

San Francisco State University

Electrical Engineering

ENGR 378 Digital Systems Design

Lab 5. Keyboard Interface

Objectives

- To learn how to interface a computer keyboard with a PS/2 port to the FPGA

Prelab

(Note that each member in the group should do this individually)

1) Read the DE2-115 User Manual about the PS/2 Serial Port from page 55 to 56.

Optional: Read any other open source documentation you deem necessary on the keyboard interfacing and on the PS/2 protocol.

Pressing a key sends a transmission of 11 bits, 8 of which are data bits in the following format (see figure below):

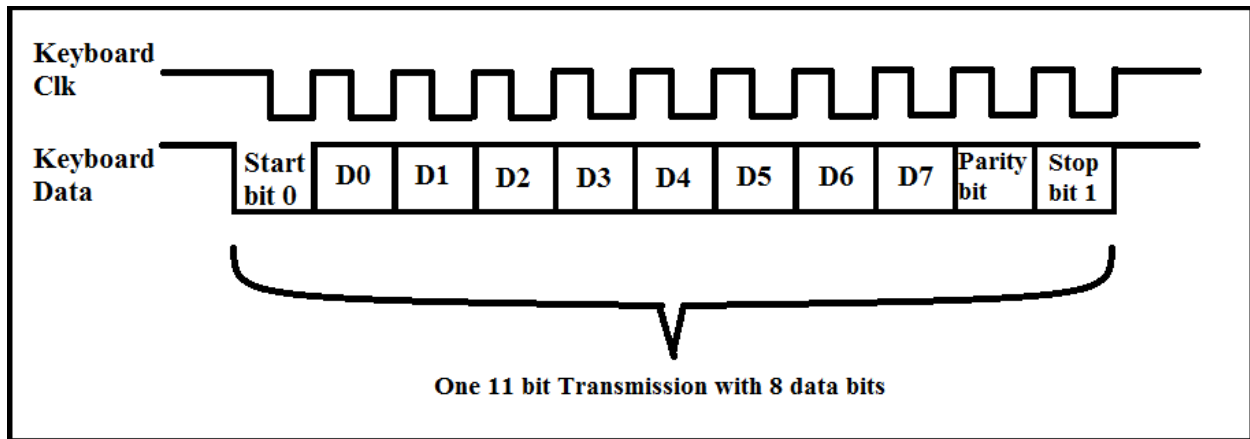


Figure 1: Keyboard Transmission

Some keys transmit two transmissions for a total of 22 bits, 16 bits which are data bits. Keys such as the arrow keys have two transmissions. The following codes that are sent for the keys when pressed are show below in the figure. The keys shown in figure 2 transmit the following hexadecimal codes for a total of 8 or 16 data bits. Also note that the keyboard clock only oscillates when it is transmitting data, else the keyboard clock is not oscillating when not transmitting.

ESC 76	F1 05	F2 06	F3 04	F4 0C	F5 03	F6 0B	F7 83	F8 0A	F9 01	F10 09	F11 78	F12 07	↑ E0 75
~ 0E	1! 16	2@ 1E	3# 26	4\$ 25	5% 2E	6^ 36	7& 3D	8* 3E	9(46	0) 45	-_ 4E	=+ 55	Back Space ← 66 E0 74
TAB 0D	Q 15	W 1D	E 24	R 2D	T 2C	Y 35	U 3C	I 43	O 44	P 4D	[{ 54]} 5B	↵ 5D E0 6B
CapsLock 58	A 1C	S 1B	D 23	F 2B	G 34	H 33	J 3B	K 42	L 4B	::; 4C	"" 52	Enter ↵ 5A E0 72	
⇧ Shift 12	Z 1Z	X 22	C 21	V 2A	B 32	N 31	M 3A	,< 41	>. 49	/? 4A	⇧ Shift 59		
Ctrl 14	Alt 11	Space 29						Alt E0 11	Ctrl E0 14				

Figure 2: Keyboard Codes (From Spartan 3 FPGA Manual)

- 2) Draw a hardware schematic of how you intend to capture and decode the data packets from the keyboard and output the **last two** data packet values to four of the seven segment displays. You should display the data packet values in hexadecimal format. Each data packet value should be displayed on two seven segment displays. Note that we will only be using one way (keyboard to computer) communications for this lab so you don't have to worry about sending data to the keyboard.

Tasks

- 1) Write Verilog code to accept input from a keyboard connected to a PS/2 port on the FPGA and output the data values of the **last two** transmissions to the four seven segment displays (display values in hexadecimal format). Use two seven segment displays to show the current data value and use another two seven segment displays to show the last data value. Note the order/orientation of the bits during transfer as this may come in handy during troubleshooting/debugging. In your design, pressing a key on the keyboard should be able to display its corresponding hexadecimal code on the seven segment displays.
- 2) Download your keyboard interface design to the FPGA and test it. For this part you need to use a keyboard with a PS/2 port and connect it to the FPGA via the PS2 port. After the design is loaded, ensure that the design works by pressing a few keys on the keyboard and matching their values against the values shown in the figure 2 above. For example, pressing and holding down the key "D" will continuously transmit and display a key code of "23" in hexadecimal. Releasing the key will send a break code of "F0" and the code for that key.
- 3) Have the lab instructor signoff a cover sheet for your working design.