



**Application Note: GP-AN-061130 Rev. B**

# **Designing Low-Cost USB Keyboards With Advanced Multi-function Touchpads**

*This application note provides the electronic designs required to develop a USB keyboard with integrated multi-function touchpads. The implementation allows the touchpad to be configured not only as a “standard mouse” but allows the use of Cirque drivers which provide many advanced touchpad operating features.*



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Attachment A : COMB3-30\_20070228.HEX – Available Upon Request

## Revision History

Date	Previous Revision	Current Revision	Description
02/27/2007		A	<p>Inserted Revision History.</p> <p>Updated BOM line item 4 from part number 20-00106-01 to part number 20-004705-00</p> <p>Update Figures 2, 3, and 4 to include connections from touchpad and keyboard data lines to pins 1 and 2 of the USB microcontroller.</p> <p>Updated text under Design Guidelines regarding termination of USB suspend using pins 1 and 2 of the USB microcontroller.</p> <p>Updated Attachment A to improve USB operation under Vista operating systems.</p>
05/03/07		B	Added statement about “boot protocol” in the Operation section

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## Introduction

USB keyboards with integrated touchpads are becoming widely used in many consumer and OEM applications. Most designs utilize a USB microcontroller to combine the keyboard and touchpad data streams (usually PS/2) and convert to the standard USB protocols. Application notes for such standard designs are readily available from many manufacturers (*Ref. A*). However, these designs will NOT properly convert the “extended mode protocols” sent by Cirque touchpads. The extended mode protocol enables advanced features of the touchpad, such as horizontal scrolling, programmable hot links, zoom, and more. This application note addresses the design of a USB keyboard that will allow the use of standard Cirque drivers to enable the advanced touchpad features.

## Reference Design Characteristics

### Benefits

- USB interface
- Generic keyboard and touchpad with standard Windows® drivers
- OEM Branded drivers available
- Low manufacturing cost
- Plug & Play operation
- Keyboard and advanced touchpad operation with Cirque driver

### Available Design Aids

- Reference Design
- USB microprocessor firmware
- Schematics
- PCB layouts

### Keyboard Support

- Interfaces to MS Type II keyboard:  
104 keys, 18 media, 3 system  
Keyboard Scan Set 2

### Touchpad Support

- Cirque TSM series OEM touchpads
- Standard touchpad features:
  - Left/Right buttons
  - Vertical Scroll
  - Taps
  - Taps & Drag
- Cirque desktop touchpad products
- Advanced Touchpad features:
  - Horizontal scroll
  - Zoom
  - Back/Forward Page
  - Rotation
  - Tapping control
  - Cursor control
  - Programmable buttons
  - Programmable hot buttons
  - Multi-function (circular, linear)

## General Description

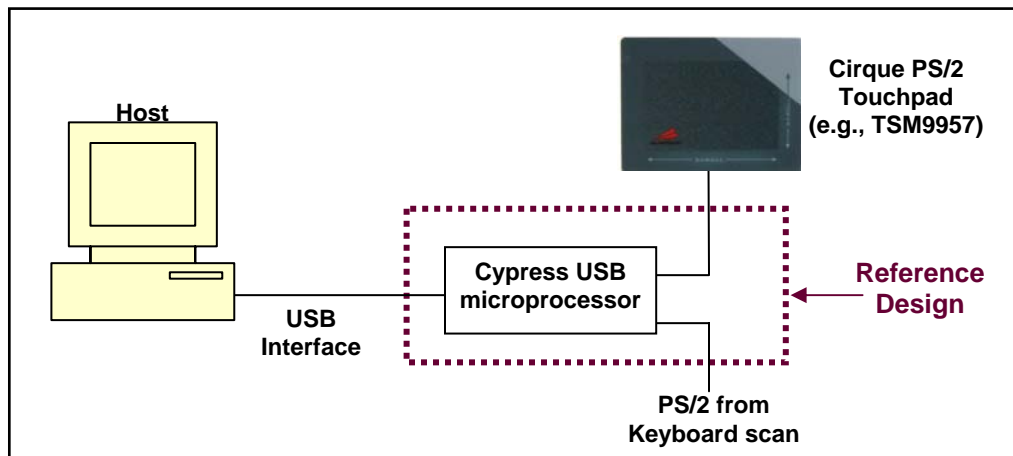


Figure 1: Block diagram of PS/2 keyboard and touchpad to USB

The major block elements of the Reference Design are shown in Figure 1. The Reference Design combines the PS/2 data stream from any Cirque TSM series touchpad and the PS/2 data from a keyboard-to-PS/2 scan converter. The resident firmware of the Cypress USB microprocessor has been developed to process keyboard commands and the “extended mode” data protocol of a Cirque TSM series touchpad. This extended mode protocol is required to interpret and execute the advanced feature set of the touchpad. When the driver receives the extended data stream, the integrated touchpad can then be configured by the consumer or OEM manufacturer to perform a variety of custom features.

The interface between the Reference Design and the host is compliant with USB specifications (*Ref. B and Ref. C*). The schematic for the Reference Design is shown in Figure 2.

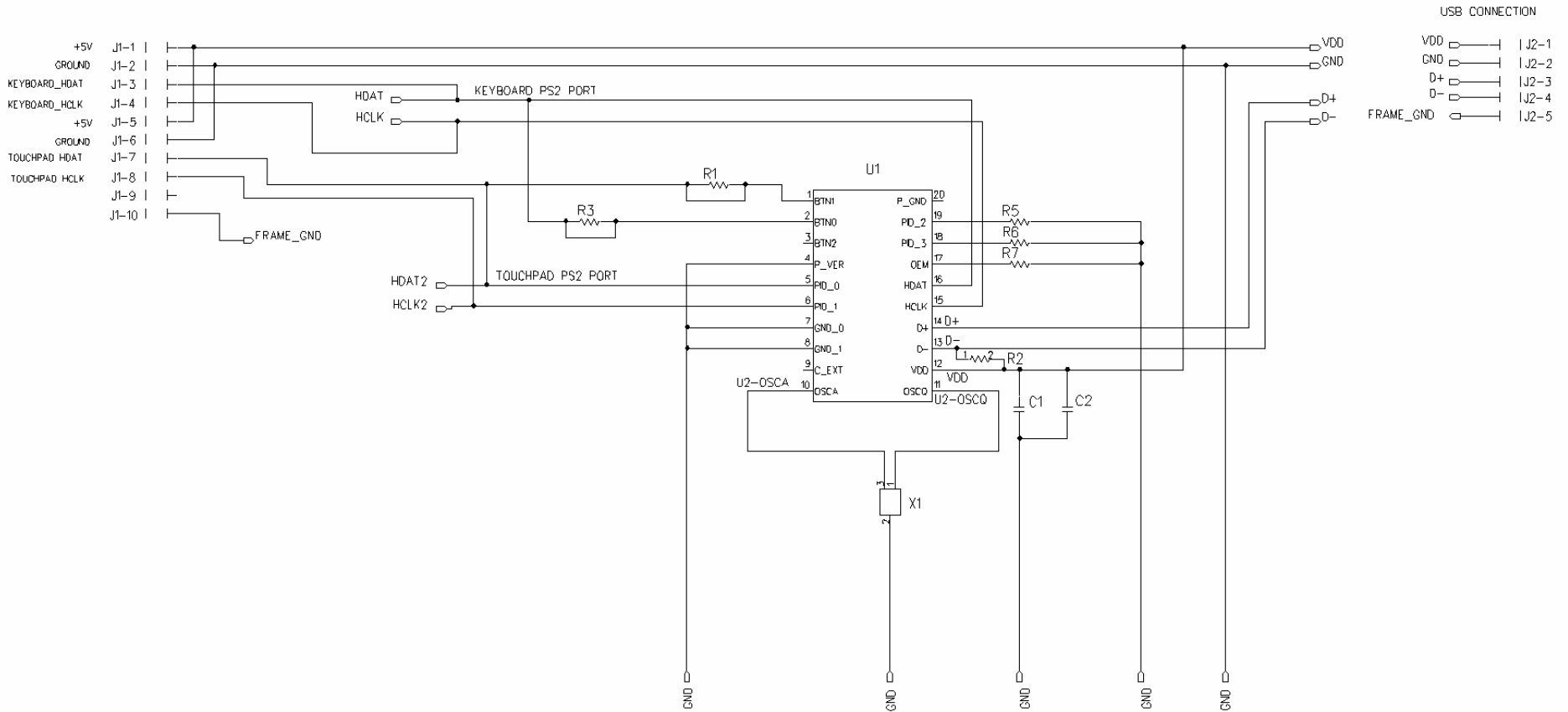


Figure 2: Schematic - USB Integration of PS/2 Touchpad with PS/2 Keyboard

## Operation

The core of the system is the USB microcontroller which interfaces to the host through USB protocol, and to the keyboard/touchpad using one control endpoint and one interrupt endpoint. All touchpad and keyboard data is reported through the interrupt endpoint. The firmware implements a “boot protocol” keyboard as well as five virtual devices using “report IDs” to identify the respective reports. The reports include keyboard, touchpad, “Extended Mode” touchpad, system, and consumer devices. Standard keys from the keyboard are reported through the keyboard report and support the LED displays required for Caps Lock, etc. The Power, Sleep, and Wake Up keys are reported through the system device. The multi-media keys (play / stop / volume +/- etc.) are reported through the consumer device. With a generic mouse driver, the touchpad reports as a standard mouse. When a Cirque driver is loaded, a vendor command is sent which causes the firmware to set the touchpad to Extended Mode for advanced features. Subsequently the system reports through the Extended Mode device. The boot protocol keyboard device allows the keyboard to be used prior to the loading of USB drivers -- for example when the PC is running BIOS setup. During this short time period, all other devices (touchpad, multi-media, etc.) will not function and should not be used.

Communication between the keyboard and the USB microcontroller is through PS/2 protocol. Many single chip keyboard scanning solutions are available in the market to convert the keyboard scan to PS/2 protocol. The typical keyboard scan should follow the MS Type II Keyboard, Scan Code Set 2 shown in Table 1. The USB micro firmware enables the keyboard and generally uses its default settings.

Communication between the USB microcontroller and the touchpad is also through PS/2 protocol. With a generic mouse driver this interface operates with a minimal startup sequence (3 byte packet: set resolution to 8, set sample rate to 100, enable) or a wheel mode startup sequence to allow vertical scrolling (4 byte packet: minimal startup sequence plus wheel enable). With a Cirque driver this interface is set to Extended Mode which is a 5 byte packet. (See “Touchpad Model TSM9957 Specification” for details.)

The Bill of Materials for this design is shown in Table 2. PCB layout files are available from Cirque Corporation for hardware development purposes and are shown in Figure 3 and Figure 4. The HEX firmware code for the Cypress USB microprocessor, “COMB\_20061201.HEX” is available upon request.

Table 1: Keyboard Scan Codes - Set 2

Key	Make	Break	Key	Make	Break	Key	Make	Break
A	1C	F0,1C	9	46	F0,46	[	54	F0,54
B	32	F0,32	`	0E	F0,0E	INSERT	E0,70	E0,F0,70
C	21	F0,21	-	4E	F0,4E	HOME	E0,6C	E0,F0,6C
D	23	F0,23	=	55	F0,55	PG UP	E0,7D	E0,F0,7D
E	24	F0,24	\	5D	F0,5D	DELETE	E0,71	E0,F0,71
F	2B	F0,2B	BKSP	66	F0,66	END	E0,69	E0,F0,69
G	34	F0,34	SPACE	29	F0,29	PG DN	E0,7A	E0,F0,7A
H	33	F0,33	TAB	0D	F0,0D	U ARROW	E0,75	E0,F0,75
I	43	F0,43	CAPS	58	F0,58	L ARROW	E0,6B	E0,F0,6B
J	3B	F0,3B	L SHFT	12	F0,12	D ARROW	E0,72	E0,F0,72
K	42	F0,42	L CTRL	14	F0,14	R ARROW	E0,74	E0,F0,74
L	4B	F0,4B	L GUI	E0,1F	E0,F0,1F	NUM	77	F0,77
M	3A	F0,3A	L ALT	11	F0,11	KP /	E0,4A	E0,F0,4A
N	31	F0,31	R SHFT	59	F0,59	KP *	7C	F0,7C
O	44	F0,44	R CTRL	E0,14	E0,F0,14	KP -	7B	F0,7B
P	4D	F0,4D	R GUI	E0,27	E0,F0,27	KP +	79	F0,79
Q	15	F0,15	R ALT	E0,11	E0,F0,11	KP EN	E0,5A	E0,F0,5A
R	2D	F0,2D	APPS	E0,2F	E0,F0,2F	KP .	71	F0,71
S	1B	F0,1B	ENTER	5A	F0,5A	KP 0	70	F0,70
T	2C	F0,2C	ESC	76	F0,76	KP 1	69	F0,69
U	3C	F0,3C	F1	5	F0,05	KP 2	72	F0,72
V	2A	F0,2A	F2	6	F0,06	KP 3	7A	F0,7A
W	1D	F0,1D	F3	4	F0,04	KP 4	6B	F0,6B
X	22	F0,22	F4	0C	F0,0C	KP 5	73	F0,73
Y	35	F0,35	F5	3	F0,03	KP 6	74	F0,74
Z	1A	F0,1A	F6	0B	F0,0B	KP 7	6C	F0,6C
0	45	F0,45	F7	83	F0,83	KP 8	75	F0,75
1	16	F0,16	F8	0A	F0,0A	KP 9	7D	F0,7D
2	1E	F0,1E	F9	1	F0,01	]	5B	F0,5B
3	26	F0,26	F10	9	F0,09	;	4C	F0,4C
4	25	F0,25	F11	78	F0,78	'	52	F0,52
5	2E	F0,2E	F12	7	F0,07	,	41	F0,41
6	36	F0,36	PRNT SCRN	E0,12,	E0,F0,7C,	.	49	F0,49
7	3D	F0,3D	SCROLL	7E	F0,7E	/	4A	F0,4A
8	3E	F0,3E	PAUSE	E1,14,77,E1,	-NONE-			
ACPI Scan Codes			Windows Multimedia Scan Codes					
Key	Make	Break	Key	Make	Break	Key	Make	Break
Power	E0,37	E0,F0,37	NextTrack	E0,4D	E0,F0,4D	Calculator	E0,2B	E0,F0,2B
Sleep	E0,3F	E0,F0,3F	PreviousTrack	E0,15	E0,F0,15	MyComputer	E0,40	E0,F0,40
Wake	E0,5E	E0,F0,5E	Stop	E0,3B	E0,F0,3B	WWWSearch	E0,10	E0,F0,10
			Play/Pause	E0,34	E0,F0,34	WWWHome	E0,3A	E0,F0,3A
			Mute	E0,23	E0,F0,23	WWWBack	E0,38	E0,F0,38
			VolumeUp	E0,32	E0,F0,32	WWWForward	E0,30	E0,F0,30
			VolumeDown	E0,21	E0,F0,21	WWWStop	E0,28	E0,F0,28
			MediaSelect	E0,50	E0,F0,50	WWWRefresh	E0,20	E0,F0,20
			E-Mail	E0,48	E0,F0,48	WWWFavorites	E0,18	E0,F0,18

1. All values are in Hexadecimal
2. Codes pertain to the 101-, 102-, and 104-key keyboards

Table 2: Bill of Materials - PS/2 Keyboard and Touchpad to Integrated USB Adapter

Item	Level	PART NUMBER	Rev.	Ref.Des.	DESCRIPTION	Qty.
1	0	PS/2_USB Adapter	A	N/A	PCBA, PS/2=>USB Adapter	1
2	1	02-000065-00	B	N/A	PCB, PS/2=>USB Adapter Rev B	1
3	1	10-000006-04	B	U1	IC, CYPRESS# CY7C63001C-SXC Program firmware: COMB3-30_20070228.HEX	1
4	1	20-004705-00	B	C1,	CAP, 4.7 uF ceramic, 1206 pkg.	1
5	1	20-001004-01	B	C2	CAP, 0.1 uF ceramic, 0805 pkg.	1
6	1	22-000752-00	B	R2	RES, 7.5K ohm 5%, 1206 pkg.	1
7	1	26-000006-00	B	X1	OSC, 6.00 MHz (AVX Corp.: PBRC 6.00BR/AL)	1
8	1	40-0000XX-00	B	J1	CON, 10 Pin header (connect PS/2 keyboard & touchpad devices here)	1
9		40-0000XX-00	B	J2	CON, 5 Pin header ( Solder USB cable I/O here)	

Note: R1, R3, R5, R6, and R7 ARE NOT POPULATED ON THE PCB.

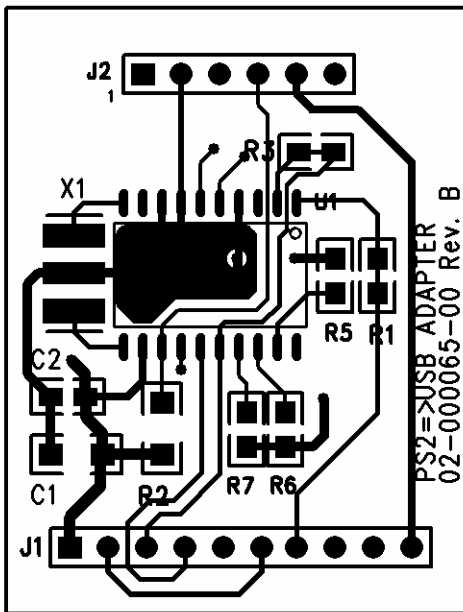


Figure 3: PCB layout, layer 1

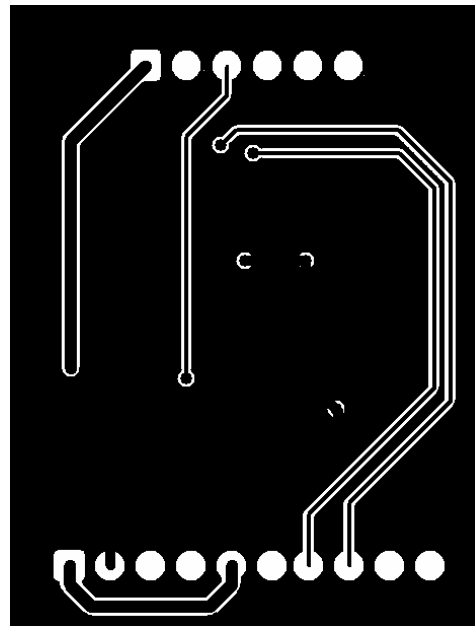


Figure 4: PCB layout, layer 2

## Design Guidelines

The entire system must be designed to fall within the USB current limit of 100mA. The USB controller and Cirque TSM touchpad require 17mA when in active operation, leaving the remaining 83mA available for the keyboard components. To comply with the USB suspend specification, additional circuitry (not included in the Reference Design) is required to turn off power to the touchpad and keyboard while in suspend mode. When pins 1, 2, or 3 (labeled BTN1, BTN0, and BTN2 respectively) of the USB microcontroller are low during suspend, suspend terminates. With pins 1 and 2 of the USB microcontroller connected to the data lines of the keyboard and touchpad (as shown in Figure 2), using the keyboard or touchpad will “wake-up” the USB microcontroller. Please contact Cirque Customer Service if additional assistance is required.

Cirque touchpads support scroll regions (a strip on the right edge for vertical scrolling, a strip along the bottom edge for horizontal scrolling).

- To disable scrolling, either use a generic mouse driver and configure the touchpad not to scroll (Intellimouse disabled), or use the Cirque driver to disable scrolling in the control panel.
- For vertical scrolling only, either use a generic driver with the touchpad configured for vertical scroll, or use the Cirque driver.
- For horizontal scrolling, use the Cirque driver Version 3.3 or later.

For further information, contact Cirque Corporation Customer Support ([www.cirque.com](http://www.cirque.com)).

## References

- A *Designing a USB Keyboard and PS/2(R) Mouse Combination Device Using the Cypress CY7C63413*  
[http://www.cypress.com/portal/server.pt?space=CommunityPage&control=SetCommunity&CommunityID=285&PageID=552&drid=59730&shortlink=&r\\_folder=&r\\_title=&ref=drs](http://www.cypress.com/portal/server.pt?space=CommunityPage&control=SetCommunity&CommunityID=285&PageID=552&drid=59730&shortlink=&r_folder=&r_title=&ref=drs)
- B *Universal Serial Bus Specification Version 2.0*  
<http://www.usb.org/developers/docs/>
- C *Device Class Definition for Human Interface Devices (HID) Version 1.11*  
<http://www.usb.org/developers/hidpage/>

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