**Department of Electrical Engineering**

**Faculty Member: Dr. Rehan Ahmed Dated: January 31, 2020**

**Semester: Spring 2020 Section: A**

**EE-222: Microprocessor System**

**Lab 1: Introduction to AVR Programming**

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| --- | --- | --- | --- | --- | --- | --- |
|  |  | **PLO4 –CLO3** | | **PLO5-CLO4** | **PLO8-CLO5** | **PLO9-CLO6** |
| **Name** | **Reg. No** | **Viva / Quiz / Lab Performance** | **Analysis of data in Lab Report** | **Modern Tool Usage** | **Ethics and Safety** | **Individual and Team Work** |
|  |  | **5 Marks** | **5 Marks** | **5 Marks** | **5 Marks** | **5 Marks** |
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# **Objectives**

* Familiarization with the user interface of Atmel Studio.
* Familiarization with the basic syntax of Atmel Assembly language.
* Familiarization with the procedure for the simulation of assembly code.
* Introduction to the burning of hex code to the microcontroller using the programmer.

# **Lab Task**

The first part of this lab activity was concerned with the basics of Atmel studio and microcontroller programming. We were to observe the execution of assembly instructions using the line-by-line debugging technique in the Atmel IDE. A pre-written assembly code was used as an example that basically changed the values of different registers of the ATmega16A microcontroller in a loop.

**Results**

The observations during this lab activity are provided in tabular form as follows.

# Iteration 1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **Cycles** | 4 | | | | | | | |
| **Time** | 4 us | | | | | | | |
| **R16** | 0x00 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 11561 | | | | | | | |
| **Time** | 11561us | | | | | | | |
| **R16** | 0x01 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 23118 | | | | | | | |
| **Time** | 23118us | | | | | | | |
| **R16** | 0x02 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 4

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 34675 | | | | | | | |
| **Time** | 34675us | | | | | | | |
| **R16** | 0x03 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 5

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 46232 | | | | | | | |
| **Time** | 46232us | | | | | | | |
| **R16** | 0x04 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 6

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 57789 | | | | | | | |
| **Time** | 57789us | | | | | | | |
| **R16** | 0x05 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 7

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 69346 | | | | | | | |
| **Time** | 69346us | | | | | | | |
| **R16** | 0x06 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 8

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 80903 | | | | | | | |
| **Time** | 80903us | | | | | | | |
| **R16** | 0x07 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 8

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 92460 | | | | | | | |
| **Time** | 92460us | | | | | | | |
| **R16** | 0x08 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 10

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 104017 | | | | | | | |
| **Time** | 104017us | | | | | | | |
| **R16** | 0x09 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 11

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 115574 | | | | | | | |
| **Time** | 115574us | | | | | | | |
| **R16** | 0x0A | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 12

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 127131 | | | | | | | |
| **Time** | 127131us | | | | | | | |
| **R16** | 0x0B | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 13

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 138688 | | | | | | | |
| **Time** | 138688us | | | | | | | |
| **R16** | 0x0C | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 14

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 150245 | | | | | | | |
| **Time** | 150245us | | | | | | | |
| **R16** | 0x0D | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 15

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 161802 | | | | | | | |
| **Time** | 161802us | | | | | | | |
| **R16** | 0x0E | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 16

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 173359 | | | | | | | |
| **Time** | 173359us | | | | | | | |
| **R16** | 0x0F | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 17

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 184916 | | | | | | | |
| **Time** | 184916us | | | | | | | |
| **R16** | 0x10 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 18

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 196473 | | | | | | | |
| **Time** | 196473us | | | | | | | |
| **R16** | 0x11 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 19

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 208030 | | | | | | | |
| **Time** | 208030us | | | | | | | |
| **R16** | 0x12 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Iteration 20

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Cycle Counter** | I | T | H | S | V | N | Z | C |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Cycles** | 219587 | | | | | | | |
| **Time** | 219587us | | | | | | | |
| **R16** | 0x13 | | | | | | | |
| **PORTB** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Conclusion/Observations**

During this lab activity a number of different things were observed as presented below:

* Assembly instructions are first converted to a hex code file by the Assembler which is then either burned to the microcontroller itself using a programming or is simulated within the IDE for observations.
* Different assembly instructions take different number of clock pulses/cycles to complete. This implies the presence of a possible layer of abstraction in assembly instructions that hide within them certain steps to ease the task of the programmer.