

# KEYPAD

## LAB EXPERIMENT

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Class

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Instructor / Professor



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## 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 CME11E9 is supported in this experiment. The system comes complete with parts, 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 CME11E9 EVBU  
Windows based PC  
KeyPad

## 2.0 Visual

Devices used in this lab are static sensitive and are easy 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 through the steps of using the development board for its intended purpose, controlling devices. 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. 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

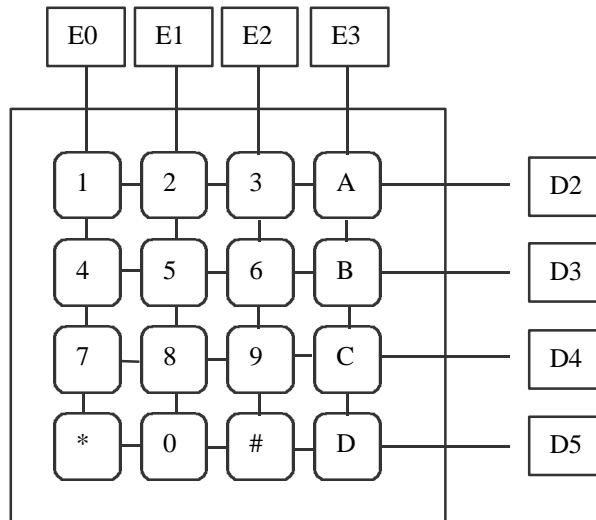
The procedure is arranged in a series of steps. Each step is to be completed before moving on to the next step. As each step is built on prior steps, the student will increase their knowledge for other labs or self-study. The student should go through the steps as many times as necessary to master the 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 D and PORT E on the HC11E9 microcontroller. PORT D is setup as a output only port. Bits 2,3,4,5 are used as the drive nibble for the keypad. This port is located at address \$1008 (PORTD) and \$1009 (DDRD) on the HC11. Writing directly to this port will change the level of each pin. PORT E is a analog input port, but you can read digital signals on this port. Bits 0,1,2,3 of PORTE form the input nibble from the keypad. These bits have pull down resistors and read low when no key is pressed. The 8 pin SS:Keypad connector implements 4 bits of port D and 4 bits of port E as simple keypad interface or may be implemented as a software key scan for a passive keypad. Using the Buffalo monitor, you will be shown the steps necessary for scanning a keypad matrix.

SS:Keypad Port

Pin	Pin	Pin	Pin	Pin	Pin	Pin	Pin
3	4	5	6	7	8	9	10
OUTPUT	OUTPUT	OUTPUT	OUTPUT	INPUT	INPUT	INPUT	INPUT
D2	D3	D4	D5	E0	E1	E2	E3



Normal Keypad Matrix

## 4.2 Detailed Steps

- Note in the following steps: PORTD refers to address \$1008  
 DDRD refers to address \$1009  
 PORTE refers to address \$100A  
 x refers to don't care
- Install a keypad on the keypad port..
- Verify power is not applied to EVBU.
- Enable ModA and Disable ModB jumper. Disable MEM\_EN jumper. This will configure EVBU for single chip mode of operation.
- Apply power to the EVBU.
- Write \$3C to DDRD. This forces PORT D bit 2,3,4,5 as outputs.
- Write \$00 to PORTD. This forces PORTD bit 2,3,4,5 outputs to low.
- Read PORTE several times while pressing any of the keys, no matter which key is pressed, it always reads \$x0.
- Write \$04 to PORTD, this forces PORT D bit 2 high. This is applied to the keypad matrix. Read PORTE, verify it stills reads \$x0.

- Press keypad key '1' while reading PORTE and verify it reads \$x1. Press keys 2,3,A, while reading PORTE and verify a value of \$x02,\$x04,\$08.
- Write \$08 to PORTD, this forces PORT D bit 3 high. This is applied to the keypad matrix. Read PORTE, verify it stills reads \$x0.
- Press keypad key '4' while reading PORTE and verify it reads \$x1. Press keys 5,6,B, while reading PORTE and verify a value of \$x02,\$x04,\$08.
- Write \$10 to PORTD, this forces PORT D bit 4 high. This is applied to the keypad matrix. Read PORTE, verify it stills reads \$x0.
- Press keypad key '7' while reading PORTE and verify it reads \$x1. Press keys 8,9,C, while reading PORTE and verify a value of \$x02,\$x04,\$08.
- Write \$20 to PORTD, this forces PORT D bit 5 high. This is applied to the keypad matrix. Read PORTE, verify it stills reads \$x0.
- Press keypad key '\*' while reading PORTE and verify it reads \$x1. Press keys 0,#,D, while reading PORTE and verify a value of \$x02,\$x04,\$08.

## 4.3 Conclusion

In conclusion, by using the 4-bit nibble on port D as four select lines. Four different set of four keys are enabled. With only 4 keys selected at a time. Port E displays the result of which key is pressed of the four keys. Port D select lines (D2,D3,D4) 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 E. The program Scan11.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 LoopUp Table

Port E (A)	\$x1	\$x2	\$x4	\$x8
D2 = high (B)	\$31 (1)	\$32 (2)	\$33 (3)	\$41 (A)
D3 = high (B)	\$34 (4)	\$35 (5)	\$36 (6)	\$42 (B)
D4 = high (B)	\$37 (7)	\$38 (8)	\$39 (9)	\$43 (C)
D5 = high (B)	\$2A (*)	\$30 (0)	\$23 (#)	\$44 (D)

# 5.0 SCAN PROGRAM

## 5.1 Program Description

The scan11.s19 program is used for a simple keypad scan. First the program sets up port D bits 2,3,4,5. Next register B is loaded with the keypad scan value. Subroutine KEYCHK is called. The subroutine writes the scan value to port D. 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 E. 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 Buffalo. Register A contains port E and register B contains the scan value in port D.

## 5.2 Running Scan Program

- Load program Scan11.s19 into Evbu. This program is located at \$0100, which is internal memory. The source is show below.
- Without pressing any keys on keypad, call 0100 <enter> on Evbu 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 0100 <enter> on Evbu terminal. The register dump shows register A is equal to \$01 and register B contains \$04.

## 5.3 Scan Source

```
*           Example Scan
*           File = Scan11.S19
*           Register Equates
PORTD      equ $1008      * port D output register
DDRD       equ $1009      * port D direction register
PORTE      equ $100A      * port E input
*
* This subroutine will scan keypad
          ORG $0100
          ldaa #$3C        * set port D bit 2,3,4,5 as outputs
          staa  DDRD

SCAN
          ldab  #$04        * start row to scan

SCANLP
```

```

        bsr  KEYCHK    * check for key
        bne  SCANRT    * quit if key found
        lslb                * next row to scan
        bne  SCANLP    * repeat until all rows are scan
SCANRT
        rts                * return

```

\* This subroutine will apply scan on port D and read port E

KEYCHK

```

        stab  PORTD    * output key columns
        xgdy                * use xgdy instruction for
        xgdy                * 8 cycle delay
        ldaa  PORTE    * input key rows
        anda  #$0F      * mask for key rows
        rts                * wait for key

```

\*

## 6.0 QUIZ

### Question One

What address is port D located?

- A. Interrupt vector \$FFF0.
- B. Internal address \$1008.
- C. Address \$0100 to \$01FF
- D. External address

### Question Two

Where is the program Scan11.s19 located in memory?

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

### Question Three

In Scan11, which register contains port E value?

- A. Internal register
- B. 16 bit register
- C. B register
- D. A register



Question Four

How's many keys are scanned at one time?

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

Question Five

What effect will result if a operator presses multiple keys?

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

Question Six

The bits of port D are a?

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

Question Seven

What is a keypad?

- A. Output device
- B. Serial device
- C. Input device
- D. Analog device

Question Eight

What must be done between writing a scan nibble and reading the result nibble?

- A. Press a key
- B. Call Scan11
- C. Reset
- D. Delay

Question Nine

What is the value read from port E if no keys are pressed?

- A. \$42
- B. \$x0
- C. Analog
- D. Delay

### Question Ten

What is largest keypad that can be used on the keypad port?

- A. 32
- B. 4
- C. 10
- D. 16

### Bonus Question

Using the lookup table, what ASCII value is A=\$08 and B=\$08?

- A. \$30
- B. \$40
- C. \$42
- D. \$41

## 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 CME11E9 development system. You can download the latest software from the Support section of our web page at:

[www.axman.com](http://www.axman.com)