

Lab 3: Addition of Keypad to LCD I/O to Cooperative  
Multitasking for LED Blinking

ME 305-03

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## Objective

The objective of this lab was to add on input-output capability to what was done in Lab 2. The user is able to enter a decimal integer that represents the number of milliseconds in the period for the specified LED pair. Magnitudes that are accepted range from 1 to 65,535. Errors are shown when no digits are entered, a zero magnitude is entered and when the magnitude is too large. The current number of milliseconds is displayed on the LCD. As in Lab 2, the LED pairs blink in the following order:

G\_LED ON and R\_LED OFF

G\_LED OFF and R\_LED OFF

G\_LED OFF and R\_LED ON

G\_LED OFF and R\_LED OFF

G\_LED ON and R\_LED ON

G\_LED OFF and R\_LED OFF

## Tasks

### Task 1: Mastermind

This task tracks the various flags and branches accordingly. The states are listed below.

- State 1: Mastermind hub: Keeps track of the various flags and branches according to which flags are set
- State 2: SHOW: Counts the time to show an error
- State 3: RESETSHOW: Clears the SHOWflag and resets SHOWCOUNT
- State 4: RESETL1: Resets L1 and clears F1flag and F2flag
- State 5: RESETL2: Resets L2 and clears F1flag and F2flag
- State 6: Prompt 1: Sets the DLINE1 flag
- State 7: Prompt 2: Sets the DLINE2 flag
- State 8: F1Press: When F1 is pressed and the numbers pressed will be displayed on the screen
- State 9: F2Press: When F2 is pressed and the numbers pressed will be displayed on the screen
- State 10: clrBUFF: Moves the contents of buffer into pointer, counts what is being stored in buffer
- State 11: ENTERpress: Occurs when Enter is pressed
- State 12: NODIG: Occurs when no digits are entered, DIGITflag is set
- State 13: DIGITpress: Tests if F1 or F2 were pressed
- State 14: PROCEED: Makes sure there are no more than 5 digits being entered
- State 15: ERROR: Returns if something other than a digit is pressed
- State 16: MAXdig: Occurs when 5 digits have been entered

- State 17: BACKSPACE: Occurs when backspace has been pressed
- State 18: NOBS: If there are no digits entered, then user cannot backspace
- State 19: BCD: Converts digits from ASCII to BCD
- State 20: Indicates the number entered is above 65,535
- State 21: ZERO: Zero was entered (zero magnitude is not possible)
- State 22: DONE1: Checks if result is zero
- State 23: SET1: If result is an appropriate number and F1 is pressed, it is moved into TICKS\_1
- State 24: SET2: If result is an appropriate number and F2 is pressed, it is moved into TICKS\_2

#### Task\_2: Keypad Driver

This task initializes the keypad and checks to see if a button has been pressed. There are two main states. The first one initializes the keypad and the second tests the L\$KEY\_FLG to see if a key is available and had been pressed.

#### Task\_3: Display State

This task controls the LCD display module based on the flags that are set:

- State1: Display Hub - checks to see what is to be displayed based on the various flags that have been set.
- State 2: Init Display1: Displays the initial prompts top row
- State 3: Init Display 2: Displays the initial prompts bottom row
- State 4: HIGHdis- Displays the error for a magnitude too high
- State 5: NODIG- displays error for no digits entered
- State 6: Zerodis - displays error for a value of zero entered
- State 7: Topotime - this is the hub for when the user is inputting digits for LED\_1
- State 8: Bottomtime-this is the hub for when the user is inputting digits on LED\_2
- State 9: BACKSPACE - deletes the last digit entered by user
- State 10: Firstdig - secures the starting address for the first digit to be displayed
- State 11: Ddigit - displays the next digit entered and addst to buffer
- State 12: Cline1 - clears the previous numerical entry by user for LED\_1
- State 13: Cline2 - clears the previous numerical entry by user for LED\_2

#### Task 4: Pattern One

This task established the blinking order of the first pair of LEDs. There are seven states. State 0 ensures that all LEDs are off when Task 1 is initialized. States one through six turn on the LEDs in the pattern stated above.

#### Task 5: Timing of first LED pair

This task counts down the first LED pair. This task has 3 main states: state 0, state 1, and state 2. State 0 initializes Task 2 and sets the next state. State 1 initializes COUNT\_1, decrements COUNT\_1 and stores it. State 2 tests to see if COUNT\_1 is already zero, counts down COUNT\_1, decrements COUNT\_1 and stores it. If it is done, the done flag is set, if it is not done then it returns.

#### Task 6: Pattern Two

This task established the blinking order of the second pair of LEDs. There are seven states and they are the same as Task 4, but applied to the second pair of LEDs and the associated variables.

#### Task 7: Timing of second LED pair

This task counts down the second LED pair. This task has 3 main states and they are the same as Task 5, but applied to the second LED pair and the associated variables.

#### Task 8: Delay

This task sets the delay time of 1.00 ms. There are two main states, State 0 and State 1. State 0 initializes Task 3 and State 1 sets the time delay of 1.00 ms.

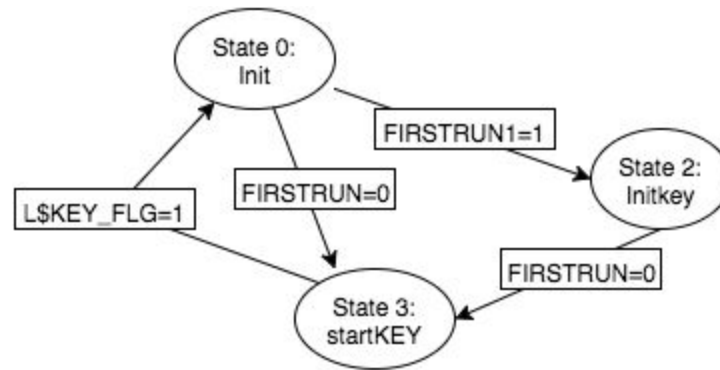
### Inter-task Communication Variables

Variable	Description	Set Location	Clear Location
BACKflag	Indicates that backspace has been presses	TASK_1, BACKSPACE	TASK_1, NOBS
FIRSTCH	Indicates that the character being displayed is the first character	Initially set	TASK_3, DCHAR_1st
DLINE1	Indicates that the initial first line is being displayed	TASK_1, PROMPT1	TASK_3, CL1
DLINE2	Indicates that the initial second line is being displayed	TASK_1, PROMPT2	TASK_3, CL2

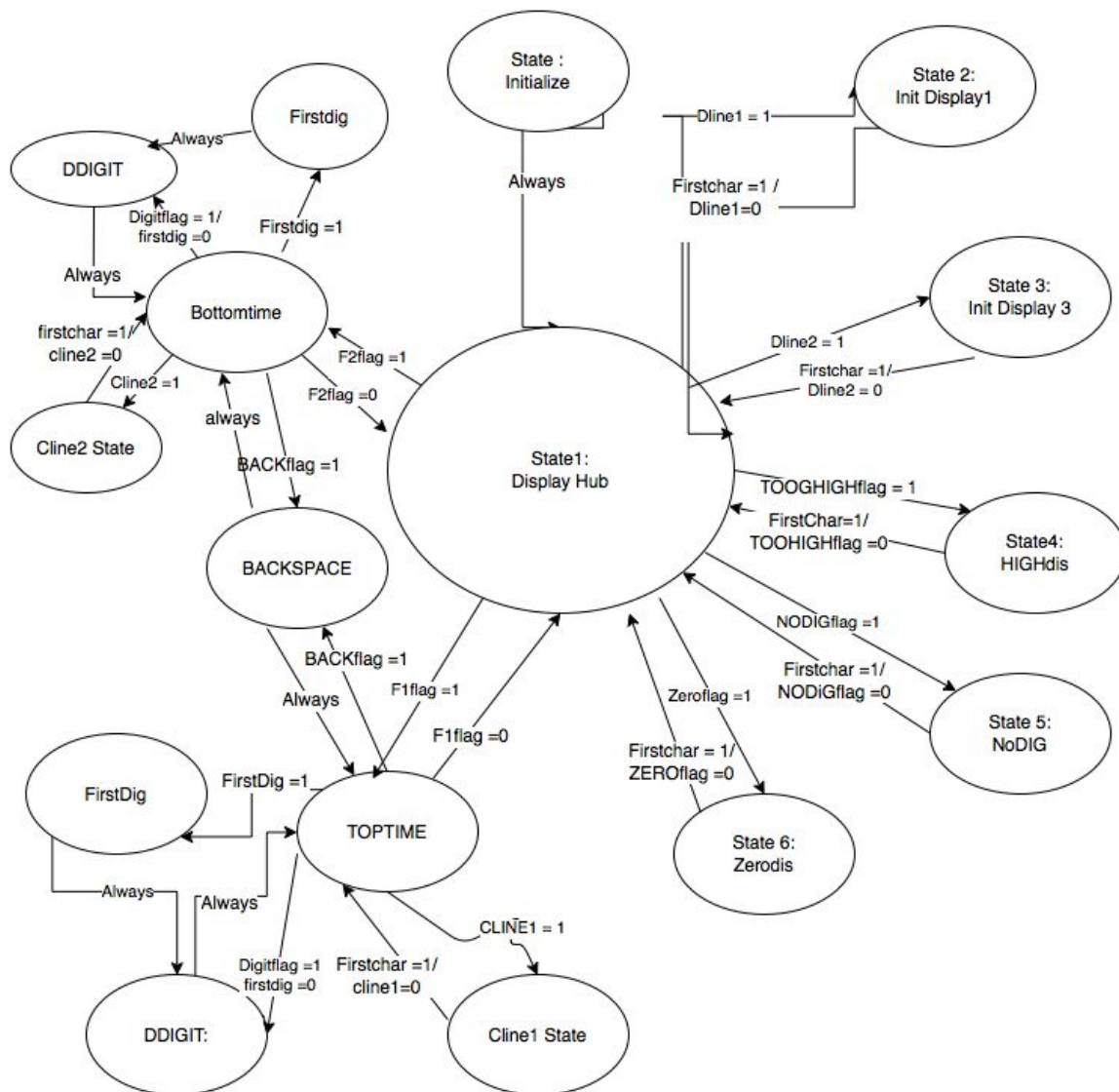
F1flag	Indicates F1 was pressed and line 1 is being written to	TASK_1, F1Press	TASK_1: RESETL1, RESETL2, F2Press TASK_4: START1
F2flag	Indicates F2 was pressed and line 2 is being written to	TASK_1, F2Press	TASK_1: RESETL1, RESETL2, F1Press TASK_6: START2
DIGITflag	Indicates that a digit is to be displayed	TASK_1, PROCEED	TASK_1: MAXdig, Ddigit
COUNT	Indicates the number of digits entered	Increments in Task_3, Ddigit	TASK_1: F1Press, F2Press, SET1, SET2
FIRSTdig	Indicates the first digit on the line being displayed	TASK_1, F1Press, F2Press	TASK_3, Ddigit_1st
TEMP	Holds the ascii value entered on the Keypad.	TASK_3	TASK_1: RESETSHOW, F1press, F2press, ENTERpress TASK_3: Ddigit, BS,
DONE_1	communicates when to switch to next task in TASK_4	TASK_5: setdone_1	TASK_5: states 0 and 1
DONE_2	communicates when to switch to next task in TASK_4	TASK_7: setdone_2	TASK_7: states 0 and 1
ON_1	indicates if LED pair 1 should be on	TASK_1: SET1	_main; TASK_1: F1press
ON_2	indicates if LED pair 2 should be on	TASK_1: SET2	_main; TASK_1: F2press
TOOHIGHflag	indicates if entered value is too high	TASK_1: toobig,	TASK_3: CHIGH
SHOWflag	indicates if screen should pause on an error	TASK_3: CHIGH, CNODIG, CZERO	TASK_1: RESETSHOW
NODIGflag	indicates no digits were entered	TASK_1: NODIG	TASK_3: CNODIG



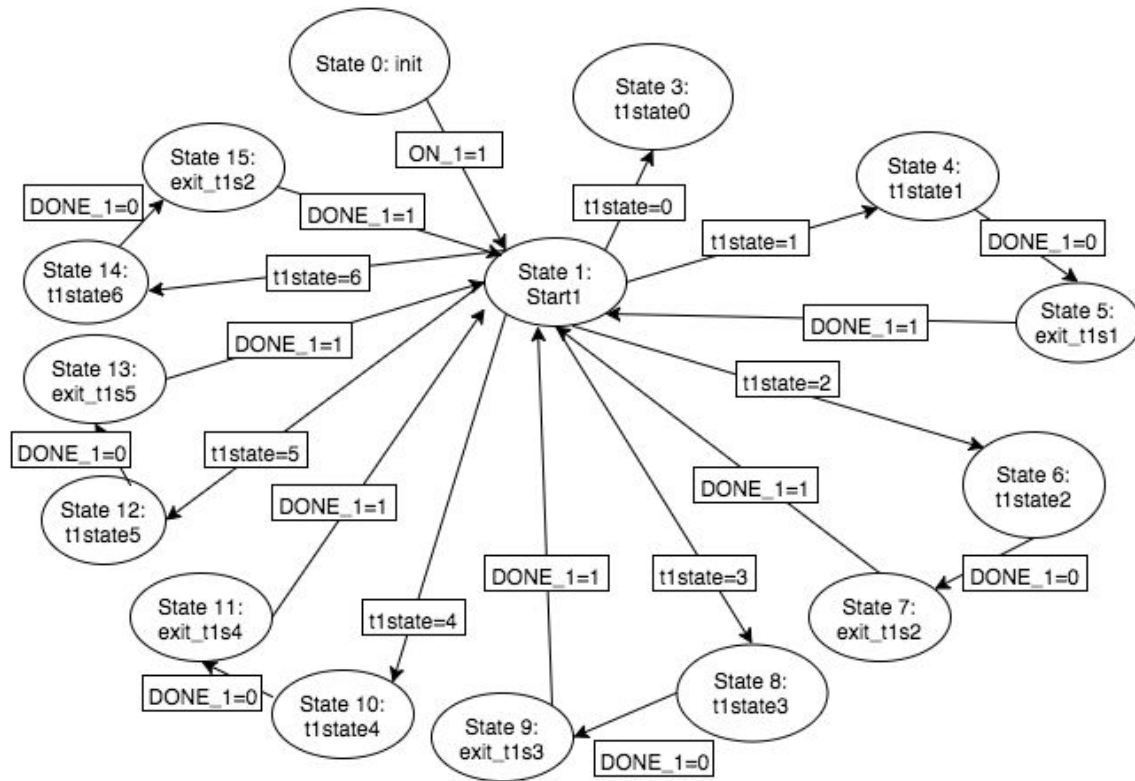
## Task\_2: Keypad Driver



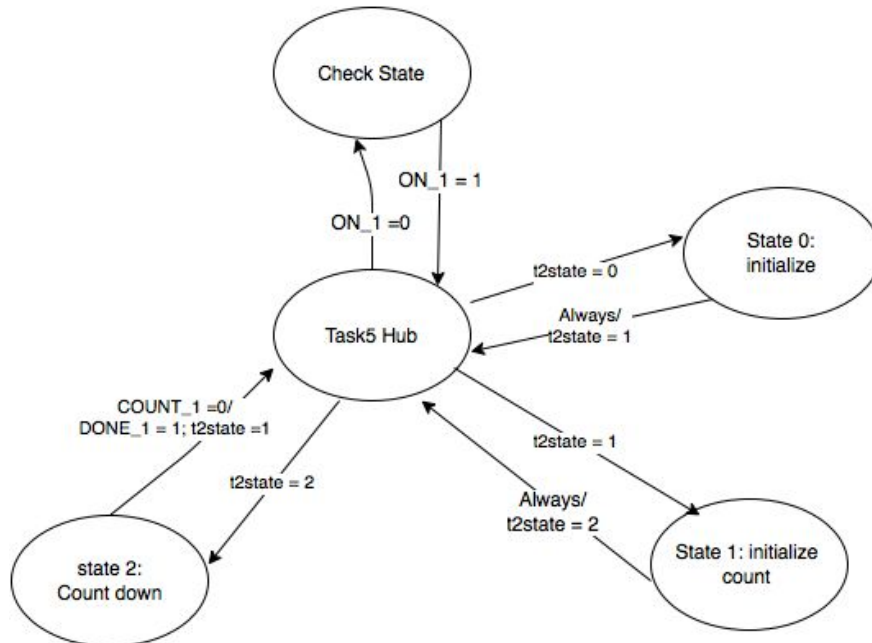
## Task\_3: Display task



Task\_4: Pattern 1 for LED pair 1

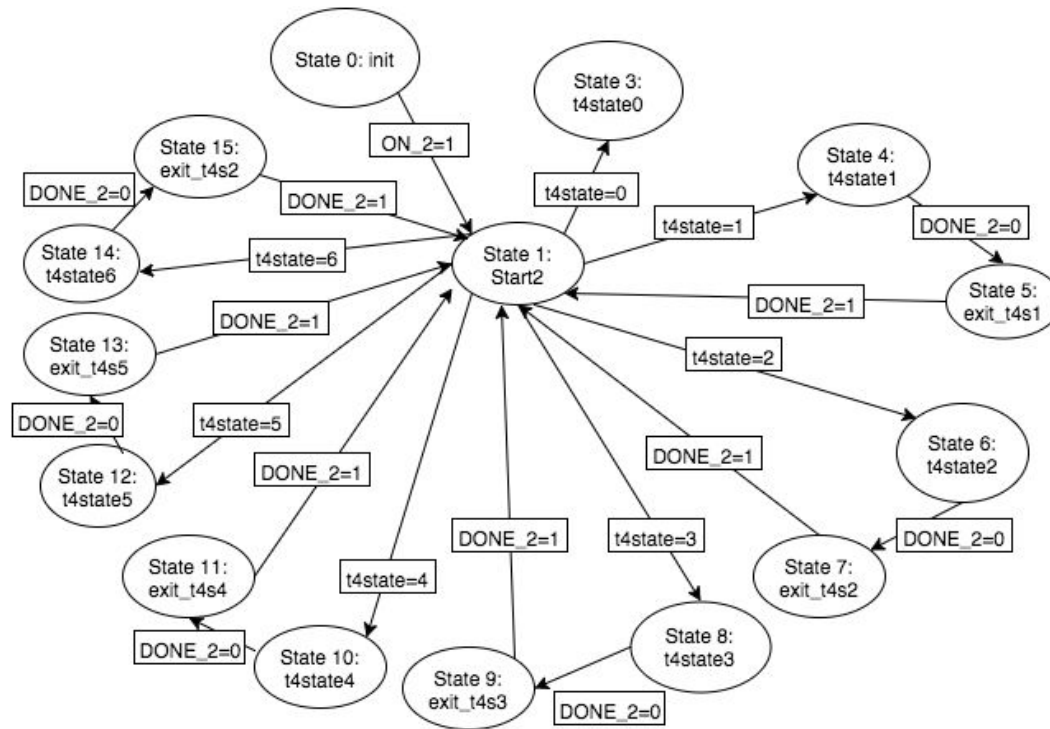


Task\_5: Count Down LED pair 1

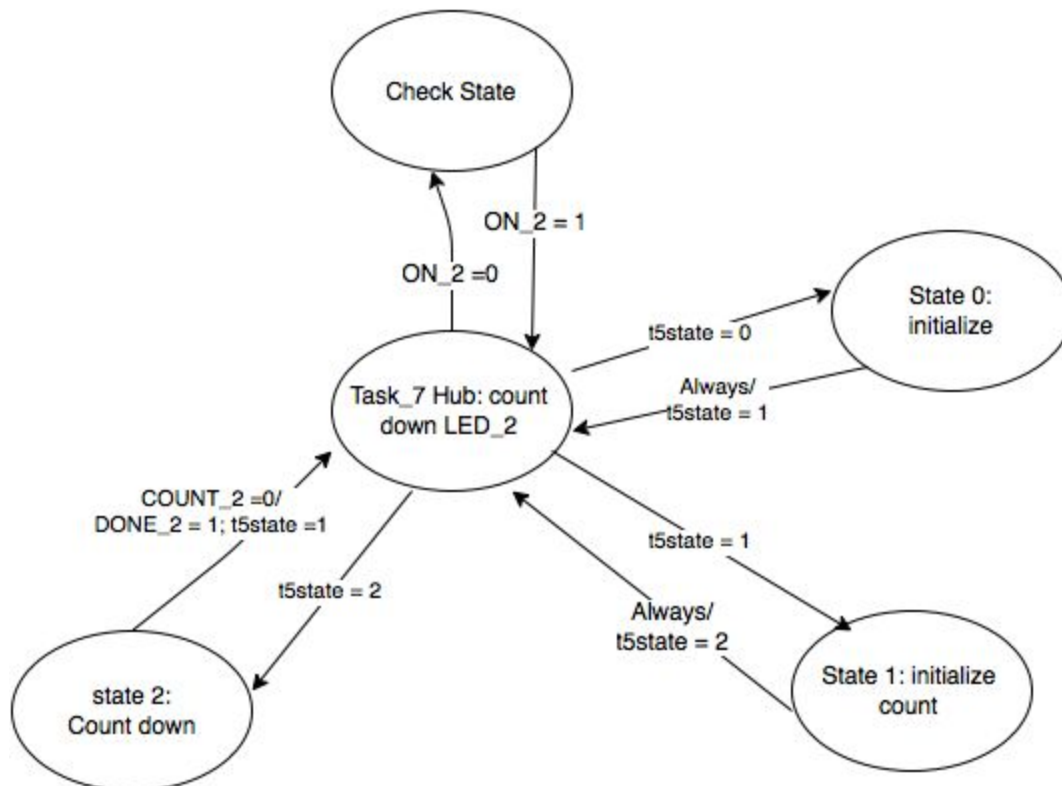




Task\_6: Pattern 2 for LED pair 2



Task\_7: count down LED\_2 pair



Task\_8: Delay 1.00 ms

