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Objective

* Get a handle for manipulating data using the SDK-85 (Student Development Kit)
* Use Appendix F (8085 Instruction Set), specifically the Arithmetic Group, to perform operations on the registers and memory locations of the SDK-85.

Theory

* The SDK-85 (Student Development Kit) is a single board microcomputer system kit using the 8085 processor. It is made by Intel and is now used to teach students about the concepts of microprocessors. Contains the following
  + **Microprocessor**
  + **Memory Element** – This describes both ROM (Read Only Memory) and RAM (Random Access Memory)
    - ROM (Read Only Memory) – Contains system boot up instructions
    - RAM (Random Access Memory) – Has Read/Write capabilities
  + **I/O Unit** – Handles input from user and provides output
* Microprocessors are computer processors that incorporate the functions of a central processing unit on a single integrated circuit (IC) or at most a few integrated circuits. They contain the following:
  + **Combinational logic Unit** ­– are logic circuits implemented by Boolean (logic gates) circuits, where the output is a pure function of the present input only. Think Half-Adders, Full-Adders, Encoders, and Decoders.
  + **Sequential logic Unit** – this is a type of logic circuit whose output depends on previous inputs as well as on the present inputs.
    - Contains Memory
    - Contains a clock
* This lab focuses on **Appendix F (the 8085 Instruction Set)**, specifically the **Arithmetic Group**. This is the set of assembly instructions that perform the adds, subtracts, increments, or decrements of data in registers or memory.

Part A:

Store in memory locations:

[ 2050 ] [ 03 ]

[ 2051 ] [ 02 ]

[ 2052 ] [ FF ]

Part B:

Assembly Code

|  |  |  |  |
| --- | --- | --- | --- |
| **Memory Location** | **OP Code** | **Cycles** | **Bytes** |
| 2000 | 21 | 10 | 3 |
| 2001 | 50 |  |  |
| 2002 | 20 |  |  |
| 2003 | 7E | 7 | 1 |
| 2004 | 23 | 6 | 1 |
| 2005 | 86 | 7 | 1 |
| 2006 | 32 | 13 | 3 |
| 2007 | 52 |  |  |
| 2008 | 20 |  |  |
| 2009 | CF | 12 | 1 |
|  | **Total:** | **55** | **10** |

Part C:

**Flow Chart:**

[HL] 2050

[ A ] [[ HL ]]

[HL] [HL] + 1

[ A ] [ A ] + [[ HL ]] + 1

[[ 2052 ]] [ A ]

Part D:

* The inputs and outputs to execute this procedure are the context stored and two inputs of memory location 2050 and 2051 and outputs of 2052.

Part E:

Single Stepping

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Memory** | **OP** | **A** | **H** | **L** | **[[HL]]** | **[[2052]]** |
| 2000 | 21 |  |  |  |  |  |
| 2003 | 7E |  | 20 | 50 | 03 |  |
| 2004 | 23 | 03 | 20 | 50 | 03 |  |
| 2005 | 86 | 03 | 20 | 51 | 02 |  |
| 2006 | 32 | 05 | 20 | 51 | 02 |  |
| 2007 | 52 | 05 | 20 | 51 | 02 |  |
| 2009 | CF | 05 | 20 | 51 | 02 | 05 |

Part F:

* Analyze the contents of Register F

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Carry |  |  | Aux Carry: |  |  |  |  |  |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **+** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
|  | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sign | Zero |  | Aux Carry |  | Parity |  | Carry |
| 0 | 0 | X | 0 | X | 1 | X | 0 |

|  |  |
| --- | --- |
| **Possible Values of F Register** | |
| 0 | 4 |
| 2 | 6 |
|  | C |
|  | E |

* (04)16 was the value we found in register F.

Part G:

* Based on the measured result obtain it was clear of an overflow which matched what we thought would happen. When checking the F register we obtained the same value as when we calculated step by step.
* Analyze the contents of Register F

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Carry |  |  | Aux Carry: | 1 |  |  |  |  |
|  | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| **+** | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sign | Zero |  | Aux Carry |  | Parity |  | Carry |
| 0 | 1 | X | 1 | X | 1 | X | 1 |

|  |  |
| --- | --- |
| **Possible Values of F Register** | |
| 5 | 5 |
| 7 | 7 |
|  | D |
|  | F |

* (55)16 was the value we found in register F.

Part H & I:

Store in memory locations:

[ 2050 ] [ A7]

[ 2051 ] [ 59 ]

[ 2052 ] [ LSB ]

[ 2053 ] [ MSB ]

**Mnemonics (Assembly): The Last Column**

|  |  |  |
| --- | --- | --- |
| **Memory Location** | **OC/Hex** | **Mnemonics** |
| 2000 | 21 | LXIH, 2050 |
| 2001 | 50 |  |
| 2002 | 20 |  |
| 2003 | 4E | MOV C, M |
| 2004 | 06 | MVI B, 00 |
| 2005 | 00 |  |
| 2006 | 23 | INXH |
| 2007 | 6E | MOV L, M |
| 2008 | 26 | MVI H, 00 |
| 2009 | 00 |  |
| 200A | 09 | DAD B |
| 200B | EB | XCHG |
| 200C | 21 | LXIH, 2052 |
| 200D | 52 |  |
| 200E | 20 |  |
| 200F | 73 | MOV M, E |
| 2010 | 23 | INXH |
| 2011 | 72 | MOV M, D |
| 2012 | CF | RST1 |

**Flow Chart**

[HL] 2050

[ C ] [[ HL ]]

[B] [00]

[ HL ] [ HL ] + 1

[ L ] [[HL]]

[H] [00]

[ HL ] [ HL ] + [BC]

[HL] [ DE ]

[ HL ] [[ 2052 ]]

[[ HL ]] [ E ]

[ HL ] [ HL ] + 1

[[ HL ]] [D]

Part J:

Single Stepping

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Memory** | **OP** | **B** | **C** | **D** | **E** | **H** | L | 2050 | 2051 | 2052 | 2053 |
| 2000 | 21 |  |  |  |  |  |  |  |  |  |  |
| 2003 | 4E |  |  |  |  | 20 | 50 | A7 |  |  |  |
| 2004 | 06 |  | A7 |  |  | 20 | 50 | A7 |  |  |  |
| 2006 | 23 | 00 | A7 |  |  | 20 | 50 | A7 |  |  |  |
| 2007 | 6E | 00 | A7 |  |  | 20 | 51 | A7 | 59 |  |  |
| 2008 | 26 | 00 | A7 |  |  | 20 | 59 | A7 | 59 |  |  |
| 200A | 09 | 00 | A7 |  |  | 00 | 59 | A7 | 59 |  |  |
| 200B | EB | 00 | A7 |  |  | F1 | F2 | A7 | 59 |  |  |
| 200C | 21 | 00 | A7 | F1 | F2 | 00 | 00 | A7 | 59 |  |  |
| 200F | 12 | 00 | A7 | F1 | F2 | 20 | 52 | A7 | 59 | F2 |  |
| 2010 | 23 | 00 | A7 | F1 | F2 | 20 | 53 | A7 | 59 | F2 |  |
| 2011 | 72 | 00 | A7 | F1 | F2 | 20 | 53 | A7 | 59 | F2 | F1 |
| 2012 | CF | 00 | A7 | F1 | F2 | 20 | 53 | A7 | 59 | F2 | F1 |

Part K:

|  |  |  |
| --- | --- | --- |
| **Address** | **OC/Hex** | **Mnemonics** |
| **[2000]**  **[2001]**  **[2002]** | **[11]**  **[09]**  **[20]** | **LXI D** |
| **[2003]**  **[2004]**  **[2005]** | **[21]**  **[0A]**  **[20]** | **LXI 200A** |
| **[2006]** | **[1A]** | **LDAX [A] ←[[DE]]** |
| **[2007]** | **[EB]** | **XCHG** |
| **[2008]** | **[12]** | **STAX D** |
| **[2009]** | **[07]** | **RLC** |
| **[200A]** | **[05]** | **DCR** |

* Flowchart

[DE] ← [2009]

[HL] ← [200A]

[DE] ←[A]

[D] ←[2007]]

[DE] ←[2008]

[Cy] ←[2009]

[B] ←[200A]

Part L:

* Flow Chart

[MVI] ← [03]

[MVI] ← [05]

[MOV] ←[C] ← [A]

[LXI] ← [2014]

[LXI] ← [2015]

**[[HL]] ←[B]**

**[[DE]] ←[A]**

* Mnemonics

|  |  |  |
| --- | --- | --- |
| **Memory** | **OC/Hex** | **Mnemonics** |
| **[2000]**  **[2001]** | **[3E]**  **[03]** | **MVI A, 03** |
| **[2002]**  **[2003]** | **[06]**  **[05]** | **MVI B 05** |
| **[2004]** | **[4F]** | **MOV C ←A** |
| **[2005]**  **[2006]**  **[2007]** | **[21]**  **[14]**  **[20]** | **LXI H, 2014** |
| **[2008]**  **[2009]**  **[200A]** | **[11]**  **[15]**  **[20]** | **LXI D, 2015** |
| **[200B]** | **[70]** | **MOV M, B** |
| **[200C]** | **[12]** | **STAX D** |

Part M:

* Flowchart

[D] ← [2007]

[MOV] ← [2001]

[MVI] ← [03]

[ADD] ← [80]

[MOV] ← [D] ← [A]

[MVI] ← [42]

[ADC] ← [88]

[MOV] ←[C] ← [A]

* Mnemonics

|  |  |  |
| --- | --- | --- |
| **Address** | **OC/Hex** | **Mnemonics** |
| **[2000]** | **[EB]** | **XCHG** |
| **[2001]** | **[7A]** | **MOV A,D** |
| **[2002]**  **[2003]** | **[06]**  **[03]** | **MVI, B** |
| **[2004]** | **[80]** | **ADD B** |
| **[2005]** | **[57]** | **MOV D,A** |
| **[2006]**  **[2007]** | **[3E]**  **[25]** | **MVI A** |
| **[2008]**  **[2009]** | **[06]**  **[42]** | **MVI B** |
| **[200A]** | **[88]** | **ADC B** |
| **[200B]** | **[4F]** | **MOV CA** |
| **[200C]** | **[CF]** | **RST 1** |

Part N:

* Flow Chart
* Mnemonics into Assembly

|  |  |  |
| --- | --- | --- |
| **Mnemonics** | **OC/Hex** | **Memory Location** |
| MVI A, 05 | 3E | 2000 |
|  | 05 | 2001 |
| LXI H | 21 | 2002 |
|  | 00 | 2003 |
|  | 20 | 2004 |
| MOV B, M | 46 | 2005 |
| MOV A, B | 78 | 2006 |
| MOV M, B | 70 | 2007 |
| INX H | 23 | 2008 |
| ADD M | 86 | 2009 |
| DCX H | 2B | 200A |
| MOV M, A | 77 | 200B |
| RST 1 | CF | 200C |

* Length of the Program (bytes): 13 bytes
* Execution Time =

Part O:

* Flow Chart
* Mnemonics into Assembly

|  |  |  |
| --- | --- | --- |
| **Mnemonics** | **OC/Hex** | **Memory Location** |
| MOV A, D | 7A | 2000 |
| MOV B, E | 43 | 2001 |
| MOV D, H | 54 | 2002 |
| MOV E, L | 5D | 2003 |
| MOV H, A | 67 | 2004 |
| MOV L, B | 68 | 2005 |

**Conclusion:**

* We successfully completed the lab. All runs worked well for us. No issues.