POTENTIOMETER

PROJECT BOARD & EVBU LAB EXPERIMENT

I

Class

Instructor / Professor

xiom
anufacturing
2813 Industrial Ln. • Garland, TX 75041 • (972) 926-9303 FAX (972) 926-6063
support@axman.com Rev 1.01 • web: http://www.axman.com

CONTENTS

1 GETTING STARTED 2
1.1 INTRODUCTION 2
1.2 SOFTWARE 2
1.3 SUPPORT SOFTWARE 2
1.4 HARDWARE 2
2.0 Visual 3
3.0 Theory 3
4.0 Procedure 3
4.1 DESCRIPTION: 3
4.2 DETAILED STEPS 4
4.2.1 Monitoring a Potentiometer 4
4.2.2 Limiting Range 4
4.3 CONCLUSION 5
5.0 Potentiometer Program 6
5.1 PROGRAM DESCRIPTION 6
5.2 RUNNING POT11 PROGRAM 6
5.3 POTENTIOMETER SOURCE 6
6.0 Quiz 7
7.0 TROUBLESHOOTING 9
8.0 Tips and Suggestions 9

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 & PROJECT BOARD 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
PROJECT BOARD
Windows based PC

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 & PROJECT BOARD. PROJECT ON_OFF switch should be set to OFF.
- [ ] Setup EVBU & PROJECT for lab experiments per PROJECT BOARD manual.
- [ ] On PROJECT BOARD, enable RANGE jumper and set JP18 to position 2 & 3.
- [ ] Enable ModA and disable ModB jumper. Disable MEM_EN jumper. This will configure EVBU for single chip operation.
- [ ] Apply power to the PROJECT BOARD. Note: EVBU should be powered from the PROJECT BOARD. Turn ON_OFF switch to ON.
- [ ] 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 continuos 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 (R35) 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.

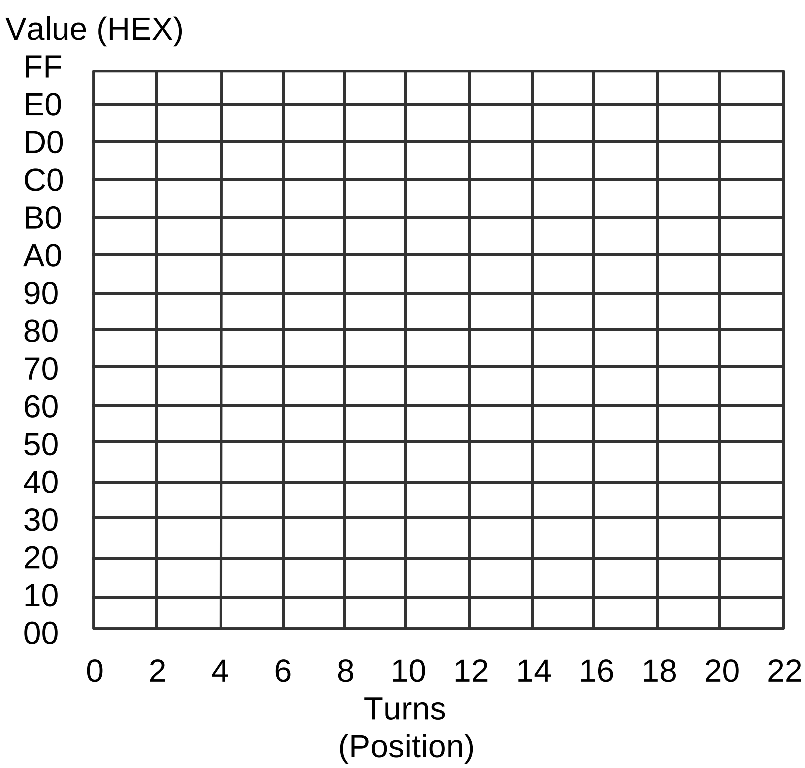
4.2.2 Limiting Range

- [ ] Disable RANGE jumper on PROJECT BOARD.
- [ ] Continually read ADR4 while adjusting pot (R35) 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 then 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 though out 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 continuos 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 AxIde 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                 * decrement count
            bne     Delay1      * 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 C. Address $0100 to $01FF

B. $1030 D. External address

Question Five

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

A. 2X C. 4X

B.1/2X D. 1X

Question Six

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

A. Position C. Turns

B. Voltage D. All of the above

Question Seven

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

A. Digital C. Continuous

B. Single D. One shot

Question Eight

How many A/D channels are on the HC11?

A. 8 C. 2

B. 3 D. 16

Question Nine

The A/D channels require what?
A. Computer C. Diode
B. Resistor D. Reference

Question Ten

How many analog channels are converted in multiple channel mode?
A. 1 C. 8
B. 5 D. 4

Bonus Question

The eight channel analog input on the HC11 goes though a?
A. Analog Mux C. Digital Mux
B. Switch 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 & PROJECT BOARD are correctly set.
B. Verify lab is setup.