

# PMOD HEX Keypad on DE1-SoC

Version 1.2 2018, by Fred Aulich



The PMOD HEX keypad uses the GPIO protocol. For more information about this protocol and the PMOD HEX Keypad got to the following link:

<https://reference.digilentinc.com/reference/pmod/pmodkypd/reference-manual>

The pin assignment for the Keypad can be found in table 1 below

Pinout Description Table

Header J1					
Pin	Signal	Description	Pin	Signal	Description
1	COL4	Column 4	7	ROW4	Row 4
2	COL3	Column 3	8	ROW3	Row 3
3	COL2	Column 2	9	ROW2	Row 2
4	COL1	Column 1	10	ROW1	Row 1
5	<u>GND</u>	Power Supply Ground	11	<u>GND</u>	Power Supply Ground
6	<u>VCC</u>	Power Supply (3.3V/5V)	12	<u>VCC</u>	Power Supply (3.3V/5V)

Any external power applied to the PmodKYPD must be within a voltage that your system board can handle; It is recommended that Pmod is operated at 3.3V.

Table 1- Pin assignments

## Objectives

To create a state machine that will do the following;

- Since there are 4 columns and 4 rows set up a 4-bit variable for each
- Check to see which column has been pressed first
- Column 4 would be [0,7,4,1]
- Column 3 would be [F,8,5,2]
- Column 2 would be [E,9,6,3]
- Column 1 would be [D,C,B,A]
- Once the Column has been determined then we need to determine the row value
- Row 1 would be [0,F,E,D]
- Row 2 would be [7,8,9,C]

- Row 3 would be [4,5,6,B]
- Row 4 would be [1,2,3A]
- Once the key has been determined display the key value on one of the HEX displays of the DE1-SOC
- Create a clock to act as a counter for the state machine
- Using one of the switches on the DE1-SoC, create a reset to make sure all the registers can be set to start location and enable state machine
- Use GPIO 2 to connect PMOD adaptor to DE1-SoC board
- Use GPIO 1 on DE1-SoC and LEDs to visually indicate the state of row and column values

Now that we have this information we can start to create the state machine. A copy of the code can be found on the DESL website at the following location:

[http://www-ug.eecg.toronto.edu/msl/peripherals\\_test\\_code.html](http://www-ug.eecg.toronto.edu/msl/peripherals_test_code.html)

Select **HEXKeypadPMOD** from list. The file is a **ZIP** file. Download the ZIP file and open it on your pc. Using Quartus version **18.0** or greater to compile the program. The program has a lot of comments to help explain the code.

Connect up the PMOD HEX keypad to the PMOD adaptor [Pmod connector 1] and use a 40 pin ribbon cable to connect the adaptor GPIO -2 of the DE1-SoC board. See **figure 1** and **figure 2** for a further explanation.

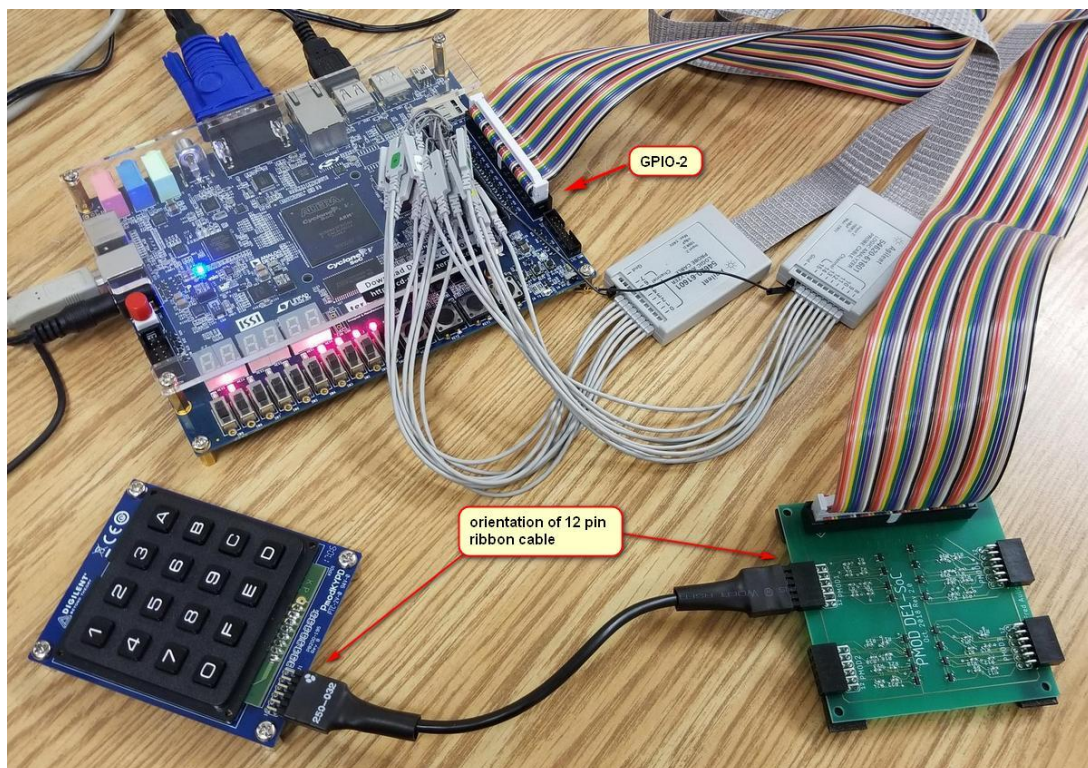


Figure 1- layout of all parts needed to make HEX Keypad work with DE1-SoC

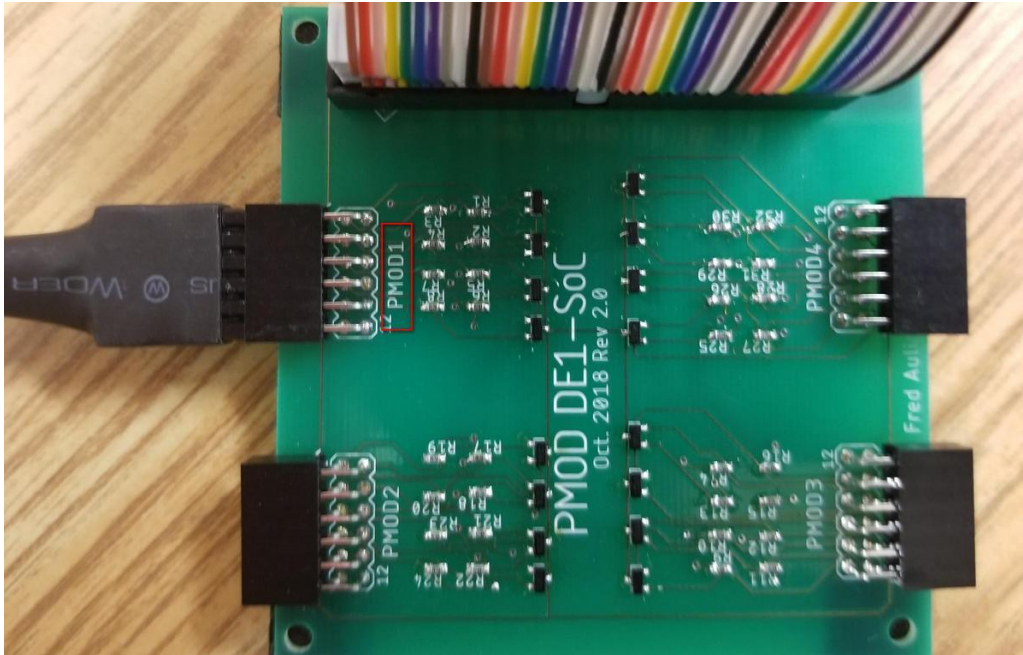


Figure 2- close up to show connect PMOD HEX Keypad to PMOD 1 of adaptor

Now that everything is connected and program is compiled, download the **SOF** file to the DE1-SoC board. Please **note** that **switch 0** on the DE1-SoC board has 2 purposes. When switch is in the **up** position it enables the state machine. In the **down** position it resets the state machine.

**Figure 3** show the key values from the Verilog code. When a key on the HEX keypad is pressed the 5-bit value determines which key it is.

```

////////////////////////////////////
//// key touch parameters //
////////////////////////////////////

parameter key_0 = 5'b00111;
parameter key_1 = 5'b01000;
parameter key_2 = 5'b01001;
parameter key_3 = 5'b01010;
parameter key_4 = 5'b01011;
parameter key_5 = 5'b01100;
parameter key_6 = 5'b01101;
parameter key_7 = 5'b01110;
parameter key_8 = 5'b01111;
parameter key_9 = 5'b10001;
parameter key_a = 5'b10010;
parameter key_b = 5'b10011;
parameter key_c = 5'b10100;
parameter key_d = 5'b10101;
parameter key_e = 5'b10110;
parameter key_f = 5'b10111;

```

Keys Pressed

HEX value 07

HEX value 0D

HEX value 0F

HEX value 12

Figure 3- Key values from Verilog code

Figure 4 shows that when key 0 is pressed on the key pad, it displays 0 on the HEX display of the DE1-SOC

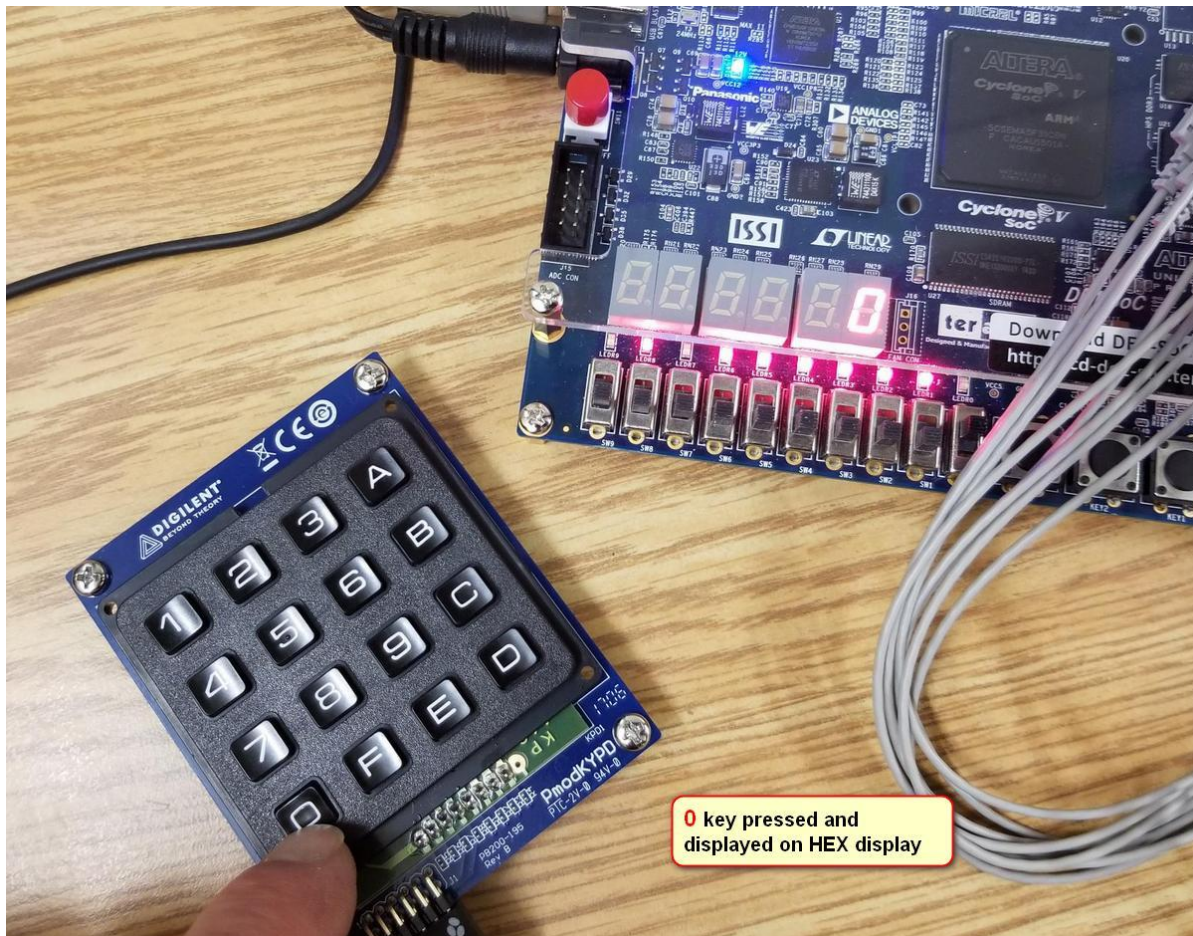


Figure 4 - When Key 0 is pressed 0 appears on HEX display of DE1-Soc

Figure 5 to 8 shows the logic analyzer result when certain keys are pressed. The logic analyzer result was done with the Keysight(Agilent) MSO-X-3024A.

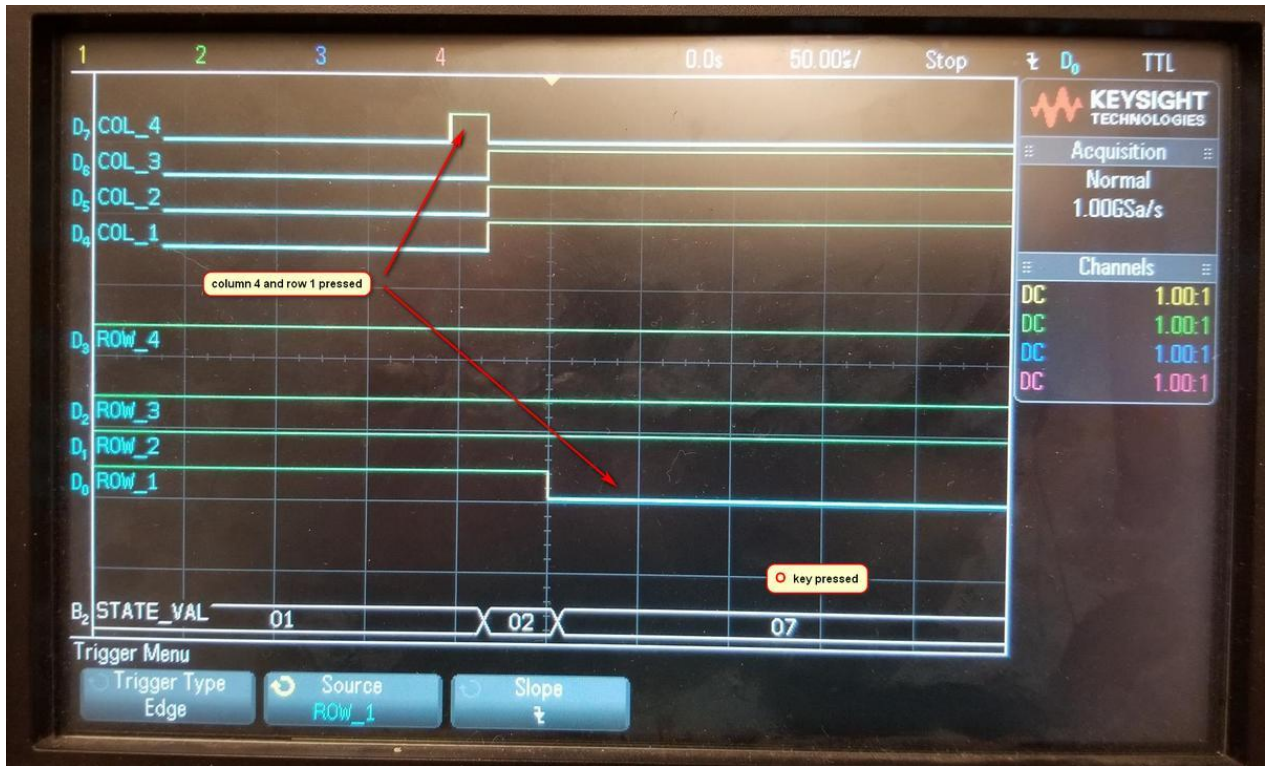


Figure 5 - Logic value result on logic Analyzer when the 0 key is pressed on the HEX keypad

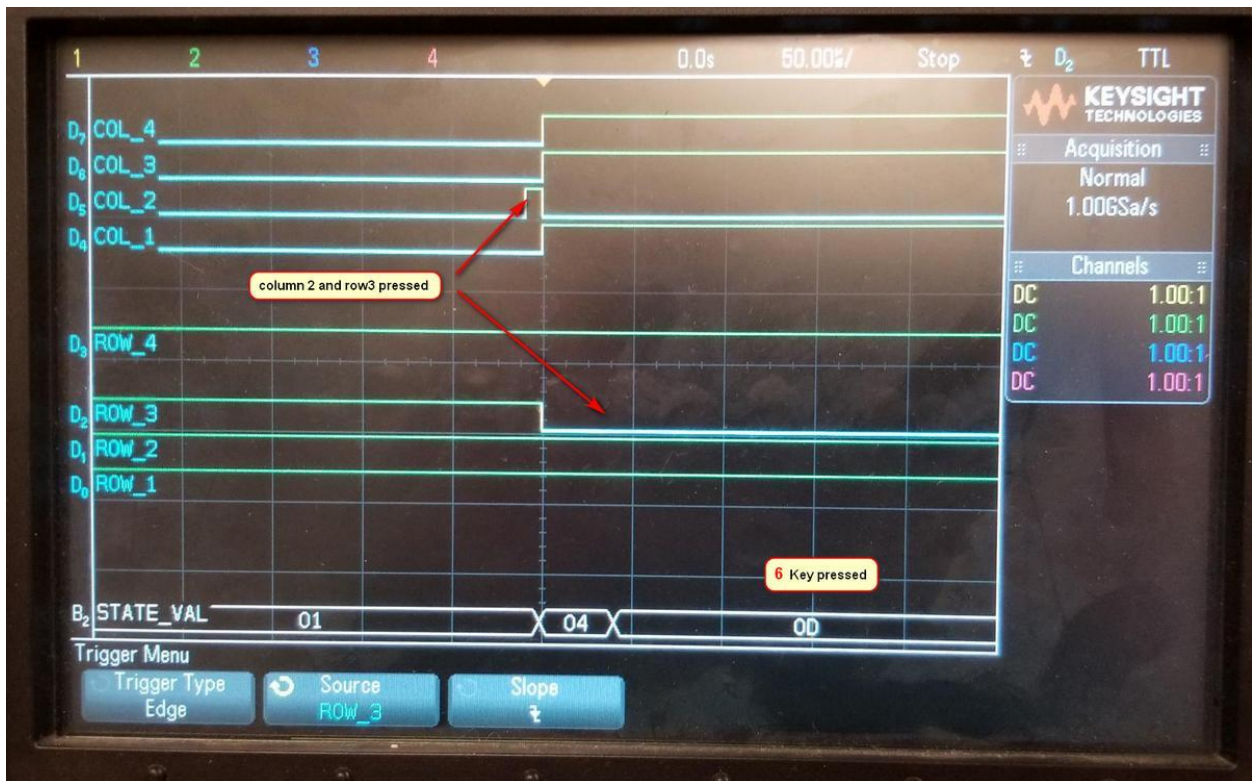


Figure 6 -Logic value result on Logic Analyzer when 6 key is pressed on the HEX keypad

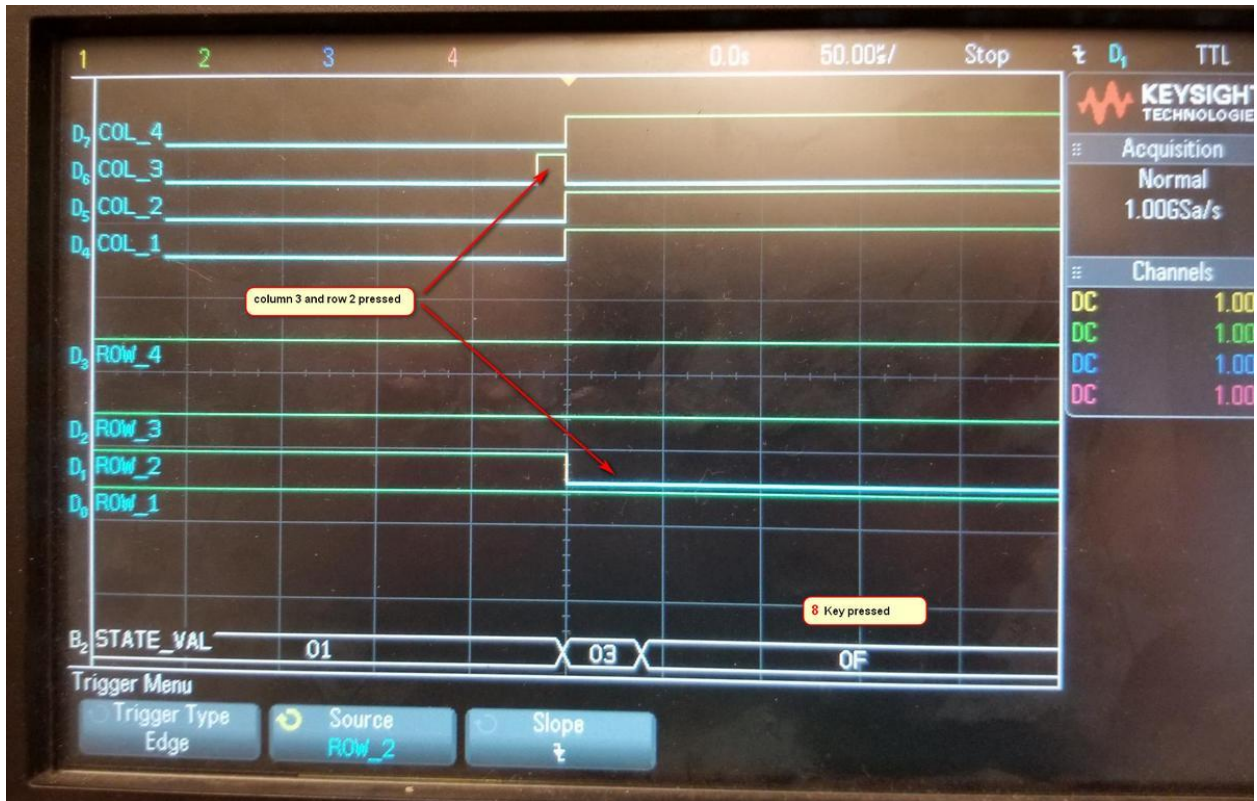


Figure 7- Logic value result on logic Analyzer when 8 key is pressed on the HEX keypad

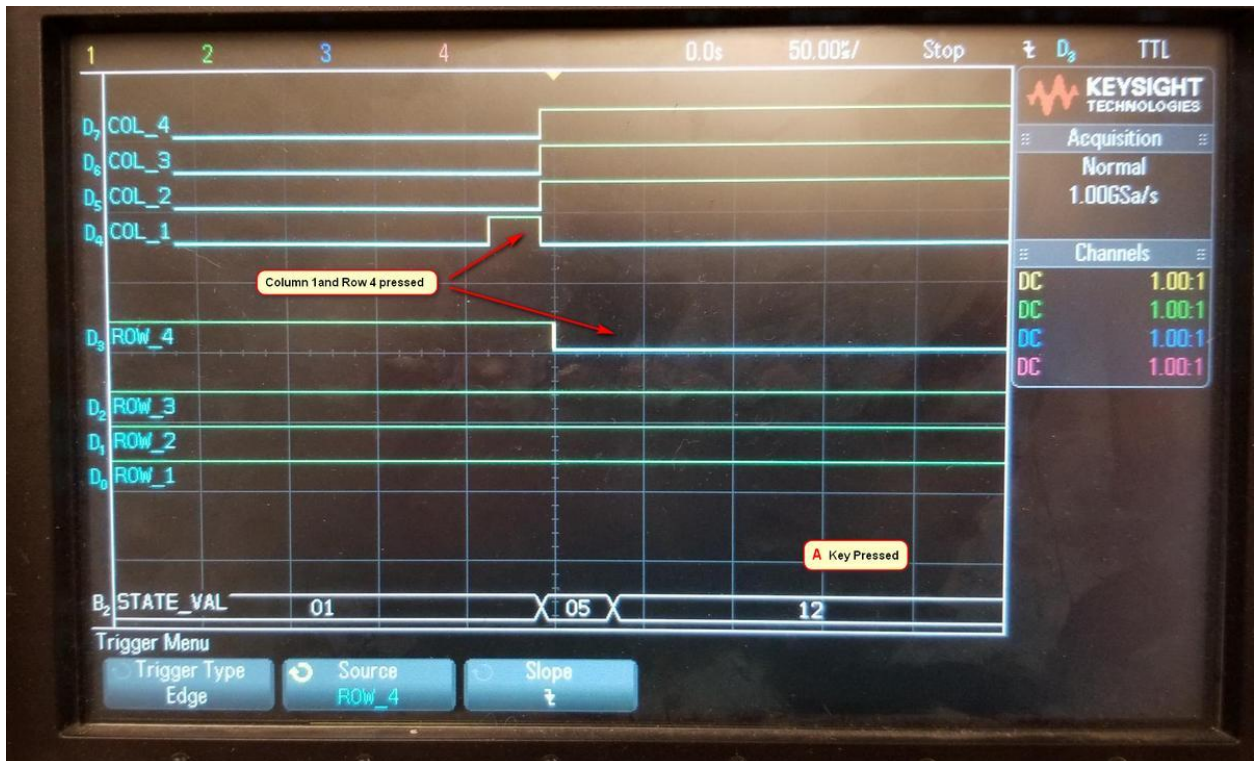


Figure 8 -logic value result on logic analyzer when the A key is pressed on the HEX keypad

This is the end of the tutorial for the PMOD HEX keypad. The objective was to give you a general insight on how to make the keypad work with the DE1-SoC board. For further information, ask the lab manager for the DESL lab. His office is BA3104.