
Demonstrating the Soft Detach Function With a PS/2[®] to USB Translator Example

*Author: Reston Condit
Microchip Technology Inc.*

INTRODUCTION

This Technical Brief describes the creation of a USB device that can enumerate as a mouse or as a keyboard, depending on which PS/2[®] peripheral is plugged into it. The Soft Detach provision of the PIC16C745/765 support firmware makes the creation of such a device possible. Technical Briefs, TB055 and TB056, describe in detail the implementation of a PS/2 to USB mouse translator and a PS/2 to USB keyboard translator, respectively. This Brief will not discuss the translation of either of these two devices. It focuses on the Soft Detach function and modifying the descriptor jump table for a device with multiple sets of descriptors.

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

SOFT DETACH

The `SoftDetachUSB` command enables the PICmicro[®] microcontroller (MCU) to have control when it is enumerated by the host. Several things occur during the Soft Detach process. The microcontroller turns off the pull-up resistor to `VUSB`. The firmware does this by clearing the `DEV_ATT` bit. Turning the pull-up resistor off has the effect of removing the microcontroller from the bus. After approximately 50 ms or enough time for the host to see the device disconnect, the firmware sets `DEV_ATT` and “reconnects” the microcontroller to the bus. Soft Detach then calls the `InitUSB` command and waits for the host to re-enumerate the PICmicro MCU.

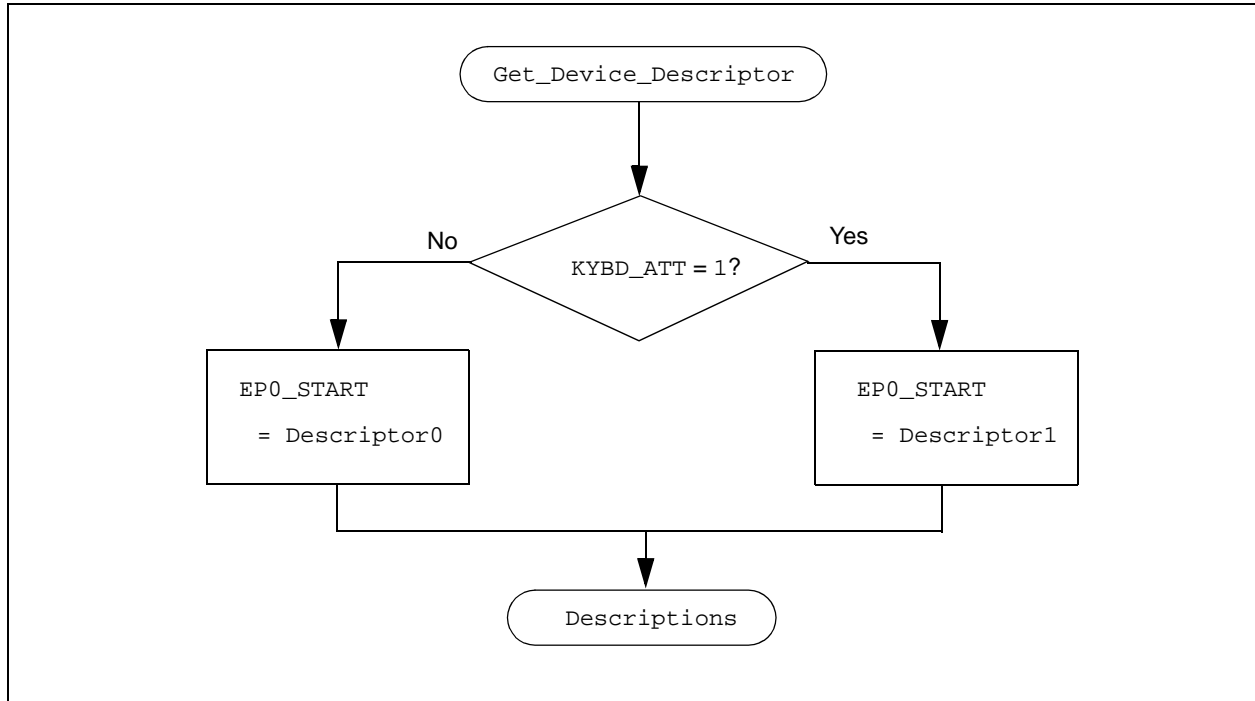
Soft Detach is one of the most useful features on Microchip's PIC16C745/765 USB microcontroller. The reason the Soft Detach command is so useful, is that, in applications such as this one, no special driver needs to be created for the host. The more typical approach to this application would be to create two configurations: one for a mouse and the other for a keyboard. A special driver would have to be created for the host that would instruct the microcontroller to change configurations. In order to do this, the host's driver would have to be able to detect which peripheral is attached. An easy way to avoid the difficulty of creating a unique driver for the host, is to give the microcontroller control over whether it will send the host mouse or keyboard data. Based on the type of data it will send to the PC, the microcontroller can perform a Soft Detach and then re-enumerate as the peripheral of choice.

Implementation of Soft Detach

The PICmicro MCU determines the type of device it will enumerate as based on the PS/2 device currently plugged into the translator circuit. For instance, if a PS/2 mouse is plugged into the translator, the PIC16C745/765 will enumerate as a USB mouse (see Figure 1 for the circuit diagram). The translator detects what type of device is attached through the following sequence of events, beginning with a PS/2 device being unplugged.

1. An interrupt is generated when the PS/2 data line goes low.
2. The receive routine is initiated because it is assumed that the data line dropping low is the result of a Start bit being sent by the PS/2 device or the PS/2 device has been unplugged.
3. The receive routine times out indicating that the data line is staying low due to the device being unplugged.
4. The PIC16C745/765 waits for a PS/2 device to be attached.
5. The clock and data lines both go high indicating a device has been plugged in.
6. The PICmicro MCU firmware asks the PS/2 device to identify itself. (See PS/2 commands and responses in the Appendix).
7. Based on the PS/2 device's response, the firmware will perform a Soft Detach and re-enumerate as the corresponding USB device.

FIGURE 2: GET_DEVICE_DESCRIPTOR ROUTINE



GET_STRING_DESCRIPTOR

No modifications to the `Get_String_Descriptor` routine are needed. The reason for this is that string descriptors are indexed. In other words, all descriptors (other than string descriptors) have fields where string indexes are specified. For a device descriptor, for instance, the `iProduct` field may be specified as a 3. This means that String 3 contains product information. This field could have easily been assigned an 8 as long as String 8 contains the product information. Therefore, for multiple descriptor sets, the first set can use strings 0 through 5 and the second set 6 through 10.

CONCLUSION

The PS/2 to USB translator demonstrates the Soft Detach function by enumerating as either a USB mouse or keyboard depending on which PS/2 device is plugged into it. Soft Detach is a useful feature included in the PIC16C745/765 support firmware because it allows developers to emulate connecting and unconnecting their peripheral while the device is plugged into the host. This characteristic makes it possible for developers to change the entire descriptor set of their device on-the-fly.

MEMORY USAGE

In the PIC16C765, the following memory was used:

- Data Memory: 50 bytes
- Program Memory: 2910 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,
7. <http://panda.cs.ndsu.nodak.edu/~achapwes/PICmicro/PS2/ps2.html>
8. TB054: *An Introduction to USB Descriptors with a Game Port to USB Game Pad Translator* (DS91054)
9. TB055: *PS/2[®] to USB Mouse Translator* (DS91055)
10. TB056: *Demonstrating the Set_Report Request with a PS/2[®] to USB Keyboard Translator Example* (DS91056)
11. TB057: *USB Combination Devices Demonstrated by a Combination Mouse and Game Pad Device* (DS91057)

APPENDIX A: PS/2® COMMANDS

TABLE 1: HOST TO PS/2® KEYBOARD COMMANDS

Hex Code	Description
ED	Turns on/off LEDs. Keyboard replies with ACK (FA) and waits for another byte to be sent. Next byte sent determines the state of the LEDs (Bits 0-2 correspond to LEDs 1, 2 and 3. Bits 3-7 should always be 0).
EE	Echo. Keyboard should respond with Echo (EE).
F0	Set Scan Code Set. Responds with ACK (FA) and waits for another byte to be sent. Next byte sent will be either 01, 02 or 03 (corresponding to scan code sets 1, 2 and 3). If 00 is sent (instead of 01, 02 or 03) keyboard will respond with ACK (FA) followed by the current scan code set (again, 01, 02 or 03).
F2	Get ID. Responds with ACK (FA) followed by an ID (A3, AB). This also enables scanning.
F3	Set repeat rate. Keyboard replies with ACK (FA) and waits for another byte to be sent. Next byte sent will determine the typematic repeat rate for the keyboard. *SEE NOTE BELOW*. After this byte is sent, keyboard responds with another ACK (FA).
F4	Enable keyboard. Clears the buffer and starts scanning for data; Replies with ACK (FA).
F5	Disable keyboard. Disables scanning and replies with ACK (FA). Does not affect indicator LEDs.
F6	Restore default values. Does not affect indicator LEDs.
F7	Set all keys typematic. Responds with ACK (FA).
F8	Set all keys make/break. Responds with ACK (FA).
F9	Set all keys make. Responds with AK (FA).
FA	Set all keys typematic/make/break. Responds with ACK (FA).
FB	Set key type typematic.
FC	Set key type make/break.
FD	Set key type make.
FE	Resend. Keyboard responds by retransmitting the last command it sent.
FF	Reset. Resets the keyboard.

TABLE 2: PS/2® KEYBOARD TO HOST COMMANDS

Hex Code	Description
00	Key detection error/keyboard buffer overflow (if set, w or 3 scan codes are enabled).
83,AB	Keyboard ID.
AA	Self-test passed.
EE	Echo. Sent to Host after receiving "Echo" command from host.
FA	Acknowledge (ACK).
FC	Self-test failed.
FE	Resend. Host responds by re-transmitting the last command sent.
FF	Key detection error/keyboard buffer overflow (if set 1 scan codes are enabled).

TABLE 3: PS/2® MOUSE COMMANDS

Hex Code	Description
FF	Reset. This command causes the mouse to enter the Reset mode and do an internal self-reset.
FE	Resend. Any time the mouse receives an invalid command, it returns a Resend command to the host system. The host system, in turn, sends this command when it detects any error in any transmission from the mouse. When the mouse receives the Resend command, it retransmits the last packet of data sent.
F6	Set Default – This command re-initializes all conditions to the power-on default state.
F5	Disable – This command is used in the Stream mode to stop transmissions initiated by the mouse. The mouse responds to all other commands while disabled. If the mouse is in the Stream mode, it must be disabled before sending it any command that requires a response.
F4	Enable – This command is used in the Stream mode to begin transmission.
F3, XX	Set sampling rate – In the Stream mode, this command sets the sampling rate to the value indicated by byte XX (Hex)/sec.
F2	Read Device Type – This command always receives a response of 0x00 from the mouse.
F0	Set Remote mode – Sets the mouse to Remote mode. Data values are reported on in response to a Read Data command.
EE	Set Wrap mode – Sets the mouse to Wrap mode. The mode remains until 0xFF or 0xEC is received.
EC	Reset Wrap mode – The mouse returns to the previous mode of operation after receiving this command.
EB	Read data – This command requests that all data defined in the data packet format be transmitted. This command is executed in either Remote or Stream mode. This data is transmitted even if there has been no movement since the last report or the switch status is unchanged.
EA	Set Stream mode – this command sets the mouse to Stream mode.
E9	Status request – When this command is issued by the system, the mouse responds with a 3-byte status report, same as Data Report.
E8, XX	Set resolution – The mouse provides 4 resolutions, selected by the second byte of the command.
E7	Set scaling 2:1 – Scaling is used to provide a course/fine tracking response. At the end of a sample interval in the Stream mode, the current X and Y data value are converted to new values. The sign bits are not involved in the conversion. 2:1 scaling is performed only in Stream mode. In response to a Read Data command, the current value before conversion is sent.
E6	Reset scaling – This command restores scaling to 1:1.

TB058

APPENDIX B: SOURCE CODE

Due to the length of the source code for the PS/2 to USB Translator, the source code is available separately. The complete source code is available as a single WinZip archive file, `tb058sc.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 Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families 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 Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is 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 products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELoQ, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, PowerSmart and rPIC are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.


AmpLab, FilterLab, microID, MXDEV, MXLAB, PICMASTER, SEEVAL, SmartShunt and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Application Maestro, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICkit, PICDEM, PICDEM.net, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, rLAB, Select Mode, SmartSensor, SmartTel and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2004, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

**QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949:2002 ==**

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELoQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 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>

Atlanta

3780 Mansell Road, Suite 130
Alpharetta, GA 30022
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, IN 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

San Jose

1300 Terra Bella Avenue
Mountain View, CA 94043
Tel: 650-215-1444
Fax: 650-961-0286

Toronto

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

ASIA/PACIFIC

Australia

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

China - Beijing

Unit 706B
Wan Tai Bei Hai Bldg.
No. 6 Chaoyangmen Bei Str.
Beijing, 100027, China
Tel: 86-10-85282100
Fax: 86-10-85282104

China - Chengdu

Rm. 2401-2402, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-86766200
Fax: 86-28-86766599

China - Fuzhou

Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506
Fax: 86-591-7503521

China - Hong Kong SAR

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

China - Shanghai

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

Rm. 1812, 18/F, Building A, United Plaza
No. 5022 Binhe Road, Futian District
Shenzhen 518033, China
Tel: 86-755-82901380
Fax: 86-755-8295-1393

China - Shunde

Room 401, Hongjian Building, No. 2
Fengxiangnan Road, Ronggui Town, Shunde
District, Foshan City, Guangdong 528303, China
Tel: 86-757-28395507 Fax: 86-757-28395571

China - Qingdao

Rm. B505A, Fullhope Plaza,
No. 12 Hong Kong Central Rd.
Qingdao 266071, China
Tel: 86-532-5027355 Fax: 86-532-5027205

India

Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaughnessy Road
Bangalore, 560 025, India
Tel: 91-80-22290061 Fax: 91-80-22290062

Japan

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

168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5932 or
82-2-558-5934

Singapore

200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan

Kaohsiung Branch
30F - 1 No. 8
Min Chuan 2nd Road
Kaohsiung 806, Taiwan
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan

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

EUROPE

Austria

Durisolstrasse 2
A-4600 Wels
Austria
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark

Regus Business Centre
Lautrup høj 1-3
Ballerup DK-2750 Denmark
Tel: 45-4420-9895 Fax: 45-4420-9910

France

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

Germany

Steinheilstrasse 10
D-85737 Ismaning, Germany
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy

Via Quasimodo, 12
20025 Legnano (MI)
Milan, Italy
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands

P. A. De Biesbosch 14
NL-5152 SC Drunen, Netherlands
Tel: 31-416-690399
Fax: 31-416-690340

United Kingdom

505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44-118-921-5869
Fax: 44-118-921-5820

02/17/04