# TB057

## USB Combination Devices
### Demonstrated by a Combination Mouse and Gamepad Device

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## 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.

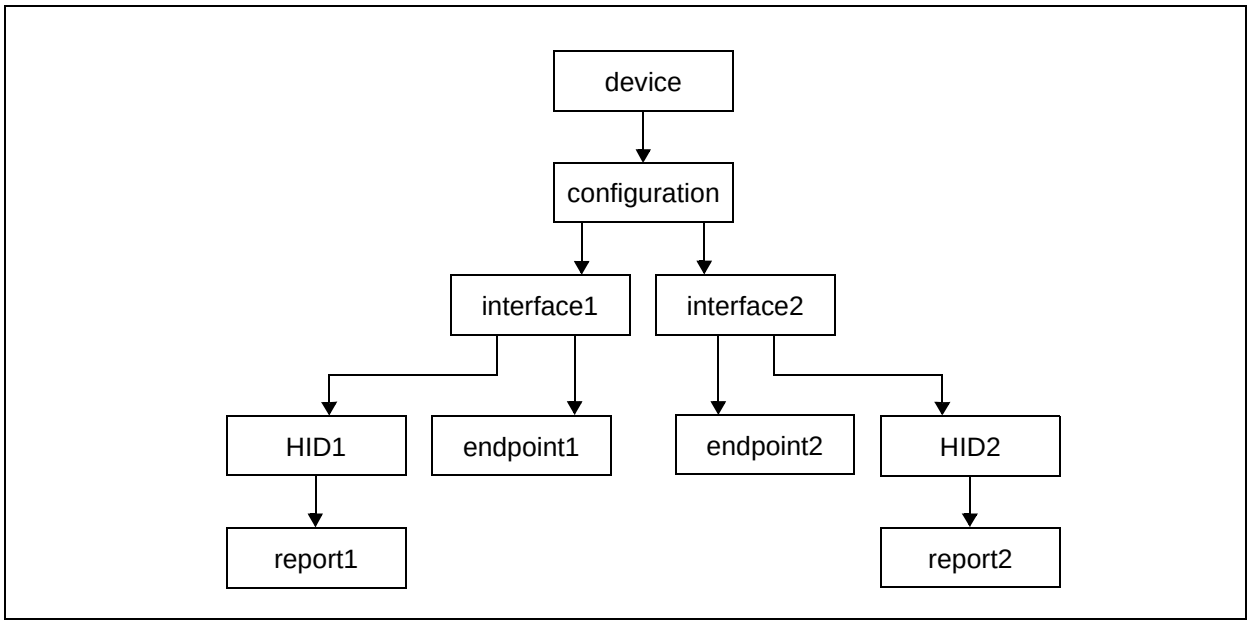
**Note:** This Technical Brief is the fourth in a series of five technical briefs. This series is meant to familiarize developers with USB. For the best understanding of USB, read the briefs in order: TB054, TB055, TB056, TB057, TB058

## 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**

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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
```


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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*


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## 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:

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01/18/02


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