

POTENTIOMETER

LAB EXPERIMENT

I

Class

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 EVBU is supported in this experiment. The manual comes complete with necessary drawings and instructions. All software and drawings are contained on the Axiom Manufacturing 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 easy via the COM port. Read your board manual for setting up 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
10k Potentiometer 20-22 turns
10k Resistor

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 though the steps of using the development board for its intended purpose, controlling devices. A potentiometer is one device that is

commonly used by a microcontroller. In this lab, a 10 k potentiometer is used for the experiment using port E. Port E is a eight channel analog to digital (A/D for short) port, which is required for reading the voltage on the potentiometer. The channels are selected by a analog mux. The A/D requires a reference. On the EVBU, the reference is connected to +5v. The potentiometer is connected between +5 and gnd. You will be using the center tap on the potentiometer connected to the analog port of the microcontroller. The device can be adjusted from the +5 level down to gnd level. By adjusting the pot in steps, the analog port will be read out in a hex value. The analog port is set up for continuous conversion of channels 4 thru 7. The results of this experiment are read from ADR4. The value from the A/D is read as a hex value with a range of 0 to \$FF. Potentiometers are used in appliances, machinery, cars, & robots plus many others. They come in many shapes and sizes for board mounting or chassis mounting.

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. You should go though the steps as many times as necessary to master the subject. As an aid in keeping track of location, the check box next to each step should be checked as completed.

4.1 Description:

You will be using PORT E on the HC11E9 microcontroller. First the analog port must be setup for continuous scan of analog input. Next the potentiometer is adjusted all the way to the gnd end of the potentiometer. The value is read from the analog port which should read close to \$00. The value determines the position of the adjustment. By adjusting the device though out its range and reading the value, you will graph the results on a chart. By graphing a line on the chart, a visual indication is show of the results. By comparing the result displayed on the graph, one can determine the position of the potentiometer.

4.2 Detailed Steps

4.2.1 Monitoring a Potentiometer

Steps:

- ☐ Note in the following steps: OPTION refers to address \$1039
ADCTL refers to address \$1030
ADR1 refers to address \$1031
ADR2 refers to address \$1032
ADR3 refers to address \$1033
ADR4 refers to address \$1034

- ☐ Verify power is not applied to EVBU.

Install a potentiometer and 10k resistor on the breadboard per figure.

- ☐ Connect the following points per figure:

EVBU	P4	to	Breadboard
GND			GND
PE7			TAP
VCC			FULL
- ☐ Enable ModA and disable ModB jumper. Disable MEM_EN jumper. This will configure EVBU for single chip operation.
- ☐ Apply power to the EVBU.
- ☐ Write \$80 to OPTION. This sets ADPU bit high which turns analog to digital converter on. Note: Buffalo turns this on for you because it must be written in the first 64 cycles.
- ☐ Write \$34 to ADCTRL. This sets A/D converter to continuous conversion and multi channels. It also selects port E channels 4,5,6,7. The results are placed in ADR1, ADR2, ADR3, ADR4.
- ☐ Continually read ADR4 while adjusting pot for a value as close to \$00 as the adjustment will allow. Read and record ADR4 value on the graph at 0 turns.
- ☐ Adjust pot two full turns in the opposite direction. Read and record ADR4 value on the graph at 2 turns.
- ☐ Continue to adjust pot two full turns while recording ADR4 value on the graph. Continue for 22 full turns.
- ☐ Graph result on the graph by drawing a line between points recorded on the graph.

4.2.2 Limiting Range

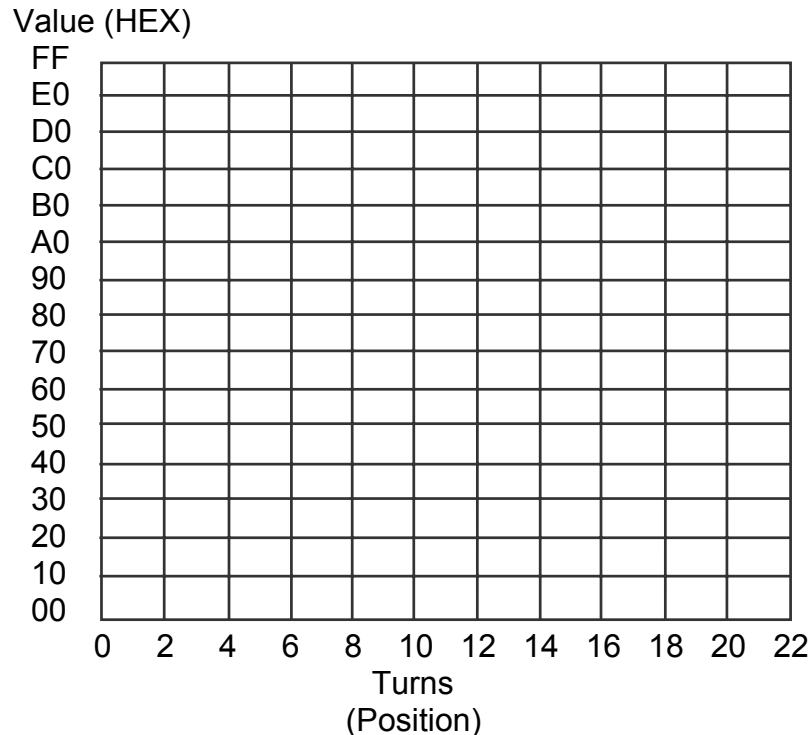
- ☐ Connect the following points per figure.

EVBU	P4	to	Breadboard
GND			GND
PE7			TAP
VCC			HALF
- ☐ Continually read ADR4 while adjusting pot for a value as close to \$00 as the adjustment will allow. Read and record ADR4 value on the graph at 0 turns.
- ☐ Adjust pot two full turns in the opposite direction. Read ADR4 and record value on graph at 2 turns.

- ☐ Continue to adjust pot two turns while recording ADR4 value on the graph. Continue for 22 full turns.
- ☐ Graph result on the graph by drawing a line between points recorded on the graph.

4.3 Conclusion

As seen in the graph, you can use the analog port to determine the position of the potentiometer. Plus the voltage on the analog port can be calculated by dividing 5 volts by 255 positions and then multiplying by the hex value (converted to decimal). Also by adding a resistor in series with the pot +5 side, the range of adjustment can be reduced by one half. This is helpful in cases where the pot is driven by a higher voltage than the microcontroller input voltage limit. By adding a resistor on the gnd, +5 or both sides of the pot; the range and position of the pot on the graph can be adjusted. The normal analog channel input range is 0 to 5 volts. With a 10k resistor, this can be extended from 0 to 10 volts range. Caution should be excised not to exceed the input range of the analog input. The maximum voltage is the HC11 supply voltage or +5 volts. Pots are used throughout the industry. Used for fluid level sensors, position sensors for robots, operator input devices.



5.0 Potentiometer Program

5.1 Program Description

The Pot11.asm program is used for easily displaying the results of our A/D conversion on the potentiometer position. First the program must setup the A/D channel. The A/D is first turned on, then set for multi channel conversion on channels 4 thru 7. Also set is the continuous conversion mode. The Buffalo routine "OUTCRLF" is called to output a carriage return and line feed for allowing the next value to be displayed. Register X is loaded with the address PE7 results. Another Buffalo routine is called to display this value as two hex numbers on the Axlde terminal. Finally, a delay is called to slow the display down for the operator and terminal. At the end of the program, the program jumps back to the beginning and repeats forever.

5.2 Running Pot11 Program

- ☐ Load program Pot11.S19 into Evbu. This program is located at \$0100, which is internal memory. The source is show below.
- ☐ Call 0100 <enter> on EVBU terminal. This starts the program running and a hex value will start to be displayed.
- ☐ The A/D result value is continually read and displayed. By adjusting the potentiometer, one can get a quick look at the position of the potentiometer.

5.3 Potentiometer Source

```
*
*      Example Pot11
*      File = Pot11.asm
*
*      Register Equates
OPTION      equ      $1039      * A/D On
ADCTL      equ      $1030      * A/D control
ADR4       equ      $1034      * A/D result
* Buffalo routines
OUTCRLF     equ      $FFC4      * car/line feed
OUT1BYT     equ      $FFBB      * display byte as hex
*
* This subroutine will turn on the A/D convertor
      org      $0100
      ldaa     #$80      * turn A/D on
      staa     OPTION
```

```

        ldaa    #$34          * A/D control
        staa    ADCTL        *
*
* read analog value and display
*
PotLoop
        jsr     OUTCRLF      * send car/LF
        ldx     #ADR4        * point to analog port
        jsr     OUT1BYT      * send hex value
        bsr     Delay        * delay
        bra     PotLoop

* Delay
Delay
        ldy     #$FFFF      * delay value

Delay1
        dey
        bne     Delay1      * decrement count
                             * repeat until done
        rts                * return
*

```

6.0 Quiz

Question One

What type port is required for reading a potentiometer?

- | | |
|----------------------|----------------------|
| A. Digital to Analog | C. Analog to Digital |
| B. Output | D. Serial |

Question Two

What is the maximum voltage allowed on port E?

- | | |
|---------------|--------------|
| A. 5 volts | C. 2.5 volts |
| B. No Maximum | D. 10 volts |

Question Three

What type of data is read from the A/D?

- | | |
|------------|-----------|
| A. Decimal | C. Sine |
| B. Hex | D. Matrix |

Question Four

What address is OPTION register located?

- A. \$1039
- B. \$1030
- C. Address \$0100 to \$01FF
- D. External address

Question Five

What is the range with the 10k resistor installed in the 5v side?

- A. 2X
- B. 1/2X
- C. 4X
- D. 1X

Question Six

Using the completed graph, what can one determine from a value on the graph?

- A. Position
- B. Voltage
- C. Turns
- D. All of the above

Question Seven

In this experiment, the A/D is setup for _____ conversion?

- A. Digital
- B. Single
- C. Continuous
- D. One shot

Question Eight

How many A/D channels are on the HC11?

- A. 8
- B. 3
- C. 2
- D. 16

Question Nine

The A/D channels require what?

- A. Computer
- B. Resistor
- C. Diode
- D. Reference

Question Ten

How many analog channels are converted in multiple channel mode?

- A. 1
- B. 5
- C. 8
- D. 4

Bonus Question

The eight channel analog input on the HC11 goes through a?

- A. Analog Mux
- B. Switch
- C. Digital Mux
- D. Decimal conversion

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.

- A. Verify jumpers on EVBU are correctly set.
- B. Verify lab components are installed correctly.

