A User Manual

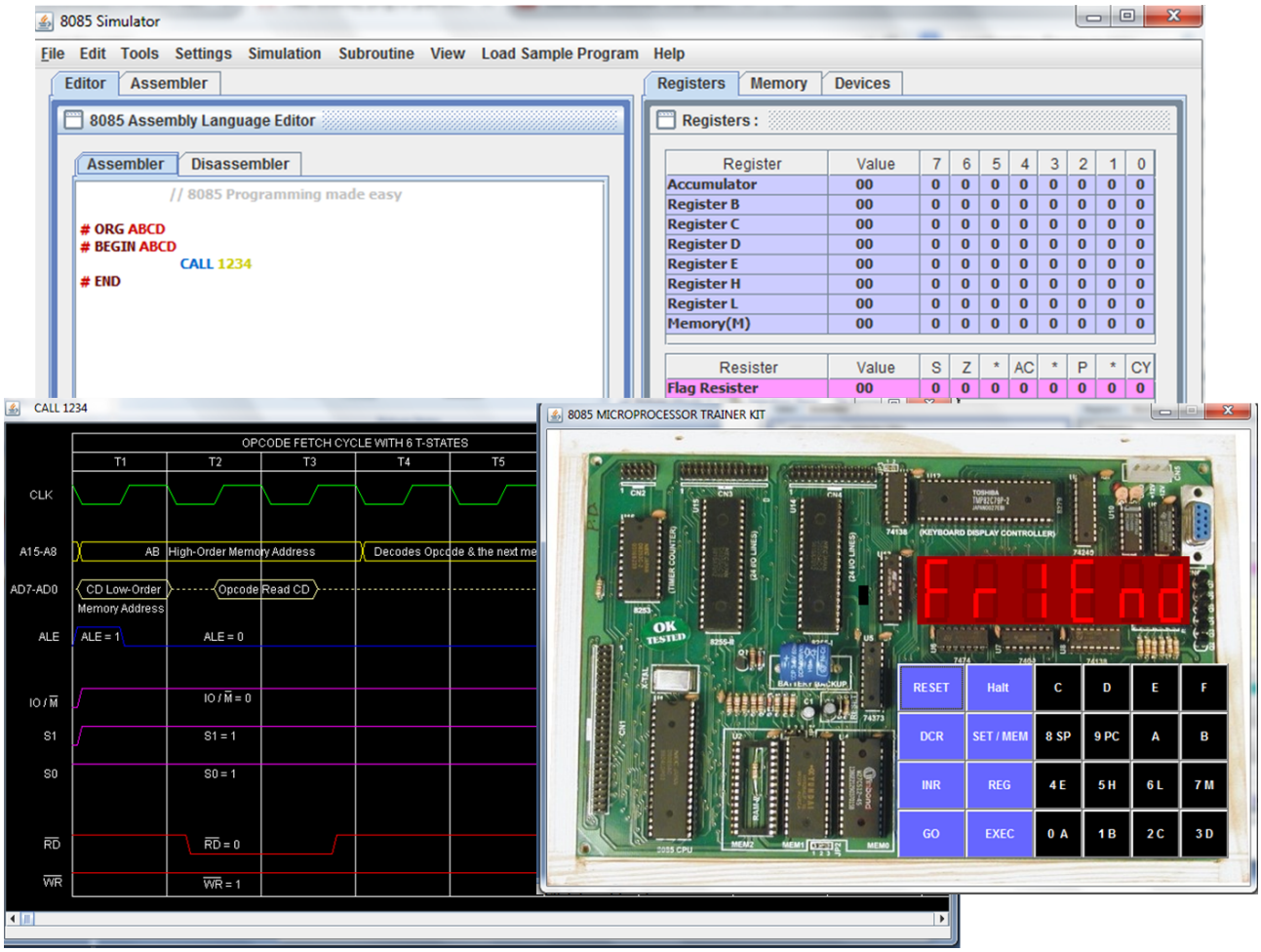
on

8085 Simulator

https://8085Simulator.github.io
https://8085simulator.codeplex.com

Product Version 2.0
STABLE RELEASE

By
JUBIN MITRA

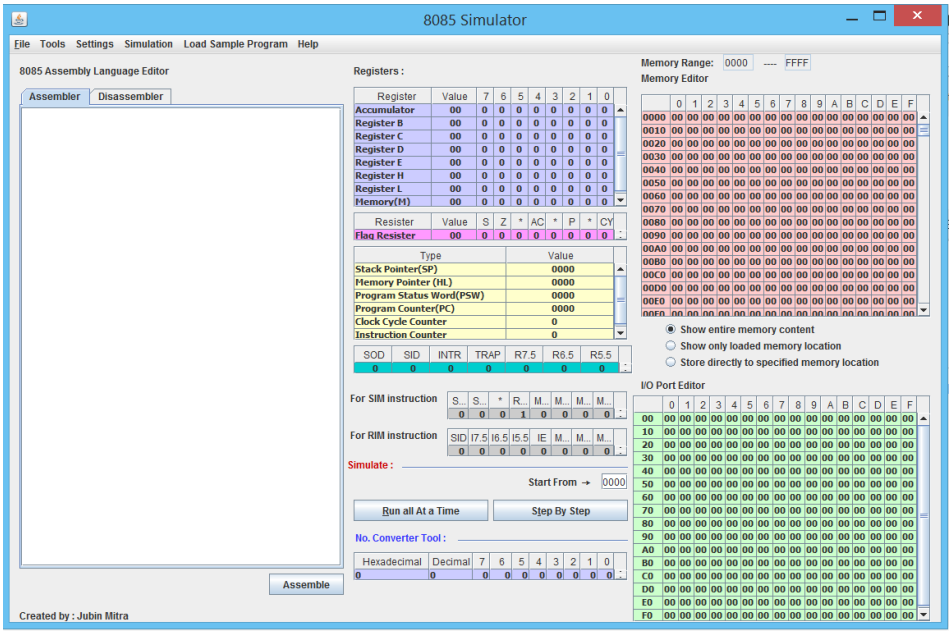


March 1, 2018

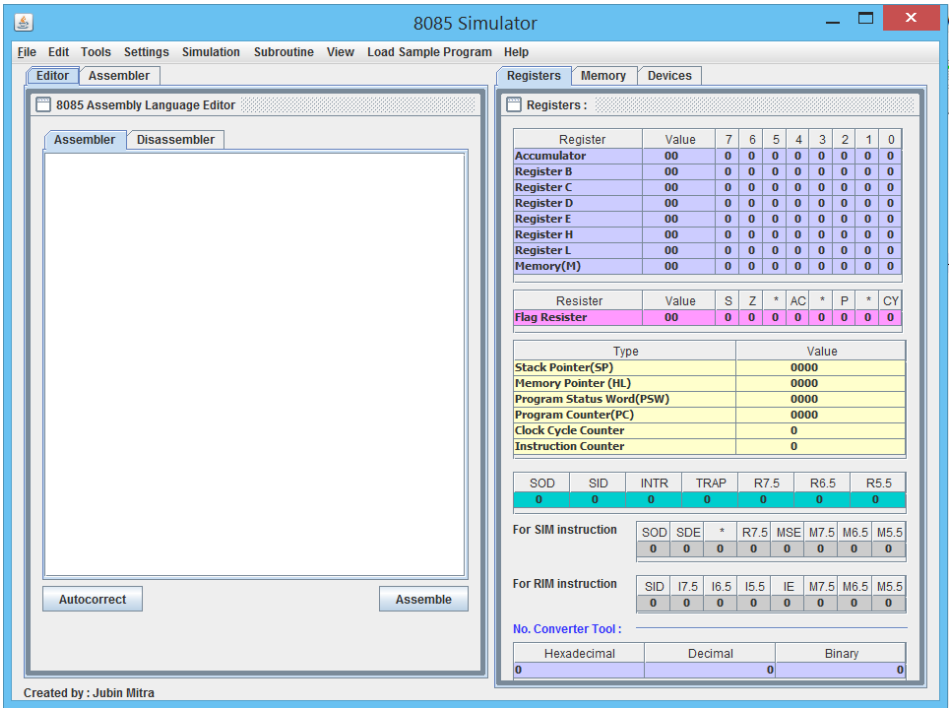
Version and Bug fixes

Release Date

Version	Release Date	Download Link
Version 1	10^{th} Oct, 2009	https://github.com/8085simulator/8085simulator/blob/master/8085Compiler_v0.jar



Version 2	1^{st} Jun, 2014	https://github.com/8085simulator/8085simulator/blob/master/8085Compiler_v1.jar



Bug fixes

From the 2nd Version of this software bug history log is maintained.

Preface

This software was first published in October 10, 2009 and since then it has been in this field. It is gratifying to see such acceptance and popularity of the software in many institutes and universities. This tool is an integrated software environment for teaching microprocessor concepts. The second version of the software has undergone many changes and bug fixing.

Migration Notice

This is to bring to the notice of the users that the previously popular site http://8085simulator.codeplex.com has been migrated to https://8085Simulator.github.io. Everything remained the same. Hope it would be of not much trouble for the users. The design still maintains the same simplicity and maintained under the open source license GPL v2.

About the Author

Author has completed his B.Tech. in Electronics and Communication Engineering from Heritage Institute of Technology, Kolkata and M.E. from Bengal Engineering and Science University (BESU), Howrah, India. He is currently pursuing Ph.D. at Variable Energy Cyclotron Centre (VECC) at Kolkata under the aegis of Homi Bhabha National Institute (HBNI).

Acknowledgment

My sincere thanks and love for my parents Dipendra Kali Mitra and Bharati Mitra for their continuous inspiration, encouragement, love, patience and support during this software development.

This software was designed during my B.Tech days when I was studying 8085 Microprocessor subject itself. Since then it has evolved and attained much maturity. I would do injustice if I do not mention the name of my friend circle, who always maintained a positive vibe and joyous environment for creative work culture. Cheers to my college friends Anirban Goswami, Debanjan Chatterjee and Abhyuday Jatty.

I salute the spontaneous guidance and inspiration of my college faculty members Amitava Hatial, Saibal Dutta, and Surajit Bagchi.

Contact Details

In the end I would love to request my esteemed users to kindly send their valuable suggestions for the improvement of the software and to notify me any errors that you may come across while using the software. You can comment in the blogspot http://8085simulatorj.blogspot.in. If you need to contact me directly just drop a mail in my mailbox, jm61288@gmail.com. If it is applicable for all users then I would suggest you to post it in the blogspot, so that it is accessible to other users as well.

Jubin Mitra

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Contents

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This is a voluntary work of an individual to develop a common platform for 8085 programming. Please be advised that nothing found here has necessarily been peer reviewed by people with the expertise required to provide you with complete, accurate or reliable information. So, user's discretion is advisable.

That is not to say that you will not always find inaccurate results in 8085 Simulator; but sometimes due to bug you may get some. However, the author cannot guarantee the validity or the liability of the results found using this software.

Chapter 1

Product Description

1.1 Motivation

Understanding of Intel 8085 microprocessor is fundamental to getting insight into the Von-Neumann Architecture. It was first introduced in 1976, since then many generations of computer architecture have come up, some still persists while others are lost in history. This microprocessor still survives because it is still popular in university and training institutes to get students acquainted with basic computer architecture. For this purpose 8085 trainer kit are available on the market. However, with more popular technologies to learn, technical syllabus has very low time bandwidth available for this topic. All that is necessary for the students is to understand the functional working model of this basic architecture and then proceed on to next advance level of the subject.

With this academic learning purpose in mind this simulator software is designed. It helps in get started easily with example codes, and to learn the architecture playfully. It also provides a trainer kit as an appealing functional alternative to real hardware. The users can write assembly code easily and get results quickly without even having the actual hardware.

1.2 Installation and Upgrade Note

The program code is written Java Syntax and available in java virtual machine executable format (.jar). To run in :

Windows :

1) Make sure you have Java installed on your system. Check this by typing **java -version** into the command terminal. If you don't have the latest version of Java, update it before proceeding.
2) Install Java (ver >6) http://www.java.com/en/download/manual.jsp
3) Just **double clic**k the ".jar " file, it should execute.
4) Otherwise you can execute in CMD (Command Prompt) by typing " **java -jar <filename>.jar** "

Linux :

1) Open terminal and type " **java -jar <filename>.jar** "

UPDATES :

Automatic or push updates are not supported in this software. Users are requested to keep track of the new release available at the web-link : https://8085simulator.codeplex.com/.

1.3 Limitations

This or any 8085 simulator software is no way a replacement for real hardware. It only does functional simulation of the codes. It is not an emulator and hence do not expect that the timing information will be accurately modeled. However, the exact performance of the code can only be monitored in real 8085 microprocessor hardware.

1.4 Known Issues

- Issue 1 : DAA instruction wrongly toggles the carry flag if already there is a carry instead of setting it high, like take for example (88H + 88H). Users need to be cautious while using this instruction. It will be fixed in future realize v2.1.
- Issue 2: In Assembler Window, during pre-processing stage of the code it flags error if ‘ ; ’ (SEMICOLON) comment marking character is followed after “ // ” (DOUBLE FORWARD SLASH). Example → "<Label>: <Assembler Code> // <Comments> ; <More Comments>"

1.5 Software Design Architecture

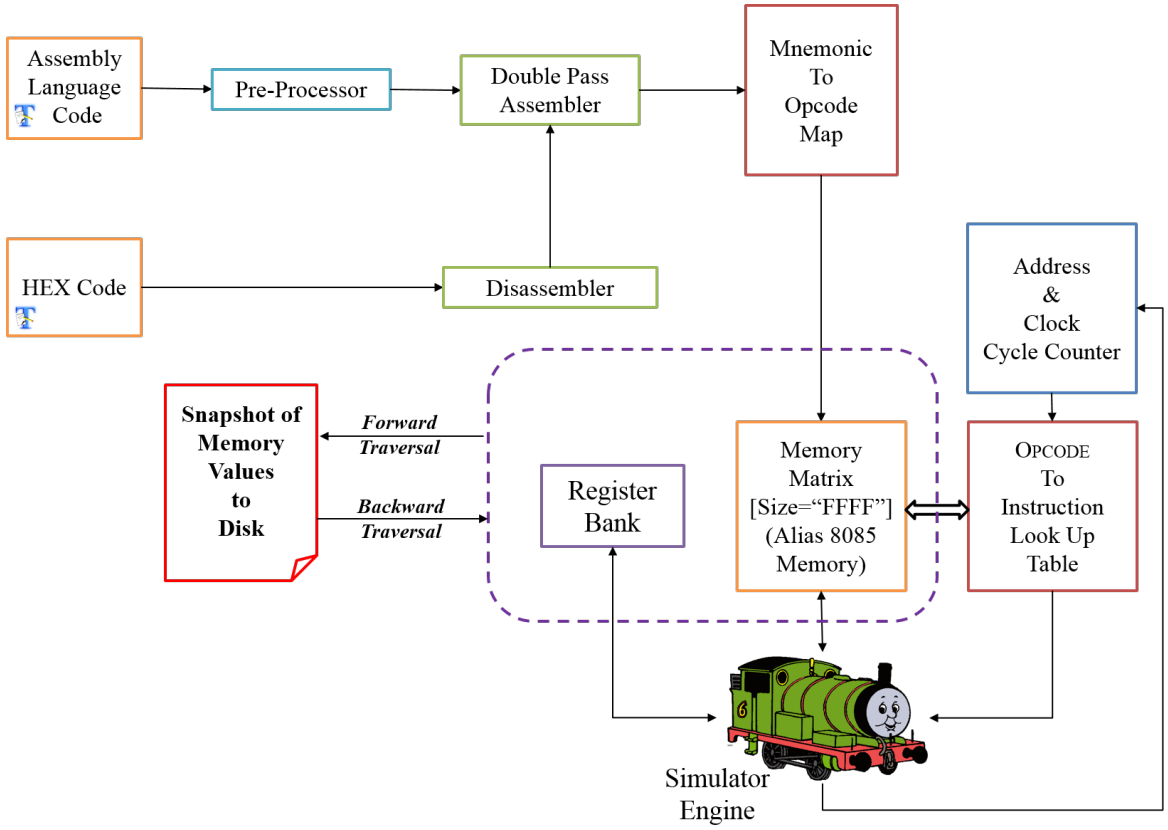


Figure 1.1: Software Architecture

1.5.1 Preprocessor

Assembler directives are lines included in the code of programs preceded by a hash sign (#). These lines are not program statements but directives for the preprocessor. The preprocessor examines the code before actual assembling of code begins and resolves all these directives before any code is actually generated by regular statements.

1.5.2 Assembler

It uses a 2 pass Assembler. In first pass it constructs *the symbol table* in which every label of the assembly program is stored with its corresponding location. In the second pass the assembler locates (using the flags array) and completes (using the symbol table) the partial mnemonics instructions. It then convert Mnemonic to Opcode using a mapping method.

1.5.3 Simulator Engine

It resets all the register. Then starts from "Origin address". It scans the opcode value and sends it to "Opcode to instruction set look table". It then instructs the simulator engine the registers that will be affected, the number of data opcode that follows after the instruction opcode to increment the address and also to increment the number of clock cycles accordingly.

1.5.4 Step-wise Traversal Controller

It consists of *memory snapshot maker* and *memory register - data value monitor*. During forward traversal *memory snapshot maker* dumps the entire memory current values to a temp file. With each forward step one temp file is created in the working directory pool of the software. During backward traversal the *memory snapshot maker* read backs the temp files and reloads with the past value. Once the process is stopped it clears out all the snapshots that are dumped. In this manner this software can able to traverse also in backward direction, inspite of using forward traversal instruction code.

1.6 Source Code

The entire design is built in **Netbeans IDE** with JDK bundle. It can easily be opened by the software. The coding was done in bit unprofessional way, as it was developed during very early stage of my academics. Students are free to use the code for their understanding and distribution as defined under the GNU license agreement.

It is being actively maintained in GIT repository find it at link :
https://8085simulator.codeplex.com/SourceControl/latest
https://github.com/8085simulator/8085simulator

Chapter 2

Features

1. Assembler Editor
    - Can load Programs written in other simulator
    - Auto-correct and auto-indent features
    - Supports assembler directives
    - Number parameters can be given in binary, decimal and hexadecimal format
    - Supports writing of comments
    - Supports labeling of instructions, even in macros
    - Has error checking facility
    - Syntax Highlighting
2. Disassembler Editor
    - Supports loading of Intel specific hex file format
    - It can successfully reverse trace the original program from the assembly code, in most of the cases
    - Syntax Highlighting and Auto Spacing
3. Assembler Workspace
    - Contains the Address field, Label, Mnemonics, Hex-code, Mnemonic Size, M-Cycles and T-states
    - Static Timing diagram of all instruction sets are supported
    - Dynamic Timing diagram during step by step simulation
    - It has error checking facility also
4. Memory Editor
    - Can directly update data in a specified memory location
    - It has 3 types of interface, user can choose from it according to his need.
        - Show entire memory content
        - Show only loaded memory location
        - Store directly to specified memory location
    - Allows user to choose memory range
5. I/O Editor
    - It is necessary for peripheral interfacing.
    - Enables direct editing of content
6. Interrupt Editor

- All possible interrupts are supported. Interrupts are triggered by pressing the appropriate column (INTR, TRAP, RST 7.5, RST 6.5, RST 5.5) on the interrupt table. The simulation can be reset any time by pressing the clear memory in the settings tab.

7. Debugger
   - Support of breakpoints
   - Step by step execution/debugging of program.
   - It supports both forward and backward traversal of programs.
   - Allows continuation of program from the breakpoint.
8. Simulator
   - There are 3 level of speed for simulation:
     - Step-by-step $\longrightarrow$ Automatic line by line execution with each line highlighting. The time to halt at each line is be decided by the user.
     - Normal $\longrightarrow$ Full execution with reflecting intermittent states periodically.
     - Ultimate $\longrightarrow$ Full execution with reflecting final state directly.
   - There are 2 modes of simulator engine:
     - Run all at a Time $\longrightarrow$ It takes the current settings from the simulation speed level and starts execution accordingly.
     - Step by Step $\longrightarrow$ It is manual mode of control of FORWARD and BACKWARD traversal of instruction set. It also displays the in-line comment if available for currently executed instruction.
   - Allows setting of starting address for the simulator
   - Users can choose the mnemonic where program execution should terminate
9. Helper
   - Help on the mnemonics is integrated
   - CODE WIZARD is a tool added to enable users with very little knowledge of assembly code could also 8085 assembly programs.
   - Already loaded with plenty SAMPLE programs
   - Dynamic loading of user code if placed in user_code folder
   - It also includes a user manual
10. Printing
    - Assembler Content
    - Workspace Content
11. Register Bank $\longrightarrow$ Each register content is accompanied with its equivalent binary value
    - Accumulator, Reg B, Reg C, Reg D, Reg E, Reg H, Reg L, Memory (M)
    - Flag Register
    - Stack Pointer (SP)
    - Memory Pointer (HL)
    - Program Status Word (PSW)
    - Program Counter (PC)
    - Clock Cycle Counter
    - Instruction Counter

- Special blocks for monitoring Flag register and the usage of SIM and RIM instruction

12. Crash Recovery
    - Can recover programs lost due to sudden shutdown or crash of application
13. 8085 TRAINER KIT
    - It simulates the kit as if the user is working in the lab. It basically uses the same simulation engine at the back-end
14. TOOLS
    - Insert DELAY Subroutine TOOL
      - It is a powerful wizard to generate delay subroutine with user defined delay using any sets of register for a particular operating frequency of 8085 microprocessor.
    - Interrupt Service Subroutine TOOL
      - It is a handy way to set memory values at corresponding vector interrupt address
    - Number Conversion Tool
      - It is a portable interconversion tool for Hexadecimal, decimal and binary numbers. So, that user do not need to open separate calculator for it.

Chapter 3

Comparitive Analysis

Table 3.1: The Comparitive analysis between different softwares

Features	8085 Simulator version 2.0 (Jubin's)	Osonsoft 8085 simulator	GNUSim8085 simulator	Vaneet 8085 simulator	Abhijit's 8085 simulator
Platform Independent	★				
Backward Traversal Feature	★				
8085 Trainer Kit Simulation	★				♦
Backward Traversal Feature	★				
Simulation speed control	★	♦			
Number Conversion Tool	★				
Setting of memory range, stop mnemonic and starting address	★	★			
Delay subroutine Insertion Tool	★				
Crash recovery feature	★				
Code Wizard	★	★			

♦–Partial Support ; ★ – Full support

The table 3.1 compares the features that are special to this simulator. Apart from the contents listed most features are common, except for the peripheral attachment which will be added in future release.

Chapter 4

Assembler Directives

The assembler directives[1] are the instructions to the assembler concerning the program being assembled; they also are called *pseudo instructions* or *pseudo opcodes*.

In the Assembler Editor, the Assembler Directives **must be preceded by '.'** or **'#'**. The editor would then understand and would automatically change font foreground color to red color. Since execution of assembler directives do not assign any machine code but it directs the assembler engine and the memory loader to load a specific user code at user defined position. So it **loads code directly in the MEMORY EDITOR, it's output code is not visible in ASSEMBLER WORKSPACE**. Section 4.1 lists the assembler directives that are currently supported by the assembler.

4.1 Directives

	Assembler Directives	Example	Description
1.	ORG (Origin)	# ORG C000H	The next block of instruction should be stored in memory locations starting at C000H
2.	BEGIN (Start)	# BEGIN 2000H	To start simulation from address 2000H
3.	END (Stop)	# END	End of Assembly. It places the mnemonic defined at "Settings → Stop Simulation at Mnemonic"
4.	EQU (Equal)	# OUTBUF EQU 3945H	The value of the label OUTBUF is 3945H. This may be used as memory location.
5.	DB (Define Byte)	# DATA: DB F5H,12H	Initializes an area byte by byte,in successive memory locations until all values are stored. Label DATA stores the initial address.
6.	DW (Define Word)	# LABEL: DW 2050H	Initializes an area two bytes at a time.
7.	DS (Define Storage)	# STACK: DS 4	Reserves a specified number of memory locations and set the initial address to label STACK.

4.2 Number Format Support

The Assembler for both code and assembler directive support flexible number entry mode

Binary Number Entry Format

- Digits should consists of 1's and 0's.
- The number of digits must be greater than 4, to prevent confusion with default Hexadecimal mode.
- The number must be followed by character 'b' or 'B', to indicate that it is a binary number.
  Example: To enter "F"(Hexadecimal Number) write it as 01111**B** or 01111**b**

Decimal Number Entry Format

- Digits should be within 0-9.
- The number of digits must be greater than 4, to prevent confusion with default Hexadecimal mode.
- The number must be followed by character 'd' or 'D', to indicate that it is a decimal number.
  Example: To enter "F"(Hexadecimal Number) write it as 0015**D** or 0015**d**

Hexadecimal Number Entry Format

- Digits should be within 0-9 and A-F.
- The number of digits can be of any size
- The number may be followed by character 'h' or 'H', to indicate that it is a hexadecimal number.
  Example: To enter "F"(Hexadecimal Number) write it as 0F**H** or 0F**h** or just 0F

Chapter 5

Disassembler

A disassembler is a computer program that translates machine language into assembly language-the inverse operation to that of an assembler. A disassembler differs from a decompiler, which targets a high-level language rather than an assembly language. Disassembly, the output of a disassembler, is often formatted for human-readability rather than suitability for input to an assembler, making it principally a **reverse-engineering tool**.

5.1 Disassembler Demonstration

Sub-figure (5.1a) shows a sample program i.e. "*1's COMPLEMENT OF A 16-BIT NUMBER*" loaded in the assembly language editor. It is then assembled by pressing the **Assemble** button. After assembling, memory content and assembler workspace are shown in sub-figure (5.1d) and sub-figure (5.1c) respectively. Then the **Hexcode** is saved by selecting "FILE→Save Hexcode" or presing "ALT+S".

The generated hexcode is now loaded in the Disassembler editor by selecting "FILE→Load Hexcode" or presing "ALT+O". As it can be seen in sub-figure (5.1e) the Intel Hex formatted code is syntactically highlighted. Now, press the **Disassemble**. If there is some error in the code that line will be highlighted in red. The tabbed window will not automatically change, even if there is no error. Now open the assembler editor the code is disassembled, as given in sub-figure (5.1b). Simultaneously the memory content is also loaded which is same as shown in sub-figure (5.1d). But, it is to be remembered that assembler workspace will remain empty, until the code is assembled from the assembler editor.

```
// 1's COMPLEMENT OF A 16-BIT NUMBER
// The 16bit number is stored in C050,C051
// The answer is stored in C052,C053
# ORG C000H
# BEGIN C000H
        LXI H,C050
        MOV A,M
        CMA
        STA C052
        INX H
        MOV A,M
        CMA
        STA C053
        HLT
// EXAMPLE-> C050=85,C051=54
// Answer-> C052=7A,C053=AB

# ORG C050
# DB 85H,54H
```

(a) Assembled Code

```
# ORG C000
        LXI H,LABEL0
        MOV A,M
        CMA
        STA C052
        INX H
        MOV A,M
        CMA
        STA C053
        HLT
# ORG C050
LABEL0: ADD L
        MOV D,H
```

(b) Disassembled Code

*	Address	Label	Mnemonics	Hexcode	Bytes	M-Cycles	T-States
√	C000		LXI H,C050	21	3	3	10
	C001			50			
	C002			C0			
√	C003		MOV A,M	7E	1	2	7
√	C004		CMA	2F	1	1	4
√	C005		STA C052	32	3	4	13
	C006			52			
	C007			C0			
√	C008		INX H	23	1	1	6
√	C009		MOV A,M	7E	1	2	7
√	C00A		CMA	2F	1	1	4
√	C00B		STA C053	32	3	4	13
	C00C			53			
	C00D			C0			
√	C00E		HLT	76	1	2	5

(c) Assembler Workspace after Assembling

Memory Address	Value
C000	21
C001	50
C002	C0
C003	7E
C004	2F
C005	32
C006	52
C007	C0
C008	23
C009	7E
C00A	2F
C00B	32
C00C	53
C00D	C0
C00E	76
C050	85
C051	54

(d) Memory Content after Assembling

```
: 10 C000 00 21 50 C0 7E 2F 32 52 C0 23 7E 2F 32 53 C0 76 00 83
: 10 C050 00 85 54 00 00 00 00 00 00 00 00 00 00 00 00 00 00 07
: 00 0000 01 FF
```

(e) Hexcode of Assembled code

Figure 5.1: Showing working of Disassembler

5.2 Intel HEX

Intel HEX[2] is a file format for conveying binary information for programming 8085 microprocessor. The assembler converts the program's assembly language code to machine code and outputs it into a HEX file. That file is then imported by a programmer to "burn" the machine code to the 8085 target system for loading and execution.

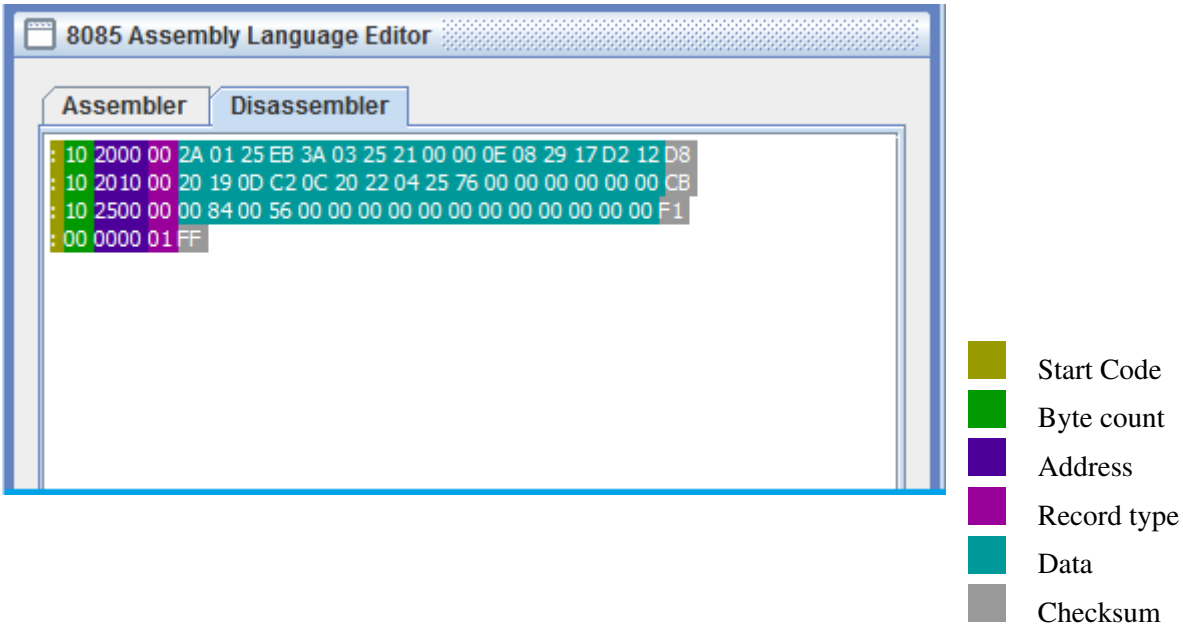


Figure 5.2: Intel HEX file format

Each line of Intel HEX fileconsists of six parts :

- **Start code**, one character, an ASCII colon ':'.
- **Byte count**, two hex digits, a number of bytes (hex digit pairs) in the data field. 16 (0x10) or 32 (0x20) bytes of data are the usual compromise values between line length and address overhead.
- **Address**, four hex digits, a 16-bit address of the beginning of the memory position for the data.
- **Record type**, two hex digits, 00 to 05, defining the type of the data field.
  - **00**, data record, contains data and 16-bit address.
  - **01**, End Of File record. Must occur exactly once per file in the last line of the file. The byte count is 00 and the data field is empty. Usually the address field is also 0000, in which case the complete line is ':00000001FF'.
- **Data**, a sequence of n bytes of the data themselves, represented by 2n hex digits.
- **Checksum**, two hex digits - the least significant byte of the two's complement of the sum of the values of all fields except fields 1 and 6 (Start code ":" byte and two hex digits of the Checksum). It is calculated by adding together the hex-encoded bytes (hex digit pairs), then leaving only the least significant byte of the result, and making a 2's complement (either by subtracting the byte from 0x100, or inverting it by XOR-ing with 0xFF and adding 0x01). If you are not working with 8-bit variables, you must suppress the overflow by AND-ing the result with 0xFF. The overflow may occur since both 0x100-0 and (0x00 XOR 0xFF)+1 equal 0x100. If the checksum is correctly calculated, adding all the bytes (the Byte count, both bytes in Address, the Record type, each Data byte and the Checksum) together will always result in a value wherein the least significant byte is zero (0x00).
  For example, on :0300300002337A1E
  03 + 00 + 30 + 00 + 02 + 33 + 7A = E2, 2's complement is 1E

5.3 Writing Hexcode in Disassembler

- **STEP 1:** To Enter the hexcode

<Start Code>	**<Byte Count>**	**<Address>**	**<Record Type>**	**<Data>**	**<Checksum>**
:	10	0000	00	Enter 10 bytes of data in Hexadecimal format	<ctrl+space>

- **STEP 2:** To mark end of file

<Start Code>	**<Byte Count>**	**<Address>**	**<Record Type>**	**<Data>**	**<Checksum>**
:	00	0000	01		FF

TOOLS EMBEDDED IN DISASSEMBLER EDITOR

- ***AUTO CHECKSUM GENERATION***
  Just press **CTRL+SPACE** at the end of each line it is auto calculated and appended to that line
- ***AUTO SYNTAX HIGHLIGHTING and FORMATING***
  It is activated on pressing of **ENTER** key.

5.3.1 Limitation of disassembler

- Cannot determine the begin address of execution
- Fails to distinguish between user defined data code and opcode, so it by default decode all as opcode.

Chapter 6

Timing Diagram generator

The 8085 Microprocessor is designed to execute 74 different types of instruction. Each instruction has two parts: OPCODE (operation code) and OPERAND. Each functions are divided into machine cycles and each cycles is further divided into T-states.

Basically, the microprocessor external communication functions can be divided into 3 categories of Machine Cycle:

1. Memory Read and Write
2. I/O Read and Write
3. Request Acknowledge

Of which Request Acknowledge machine cycle is not yet supported in this version of the software, but internally it is simulated.
There are three methods of Timing Diagram Generation :

1. Static Timing Diagram Generation
2. Dynamic Timing Diagram Generation
   (a) By Manual Step by Step Simulation
   (b) By Automatic Step by Step Simulation

6.1 Static Timing Diagram Generation

To open the Timing Diagram window click the filled rows of the column named "T-states" in the Assembler workspace, as shown in fig. 6.1. Static Timing Diagram is basically the machine cycles of the instruction in pre-simulation state. As, can be seen in fig. 6.2 where default values(00H in this case) are loaded during the Memory Read Cycle of "LDA 1234H" from address 1234H.

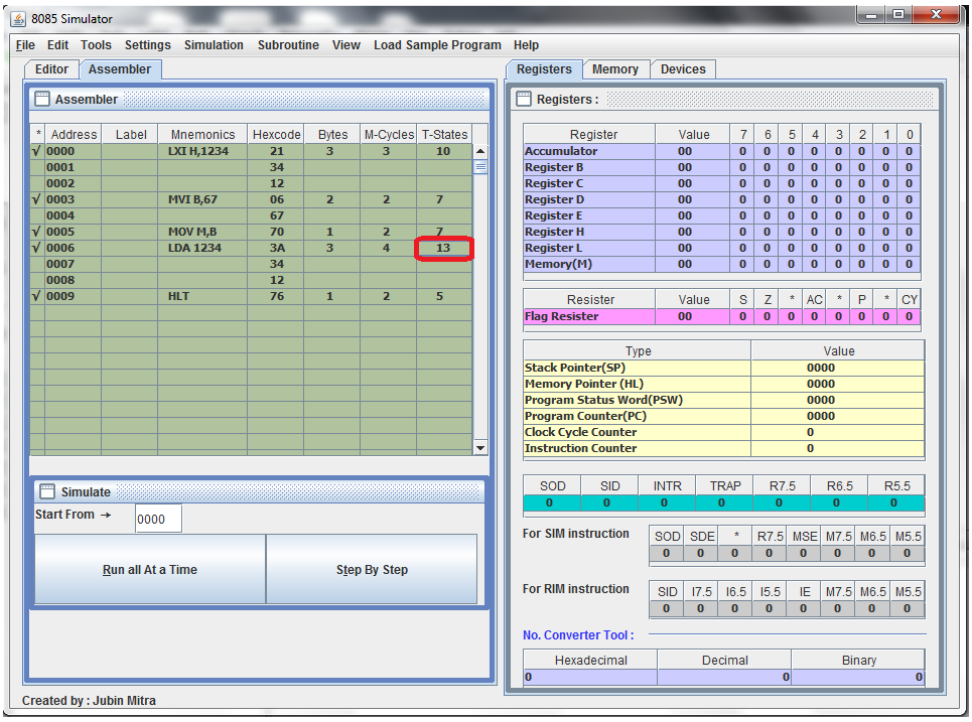


Figure 6.1: The Red box marks the area of the Assembler workspace to be clicked before execution of the program

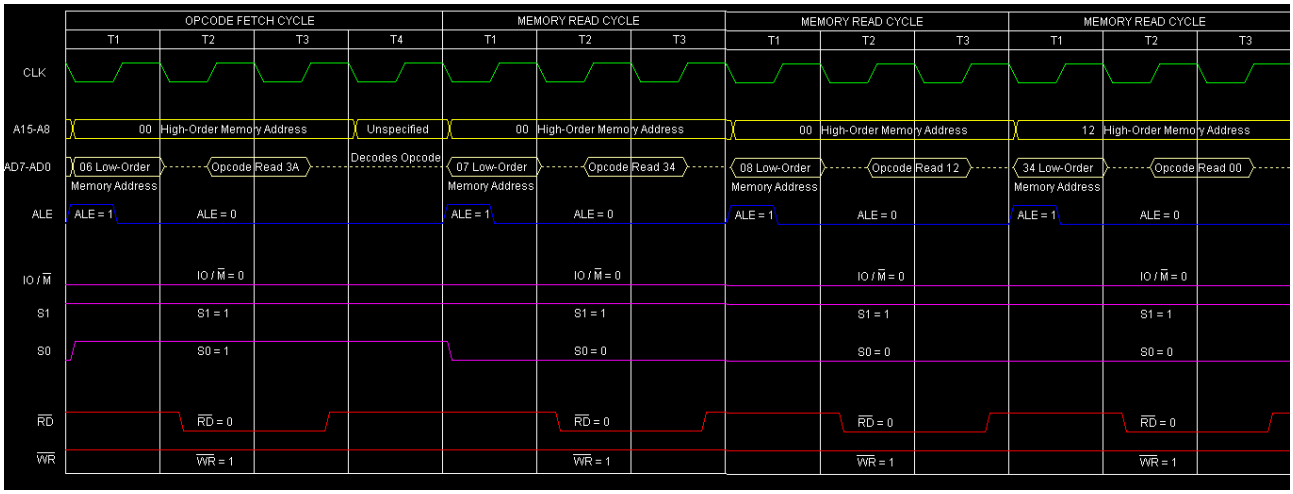


Figure 6.2: Timing Diagram of "LDA 1234", where the last MEMORY READ CYCLE shows the value at address 1234H is set with default value 00H

6.2 Dynamic Timing Diagram Generation By Manual Step by Step Simulation

Dynamic Timing Diagram is the machine cycles of the instruction in real time simulation state. The stepping to the next instruction is controlled manually by the user, using "Step by Step" mode of execution. Here again as shown in fig. 6.3, need to click on the column named "T-states" of the currently highlighted row. Note carefully in fig. 6.4 that the values(67H in this case) are loaded in the Memory Read Cycle of "LDA 1234H" during reading of memory content at address 1234H.

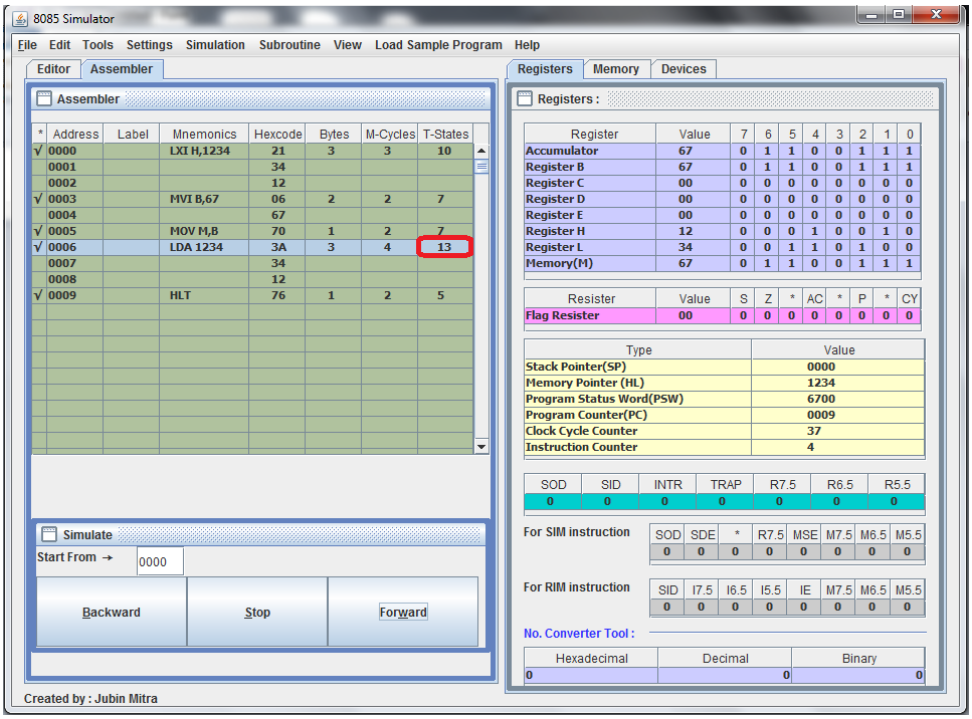


Figure 6.3: The Red box marks the area of the Assembler workspace to be clicked during manual step by step simulation

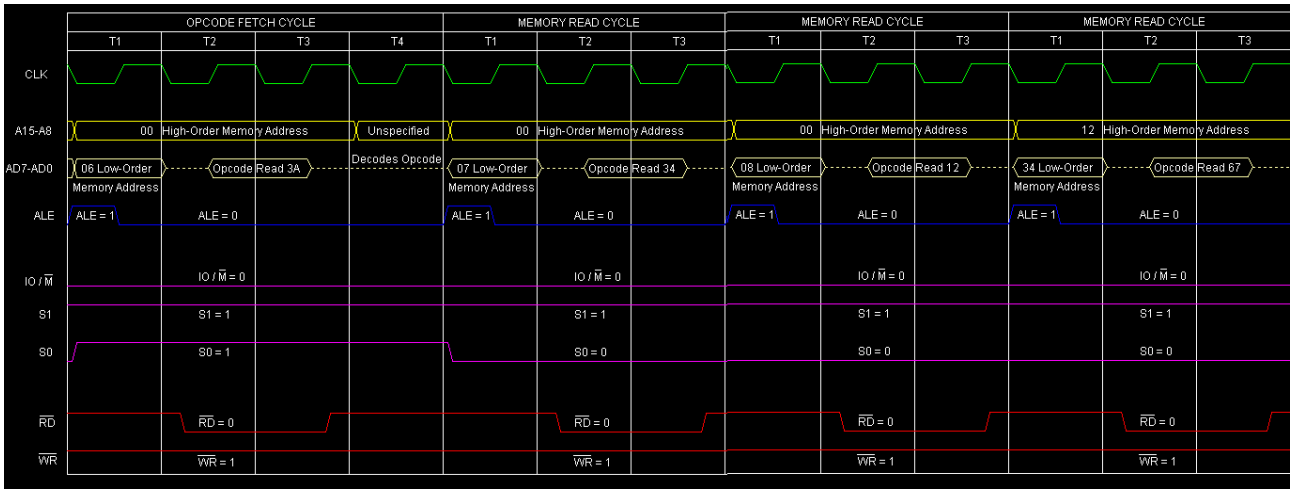


Figure 6.4: Timing Diagram of "LDA 1234", where the last MEMORY READ CYCLE shows the value at address 1234H is loaded with 67H

6.3 Dynamic Timing Diagram Generation By Automatic Step by Step Simulation

Dynamic Timing Diagram is the machine cycles of the instruction in real time simulation state. The stepping to the next instruction is not controlled manually but by the simulator itself. As in this case user need to step down the "Run all at a Time" simulation speed to "Step by Step " mode of execution with user defined delay. Initially user need to open one time Static Timing Diagram Window, then it opens automatically and updates during each step of execution.

Chapter 7

Trainer Kit Emulator

The keyboard enables the user to enter and store the 8085 Hex machine code in the R/W memory. The seven segment display is used to display memory addresses and their contents while entering , monitoring or modifying the programs. It also has two LEDS which blink alternatively on program execution. The Graphical Trainer Kit can be launched from the sub-menu item "**8085 microprocessor trainer kit**" placed under menu item "View". Shortcut key for launching this Trainer Kit Emulator is **"F9"**. In the back-end it is basically using the same engine, so at any step user can switch between any two environments.

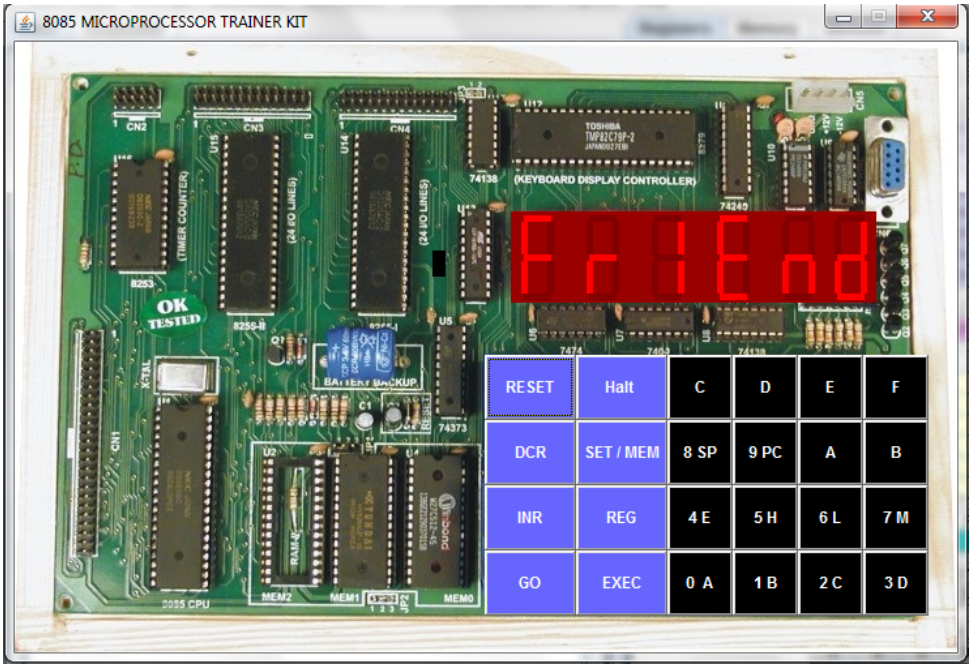


Figure 7.1: 8085 Trainer Kit

7.1 Keyboard

The keyboard has 24 keys; 16 keys for the Hex digits 0 to F and remaining keys are used to perform various functions. Some of the Hex digit keys has dual function: data entry mode and register monitor mode. The function of these keys are described as follows:

1. 0 to F: Enter Hex digits
2. Reset: To terminate the current execution. It does not clear register or memory contents. It is doing the same function as pressing STOP button during the execution of code in 8085 simulator workspace. To clear memory content, goto Settings → Clear Memory, or press "CTRL+SHIFT+DELETE".

3. Halt: It pauses the program at any stage of execution. It is equivalent to pressing PAUSE during the execution of code in 8085 simulator workspace. From where it is possible to do both forward and backward traversal.
4. DCR: Decrements the memory address and displays the new address and its data.
5. INR: Increments the memory address and displays the new address and its data.
6. SET/MEM: To enter contents in particular memory address.
7. REG: To monitor the current register content.
8. GO: To set the starting address of execution.
9. EXEC: To begin execution of the program from the begin address that is set. It takes the simulation speed that is default by the user in the editor. But, the default speed is set to ultimate.

7.2 Using the Trainer Kit Emulator

7.2.1 How to enter a program

Let's take one of the sample program as shown in fig. 7.2, to illustrate the programing process. The detailed step by step loading instruction are given in table 7.1.

*	Address	Label	Mnemonics	Hexcode	Bytes	M-Cycles	T-States
√	C000		LDA C050	3A	3	4	13
	C001			50			
	C002			C0			
√	C003		CMA	2F	1	1	4
√	C004		STA C051	32	3	4	13
	C005			51			
	C006			C0			
√	C007		HLT	76	1	2	5

Figure 7.2: Sample Program of 1's COMPLEMENT OF AN 8-BIT NUMBER

When we load a program we enter the Hex codes in memory locations for given instructions.

7.2.2 To Execute the Program

For proper execution of the program, it is needed to direct the processor to the starting address of the code and then begin execution, as shown in table 7.2.

7.2.3 How to examine memory and register contents

After program execution it is essential to examine the contents of registers and memory. Table 7.3 lists the methods to access each and every register. It also lists how to examine the content at particular memory address.

Table 7.1: Showing the buttons to be pressed sequentially to load the program in the memory

To load the Program		
STEP	1:	$\boxed{RESET}$
STEP	2:	$\boxed{SET/MEM}$
STEP	3:	$\boxed{C}\boxed{0}\boxed{0}\boxed{0}$
STEP	4:	$\boxed{INR}$
STEP	5:	$\boxed{3}\boxed{A}$
STEP	6:	$\boxed{INR}$
STEP	7:	$\boxed{5}\boxed{0}$
STEP	8:	$\boxed{INR}$
STEP	9:	$\boxed{C}\boxed{0}$
STEP	10:	$\boxed{INR}$
STEP	11:	$\boxed{2}\boxed{F}$
STEP	12:	$\boxed{INR}$
STEP	13:	$\boxed{3}\boxed{2}$
STEP	14:	$\boxed{INR}$
STEP	15:	$\boxed{5}\boxed{1}$
STEP	16:	$\boxed{INR}$
STEP	17:	$\boxed{C}\boxed{0}$
STEP	18:	$\boxed{INR}$
STEP	19:	$\boxed{7}\boxed{6}$
To load a value in C050		
STEP	20:	$\boxed{SET/MEM}$
STEP	21:	$\boxed{C}\boxed{0}\boxed{5}\boxed{0}$
STEP	22:	$\boxed{INR}$
STEP	23:	$\boxed{9}\boxed{6}$

Table 7.2: Showing the buttons to be pressed for proper execution of the code

To begin execution		
STEP	1:	$\boxed{RESET}$
STEP	2:	$\boxed{GO}$
STEP	3:	$\boxed{C}\boxed{0}\boxed{0}\boxed{0}$
STEP	4:	$\boxed{EXEC}$

Table 7.3: Showing the buttons to be pressed for register and memory monitoring

To examine Accumulator	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{0A}$
To examine B	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{1B}$
To examine C	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{2C}$
To examine D	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{3D}$
To examine E	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{4E}$
To examine H	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{5H}$
To examine L	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{6L}$
To examine Memory pointed by HL	
STEP 1:	$\boxed{REG}$
STEP 2:	$\boxed{7M}$
To examine Stack Pointer	
STEP 1:	$\boxed{SP}$
STEP 2:	$\boxed{8SP}$
To examine Program Counter	
STEP 1:	$\boxed{PC}$
STEP 2:	$\boxed{9PC}$
To examine a Memory Address	
STEP 1:	$\boxed{SET/MEM}$
STEP 2:	$\boxed{C}\boxed{0}\boxed{5}\boxed{1}$
STEP 3:	$\boxed{INR}$

7.3 Shortcut Keys for Trainer Kit Button

To prevent too much switching between keyboard and mouse, some handy shortcut key listeners are integrated with some commonly used buttons, as listed in table 7.4.

Table 7.4: List of shortcut keys

Keys	Buttons
Esc	RESET
Alphanumeric Keys: 0-9,A-F	HEXADECIMAL DIGITS
Up-Arrow	INR
Down-Arrow	DCR

Chapter 8

Debugging Mode

The debug mode allows the user to view and/or manipulate the program's internal state for the purpose of debugging. The software allows step wise or block wise line monitor with both forward and backward traversal facility. Figures 8.1 to 8.4 illustrates how users can use this feature in their own instruction set.

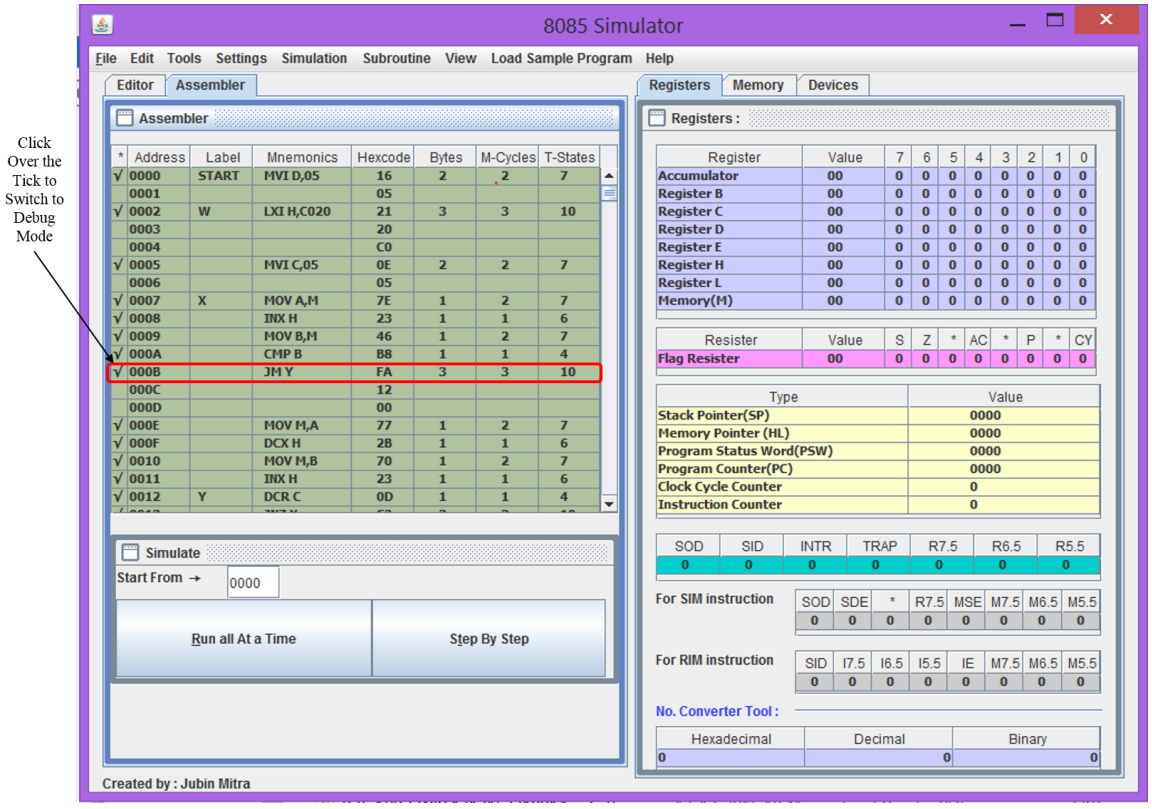


Figure 8.1: To Enter into debug mode click on the tick mark

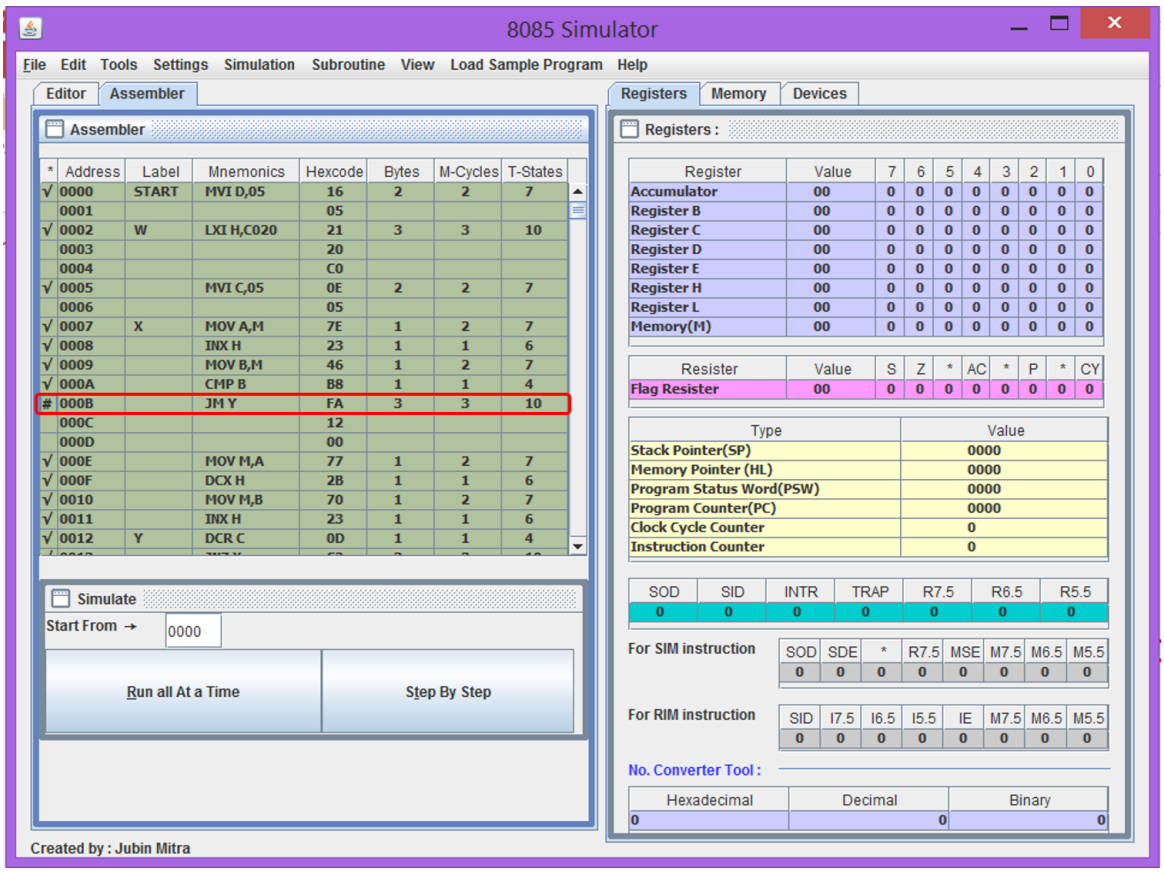


Figure 8.2: Figure shows the line is now marked with ' #' (HASH) character and it is ready to go into debuuging mode during execution of the line

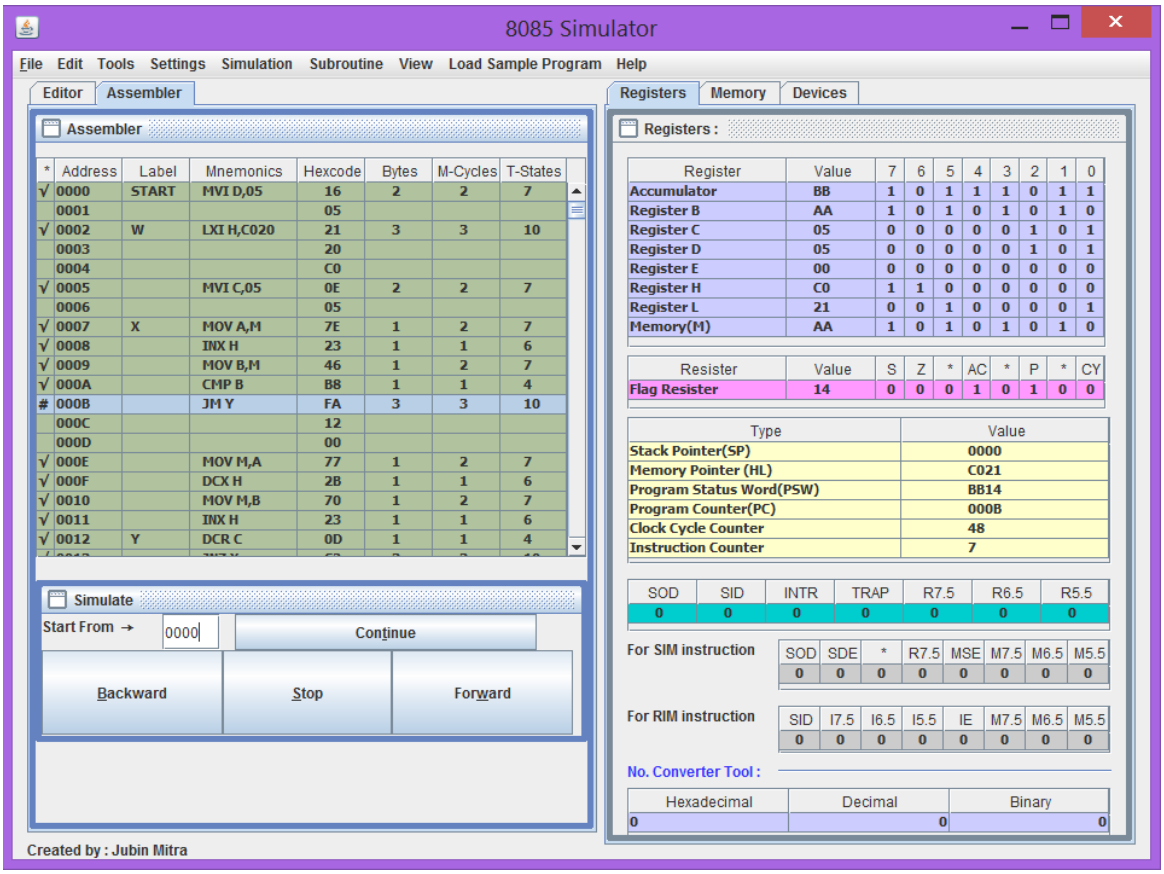


Figure 8.3: During run-time the simulation engine stops at marked line and switches to debug mode

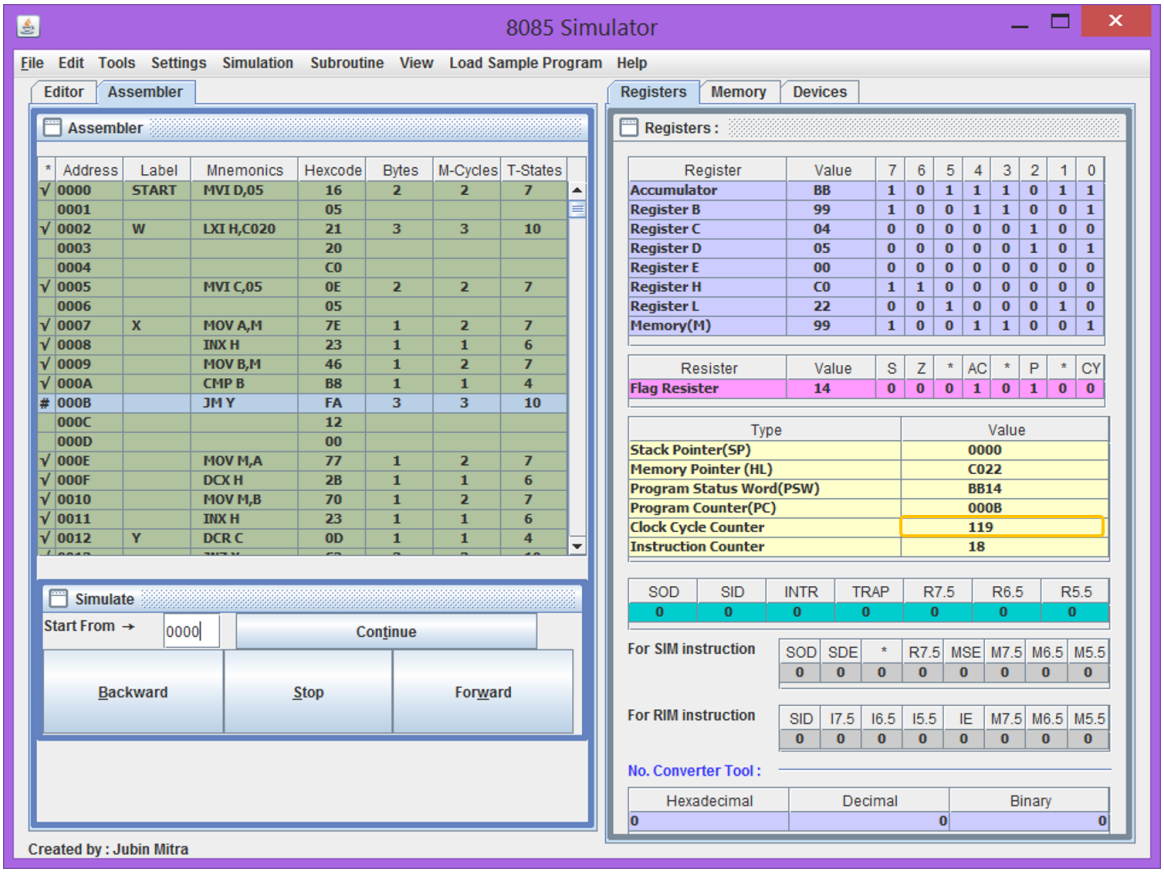


Figure 8.4: On pressing ‘ Continue ’ the simulator debugger engine steps over it on next halt. In the figure the changes are marked by ‘ Program Counter (PC) ’ register

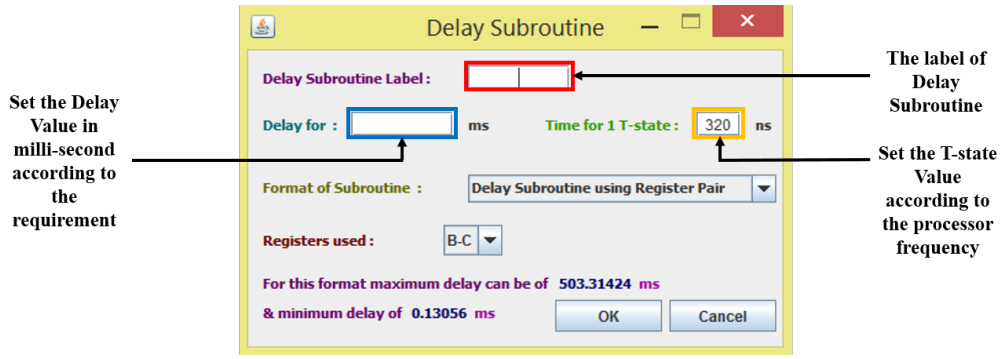
Chapter 9

Tools

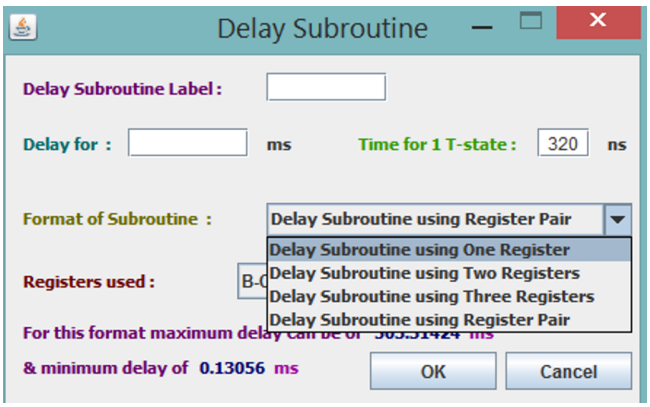
Give ordinary people the right tools, and they will design and build the most extraordinary things.
– Neil Gershenfeld

9.1 Insert Delay Subroutine

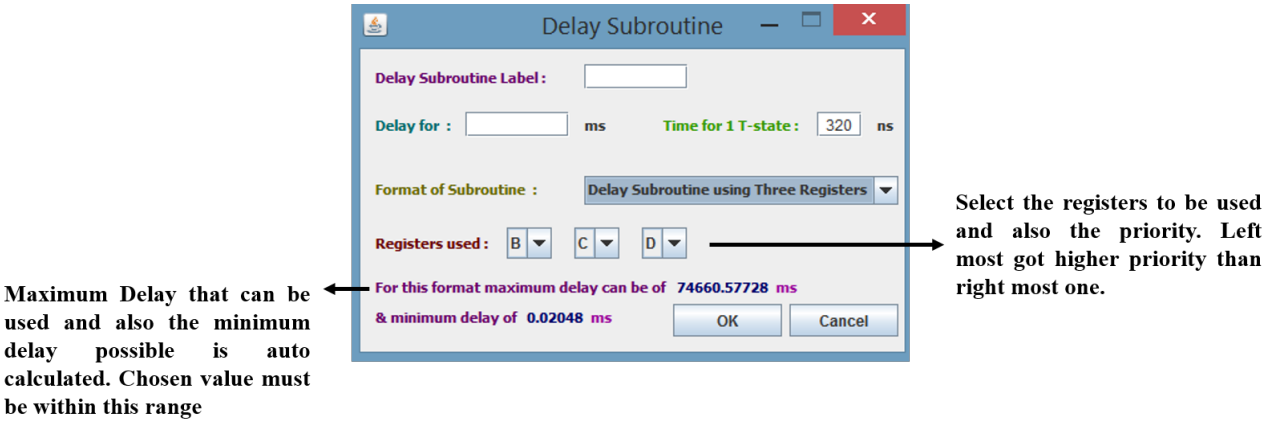
It is a powerful wizard to generate delay subroutine with user defined delay using any sets of register for a particular operating frequency of 8085 microprocessor.



(a) Enter the marked boxes, in the order **Label**, **T-state** and **Delay**



(b) Showing the modes supported



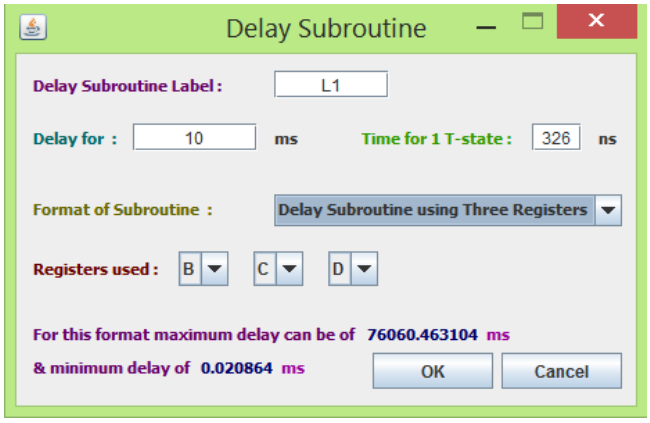
(c) How to choose the registers

Figure 9.1: The Delay Subroutine dialog box details

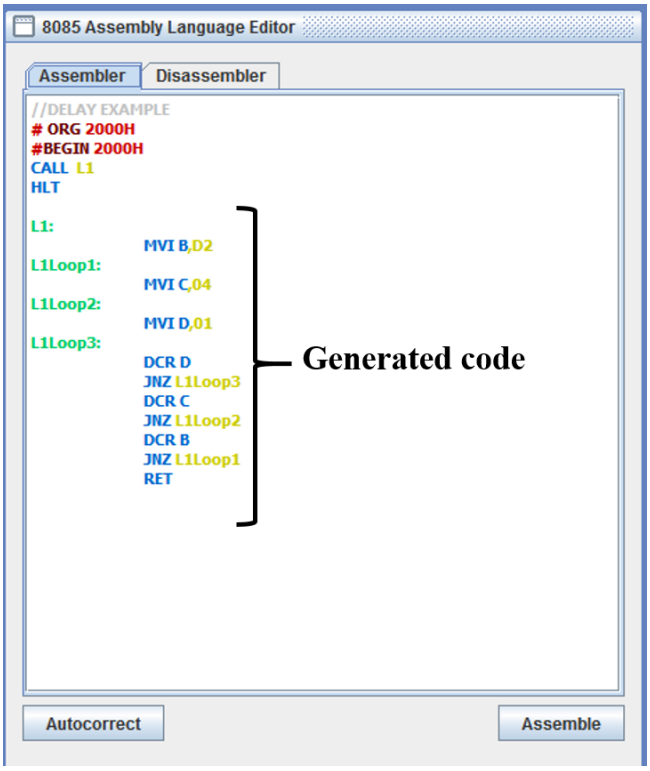
9.1.1 Working Example of a delay sub-routine

Problem Statement : ***Use 3 registers to generate 10 ms delay in a 8085 having operating frequency of 3.072 MHz.***

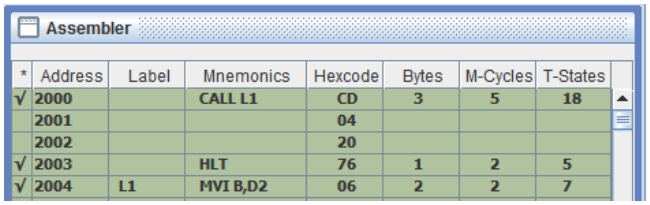
Solution:: The problem is solved using the tool as shown in fig. 9.2.
The tool generated values for register $\mathbf{B = D2\ H}$, $\mathbf{C = 04\ H}$ and $\mathbf{D = 01\ H}$.
After "Run all At a Time" the $\mathbf{Clock\ Cycle\ Counter = 30697}$
The Clock Cycles taken by the delay subroutine is calculated by subtracting the clock cycles taken from the clock cycles of user written code = $\mathbf{30697 - 18 - 5 = 30674}$.
Thus, the time taken by the delay code $= 30674 \times 326\ ns = \mathbf{9999724\ ns}$
Error Offset $= 10,000,000 - 9,999,724 = \mathbf{276\ ns}$



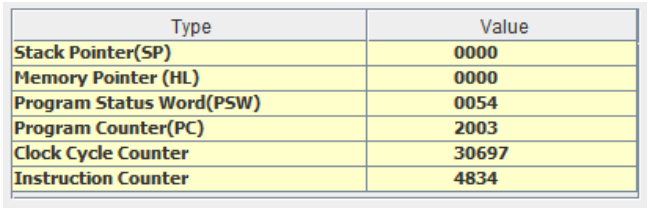
(a) Delay subroutine tool is set to the problem value



(b) The generated code + few user added lines in the top



(c) Showing the delay of the user added code

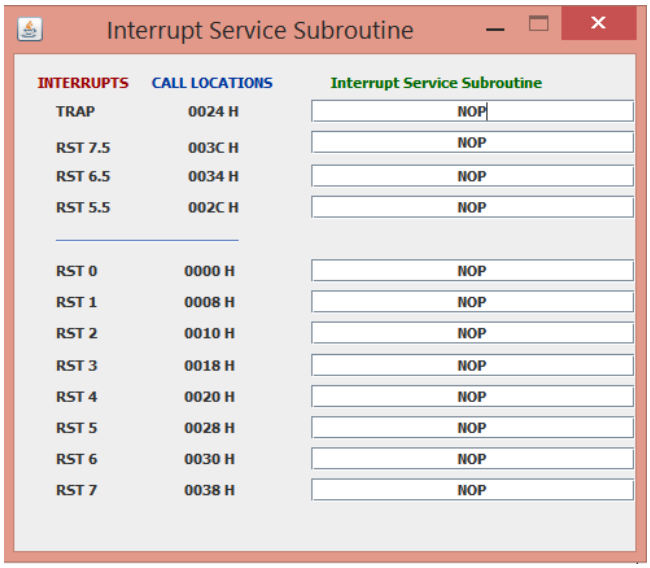


(d) Total clock cycles taken by the program after Full Run

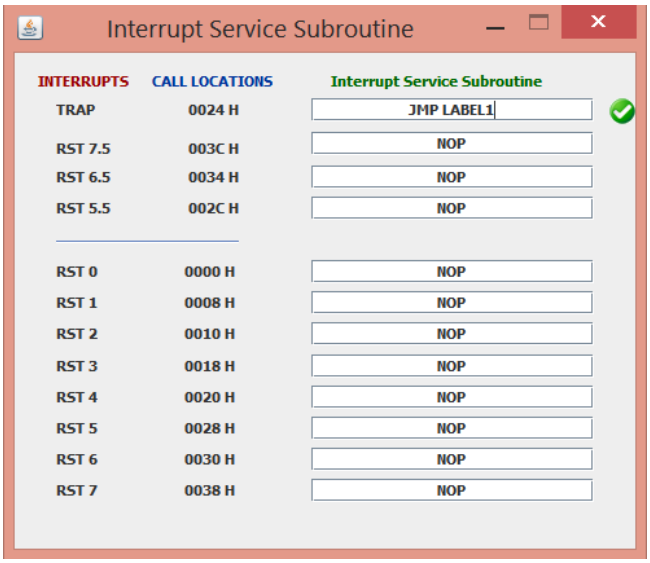
Figure 9.2: Solution of the problem graphically

9.2 Interrupt Service Subroutine

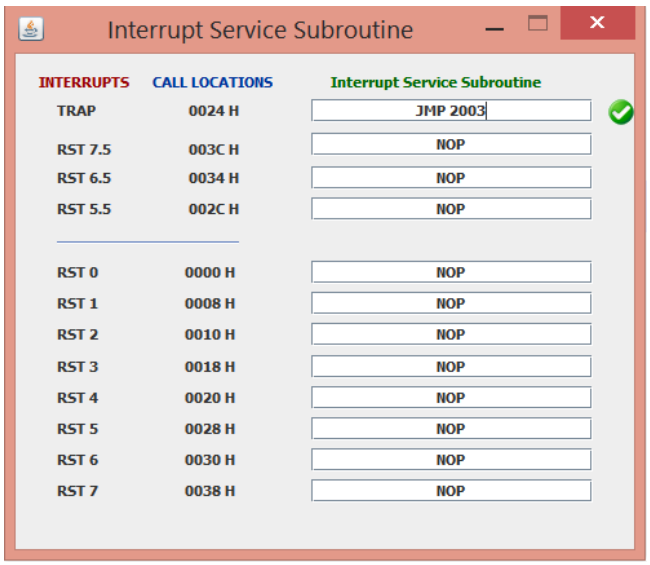
It is a handy way to set memory values at corresponding vector interrupt address. To invoke the tool select the option '**Subroutine**' → '**Interrupt Service Subroutine**'. Fig. 9.3 shows the steps to insert Interrupt Service Subroutine to cater to a particular interrupt that refers to a particular call location. In general branch instruction are used in interrupt call location to point to a particular address.



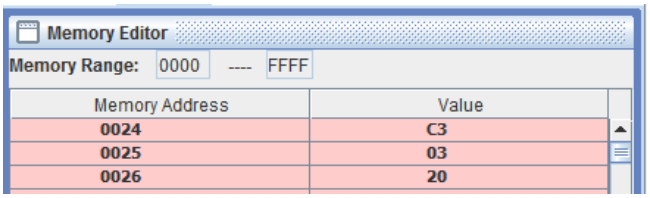
(a) Showing the entry of TRAP Interrupt



(b) '*Label1*' defined in the **assembled** code and used in entering



(c) On pressing '*Enter*', label is replaced by address

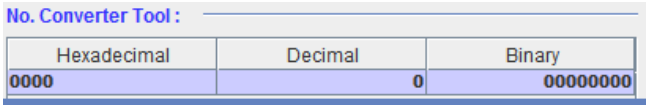


(d) After closing of the window, memory is updated

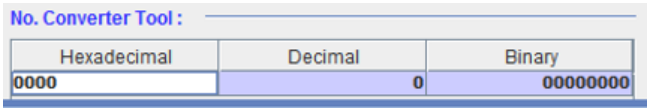
Figure 9.3: Procedure to use Interrupt Service Subroutine TOOL

9.3 Number Conversion Tool

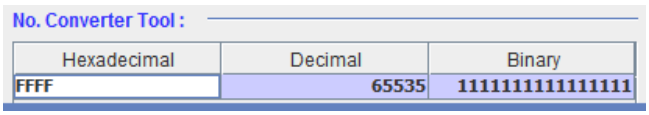
It is a portable number base conversion tool between Hexadecimal, decimal and binary standards. It allows the developers to use the same software to calculate simple conversion instead of opening a new calculator and also shows all the value in Hexadecimal, decimal and binary format simultaneously



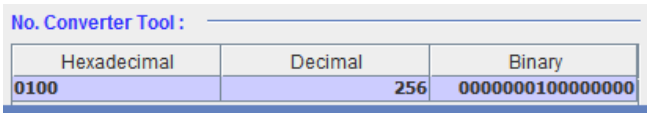
(a) When Unselected



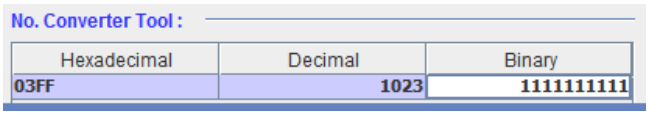
(b) When Hexadecimal text-box is selected



(c) After pressing enter on Hexadecimal text-box



(d) Decimal value of 256 entered



(e) A 10-bit binary value entered for conversion

Figure 9.4: Using number conversion tool

N.B.: The tool text-boxes correctly support upto "FFFF" Hexadecimal and 8-bit binary full scale value.

Bibliography

[1] Intel Corporation, “Intel 8080-8085 assembly language programming guide,” 1978 (cit. on p. 12).

[2] Intel, “Hexadecimal object file format specification, Revision a,” *journaltitle*, [Online]. Available: http://microsym.com/editor/assets/intelhex.pdf (cit. on p. 16).