example*
10. TB058: *Demonstrating the Soft Detach Function with a PS/2 to USB Translator Example*

APPENDIX A: SOURCE CODE

Due to the length of the source code for the USB Combination Mouse/Gamepad example, the source code is available separately. The complete source code is available as a single WinZip archive file, `tb057sc.zip`, which may be downloaded from the Microchip corporate Web site at:

www.microchip.com

Note the following details of the code protection feature on PICmicro® MCUs.

- The PICmicro family meets the specifications contained in the Microchip Data Sheet.
- Microchip believes that its family of PICmicro microcontrollers is one of the most secure products of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the PICmicro microcontroller in a manner outside the operating specifications contained in the data sheet. The person doing so may be engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as “unbreakable”.
- Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our product.

If you have any further questions about this matter, please contact the local sales office nearest to you.

DNV Certification, Inc. USA — ANSI-RAB QMS ACCREDITED — DNV MSC The Netherlands Accredited by the RvA — DNV — ISO 9001 / QS-9000 REGISTERED FIRM

Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999. The Company’s quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs and microperipheral products. In addition, Microchip’s quality system for the design and manufacture of development systems is ISO 9001 certified.

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo
2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

New York
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

Australia
Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing
Microchip Technology Consulting (Shanghai) Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu
Microchip Technology Consulting (Shanghai) Co., Ltd., Chengdu Liaison Office
Rm. 2401, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-6766200 Fax: 86-28-6766599

China - Fuzhou
Microchip Technology Consulting (Shanghai) Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Shanghai
Microchip Technology Consulting (Shanghai) Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen
Microchip Technology Consulting (Shanghai) Co., Ltd., Shenzhen Liaison Office
Rm. 1315, 13/F, Shenzhen Kerry Centre,
Renminnan Lu
Shenzhen 518001, China
Tel: 86-755-2350361 Fax: 86-755-2366086

Hong Kong
Microchip Technology Hongkong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India
Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-334-8870 Fax: 65-334-8850

Taiwan
Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Denmark
Microchip Technology Nordic ApS
Regus Business Centre
Lautrup hoj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Italy
Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

01/18/02