Keil uVision
Debugging Programs

WEL Labs, IITB

2016

Development Tools (Revision)

- Coding – Editor => Entry of code into file(s)
- Translation – Assembler or Compiler

  => Generate machine code from source code
- Execution check – using Debugger to verify operation of program (on Simulator)
- Program – Programmer

  => Put machine code in the chip

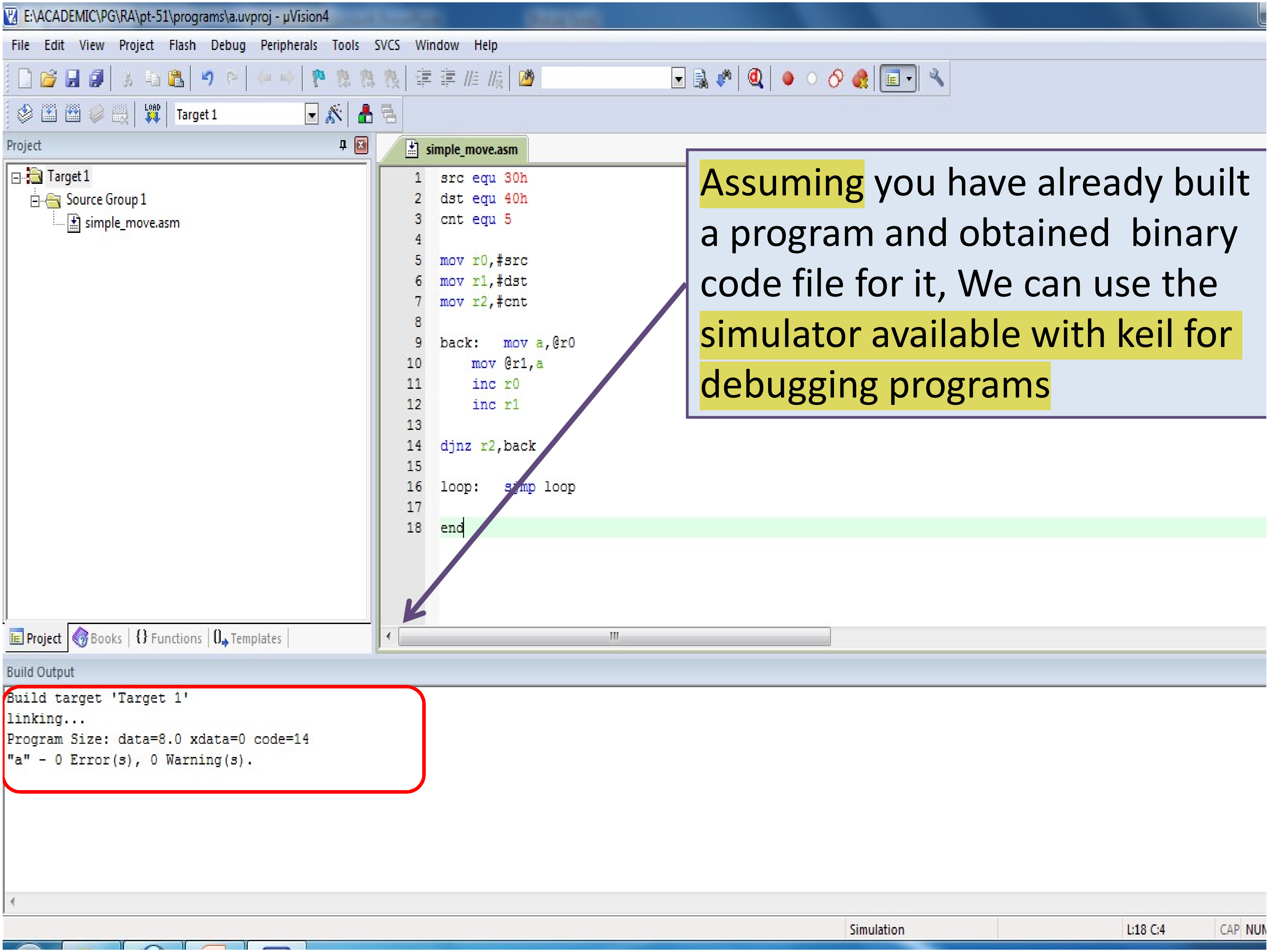
Single Point Solution – IDE e.g. Keil

Keil uVision IDE …

- ✓ **Project :** A **collection of files related to a particular programming task**.
- ✓ **Build :** The process in which **only the files modified since last build** are assembled/compiled for the chosen microcontroller device.
- ✓ **Rebuild :** The process in which **all files are assembled/compiled** irrespective of their modification state.
- ✓ **Debug : The process of finding errors happening during program execution and removing them.**

Simulator and Debugger

- Simulation of microcontroller behavior while executing the user program
- The Debug mode UI allows the user to perform the following
  1. ✓ Observe microprocessor Registers, Memory, Ports and Peripherals
  2. ✓ Place breakpoints to stop simulation as specific instruction or on condition
  3. ✓ Monitor code under execution
  4. ✓ Modify data variables
  5. ✓ Monitor timing of execution

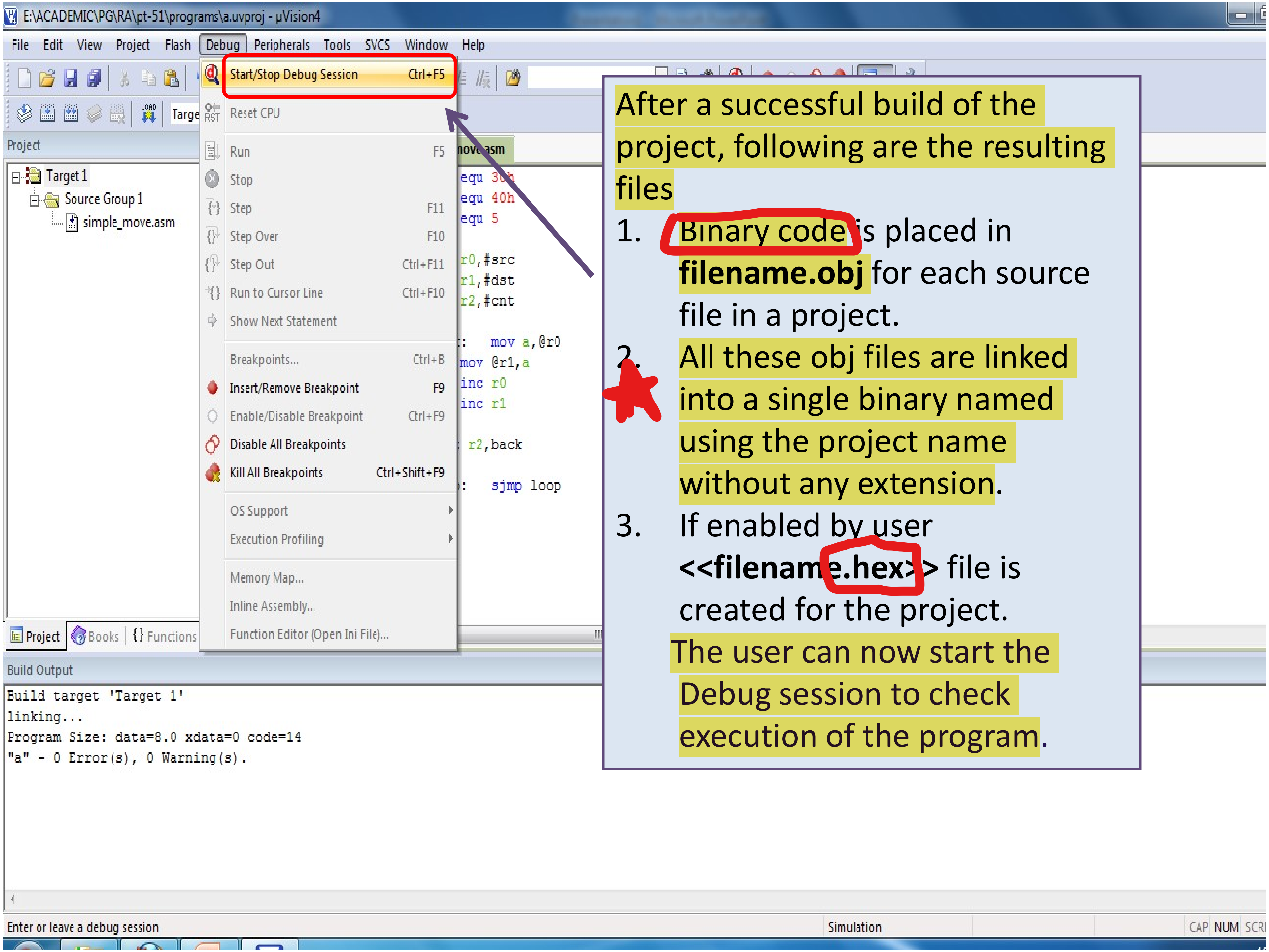

E:\ACADEMIC\PG\RA\pt-51\programs\a.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
Target 1
Project
Target 1
Source Group 1
simple_move.asm
Project Books Functions Templates
Build Output
Simulation
L:18 C:4
CAP NUM

simple_move.asm

```
src equ 30h
dst equ 40h
cnt equ 5

mov r0,#src
mov r1,#dst
mov r2,#cnt

back:   mov a,@r0
        mov @r1,a
        inc r0
        inc r1

djnz r2,back

loop:   sjmp loop

end
```

```
Build target 'Target 1'
linking...
Program Size: data=8.0 xdata=0 code=14
"a" - 0 Error(s), 0 Warning(s).
```

Assuming you have already built a program and obtained binary code file for it, We can use the simulator available with keil for debugging programs



```
equ 30h
equ 40h
equ 5

r0,#src
r1,#dst
r2,#cnt

:   mov a,@r0
mov @r1,a
inc r0
inc r1

 r2,back

:   sjmp loop
```

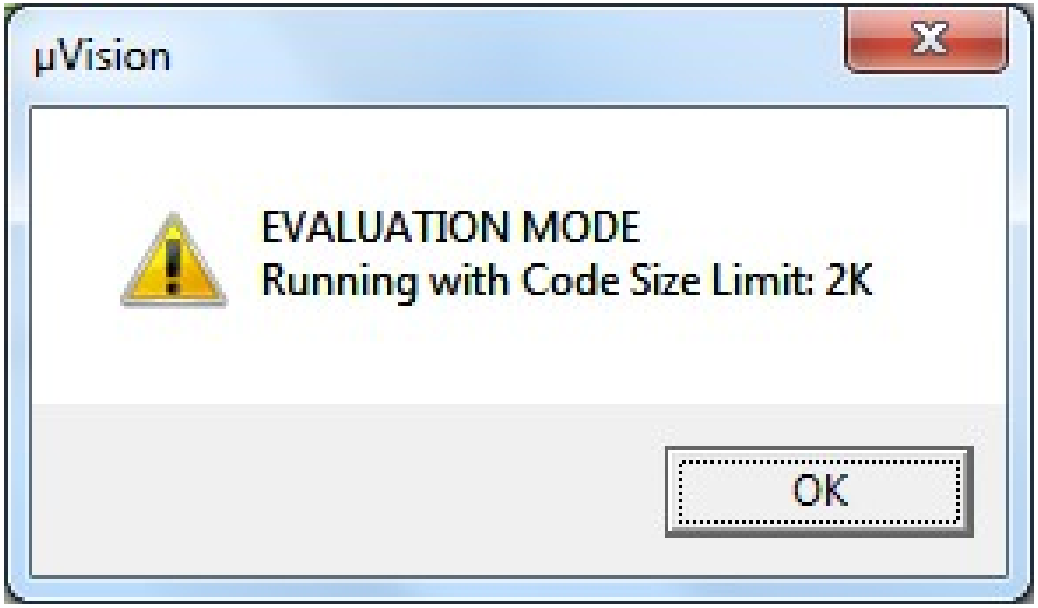
```
Build target 'Target 1'
linking...
Program Size: data=8.0 xdata=0 code=14
"a" - 0 Error(s), 0 Warning(s).
```

Enter or leave a debug session

After a successful build of the project, following are the resulting files

1. Binary code is placed in **filename.obj** for each source file in a project.
2. All these obj files are linked into a single binary named using the project name without any extension.
3. If enabled by user **<<filename.hex>>** file is created for the project.

The user can now start the Debug session to check execution of the program.

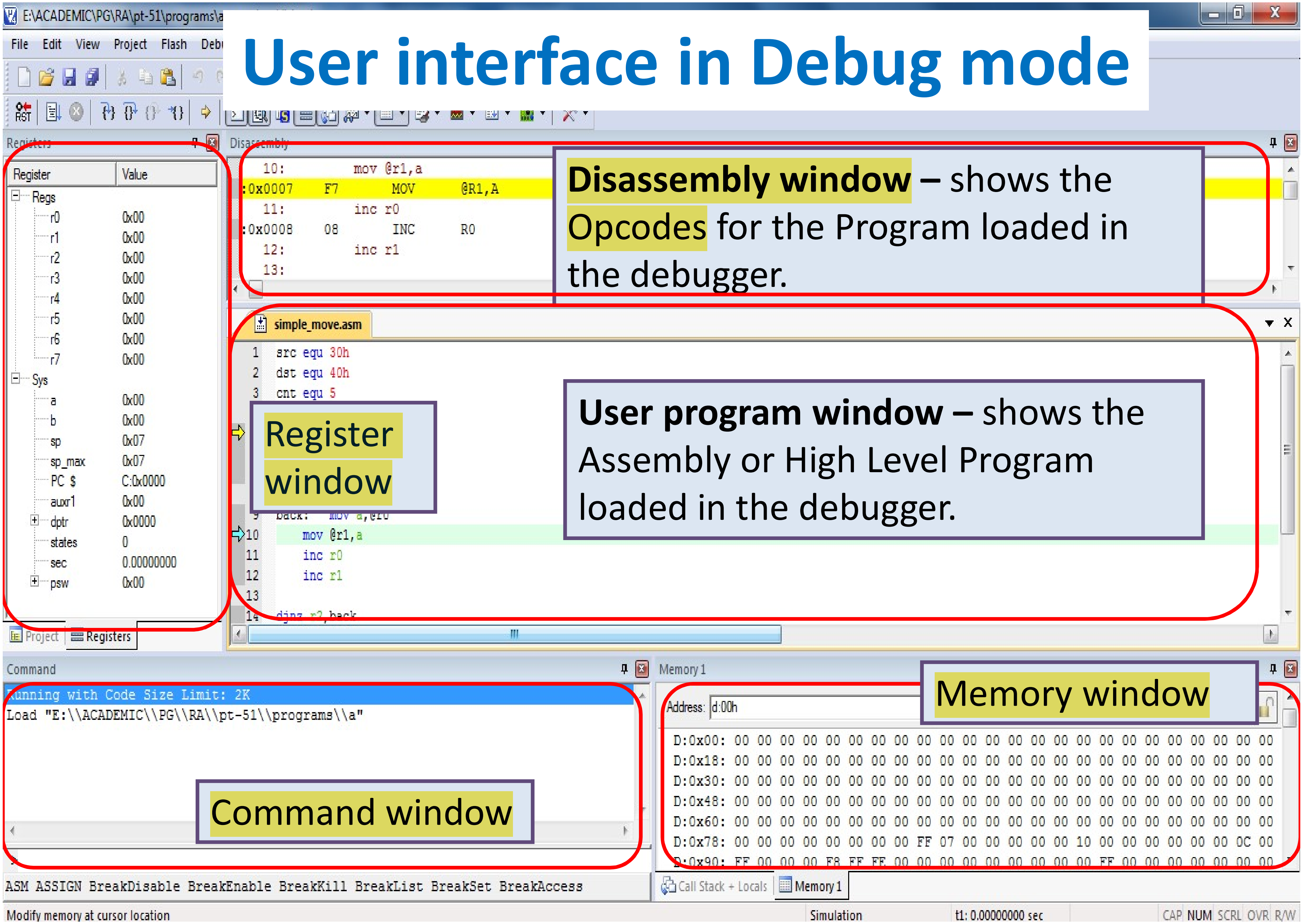


EVALUATION MODE
Running with Code Size Limit: 2K

A popup of Evaluation version is presented which shows the limitation of the mode.
On clicking “OK” the popup closes and the user is presented with the **Debug Mode** user interface (UI)

Opcodes are binary or hexadecimal codes that represent the instructions a microcontroller or processor executes. These are part of machine language and directly control the hardware.

User interface in Debug mode



Register	Value
Regs	
r0	0x00
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC $	C:0x0000
auxr1	0x00
dptr	0x0000
states	0
sec	0.00000000
psw	0x00

```
    10:          mov @r1,a
:0x0007     F7          MOV        @R1,A
    11:          inc r0
:0x0008     08          INC        R0
    12:          inc r1
    13:
```

Disassembly window – shows the Opcodes for the Program loaded in the debugger.

```
src equ 30h
dst equ 40h
cnt equ 5
back:   mov a,@r0
    mov @r1,a
    inc r0
    inc r1

djnz r2,back
```

Register window

User program window – shows the Assembly or High Level Program loaded in the debugger.

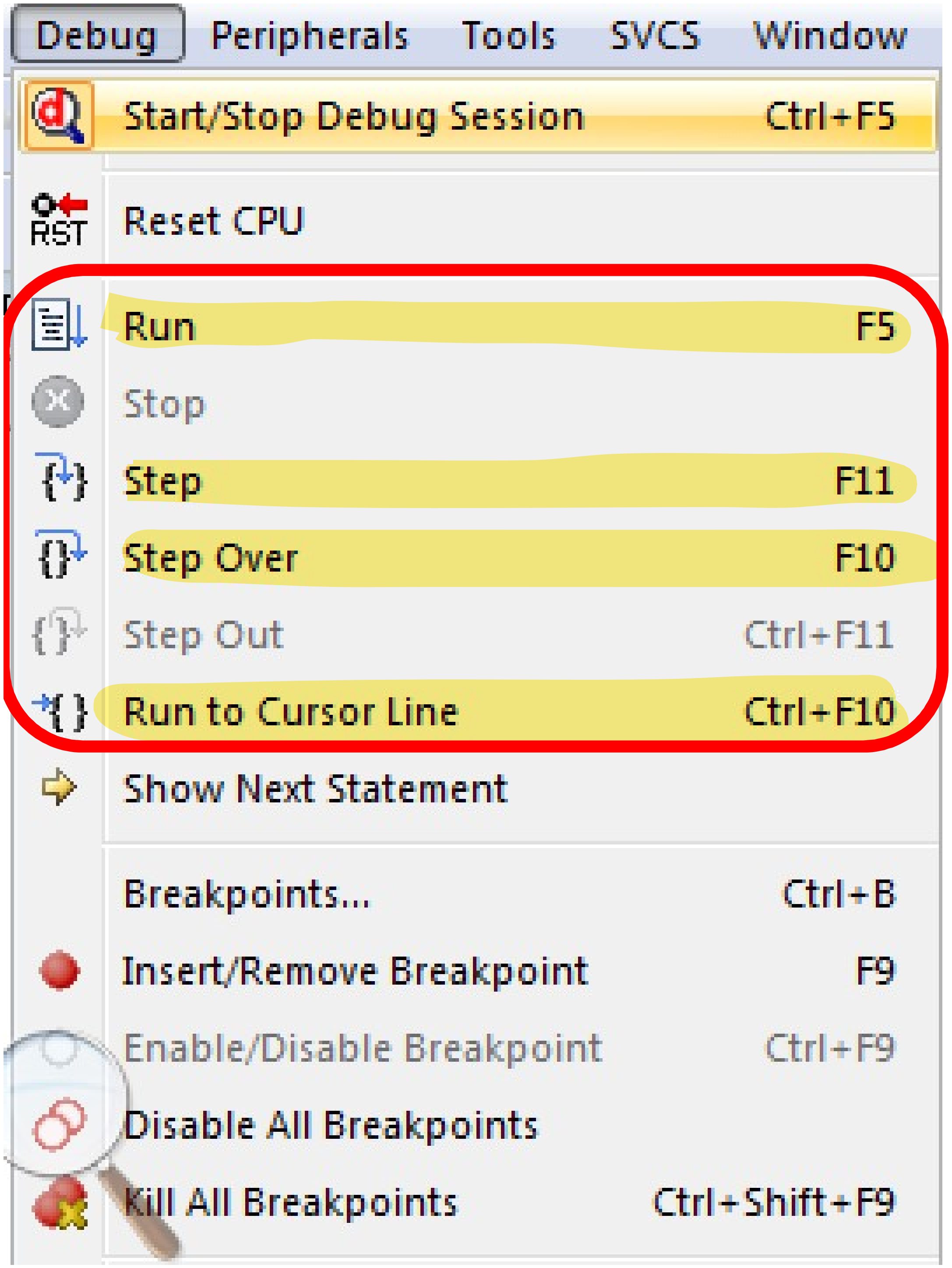
```
Running with Code Size Limit: 2K
Load "E:\\ACADEMIC\\PG\\RA\\pt-51\\programs\\a"
```

Command window

```
ASM ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess
```

```
Address: d:00h

D:0x00: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x18: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x30: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x48: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x78: 00 00 00 00 00 00 00 00 FF 07 00 00 00 00 00 10 00 00 00 00 00 00 0C 00
D:0x90: FF 00 00 00 F8 FF FF 00 00 00 00 00 00 00 00 00 FF 00 00 00 00 00 00 00
```

Memory window


Debug
Peripherals
Tools
SVCS
Window
Start/Stop Debug Session Ctrl+F5
Reset CPU
Run F5
Stop
Step F11
Step Over F10
Step Out Ctrl+F11
Run to Cursor Line Ctrl+F10
Show Next Statement
Breakpoints... Ctrl+B
Insert/Remove Breakpoint F9
Enable/Disable Breakpoint Ctrl+F9
Disable All Breakpoints
Kill All Breakpoints Ctrl+Shift+F9

User can execute instructions in multiple modes :

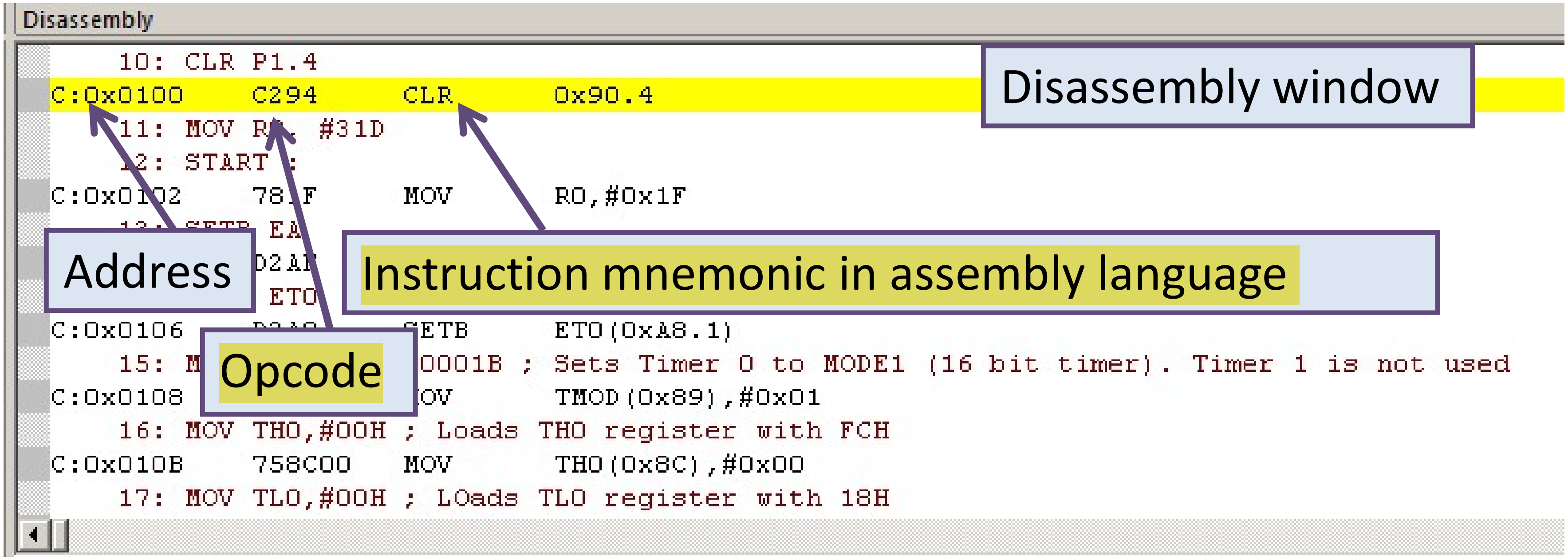
1. **Run (F5)** – Continues executing the program until the next active breakpoint is reached or till the program termination.

2. **Step (F11)--** Executes a single-step into a function; Executes the current instruction line.

3. **Step Over (F10) –** Executes a single-step over a function.

4. Run to Cursor Line **(Ctrl+F10)** Allows user to place a cursor and run the program till that line.

Details of Disassembly and Memory window



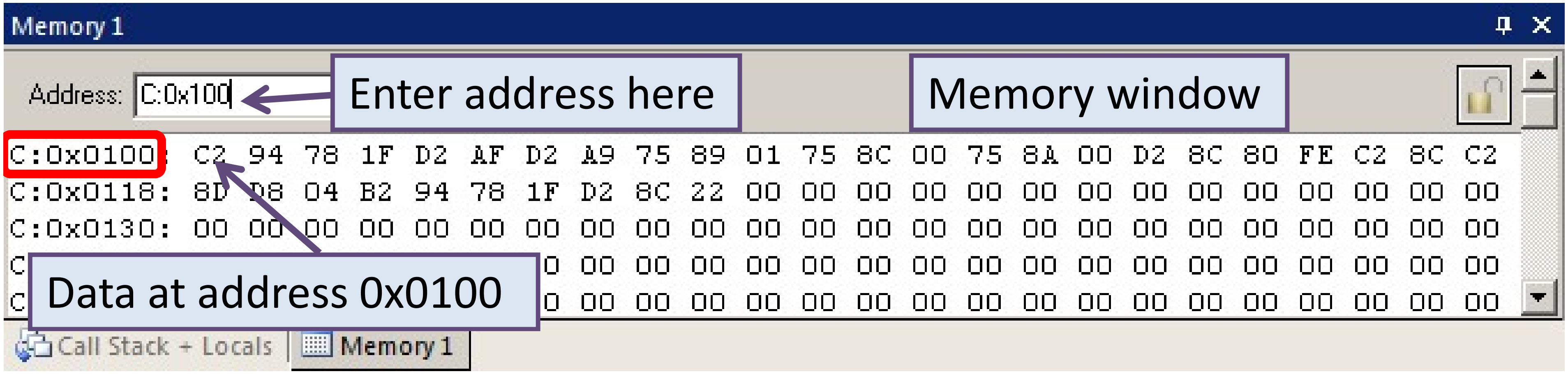
```
    10: CLR P1.4
C:0x0100    C294     CLR      0x90.4
    11: MOV R0, #31D
    12: START :
C:0x0102    781F     MOV      R0,#0x1F
    13: SETB EA
            D2AF
            ETO
C:0x0106             SETB     ETO(0xA8.1)
    15: M           0001B ; Sets Timer 0 to MODE1 (16 bit timer). Timer 1 is not used
C:0x0108             OV       TMOD(0x89),#0x01
    16: MOV THO,#00H ; Loads THO register with FCH
C:0x010B    758C00   MOV      THO(0x8C),#0x00
    17: MOV TLO,#00H ; LOads TLO register with 18H
```

Disassembly window

Address

Opcode

Instruction mnemonic in assembly language



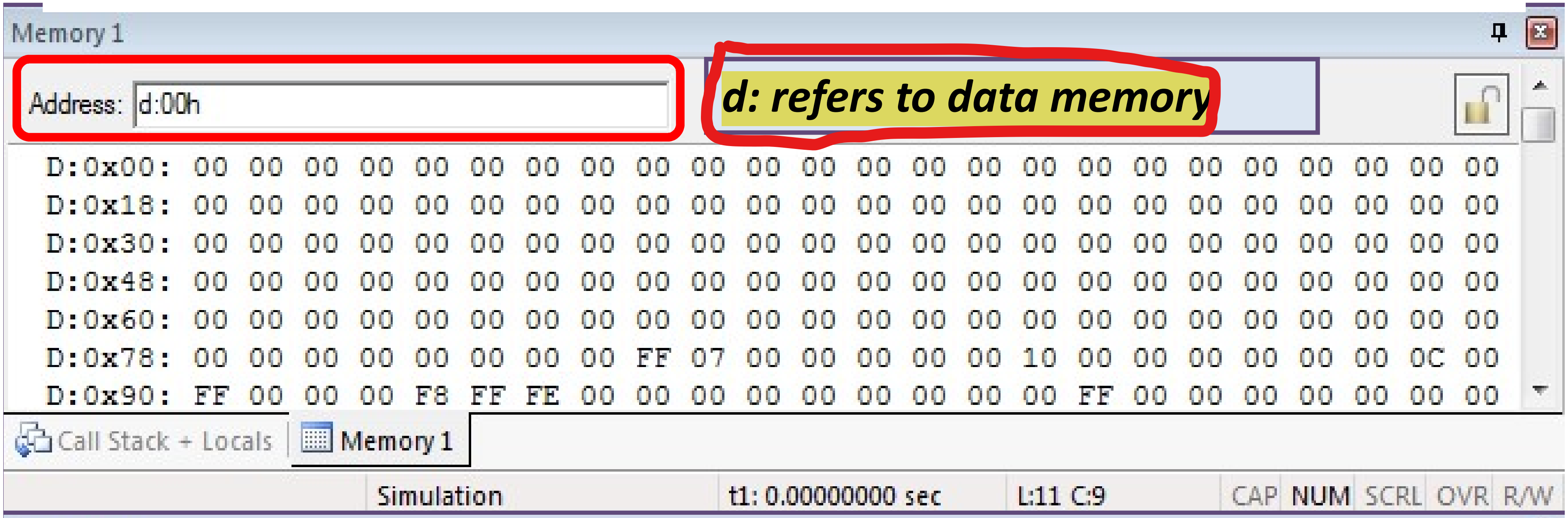
```
C:0x0100: C2 94 78 1F D2 AF D2 A9 75 89 01 75 8C 00 75 8A 00 D2 8C 80 FE C2 8C C2
C:0x0118: 8D D8 04 B2 94 78 1F D2 8C 22 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C:0x0130: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C                                  0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C                                  0 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

Enter address here

Memory window

Data at address 0x0100

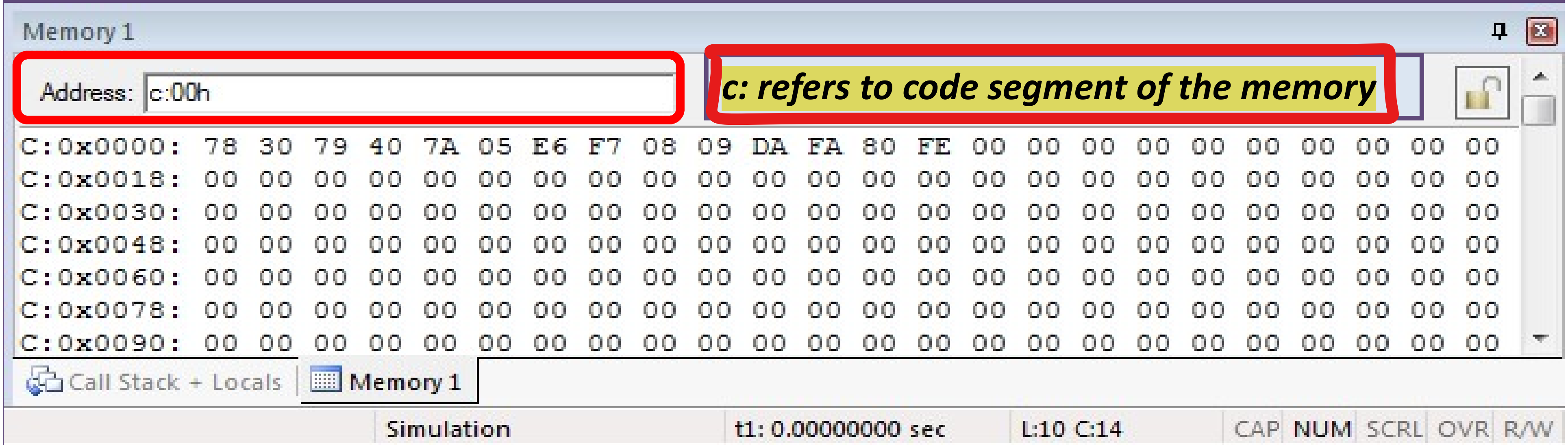
Code and Data memory access



Address: d:00h

d: refers to data memory

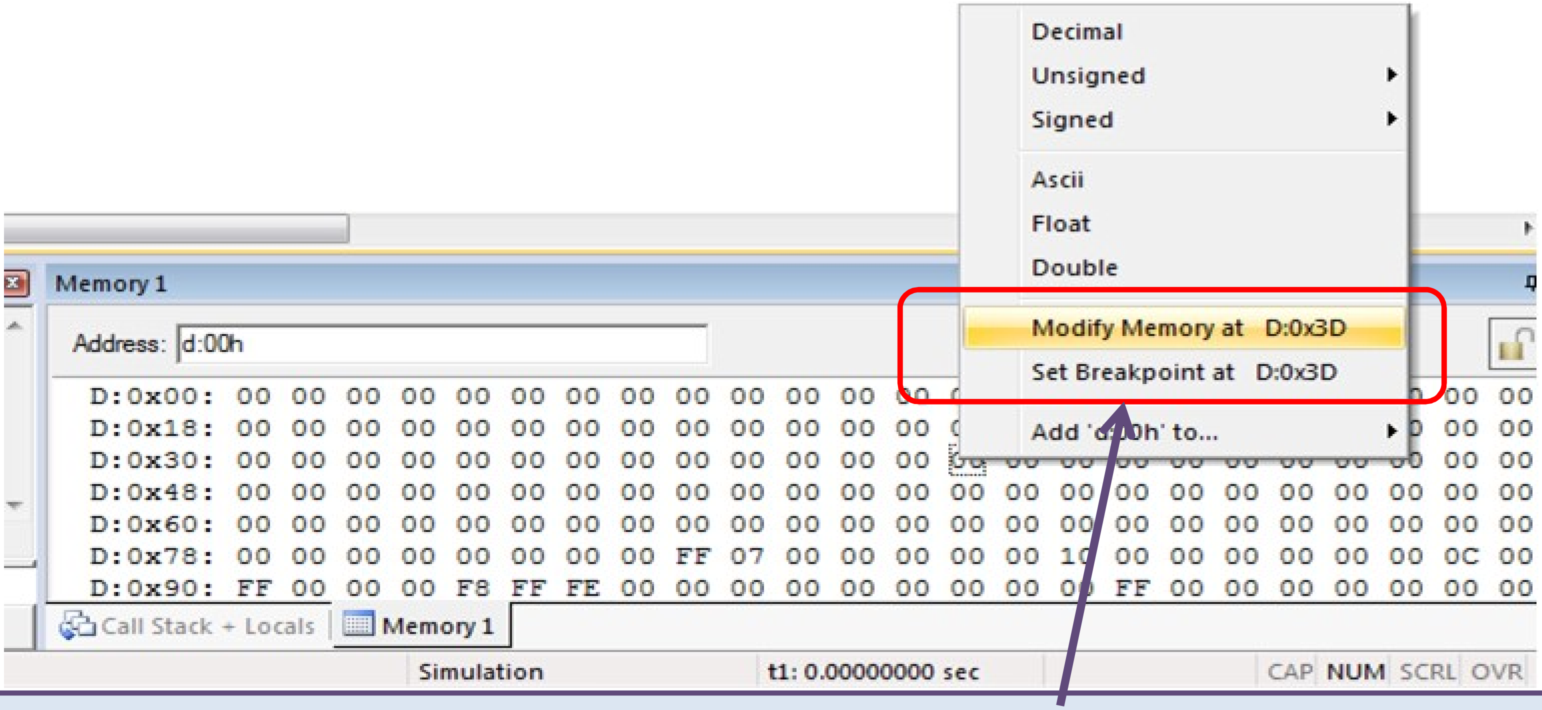
```
D:0x00: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x18: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x30: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x48: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x78: 00 00 00 00 00 00 00 00 FF 07 00 00 00 00 00 10 00 00 00 00 00 00 0C 00
D:0x90: FF 00 00 00 F8 FF FE 00 00 00 00 00 00 00 00 00 FF 00 00 00 00 00 00 00
```



Address: c:00h

c: refers to code segment of the memory

```
C:0x0000: 78 30 79 40 7A 05 E6 F7 08 09 DA FA 80 FE 00 00 00 00 00 00 00 00 00 00
C:0x0018: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C:0x0030: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C:0x0048: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C:0x0060: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C:0x0078: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
C:0x0090: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```



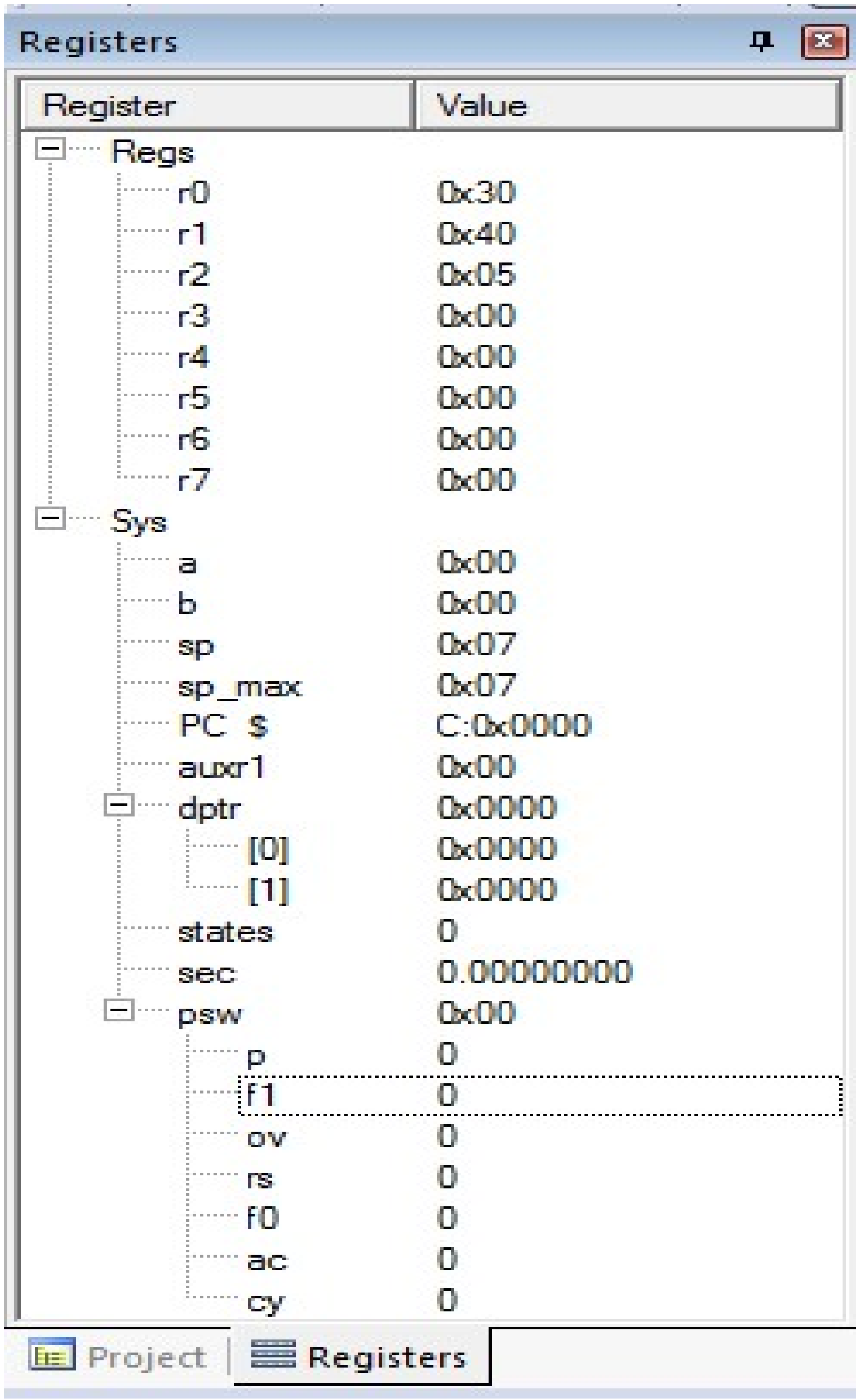
Address: d:00h

```
D:0x00: 00 00 00 00 00 00 00 00 00 00 00 00                         00 00
D:0x18: 00 00 00 00 00 00 00 00 00 00 00 00 00                      00 00
D:0x30: 00 00 00 00 00 00 00 00 00 00 00 00 00                      00 00
D:0x48: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x60: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
D:0x78: 00 00 00 00 00 00 00 00 FF 07 00 00 00 00 00 10 00 00 00 00 00 00 0C 00
D:0x90: FF 00 00 00 F8 FF FE 00 00 00 00 00 00 00 00 00 FF 00 00 00 00 00 00 00
```

Simulation t1: 0.00000000 sec

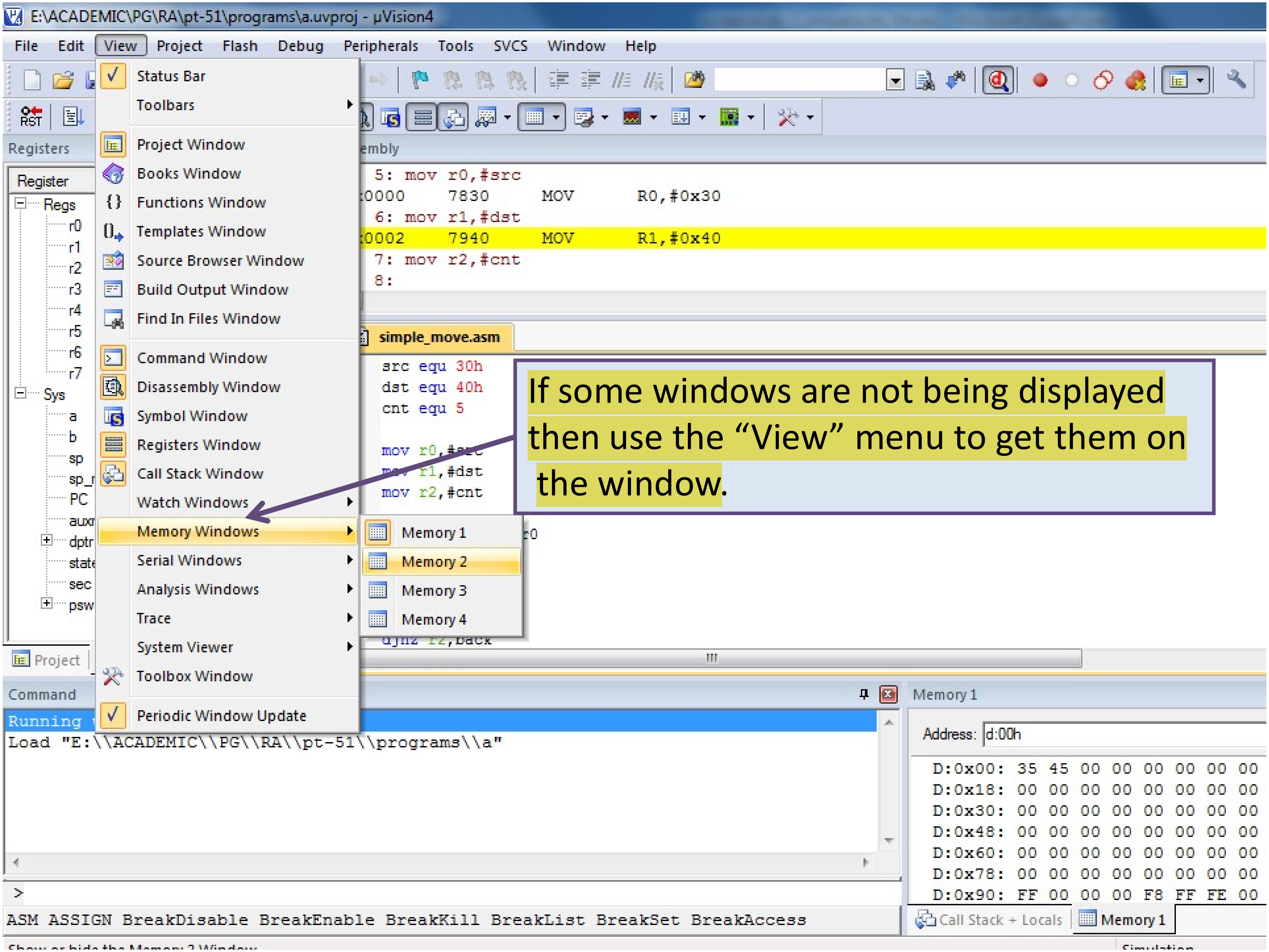
During execution, user can right click on the required memory location in the memory window to modify RAM data. Functionality for selecting the number system in which the memory contents are to be displayed is also available .

Note: To initialize memory contents on hardware, user has to add necessary instructions in the program code.



Register	Value
Regs	
r0	0x30
r1	0x40
r2	0x05
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC $	C:0x0000
auxr1	0x00
dptr	0x0000
[0]	0x0000
[1]	0x0000
states	0
sec	0.00000000
psw	0x00
p	0
f1	0
ov	0
rs	0
f0	0
ac	0
cy	0

The Registers window provides access to all the registers including the flag register , DPTRs etc.



```
 5: mov r0,#src
:0000    7830     MOV     R0,#0x30
 6: mov r1,#dst
:0002    7940     MOV     R1,#0x40
 7: mov r2,#cnt
 8:
```

```
src equ 30h
dst equ 40h
cnt equ 5

mov r0,#src
mov r1,#dst
mov r2,#cnt
r0
djnz r2,back
```

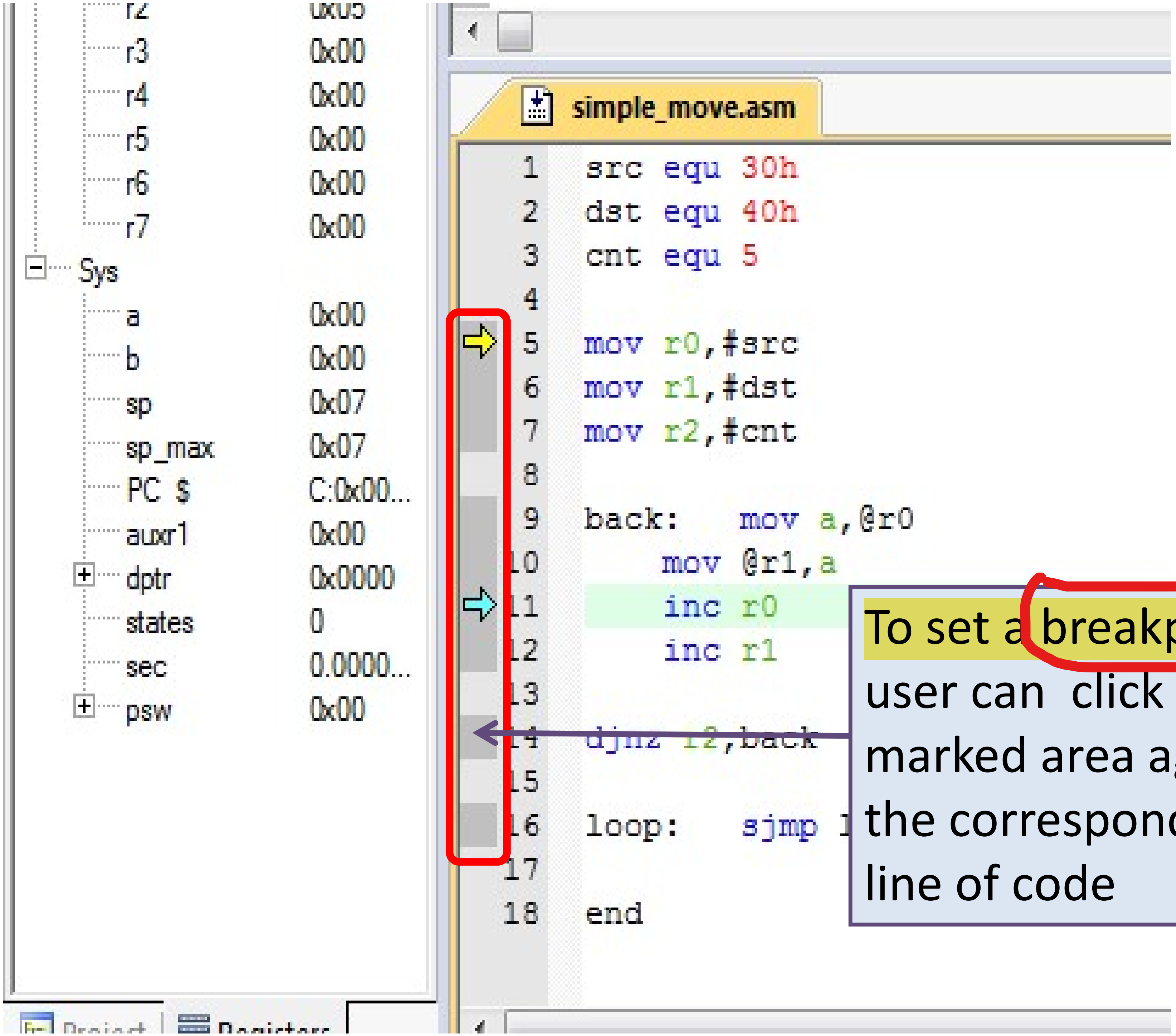
```
Running w
Load "E:\\ACADEMIC\\PG\\RA\\pt-51\\programs\\a"
>
ASM ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess
```

Address: d:00h

```
D:0x00: 35 45 00 00 00 00 00 00
D:0x18: 00 00 00 00 00 00 00 00
D:0x30: 00 00 00 00 00 00 00 00
D:0x48: 00 00 00 00 00 00 00 00
D:0x60: 00 00 00 00 00 00 00 00
D:0x78: 00 00 00 00 00 00 00 00
D:0x90: FF 00 00 00 F8 FF FE 00
```

Show or hide the Memory 2 Window

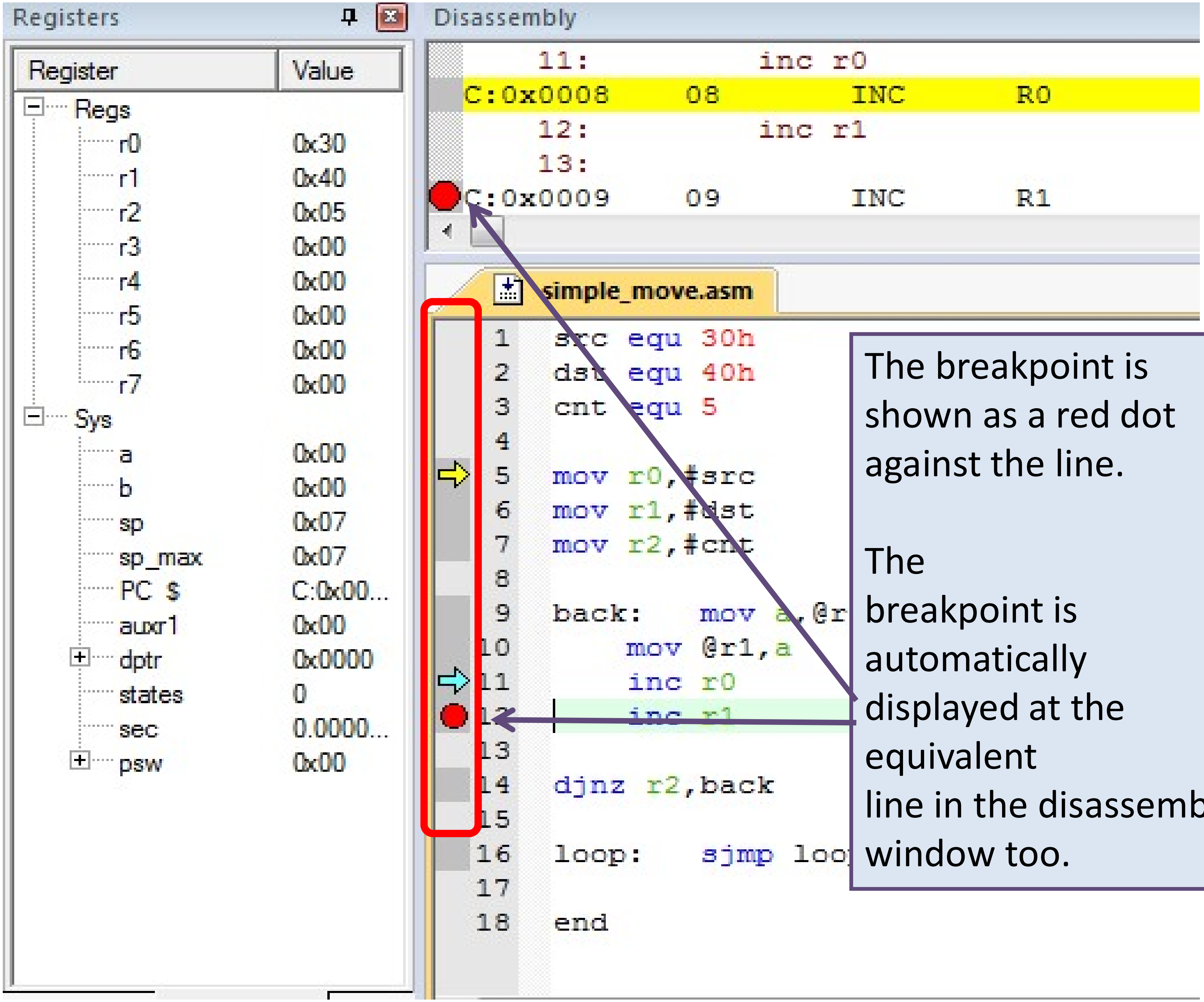
If some windows are not being displayed then use the “View” menu to get them on the window.



r2	0x05
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC $	C:0x00...
auxr1	0x00
dptr	0x0000
states	0
sec	0.0000...
psw	0x00

```
src equ 30h
dst equ 40h
cnt equ 5

mov r0,#src
mov r1,#dst
mov r2,#cnt

back:   mov a,@r0
        mov @r1,a
        inc r0
        inc r1

djnz r2,back

loop:   sjmp l

end
```

To set a breakpoint, user can click in the marked area against the corresponding line of code



Register	Value
Regs	
r0	0x30
r1	0x40
r2	0x05
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC $	C:0x00...
auxr1	0x00
dptr	0x0000
states	0
sec	0.0000...
psw	0x00

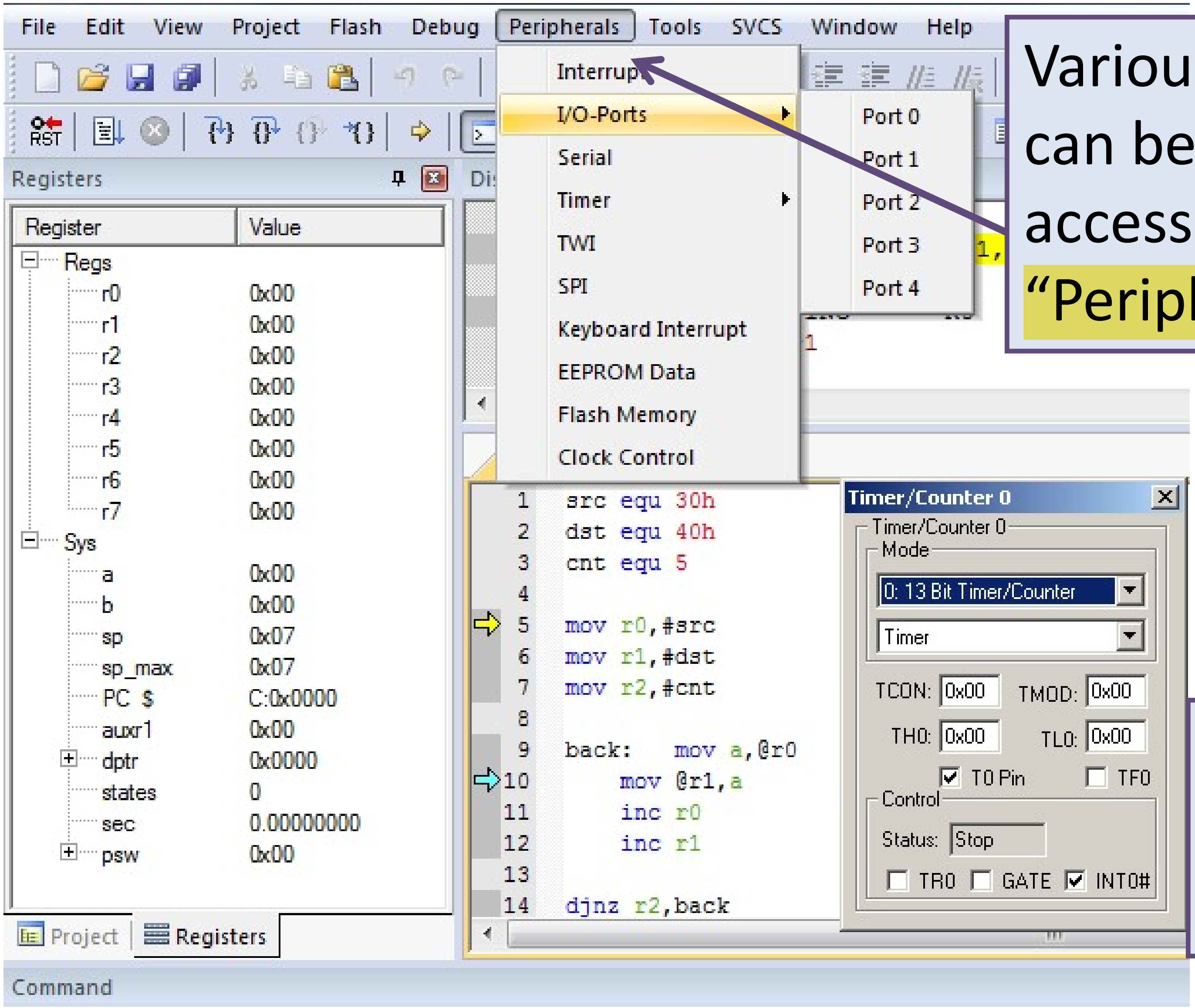
```
    11:          inc r0
C:0x0008    08         INC        R0
    12:          inc r1
    13:
C:0x0009    09         INC        R1
```

```
src equ 30h
dst equ 40h
cnt equ 5

mov r0,#src
mov r1,#dst
mov r2,#cnt

back:   mov a,@r
        mov @r1,a
        inc r0
        inc r1

djnz r2,back

loop:   sjmp loo

end
```

The breakpoint is shown as a red dot against the line.

The breakpoint is automatically displayed at the equivalent line in the disassembly window too.

Peripherals menu



Register	Value
Regs	
r0	0x00
r1	0x00
r2	0x00
r3	0x00
r4	0x00
r5	0x00
r6	0x00
r7	0x00
Sys	
a	0x00
b	0x00
sp	0x07
sp_max	0x07
PC $	C:0x0000
auxr1	0x00
dptr	0x0000
states	0
sec	0.00000000
psw	0x00

```
src equ 30h
dst equ 40h
cnt equ 5

mov r0,#src
mov r1,#dst
mov r2,#cnt

back:   mov a,@r0
        mov @r1,a
        inc r0
        inc r1

djnz r2,back
```

Timer/Counter 0

Timer/Counter 0

Mode: 0: 13 Bit Timer/Counter

Timer

TCON: 0x00 TMOD: 0x00

TH0: 0x00 TL0: 0x00

☑ T0 Pin ☐ TF0

Control

Status: Stop

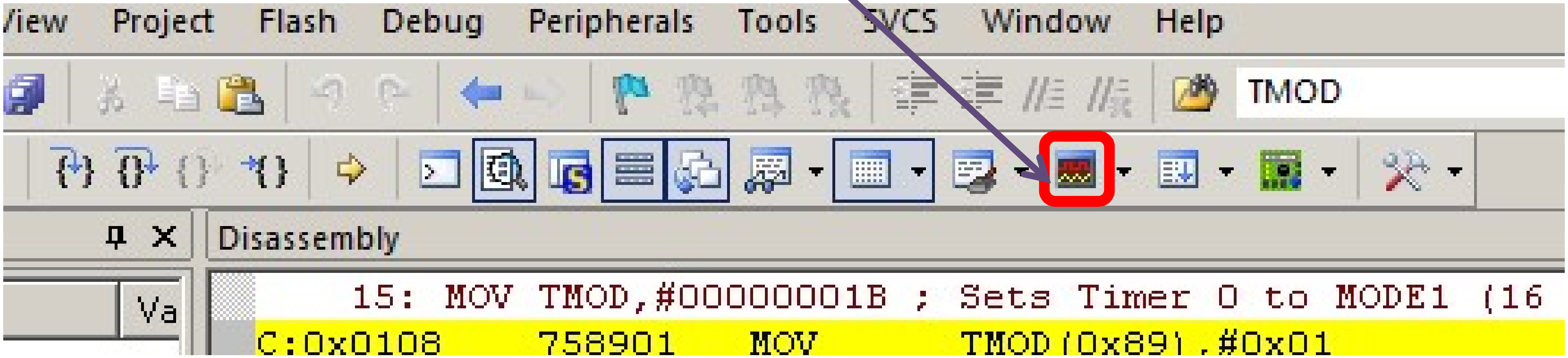
☐ TR0 ☐ GATE ☑ INT0#

Various Peripherals can be accessed through the "Peripherals" menu.

Window corresponding to Timer 0

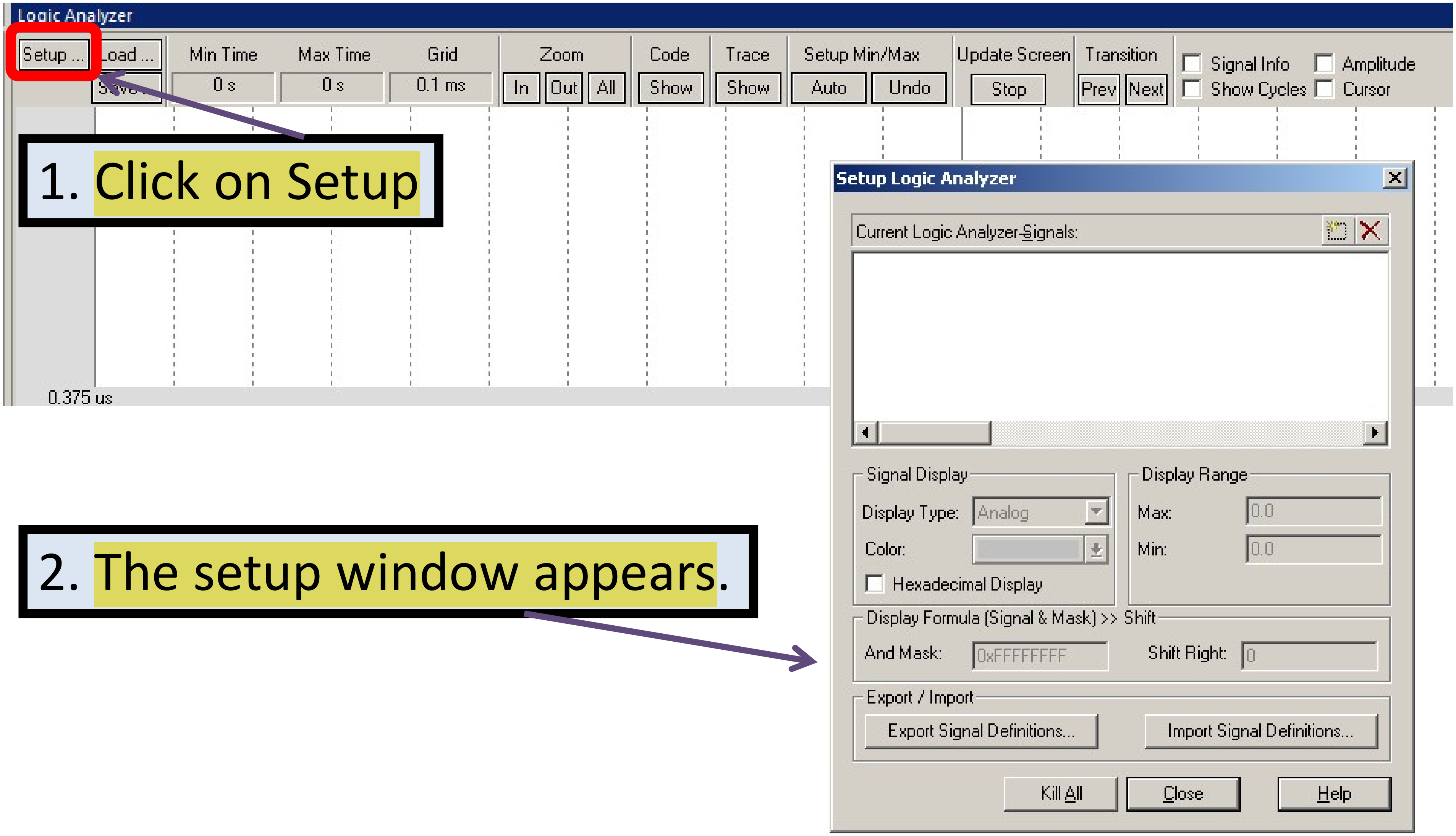
Logic analyzer

To start the logic analyzer click on the highlighted icon or go to
View > Analysis Window > Logic Analyzer.



```
      15: MOV TMOD,#00000001B ; Sets Timer 0 to MODE1 (16
C:0x0108    758901   MOV      TMOD(0x89),#0x01
```

Logic Analyzer window



Min Time: 0 s

Max Time: 0 s

Grid: 0.1 ms

Display Type: Analog

Max: 0.0

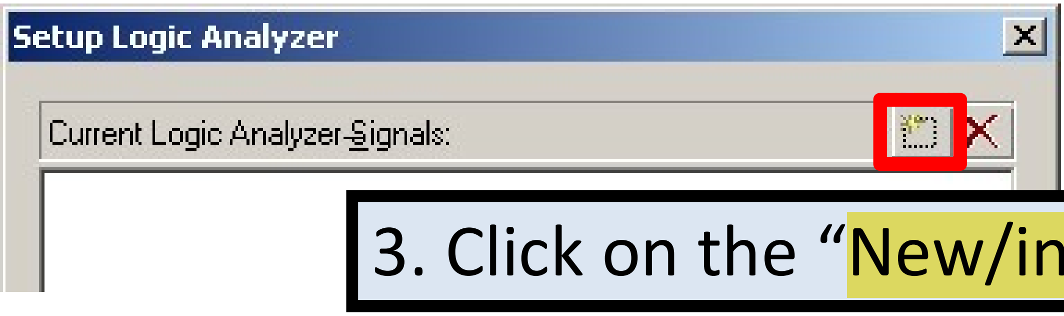
Min: 0.0

And Mask: 0xFFFFFFFF

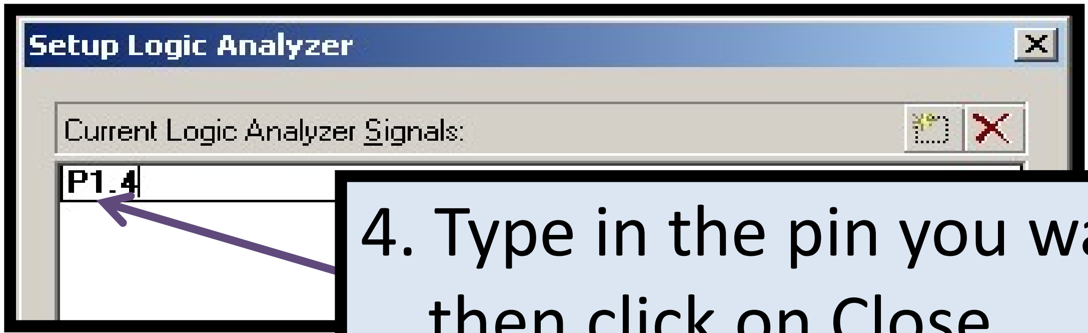
Shift Right: 0

1. Click on Setup

2. The setup window appears.



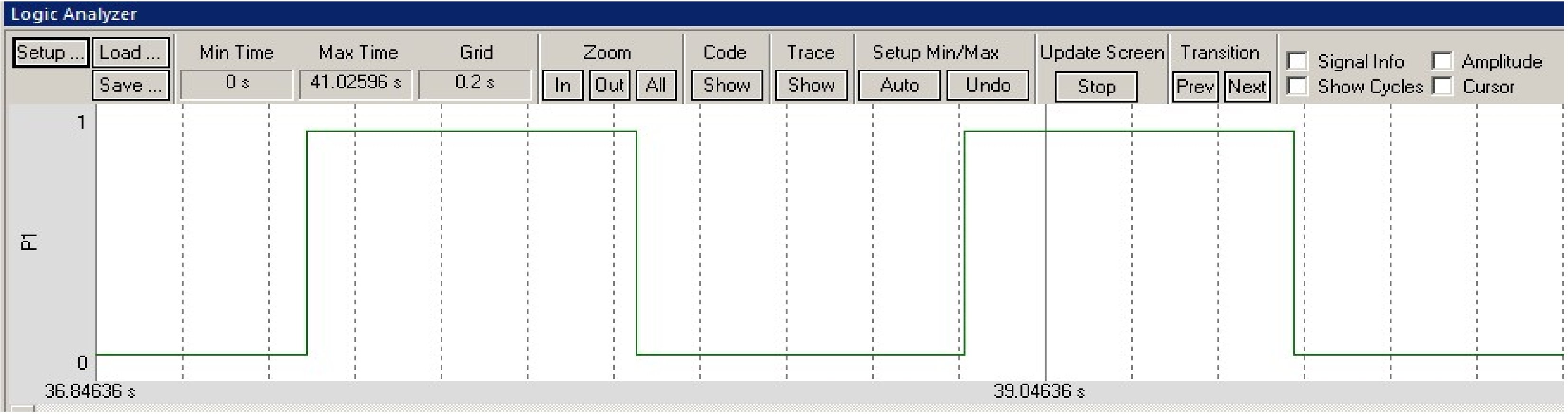
3. Click on the “New/insert” icon.



P1.4

4. Type in the pin you want to monitor then click on Close.

5. After running a simulation, you can pause it and look at the timing waveforms to debug your code.



Questions ?

Thank you

WEL Labs, IITB

2016

For doubts/errors in this PPT contact :
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