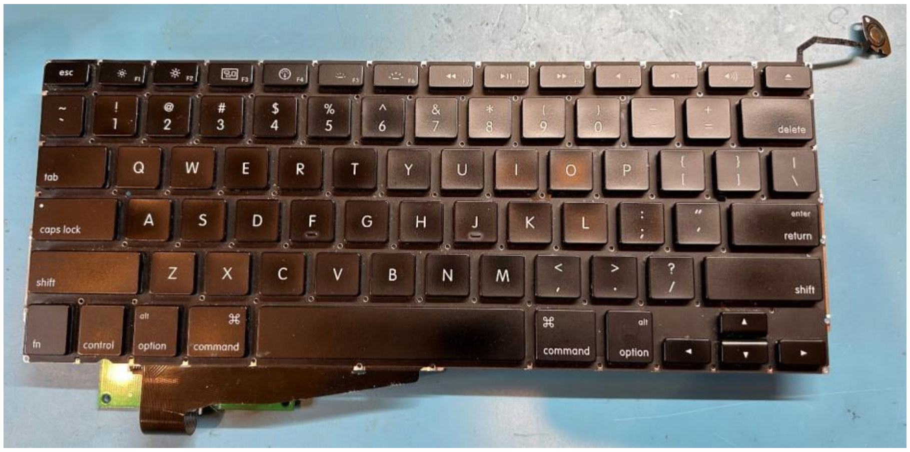
The MacBook Pro Model A1286 15" keyboard is shown below. It has a 30 pin 0.5mm pitch FPC cable. I used the Matrix_Decoder_4p1 code with my Teensy 4.1 connector board to create a key list text file. Pins 1 and 2 were shorted (probably grounds) so I had to set the min_pin variable in the code to 3 so the routine would jump over pins 1 and 2.

Differences from a Windows PC style keyboard:

- Two Clover keys instead of one Windows key. I programmed them both as GUI keys.
- The Delete key acts as a backspace and there is no key that acts as a Delete key.
- There is no Insert key, also no Print Screen, Home, End, Page Up, or Page Down keys.
- The Power-On push button is a separate switch in the upper right corner.



The Python program failed to create a matrix because this keyboard doesn't follow my generic keyboard "rules", (I blame Apple). The Python results showed pin 27 was a column input and pins 28, 29, and 30 were row outputs but that's all it could find. The keylist results are given on the next page so you can follow along as I explain how to figure out the input pins manually. Looking first at the modifier keys; Control-Left, Shift-Left, and Alt-Left show that I could either make pin 27 an input or pins 28, 29, and 30. Scanning the key list I see 28, 29, and 30 are not used by any other keys so I chose pin 27 as an input (either way would work). The input pins are often grouped together so a good first guess is to look at pins that are close to pin 27. If I can't place a key in the matrix later on, then I've guessed wrong. The Fn and Alt-Right use pin 23, GUI-Right uses pin 24, and Shift-Right uses pin 25 so these were picked as inputs. I could make pin 26 an input if I wanted the Teensy to detect the Power-On Push button. For now, I'll leave this out of the matrix so it can be wired directly to a power supply turn on circuit. At this point I have 23, 24, 25, and 27 as inputs. The GUI-Right already made 24 an input and therefor 13 an output. GUI-Left also uses pin 13 which we know is an output so its other pin, pin 6 must be an input. Now I'll look down the list and every time I see a key that uses input pins 6, 23, 24, 25, or 27, I know that the other pin must be an output and can be disregarded in my search for input pins. On a scratch pad, I list the pins that have been eliminated as inputs. The Z key shows pin 7 is an output so looking at the A key, I know that pin 5 is an input. At this point I suspect pins 4 and 3 could be inputs so I'll scan down the list to see if they work. Note that pins 1 and 2 are not used. At this point I have pins 3, 4, 5, 6, 23, 24, 25, 27 as inputs. 8 input pins is very common so I'll start filling out the key matrix table. When I get to the P key, I find I need to add pin 22 as an input. Now all keys can be placed in the matrix table.

Pin List Text Results – shows the 2 pins that are connected when a key is pushed

Power-On Push Button	26	18	Not used in the code
MODIFIERKEY_LEFT_CTRL	27	30	
MODIFIERKEY_LEFT_SHIFT	27	28	
MODIFIERKEY_RIGHT_SHIFT	12	25	
MODIFIERKEY_LEFT_ALT	27	29	
MODIFIERKEY_RIGHT_ALT	23	15	
MODIFIERKEY_LEFT_GUI	13	6	
MODIFIERKEY_RIGHT_GUI	24	13	
MODIFIERKEY_FN	14	23	
KEY_A	5	7	
KEY_B	14	6	
KEY_C	6	9	
KEY_D	5	9	
KEY_E	3	9	
KEY_F	5	11	
KEY_G	5	14	
KEY_H	5	10	
KEY_I	20	3	
KEY_J	5	19	
KEY_K	5	20	
KEY_L	5	21	
KEY_M	19	6	
KEY_N	10	6	
KEY_O	21	3	
KEY_P	16	22	
KEY_Q	3	7	
KEY_R	3	11	
KEY_S	5	8	
KEY_T	3	14	
KEY_U	3	19	
KEY_V	6	11	
KEY_W	8	3	
KEY_X	6	8	
KEY_Y	3	10	

KEY_Z	7	6	
KEY_TILDE	8	24	
KEY_1	4	7	
KEY_2	8	4	
KEY_3	9	4	
KEY_4	11	4	
KEY_5	14	4	
KEY_6	4	10	
KEY_7	4	19	
KEY_8	4	20	
KEY_9	21	4	
KEY_0	13	22	
KEY_MINUS		14	22
KEY_EQUAL		10	24
KEY_BACKSPACE		7	23
KEY_ESC	8	22	
KEY_F1	7	25	
KEY_F2	8	25	
KEY_F3	9	25	
KEY_F4	11	25	
KEY_F5	14	25	
KEY_F6	10	25	
KEY_F7	19	25	
KEY_F8	20	25	
KEY_F9	21	25	
KEY_F10	15	22	
KEY_F11	22	7	
KEY_F12	7	24	
KEY_RIGHT		20	24
KEY_LEFT	20	23	
KEY_UP	21	24	
KEY_DOWN		21	23
KEY_SLASH		10	22
KEY_PERIOD		6	21
KEY_COMMA		6	20

KEY_SEMICOLON	22	19	
KEY_QUOTE	19	23	
KEY_ENTER	22	12	
KEY_LEFT_BRACE	14	24	
KEY_RIGHT_BRACE	11	24	
KEY_BACKSLASH	21	22	
KEY_CAPS_LOCK	16	23	
KEY_TAB	8	23	
KEY_SPACE	10	23	
KEY_MEDIA_REWIND	FN	19	25
KEY_MEDIA_FAST_FORWARD	FN	21	25
KEY_MEDIA_VOLUME_DEC	FN	22	7
KEY_MEDIA_VOLUME_INC	FN	24	7
KEY_MEDIA_PLAY_PAUSE	FN	25	20
KEY_MEDIA_MUTE	FN	15	22
KEY_MEDIA_EJECT	FN	19	24

The keyboard matrix table is given below. The completed USB Keyboard code is called “Macbook_Pro_A1286_15in.ino” at my repo.

FPC pins	3	4	5	6	22	23	24	25	27
7	q	1	a	z	F11	backspc	F12	F1	
8	w	2	s	x	esc	tab	~	F2	
9	e	3	d	c				F3	
10	y	6	h	n	/	space	=	F6	
11	r	4	f	v			]	F4	
12					enter			Shift-R	
13				GUI-L	0		GUI-R		
14	t	5	g	b	-	Fn	[	F5	
15						Alt-R		F10	
16					p	Caps lk			
19	u	7	j	m	;	quote		F7	
20	i	8	k	comma		left	right	F8	
21	o	9	L	period	\	down	up	F9	
28									Shift-L
29									Alt-L
30									Cntr-L

There are 16 rows and 9 columns. This is defined in the code as follows.

```
const byte rows_max = 16; // sets the number of rows in the matrix
const byte cols_max = 9; // sets the number of columns in the matrix
```

The above matrix was manually transferred to the normal and modifier arrays shown below. You must use the key name from the PJRC "All Keys Codes" table.

```
unsigned int normal[rows_max][cols_max] = {
{KEY_Q,KEY_1,KEY_A,KEY_Z,KEY_F11,KEY_BACKSPACE,KEY_F12,KEY_F1,0},
{KEY_W,KEY_2,KEY_S,KEY_X,KEY_ESC,KEY_TAB,KEY_TILDE,KEY_F2,0},
{KEY_E,KEY_3,KEY_D,KEY_C,0,0,0,KEY_F3,0},
{KEY_Y,KEY_6,KEY_H,KEY_N,KEY_SLASH,KEY_SPACE,KEY_EQUAL,KEY_F6,0},
{KEY_R,KEY_4,KEY_F,KEY_V,0,0,KEY_RIGHT_BRACE,KEY_F4,0},
{0,0,0,0,KEY_ENTER,0,0,0,0},
{0,0,0,0,KEY_0,0,0,0,0},
{KEY_T,KEY_5,KEY_G,KEY_B,KEY_MINUS,0,KEY_LEFT_BRACE,KEY_F5,0},
{0,0,0,0,0,0,0,KEY_F10,0},
{0,0,0,0,KEY_P,KEY_CAPS_LOCK,0,0,0},
{KEY_U,KEY_7,KEY_J,KEY_M,KEY_SEMICOLON,KEY_QUOTE,0,KEY_F7,0},
{KEY_I,KEY_8,KEY_K,KEY_COMMA,0,KEY_LEFT,KEY_RIGHT,KEY_F8,0},
{KEY_O,KEY_9,KEY_L,KEY_PERIOD,KEY_BACKSLASH,KEY_DOWN,KEY_UP,KEY_F9,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0}
};
```

```
unsigned int modifier[rows_max][cols_max] = {
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,MODIFIERKEY_RIGHT_SHIFT,0},
{0,0,0,MODIFIERKEY_LEFT_GUI,0,0,MODIFIERKEY_GUI,0,0},
{0,0,0,0,0,MODIFIERKEY_FN,0,0,0},
{0,0,0,0,0,MODIFIERKEY_RIGHT_ALT,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,MODIFIERKEY_LEFT_SHIFT},
{0,0,0,0,0,0,0,0,MODIFIERKEY_LEFT_ALT},
{0,0,0,0,0,0,0,0,MODIFIERKEY_LEFT_CTRL}
};
```

The PJRC All Key Codes Table also lists the media key names. Place them at the same location as the non-Fn key. For example, volume decrease is at the F11 key location so it will go on the first row, 5th column just like the F11 key in the normal matrix.

```
unsigned int media[rows_max][cols_max] = {
{0,0,0,0,KEY_MEDIA_VOLUME_DEC,0,KEY_MEDIA_VOLUME_INC,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,KEY_MEDIA_MUTE,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,KEY_MEDIA_EJECT,KEY_MEDIA_REWIND,0},
{0,0,0,0,0,0,0,KEY_MEDIA_PLAY_PAUSE,0},
{0,0,0,0,0,0,0,KEY_MEDIA_FAST_FORWARD,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0},
{0,0,0,0,0,0,0,0,0}
};
```

The old_key array has 16 rows and 9 columns of 1's. The program uses this array to keep track of when a key is held down.

```
boolean old_key[rows_max][cols_max] = {
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1},
{1,1,1,1,1,1,1,1,1}
};
```

The row and column FPC pins were translated to the Teensy 4.1 I/O numbers per the table in step 14 of my Instructable. Example: FPC pin number 7 is connected to Teensy I/O number 20 with a trace on the 4.1 connector board.

```
unsigned int Row_IO[rows_max] = {20,3,19,4,18,5,17,6,16,7,14,9,10,28,29,30};
//
unsigned int Col_IO[cols_max] = {22,1,21,2,11,12,24,25,27};
```