Raspberry Pi Pico W Keyboard Controller

This document will describe how to make a USB and Bluetooth controller for the Thinkpad T61 keyboard shown below using a Raspberry Pi Pico W. This is an ongoing project that has not been built or tested yet. I'm providing my design information to help others and perhaps they can help me too (especially with the software). All associated files are at my Github repository.
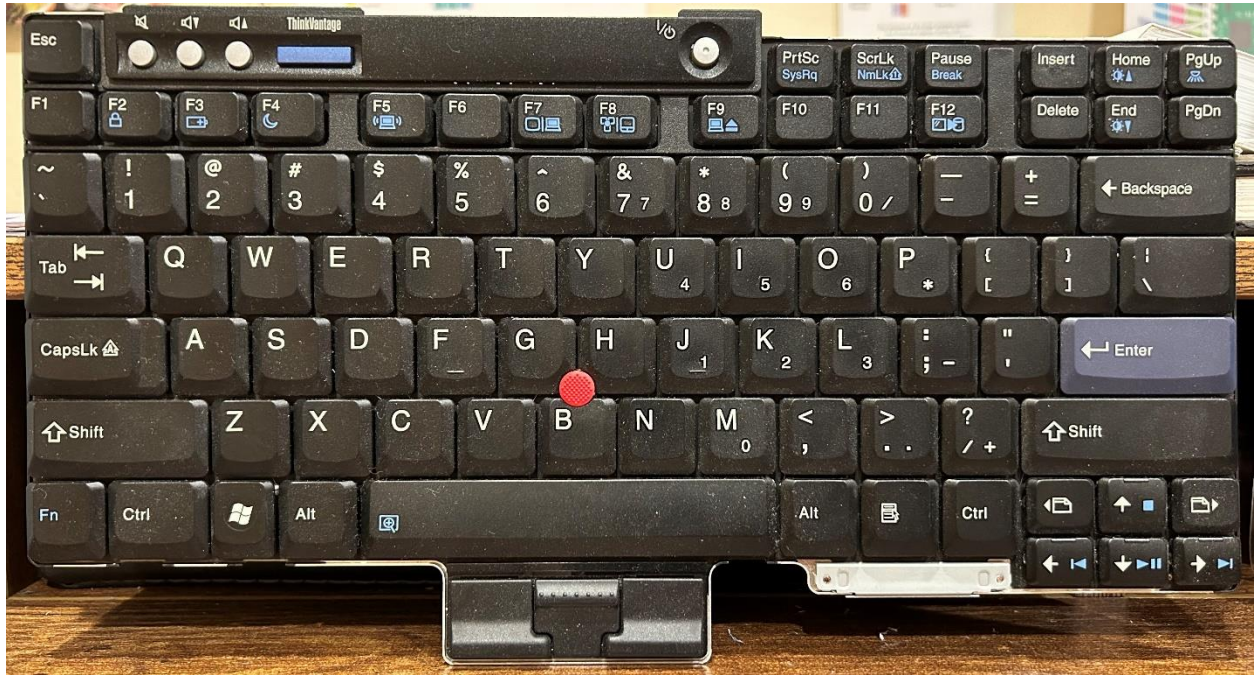
Lenovo T60, T61, T400, T500 laptops and their variants have a 44 pin connector soldered to the end of their keyboard's FPC cable. The 4 corner pins are not used and the Thinkpad motherboard has a 40 pin mating connector, part number AA01B-S040 available at AliExpress. The following pages document the circuit board I designed that connects a Pi Pico W (with or without header pins) to the 40 pin keyboard connector.

The Pico T61 keyboard controller board is shown below as depicted by OSHPark.
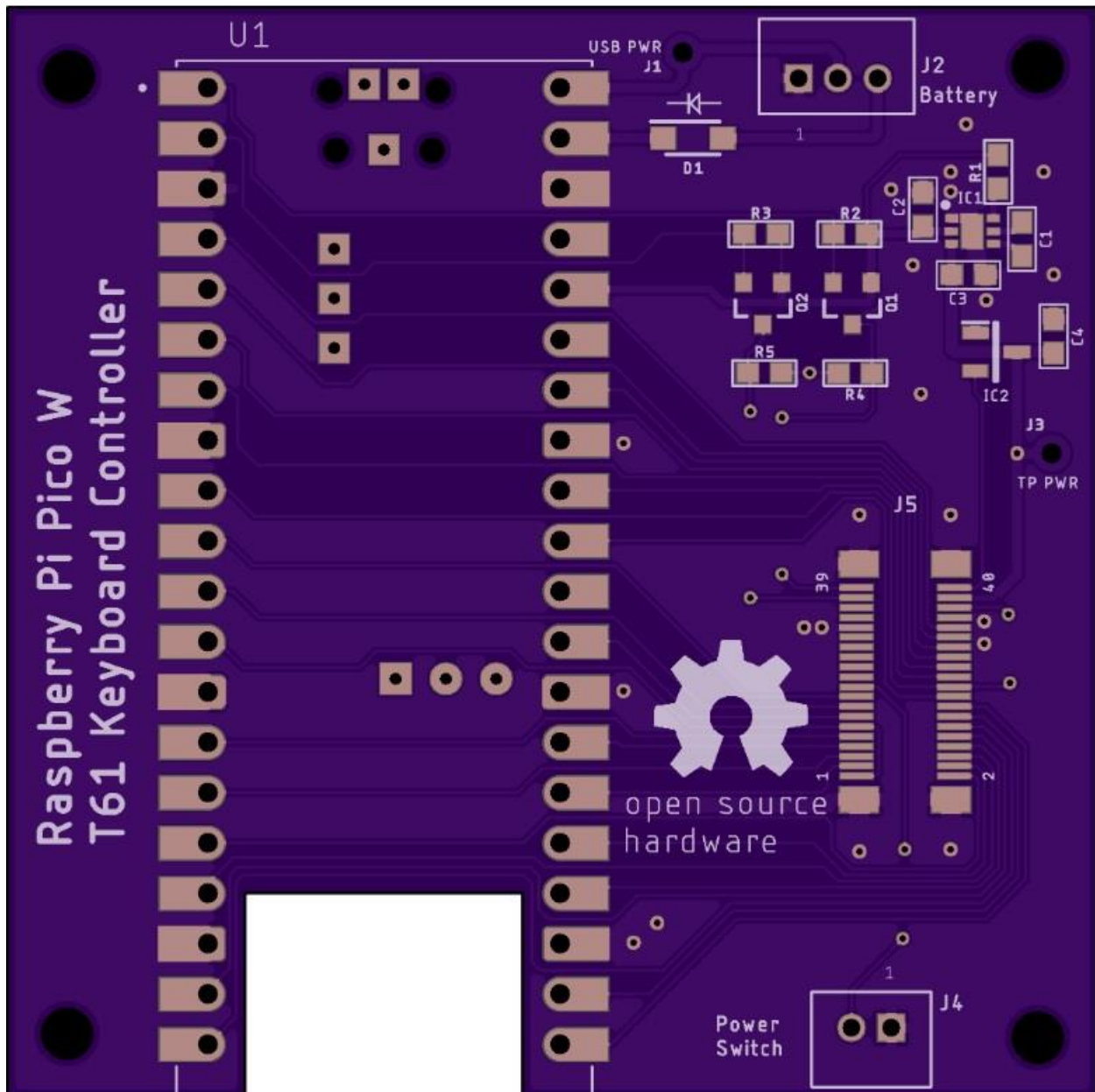
The cutout in the board gives better reception for the Bluetooth antenna on the Pico. The Pico can be mounted with header pins or soldered directly to the board for a lower profile.

The "Pico_T61_Keyboard.brd" Eagle file and "Pico_T61_Keyboard.zip" Gerber file at my repo can be fabricated by OSH Park or other fab houses like JLCPCB. The Eagle layout (without area fill) is shown below.
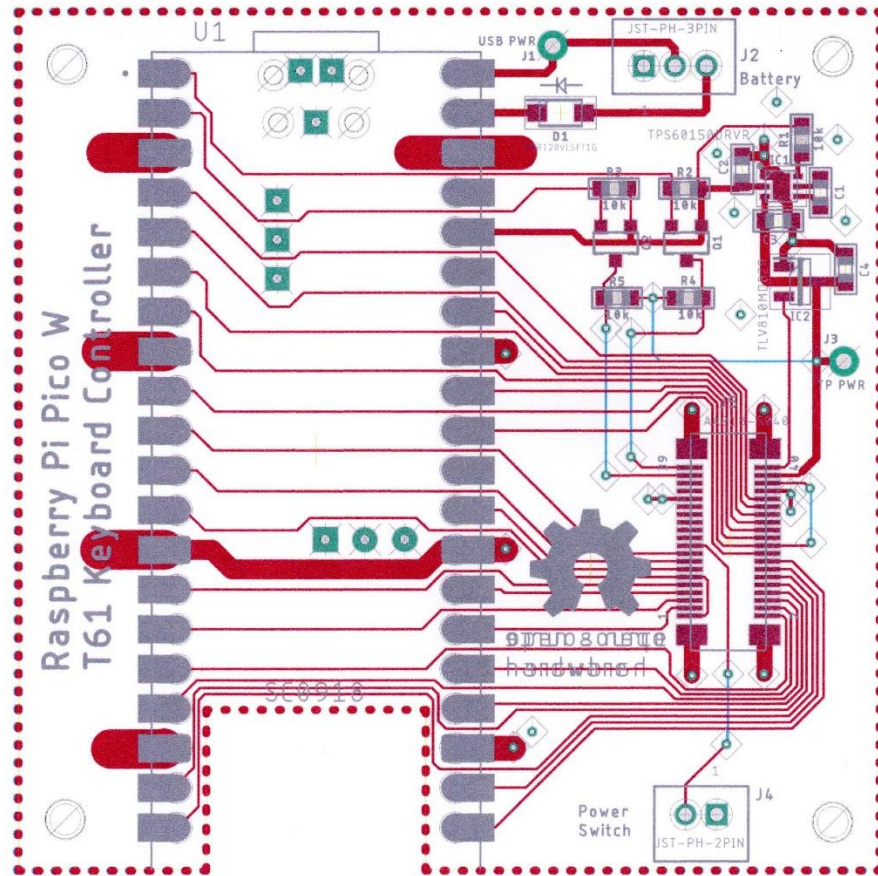

The trackpoint circuitry in the keyboard is powered with 5 volts. The Pico GP I/O's are not 5 volt tolerant so there are level translators for the trackpoint Clock and Data signals.

Bluetooth operation implies the controller will be running from a separate lithium battery with a charging circuit. USB 5 volts on the Pico VBUS pin is routed to the 3 pin JST connector for an off board battery charger circuit. The nominal 3.7 volt battery output should be connected to VBAT on the 3 pin JST connector. A Schottky diode "or-ties" the battery voltage to the Pico's VSYS pin. There is another Schottky diode in the Pico that brings USB power to VSYS when the USB cable is attached.

A TPS60150 switched capacitor charge pump boosts the 3.3 volts from the Pico up to 5 volts to power the trackpoint. The trackpoint reset signal can be created with a resistor and capacitor but to be more robust, I've included a TLV810 reset generator.

If the keyboard will only be used for USB, solder a jumper wire from J1 to J3. This provides USB 5 volts to the trackpoint. Do not install the charge pump or its associated components. Do not install the Schottky diode or 3 pin JST connector (these are for battery operation).

The Eagle schematic "Pico_T61_Keyboard.sch" at my repo is shown below.
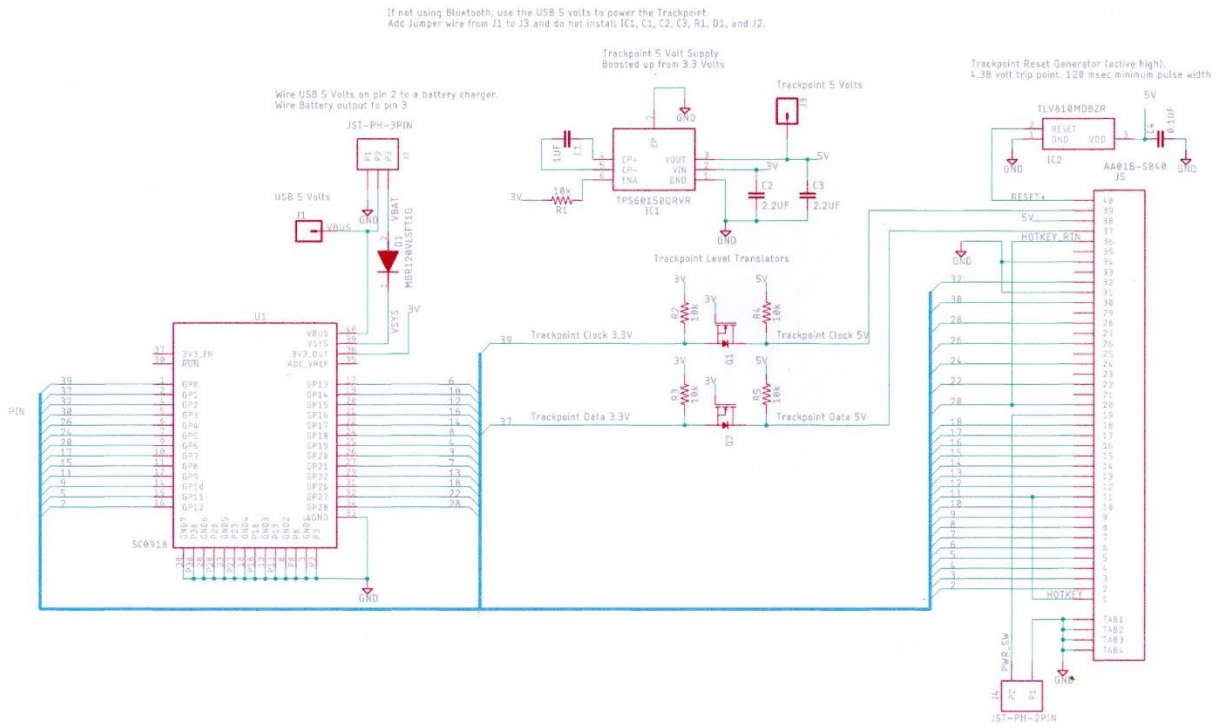
The 2 pin JST connector at J4 is provided so the "Power" button on the keyboard can be wired to an off board power latch circuit.

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Partlist for Pico_T61_Keyboard

Qty Value              Device                      Package              Parts              Description
2   None               CONN_01PTH_NO_SILK_KIT 1X01NS_KIT               J1, J3             Single connection point for jumper wire.
1   0.1UF              0603_CAP                    0603_CAP             C4                 Bypass cap for reset generator IC
5   10k                10KOHM-0603-1/10W-1%        0603                 R1, R2, R3, R4, R5 10KΩ 0603 size resistor
1   1UF                0603_CAP                    0603_CAP             C1                 1uF X7R 0603 size capacitor
2   2.2UF              0603_CAP                    0603_CAP             C2, C3             2.2uF X7R 0603 size capacitor
2   220mA/50V/3.5Ω MOSFET-NCH-BSS138              SOT23-3              Q1, Q2             BSS138 N-channel MOSFET
1   AA01B-S040         AA01B-S040                  AA01B-S040           J5                 40 Pin Keyboard Connector
1   JST-PH-2PIN        JST-PH-2PIN                 JST-PH-2PIN          J4                 2 Pin JST Connector
1   JST-PH-3PIN        JST-PH-3PIN                 JST-PH-3PIN          J2                 4 Pin JST Connector
1   MBR120VLSFT1G      MBR120VLSFT1G               SODFL3616X98N        D1                 Diode Schottky 20V 1A
1   SC0918             SC0918                      MODULE_SC0918        U1                 Raspberry Pi Pico W (with or without header pins)
1   TLV810MDBZR        TLV810MDBZR                 SOT95P237X112-3N     IC2                3-pin Reset IC with active-high, push-pull output
1   TPS60150DRVR       TPS60150DRVR                SON65P200X200X80-7N  IC1                140mA, 5V Charge Pump
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The keyboard connections to the Pico GP I/O and other devices are shown below.

Lenovo ThinkPad T61 FPC Connector	Pico GP I/O number	Notes	T61 Schematic Signal Name
1	9	Added to key matrix	HOTKEY
2	12		DRV<4>
3	20		SENSE<5>
4	19		DRV<5>
5	11		SENSE<0>
6	13		DRV<8>
7	21		SENSE<3>
8	18		DRV<6>
9	10		SENSE<2>
10	14		DRV<3>
11	9		SENSE<4>
12	15		DRV<7>
13	22		SENSE<1>
14	17		DRV<2>
15	8		SENSE<6>
16	16		DRV<10>
17	7		SENSE<7>
18	26		DRV<1>
19		PWR SW – J4 Pin 2	PWR SW
20	6		DRV<9>
21	No connect		NC
22	27		DRV<0>
23	No connect		NC
24	5		DRV<11>
25	No connect		KBDID0
26	4		DRV<14>
27	No connect		KBDID1
28	28		DRV<12>
29	No connect		KBDID2
30	3		DRV<15>
31	Pico GND		KBDID RTN
32	2		DRV<13>
33	No connect		NC
34	Pico GND		KBDID RTN
35	No connect		NC
36	6	Added to key matrix	HOTKEY RTN
37	1	Level Translated	TP_DATA
38		5 volts from TPS60150	TP_5V
39	0	Level Translated	TP_CLK
40		TLV810 Reset Generator	TP_RESET

The Pico inputs are the Sense<0> thru <7> columns across the top which must be programmed with pullup resistors. The Pico outputs are the Drive<0> thru <15> rows on the side and are either driven low or floated. Floating a pin is done by making it an input.

Matrix for the Lenovo ThinkPad T61 Keyboard

Pico GP I/O Number	Sense<0> GP 11	Sense<1> GP 22	Sense<2> GP 10	Sense<3> GP 21	Sense<4> GP 9	Sense<5> GP 20	Sense<6> GP 8	Sense<7> GP 7
Drive<0> GP 27	Back-Tick	1	Q	Tab	A	Esc	Z	
Drive<1> GP 26	F1	2	W	Caps-Lock	S		X	
Drive<2> GP 17	F2	3	E	F3	D	F4	C	
Drive<3> GP 14	5	4	R	T	F	G	V	B
Drive<4> GP 12	6	7	U	Y	J	H	M	N
Drive<5> GP 19	Equal	8	I	Right-Brace	K	F6	Comma	
Drive<6> GP 18	F8	9	O	F7	L		Period	
Drive<7> GP 15	Minus	0	P	Left-Brace	Semi-colon	Quote		Forward-Slash
Drive<8> GP 13	F9	F10		Back-Space	Back-Slash	F5	Enter	Space
Drive<9> GP 6	Insert	F12			**Fn added here**			Arrow-Right
Drive<10> GP 16	Delete	F11	Volume-Up	Volume-Down	Mute	Think-Vantage		Arrow-Down
Drive<11> GP 5	Page-Up	Page-Down	**GUI**		Menu		Page-Left	Page-Right
Drive<12> GP 28	Home	End				Arrow-Up	Pause	Arrow-Left
Drive<13> GP 2		Print-Screen	Scroll-Lock			**Alt-L**		**Alt-R**
Drive<14> GP 4				**Shift-L**			**Shift-R**	
Drive<15> GP 3	**Cntrl-L**						**Cntrl_R**	

The keyboard will use 24 Pico GP I/O's and the trackpoint will use 2 GP I/O's. There are no spare GP I/O's for the Fn "Hotkey" so it has been wired into the matrix at the location shown above.

The LED on the Pico can be programmed as a CAPS LOCK LED.