LIGHT EMITTING DIODES (LEDs)
LAB EXPERIMENT # 1

Microprocessor Systems Laboratory

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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

This Lab introduces students to programming in assembly using the CML12S256 Axiom boards and software. Students will also lean basic interfacing principles using the output port of the processor and controlling external LED’s in some predetermined pattern.

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 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 CML12S256
- Windows based PC
- LEDS Lab Kit
  - Four LEDS
  - Four 470 ohm resistors
  - Five 3.5 inch jumpers
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 LED is one device that is controllable by a microcontroller. In this lab four LEDs are used for the experiment. A LED is a solid state device that when current is forced though the device, will emit a light. The port on the microcontroller will output a +5 volt high signal.

This signal is apply to the anode of the LED. The cathode of the LED is connected though a resistor to ground. The resistor is a current limiting resistor for the port. This limits the current flow on the port to its rated value, otherwise the port would over heat and possibly damage the port. LED intensity is depended on the current flow. Driving LEDs at a higher intensity would require external drivers rated for LED being used.

PROJECT board is one such board that includes the on board drivers. LEDs are good indicators for appliances, machinery, cars, & alarms plus many others. They come in several colors such as red, green, yellow, orange and blue. One LED can be used as power on indicator, another as a flashing alarm indicator, still another as a fault indicator.

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’s 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 location, the check box next to each step should be checked as completed.
4.1 Description

You will be using PORT K on the DP256 microcontroller. PORT K is a multiple functional and Bi_Directional port. Bits 0,1,2,3 are used as the drive for the four LEDs. PORT K output register is located at address $0032 and its data direction register is located at $0033 on the DP256. Writing directly to this port will change the level of each pin. Writing a binary one will turn the LED on and writing a binary zero will turn LED off.

4.2 Detailed Steps

Note in the following steps: DDRK refers to address $0033.
Note in the following steps: PORTK refers to address $0032.
Verify power is not applied to CML12S256.
Install four LEDs and the four resistors on the breadboard area per drawing. Install five jumpers per the following:

<table>
<thead>
<tr>
<th>MCU PORT</th>
<th>Breadboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>to GND</td>
</tr>
<tr>
<td>PK0</td>
<td>to D1</td>
</tr>
<tr>
<td>PK1</td>
<td>to D2</td>
</tr>
<tr>
<td>PK2</td>
<td>to D3</td>
</tr>
<tr>
<td>PK3</td>
<td>to D4</td>
</tr>
</tbody>
</table>

- Apply power to the CML12S256.
- Write $0F to DDRK. This configures PORT K bits 0 – 3 as outputs.
- Write $00 to PORTK, verify all LEDs are off. This forces all outputs low, thus removing the drive for all the LEDs.
- Write $01 to PORTK, verify LED 1 is on. This forces PORTK bit 0 high, thus applying a drive for LED 1.
- Write $02 to PORTK, verify LED 2 is on. This forces PORTK bit 1 high, thus applying a drive for LED 2.
- Write $04 to PORTK, verify LED 3 is on. This forces PORTK bit 2 high, thus applying drive for LED 3.
- Write $08 to PORTK, verify LED 4 is on. This forces PORTK bit 3 high, thus applying a drive for LED 4.

4.3 Conclusion

In conclusion, by using the four bits of port B as drive for the four LEDs, the LEDs are directly set on or off. Any combination of LEDs can be set. All on at once or only one, two, three LEDs on. In development, one can assign each LED
a function. Maybe one LED as a “Run” indicator. One as a “FAULT” indicator. Still another as a cycle indicator, example would be “RINSE” in a washing machine. Last would indicate a “Spin” cycle. The LED brightness is not readable in strong light levels. Normally a driver is provided between the microcontroller and LEDs. This increases the current, which increases the intensity of the LEDs.

5.0 Software Control of LEDs

5.1 Program Description

The program starts by loading the X register with the address of port K. This address is used as a pointer to port K. Using equates LED1,LED2,LED3,LED4 as a mask, bits 0,1,2,3 of port B are cleared. This turns all LEDs off. The next step uses mask bit “LED1” to set LED1 on. The LED is made visual by calling a delay routine. This delay is long enough for a human to see the LED as being on. The next step uses the same mask bit “LED1” to turn LED1 off. The remaining steps turn LEDs 2,3,4 on and off in the same way. Final the program jumps back to the beginning and repeats forever.

5.2 Running LED12 Program

- Load program LEDS2P.S19 into CML12S256. This program is located at $1000, which is internal memory. The source is show below.
- Program is executed by entering “CALL 1000” on CML12S256 and pressing enter.
- LED1, LED2, LED3 and LED4 will continue to flash forever.
5.3 LED12 Source

; Hardware
; Four Led's with cathode's connected by
; four 1k resistor to ground
; Led anode's connected to Port K bits 0 thru 3.
;
; Blinking Led's
;
PORTK: equ $32 ; port K data
DDRK: equ $33 ; port K direction
;
org $1000
;
; Setup port K
MAIN Movb #$0F,DDRK ; bits 0-3 as outputs
movb #$00,PORTK ; all bits low
jsr DELAY
;
; turn on led one
movb #$01,PORTK ; led one on
jsr DELAY
;
; turn on led two
movb #$02,PORTK ; led one on
jsr DELAY
;
; turn on led three
movb #$04,PORTK ; led one on
jsr DELAY
;
; turn on led four
movb #$08,PORTK ; led one on
jsr DELAY
;
; count up
clrb
clra
COUNTL staa PORTK ; led one on
jsr DELAY
inca
dbne B,COUNTL
jmp MAIN ; start over
;
; Delay subroutine
DELAY ldab #$0F
DELAYL1 ldx #$ffff
DELAY dbne X,DELAYL
dbne B,DELAYL1
rts
6.0 Quiz

Question One
Where is the program LEDS2P.S19 located in memory?
A. External memory  C. Eprom
B. Internal memory  D. Rom

Question Two
Writing $04 to PORTK, turns which LED on?
A. LED1  C. LED3
B. LED2  D. LED4

Question Three
What causes a LED to emit light?
A. Current  C. Voltage
B. Resistor  D. Diode

Question Four
Is PORT K?
A. Input  C. Bi_Directional
B. Output  D. Wired Or

Question Five
How many LEDS can be on at one time?
A. 1  C. 3
B. 2  D. 4

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.