KEYPAD

CML12S LAB EXPERIMENT

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Class

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Instructor / Professor

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CONTENTS

1 GETTING STARTED

The following section has been designed to help users to quickly learn proper setup and operation of the lab experiment.

1.1 Introduction

The experiment requires a single board development system that is fully assembled and fully functional from Axiom Manufacturing. Development board CML12S is supported in this experiment. The system comes complete with schematic and instructions. All software, drawings, and manuals are contained on the CD.

1.2 Software

The CD comes with AxIDE, which is an integrated development environment designed exclusively for use with Axiom development boards, providing an interface to programs running on these boards. AxIDE also makes uploading programs and easy via the COM port. Read your board manual for setting up the AxIDE.

1.3 Support Software

There are many useful programs on the included CD that can make developing projects easier. The CD also contains example software programs for this experiment on each board. . You can also download the latest software free from our web site at: http://www.axman.com.

1.4 Hardware

The following hardware is required:

Axiom CML12S
Windows based PC
KeyPad

2.0 Visual

Devices used in this lab are static sensitive and are easily damaged by mishandling. Use caution when installing wires and devices on the breadboard to prevent the bending of leads. Experiments should be laid out in a orderly fashion. Start your lab time with the bench clean and free of metal objects. Leave the lab area in a clean condition by picking up loose parts, wires and small objects.

3.0 Theory

Axiom's development board is designed for quickly and effectively learning the basics of microcontrollers. This lab will walk the student though the steps of using the development board for its intended purpose, inputting information, making a decision on that information. A keypad is one device that is commonly used by a microcontroller. In this lab, a 4x4 keypad is used for the experiment. A keypad is a matrix of switches that are organized as 4 input pins and 4 output pins. The microcontroller will scan this matrix of switches using the keypad port, driving a nibble (4 bits) and reading the results in a nibble (4 bits). The keypad port is only able to scan a maximum of 16 keys (4 x 4 = 16). A scan program must provide some delay between writing a port and reading the result. This delay is necessary because of delays in the microcontroller and the switch bounce in the keypad. A keypad is a good input device for appliances, machinery, cars, & alarms plus many others.

4.0 Procedure

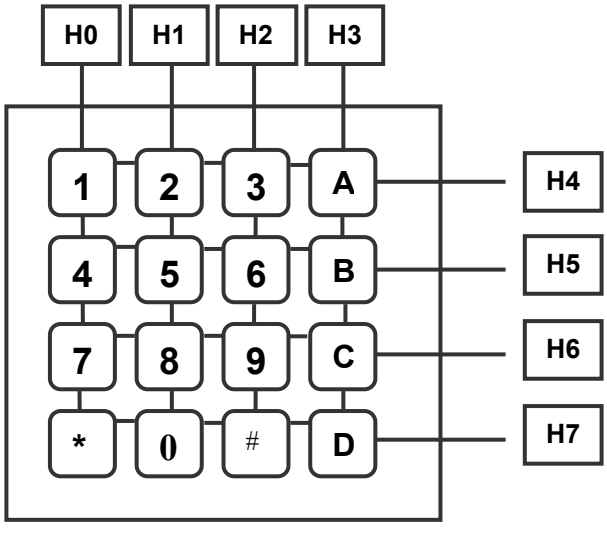
The procedure is arranged in a series of steps. Each step is to be completed before moving on to the next step. As each step is built on prior steps, the student will increase their knowledge for other labs or self-study. The student should go though the steps as many times as necessary to master the subject. As an aid in keeping track of your location, the check box next to each step should be checked as completed.

4.1 Description

You will be using PORT H on the DP256 microcontroller. PORT H is setup as an output on bits 0, 1, 2, and 3 only. These bits are used as the drive nibble for the keypad. Bits 4, 5, 6, and 7 on PORT H are the input nibble. Port H data register is located at address $0260. The input register is at $0261. Before anything can be written to port H, the direction register has to be setup and it is located at $0262. Writing directly to this port will change the level of each pin. The input bits have pull down resistors enabled in the microcontroller and read low when no key is pressed. The 8 pin KEYPAD/PORT-H connector implements 4 bits of output and 4 bits input of port H as a simple keypad interface or may be implemented as a software key scan for a keypad. Using the monitor, you will be shown the steps necessary for scanning a keypad matrix.

KEYPAD/PORT-H

Pin	Pin	Pin	Pin	Pin	Pin	Pin	Pin
1	2	3	4	5	6	7	8
OUTPUT	OUTPUT	OUTPUT	OUTPUT	INPUT	INPUT	INPUT	INPUT
H0	H1	H2	H3	H4	H5	H6	H7



Normal Keypad Matrix

4.2 Detailed Steps

- [ ] Note in the following steps: PTH - refers to address $0260
  PTIH - refers to address $0261
  DDRH - refers to address $0262
  PERH - refers to address $0264
  PPSH - refers to address $0265

- [ ] Verify power is not applied to CML12S.

- [ ] Install a keypad on the keypad port.

- [ ] Enable JP1, JP2, MEM_EN, and NO_AUTO jumpers. Disable MODC and ECS jumpers. This will configure CML12S for single chip mode of operation.

- [ ] Apply power to the CML12S.

- [ ] Write $F0 to PPSH. This select pull down devices on bits 4, 5, 6, and 7. This forces the keypad inputs low when no keys are pressed.

- [ ] Write $F0 to PERH. This turns on the pull down devices for bits 4, 5, 6, and 7. The internal pull-down in the DP256 is now active.

- [ ] Write $0F to DDRH. This forces port H bit 0, 1, 2, and 3 as outputs.

- [ ] Write $00 to PTH. This forces port H bit 0, 1, 2, and 3 outputs to low.

- [ ] Read PTIH several times while pressing any of the keys, no matter which key is pressed, it always reads $0x.

- [ ] Write $01 to PTH, this forces port H bit 0 high. This is applied to the keypad matrix. Read PTIH, verify it stills reads $0x.

- [ ] Press keypad key ‘1’ while reading PTIH and verify it reads $x1. Press keys 2, 3, and A, while reading PTIH and verify a value of $2x, $4x, and $8x.

- [ ] Write $02 to PTH, this forces port H bit 1 high. This is applied to the keypad matrix. Read PTIH, verify it stills reads $0x.

- [ ] Press keypad key ‘4’ while reading PTIH and verify it reads $1x. Press keys 5, 6, and B, while reading PTIH and verify a value of $2x, $4x, and $8x.

- [ ] Write $04 to PTH, this forces port H bit 4 high. This is applied to the keypad matrix. Read port H, verify it stills reads $0x.

- [ ] Press keypad key ‘7’ while reading PTIH and verify it reads $x1. Press keys 8, 9, and C, while reading PORTE and verify a value of $2x, $4x, and $8x.

☐ Write $80 to PTH, this forces port H bit 3 high. This is applied to the keypad matrix. Read PTIH, verify it stills reads $0x.

☐ Press keypad key '*' while reading PTIH and verify it reads $1x. Press keys 0, #, and D, while reading PTIH and verify a value of $2x, $4x, and $8x.

4.3 Conclusion

In conclusion, by using the 4-bit nibble on port H as four select lines. Four different sets of four keys are enabled. With only 4 keys selected at a time. Port H displays the result of which key is pressed of the four keys. Port H select lines (H0, H1, H2, and H3 should only have one bit high at a time or otherwise the results would be meaning less. If more then one key is press at a time, multiple bits will be set in port H. The program Key2D.S19 doesn't check for this condition.

Using the results of the scan, they are applied to a look up table. The table is another matrix with the ASCII value of the key that way pressed.

Table Loop-Up Table

Port H (A)	$1x (H4)	$2x (H5)	$4x (H6)	$8x (H7)
H0 = high (B)	$31 (1)	$32 (2)	$33 (3)	$41 (A)
H1 = high (B)	$34 (4)	$35 (5)	$36 (6)	$42 (B)
H2 = high (B)	$37 (7)	$38 (8)	$39 (9)	$43 (C)
H3 = high (B)	$2A (*)	$30 (0)	$23 (#)	$44 (D)

5.0 Key2D PROGRAM

5.1 Program Description

The Key2D.s19 program is used for a simple keypad scan. First the program sets up port H bits 0, 1, 2, and 3 as outputs and bits 4, 5, 6, and 7 as inputs with pull down resistors. Next register B is loaded with the keypad scan value. Subroutine KEYCHK is called. The subroutine writes the scan value to port H. Next, a small delay is executed. This allows scan signals some time to settle before being read. After the delay, register A is loaded with the value of port H. The Z flag in the CCR reflects if A is zero. The program next returns to the main program. If A is zero, then the next scan value is loaded and the subroutine is called again until all four bits are scanned. Otherwise, if a bit is set in A, the program quits to monitor. Register A contains port E and register B contains the scan value in port D.

5.2 Running Key2D Program

☐ Load program Key2D.s19 into CML12S. This program is located at $1000, which is internal memory. The source is show below.

- [ ] Without pressing any keys on keypad, call 1000 <enter> on CML12S terminal.

- [ ] The register dump shows that register A and B both contain $00 when no keys are pressed.

- [ ] Press and hold key “1” on keypad. Enter call 1000 <enter> on CML12S terminal. The register dump shows register A is equal to $1x and register B contains $x4.

5.3 Key2D Source

```
;                   Example Scan
;
;                  Register Equates
PTH:        equ     $0260       ; port H output register
PTIH:       equ     $0261       ; port H input
DDRH:       equ     $0262       ; port H direction register
PERH:       equ     $0264       ; pull down enable
PPSH:       equ     $0265       ; select pull-down
;
; This subroutine will scan keypad

            org     $1000
            movb    #$0F,DDRH   ; set port H bit 0,1,2,3 as outputs
            movb    #$F0,PERH   ; enable the pull devices
            movb    #$F0,PPSH   ; select pull-down

SCAN:
            ldab    #$01        ; start row to scan
SCANLP:
            bsr     KEYCHK      ; check for key
            bne     SCANRT      ; quit if key found
            lslb                ; next row to scan
            andb    #$0F        ; mask row only
            bne     SCANLP      ; repeat until all rows are scan
SCANRT:
            rts                 ; return
; This subroutine will apply scan on port H
KEYCHK:
            stab    PTH         ; output key columns
            xgdy                ; use xgdy instruction for
            xgdy                ; 8 cycle delay
            ldaa    PTIH        ; input key rows
            anda    #$F0        ; mask for key rows
            rts                 ; return with result

;
```

6.0 QUIZ

Question One

What address is PTIH register located?

A. Interrupt vector $FFF0.
B. Internal address $0261.
C. Address $0262
D. External address

Question Two

Where is the program Key2D.S19 located in memory?

A. External memory
B. Internal memory
C. Eprom
D. Rom

Question Three

In Key2D, which bits of port H are outputs?

A. 1, 2, 3, 4
B. Even Bits
C. 0, 1, 2, 3
D. 4, 5, 6, 7

Question Four

How's many keys are scanned at one time?

A. One
B. Five
C. Sixteen
D. Four

Question Five

What is the effect when an operator presses multiple keys?

A. Program stops
B. Keys are added
C. More then one bit set
D. System Failure

Question Six

Four-bits of port H are a?

A. Word
B. Nibble
C. Input
D. Result

Question Seven

What is a keypad?
A. Output device C. Input device
B. Serial device D. Analog device

Question Eight

What must be done between writing a scan nibble and reading the result nibble?
A. Press a key C. Reset
B. Call Scan11 D. Delay

Question Nine

What is the value read from port H (Vx) V = Value, X = Don't care when no key is pressed?
A. $1x C. Analog
B. $0x D. Delay

Question Ten

What is largest keypad that can be used on the keypad port?
A. 32 C. 10
B. 4 D. 16

Bonus Question

Using the lookup table, what ASCII character is A = $8x and B=$x8?
A. * C. D
B. A D. E

7.0 TROUBLESHOOTING

The development system is fully tested and operational before shipping. If it fails to function properly, consult the troubleshooting section of your user manual.

8.0 Tips and Suggestions

Following are a number of tips, suggestions and answers to common questions that will solve most problems users have with the development system. You can download the latest software from the Support section of our web page at: www.axman.com