This document will describe how I made a USB keyboard from a Lenovo ThinkPad T61 keyboard using a Teensy LC microcontroller. All associated files are in the Teensy LC folder under the Lenovo_Thinkpad_T61 folder at my Github repo. I initially designed a board for a Teensy 3.2 which taught me a lot about the keyboard. I used that information to design a Teensy LC board with the following changes from the 3.2 board.

1. The TrackPoint Clock and Data signals are translated to 5 volts with two BSS138 FETs and four 10K pullups. This was done because the Teensy LC does not have 5 volt tolerant I/Os.
2. The TrackPoint power-on-reset signal is created from a TLV810MDBZR in order to not use a Teensy I/O pin.
3. The Fn key switch is wired into the matrix by connecting FPC pin 1 to pin 11 and pin 36 to pin 20. Placing the Fn switch into the matrix was done to not use a Teensy I/O pin.
4. The Caps Lock signal on I/O #13 has a 715 ohm dropping resistor for a 2ma (low current) LED. This was done so the 3ma LED on the Teensy doesn't need to be removed.
5. I rearranged the Teensy and FPC connector locations on the board to get away from the mounting post on the bottom of the keyboard. This layout change also keeps the circuit board underneath the keyboard so it can be hidden if mounting on a block of wood.

The picture below shows the Teensy LC circuit board connected to a ThinkPad T61 keyboard.

T61_LC_Scanner.brd file was sent to OSH Park for fabrication. The bare and assembled board is shown below. The Eagle board and schematic files are in the Eagle folder at my Github repo.

Parts List:
T61_LC_Scanner circuit board as shown above
Teensy LC from Amazon
Header pins and wire to connect the Teensy to the board

Digikey parts:
WM6787CT-ND 40 Pin Keyboard Connector Qty 1

TLV810MDBZR 4.38 Volt Reset Generator SOT23 Qty 1

BSS138CT-ND NFET SOT23 Qty 2

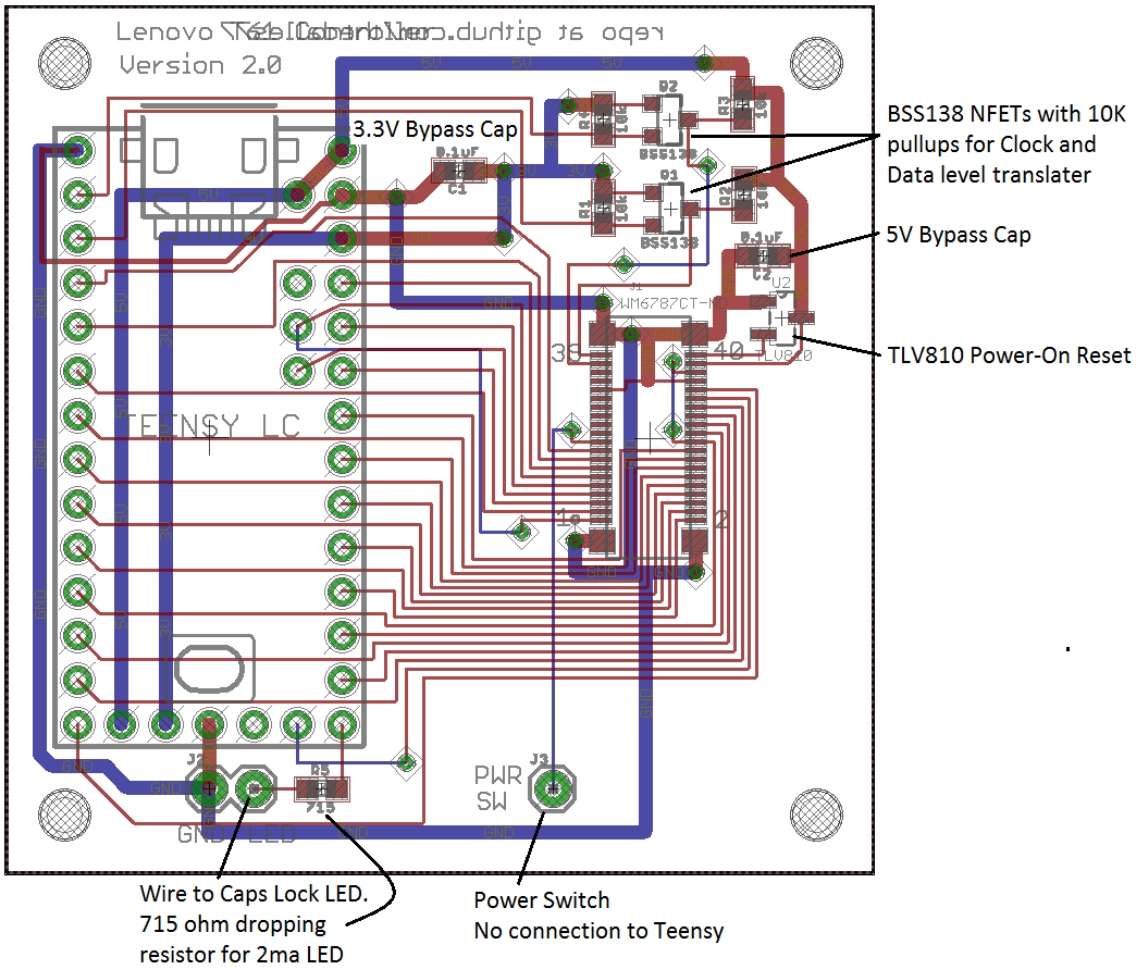
10K Resistors 0603 ¼ Watt 1% Qty 4

715 ohm Resistor 0603 1/10 Watt 1% Qty 1

0.1uf Ceramic Capacitor 0603 50V Y5V Qty 2

754-1592-ND 2ma Yellow LED axial lead Qty 1

Part placement and description shown below.



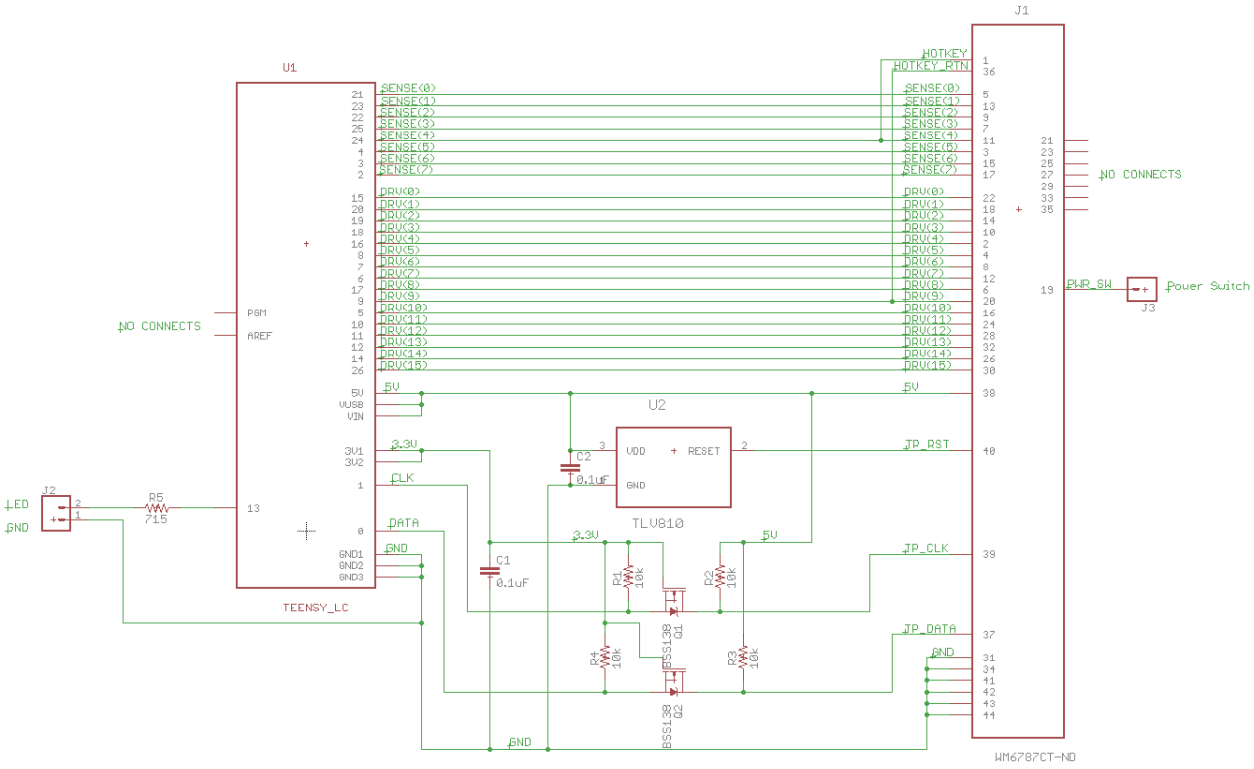
The WM6787CT-ND connector from Digikey will work with the Lenovo T61 keyboard but I did have some trouble with alignment, as originally discovered with the Teensy 3.2 board. Once I got the plug correctly installed in the socket, it worked fine so I don't view this as a big problem. The alternative to using the Digikey connector is to search for the original JAE AA01B_S040VA1 connector or unsolder it from a broken motherboard. Forum posters have reported that the original connector is hard to find and only available in large lot sizes.

The keyboard connections to the Teensy LC pins are shown below.

Lenovo ThinkPad T61 FPC Connector	Teensy LC I/O number	T61 Schematic Signal Name
1	24	HOTKEY
2	16	DRV<4>
3	4	SENSE<5>
4	8	DRV<5>
5	21	SENSE<0>
6	17	DRV<8>

7	25	SENSE<3>
8	7	DRV<6>
9	22	SENSE<2>
10	18	DRV<3>
11	24	SENSE<4>
12	6	DRV<7>
13	23	SENSE<1>
14	19	DRV<2>
15	3	SENSE<6>
16	5	DRV<10>
17	2	SENSE<7>
18	20	DRV<1>
19	PWR SW Pad	PWR SW
20	9	DRV<9>
21	No connect	NC
22	15	DRV<0>
23	No connect	NC
24	10	DRV<11>
25	No connect	KBDID0
26	14	DRV<14>
27	No connect	KBDID1
28	11	DRV<12>
29	No connect	KBDID2
30	26	DRV<15>
31	Teensy GND	KBDID RTN
32	12	DRV<13>
33	No connect	NC
34	Teensy GND	PWR SW RTN
35	No connect	NC
36	9	HOTKEY RTN
37	0	TP_DATA
38	Teensy 5V	TP_5V
39	1	TP_CLK
40	TLV810	TP_RESET
41 thru 44	Teensy GND	GND

The Eagle schematic for the connections on the circuit board is given below. This schematic is in the Eagle folder at my repo.



It was easy to find a Lenovo motherboard schematic online that provided me with the connector pins for the DRV and SENSE signals. The Matrix_Decoder_T61_LC.ino code at my repo scans the DRV and SENSE pins and sends key press connection characters over USB for capture by an editor. The key press results in the file Lenovo_T61_LC_io_list.txt at my repo were used to build the matrix table shown below. The Teensy inputs aka Sense<0> thru <7> are the columns across the top and the Teensy outputs aka Drive<0> thru <15> are the rows on the side.

Matrix for the LC Lenovo ThinkPad T61 – Keyboard Part Number 42T3177

Teensy 3.2 I/O Number	**Sense<0> I/O 21**	**Sense<1> I/O 23**	**Sense<2> I/O 22**	**Sense<3> I/O 25**	**Sense<4> I/O 24**	**Sense<5> I/O 4**	**Sense<6 > I/O 3**	**Sense<7> I/O 2**
Drive<0> I/O 15	Back-Tick	1	Q	Tab	A	Esc	Z	
Drive<1> I/O 20	F1	2	W	Caps-Lock	S		X	
Drive<2> I/O 19	F2	3	E	F3	D	F4	C	
Drive<3> I/O 18	5	4	R	T	F	G	V	B
Drive<4> I/O 16	6	7	U	Y	J	H	M	N
Drive<5> I/O 8	Equal	8	I	Right-Brace	K	F6	Comma	
Drive<6> I/O 7	F8	9	O	F7	L		Period	
Drive<7> I/O 6	Minus	0	P	Left-Brace	Semi-colon	Quote		Forward-Slash
Drive<8> I/O 17	F9	F10		Back-Space	Back-Slash	F5	Enter	Space
Drive<9> I/O 9	Insert	F12			**Fn**			Arrow-Right
Drive<10> I/O 5	Delete	F11	Volume-Up	Volume-Down	Mute	Think-Vantage		Arrow-Down
Drive<11> I/O 10	Page-Up	Page-Down	**GUI**		Menu		Page-Left	Page-Right
Drive<12> I/O 11	Home	End				Arrow-Up	Pause	Arrow-Left
Drive<13> I/O 12		Print-Screen	Scroll-Lock			**Alt-L**		**Alt-R**
Drive<14> I/O 14				**Shift-L**			**Shift-R**	
Drive<15> I/O 26	**Cntrl-L**						**Cntrl_R**	

The Fn “Hotkey” has its own dedicated pins but has been wired into the matrix at Drive<9> & Sense<4> in order to save an I/O pin on the Teensy LC.

With the key matrix information shown above, you can load the TMK software into the Teensy. I have written a keyboard and trackpoint routine as a simple alternative called Lenovo_T61_KBandTP_LC.ino. It uses the Teensyduino "Micro-Manager Method" to send keys over USB. All of the normal and modifier keys are supported but only the volume control multimedia keys are part of this routine. A description of the Teensyduino keyboard functions is at www.pjrc.com/teensy/td_keyboard.html.

The PS/2 code for the Trackpoint was coded based on the timing diagrams and uses the PJRC Mouse functions to send over USB. A watchdog timer in the "while loops" won’t let the code hang if the Teensy misses a clock edge. This can happen when the Teensy is interrupted by the USB port to receive the keyboard_leds (CAPS LOCK) data.

I have found that the alignment tab on the T61 keyboard connector can be broken by forcing it into the WM6787CT-ND Digikey motherboard connector. The picture below shows how one tab is missing. This probably happened when I tried attaching the connectors without having them properly aligned. The keyboard can still be plugged into the WM6787CT-ND or JAE AA01B_S040VA1 motherboard connector but it may take many tries to get the alignment correct. I have a second keyboard that has both alignment tabs broken off but it still works fine.