Tutorial 14: ARM Stack Frame

Computer Science Department
CS2208: Introduction to Computer Organization and Architecture
Winter 2020-2021
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ARM Stack Frame

```
        AREA TestProg, CODE, READONLY
        ENTRY                   ;This is the calling environment


Main    ADR     sp,Stack        ;set up r13 as the stack pointer

        MOV     r0,#124         ;set up a dummy parameter in r0
        MOV     fp,#123         ;set up dummy frame pointer

        STR     r0,[sp,#-4]!    ;push the parameter

        BL      Sub             ;call the subroutine

        LDR     r1,[sp],#4      ;pop the parameter

Loop    B       Loop            ;wait here (endless loop)
```

FD Stack

You need to re-do it yourself using the other stack types.

ARM Stack Frame

```
Sub    STMFD sp!,{fp,lr}   ;push frame-pointer and link-register
       MOV   fp,sp         ;frame pointer at the bottom of the frame
       SUB   sp,sp,#4      ;create the stack frame (one word)

       LDR   r2,[fp,#8]    ;get the pushed parameter
       ADD   r2,r2,#120    ;do a dummy operation on the parameter
       STR   r2,[fp,#-4]   ;store it in the stack frame

       ADD   sp,sp,#4      ;clean up the stack frame
       LDMFD sp!,{fp,pc}   ;restore frame pointer and return

       DCD   0x0000        ;clear memory
       DCD   0x0000
       DCD   0x0000
       DCD   0x0000
Stack  DCD   0x0000        ;start of the stack

       END
```

The body of an FD stack

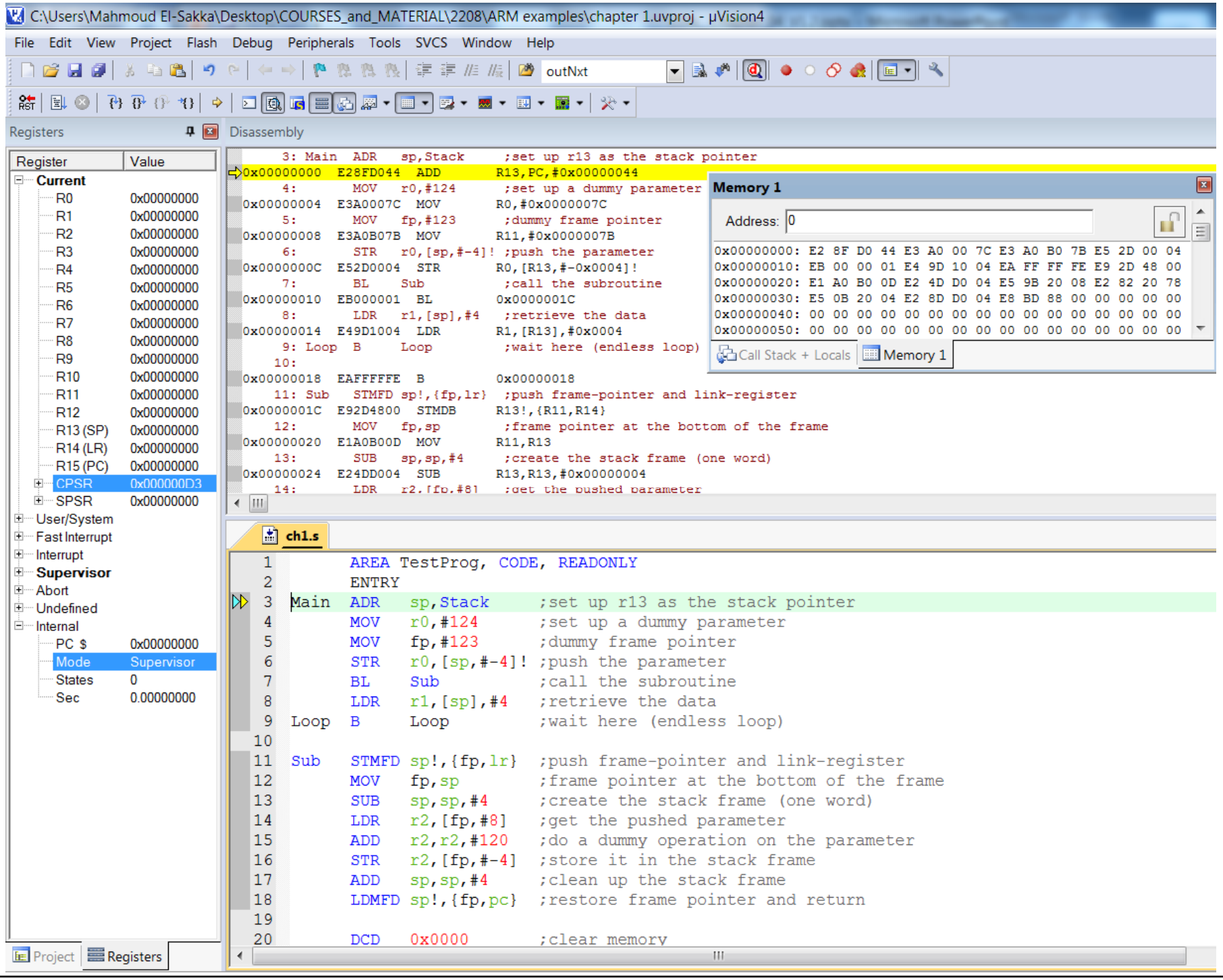
FP

To be used as a local variable

To be used to push fp (i.e., R11)

To be used to push lr (i.e., R14)

To be used to push the parameter


C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x00000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000000
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000000
Mode Supervisor
States 0
Sec 0.00000000
Project
Registers
3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
5: MOV fp,#123 ;dummy frame pointer
0x00000008 E3A0B07B MOV R11,#0x0000007B
6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bottom of the frame
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (one word)
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D 00 04
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2D 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 00
0x00000040: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
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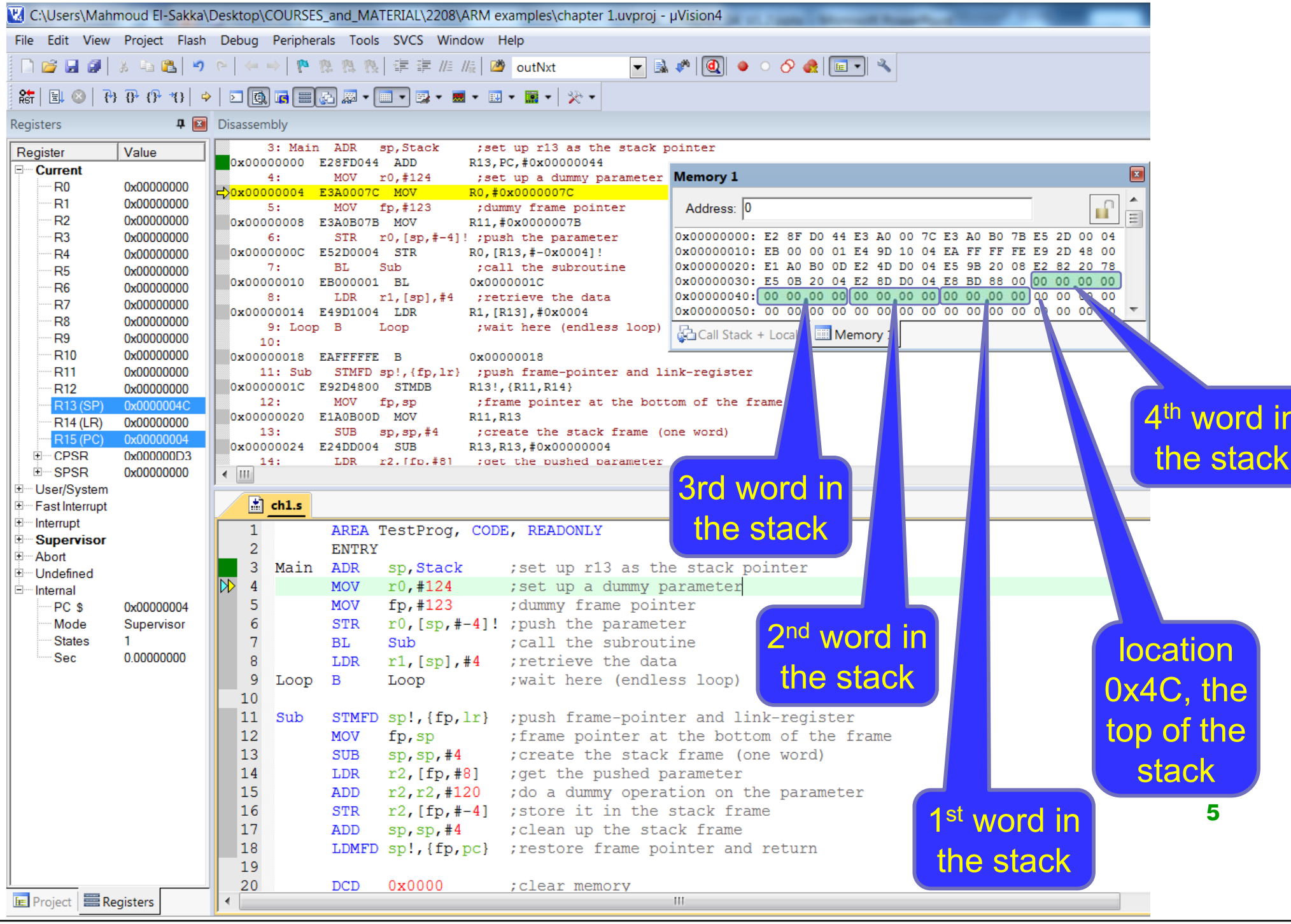
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory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Registers
Disassembly
Register Value
Current
R0 0x00000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x0000004C
R14 (LR) 0x00000000
R15 (PC) 0x00000004
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000004
Mode Supervisor
States 1
Sec 0.00000000
3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
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5: MOV fp,#123 ;dummy frame pointer
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6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
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8: LDR r1,[sp],#4 ;retrieve the data
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0x00000024 E24DD004 SUB R13,R13,#0x00000004
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Address: 0
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0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2D 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
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8 LDR r1,[sp],#4 ;retrieve the data
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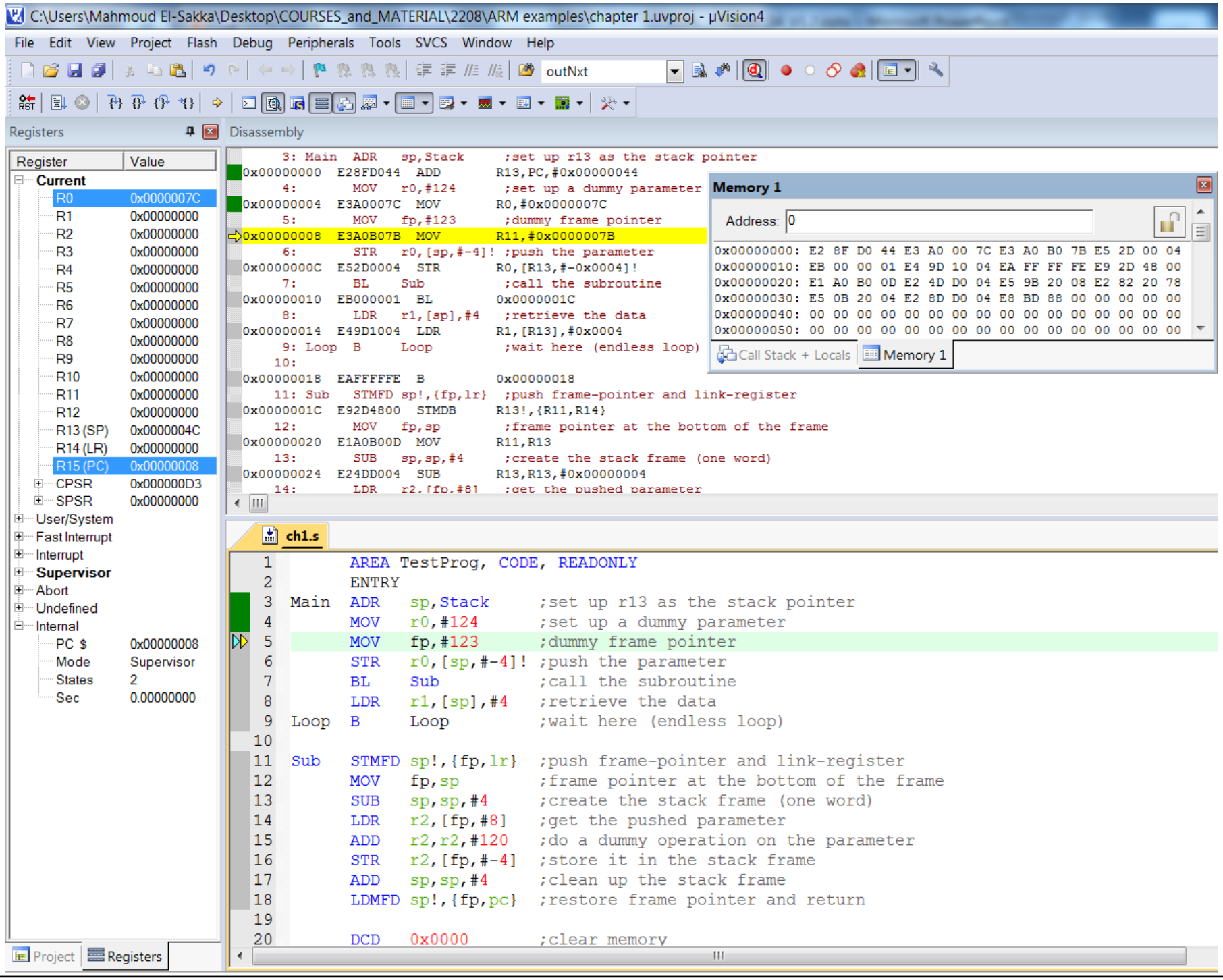
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers
3rd word in the stack
2nd word in the stack
1st word in the stack
4th word in the stack
location 0x4C, the top of the stack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R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x0000004C
R14 (LR) 0x00000000
R15 (PC) 0x00000008
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000008
Mode Supervisor
States 2
Sec 0.00000000
Project
Registers
3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
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13: SUB sp,sp,#4 ;create the stack frame (one word)
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5 MOV fp,#123 ;dummy frame pointer
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7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
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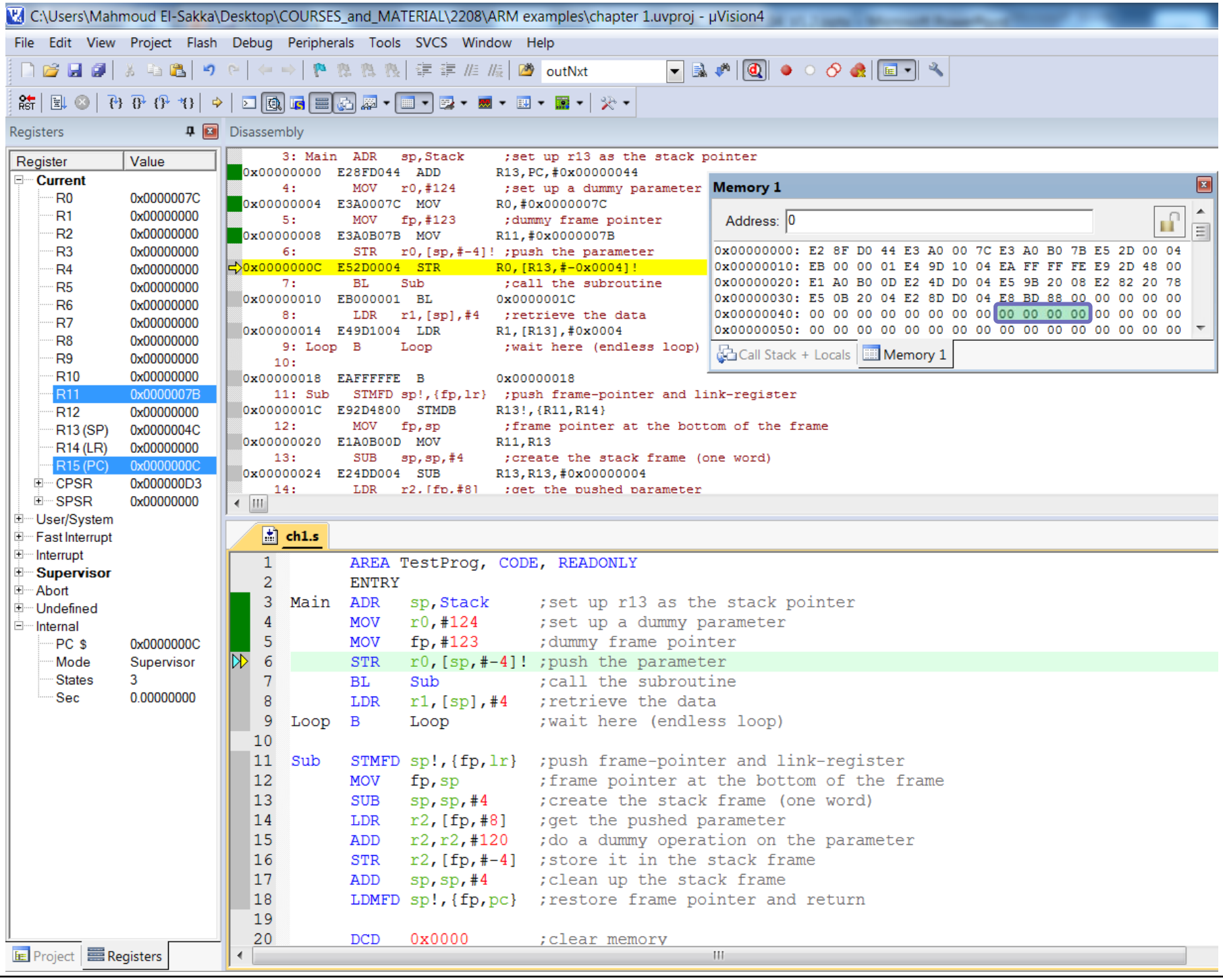
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R13 (SP) 0x0000004C
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R15 (PC) 0x0000000C
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x0000000C
Mode Supervisor
States 3
Sec 0.00000000
3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
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5 MOV fp,#123 ;dummy frame pointer
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7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
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16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
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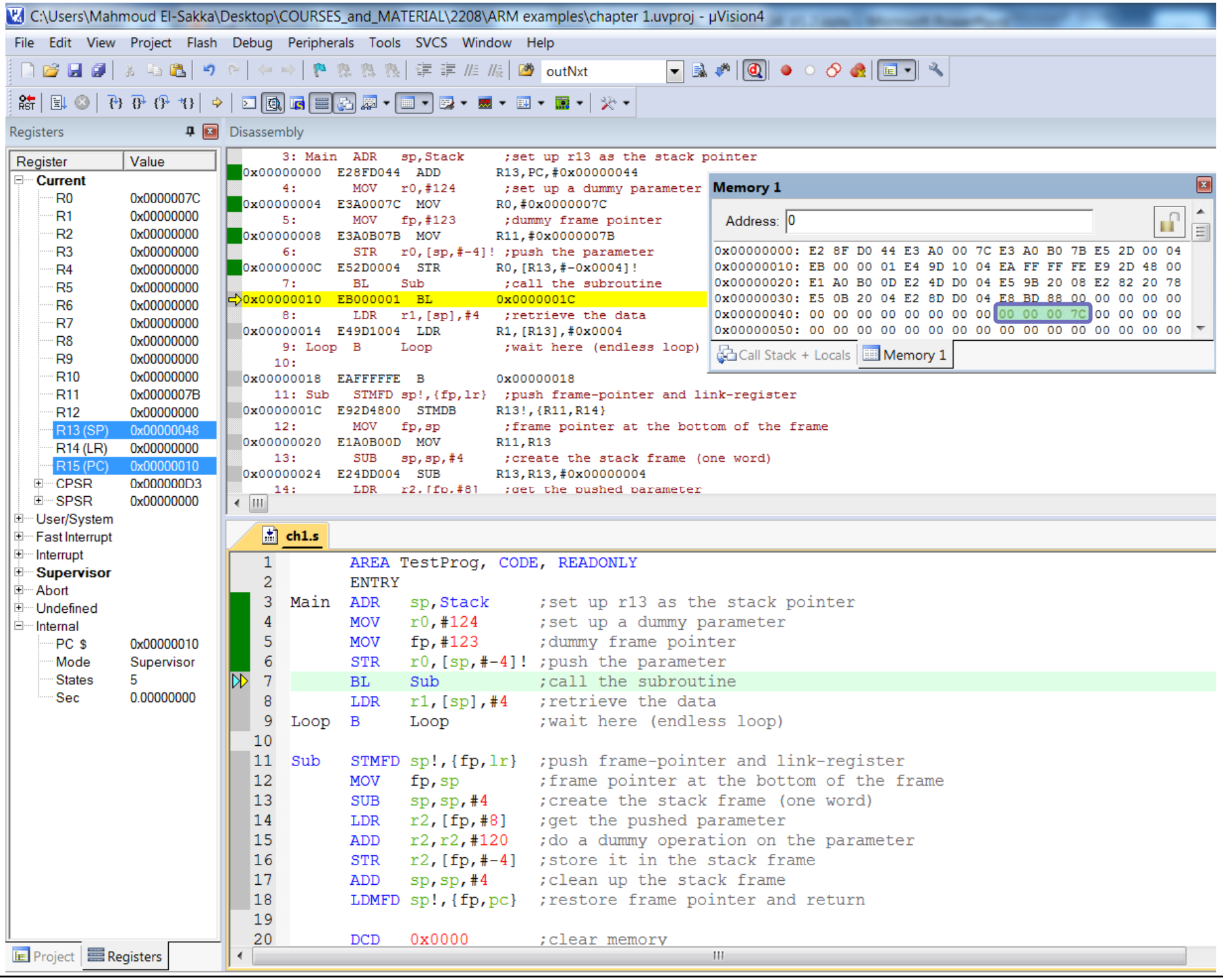
20 DCD 0x0000 ;clear memory
Project
Registers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R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x0000007B
R12 0x00000000
R13 (SP) 0x00000048
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 5
Sec 0.00000000
3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
5: MOV fp,#123 ;dummy frame pointer
0x00000008 E3A0B07B MOV R11,#0x0000007B
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0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
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13: SUB sp,sp,#4 ;create the stack frame (one word)
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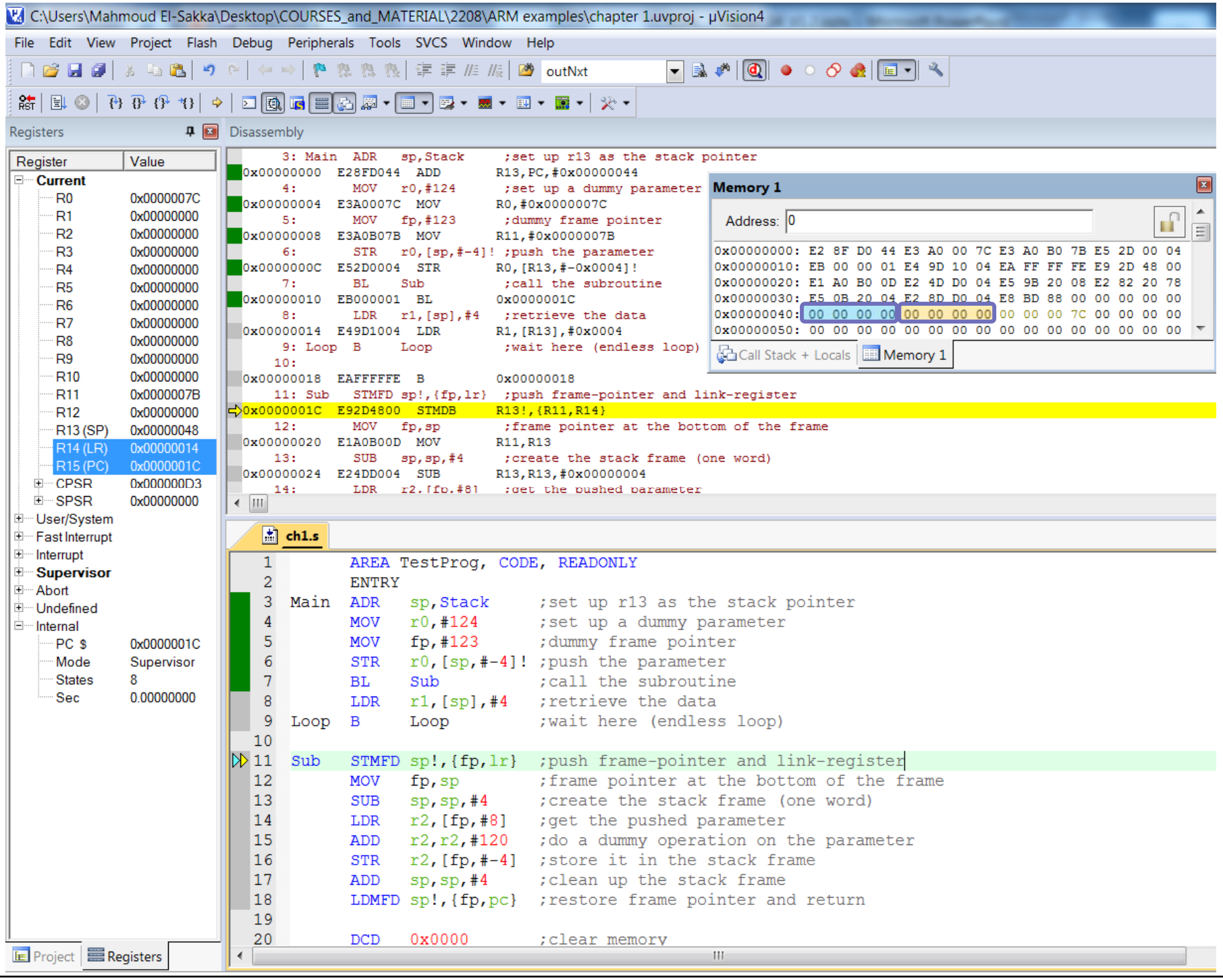
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CPSR 0x000000D3
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User/System
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PC $ 0x0000001C
Mode Supervisor
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3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
5: MOV fp,#123 ;dummy frame pointer
0x00000008 E3A0B07B MOV R11,#0x0000007B
6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
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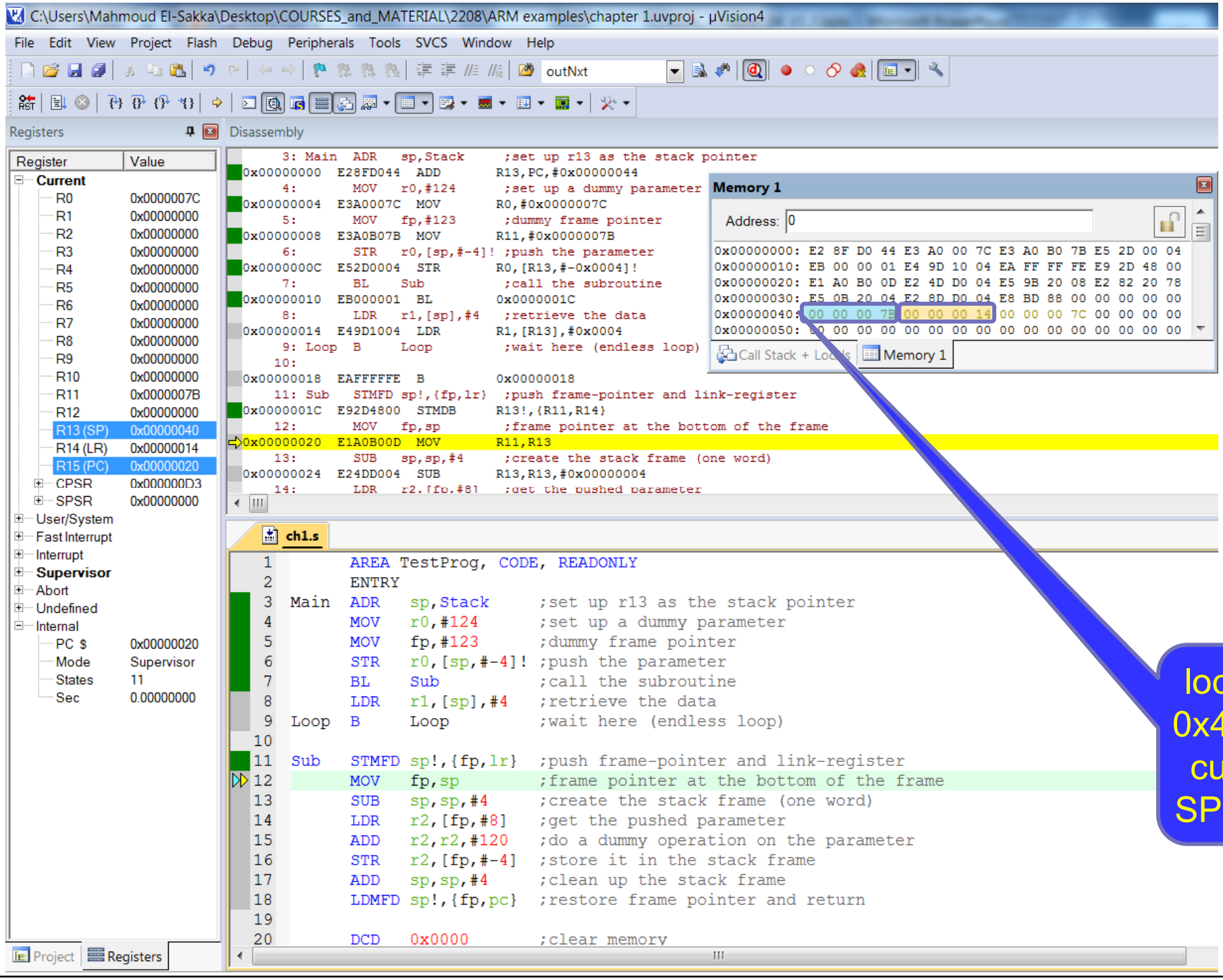
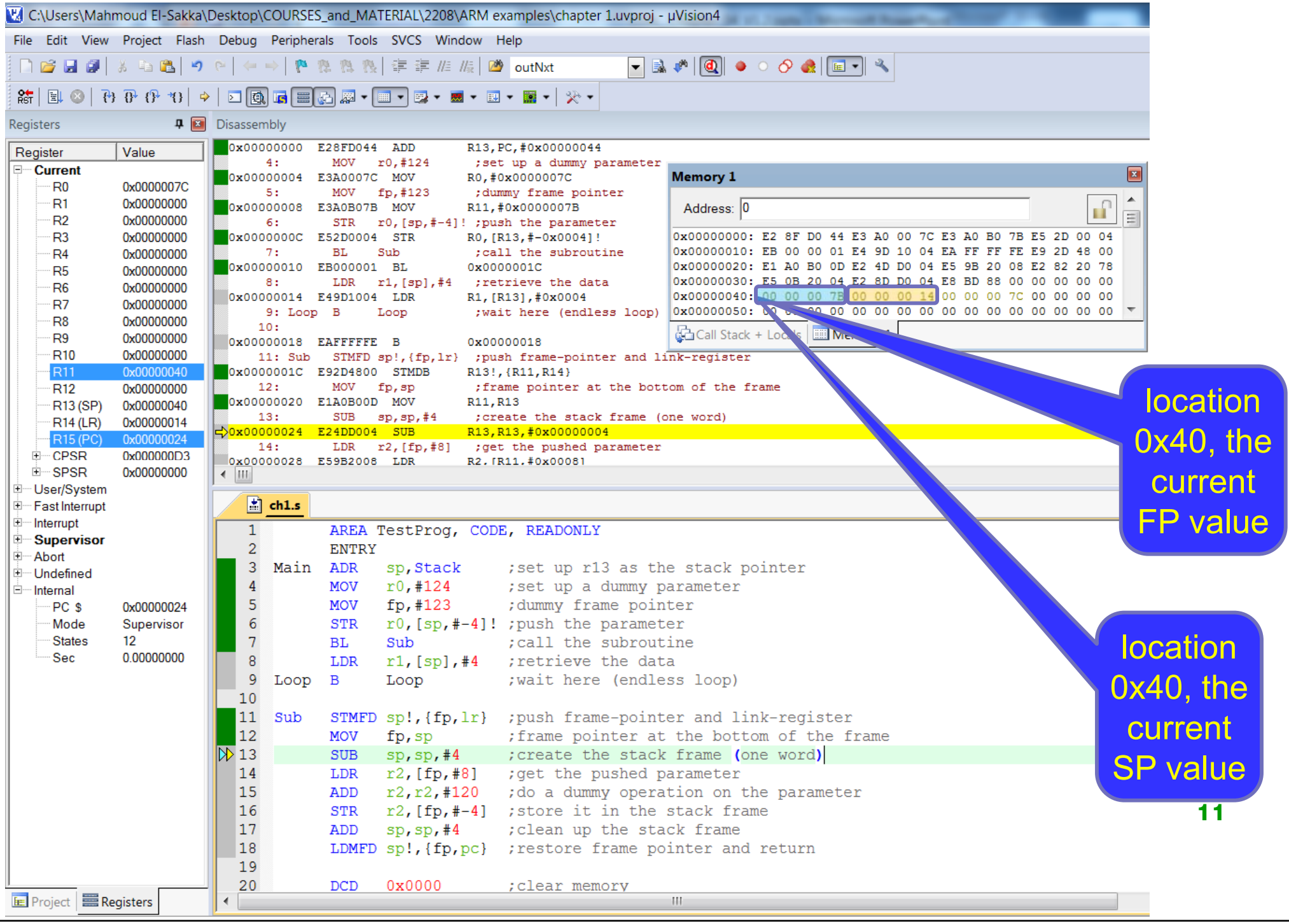
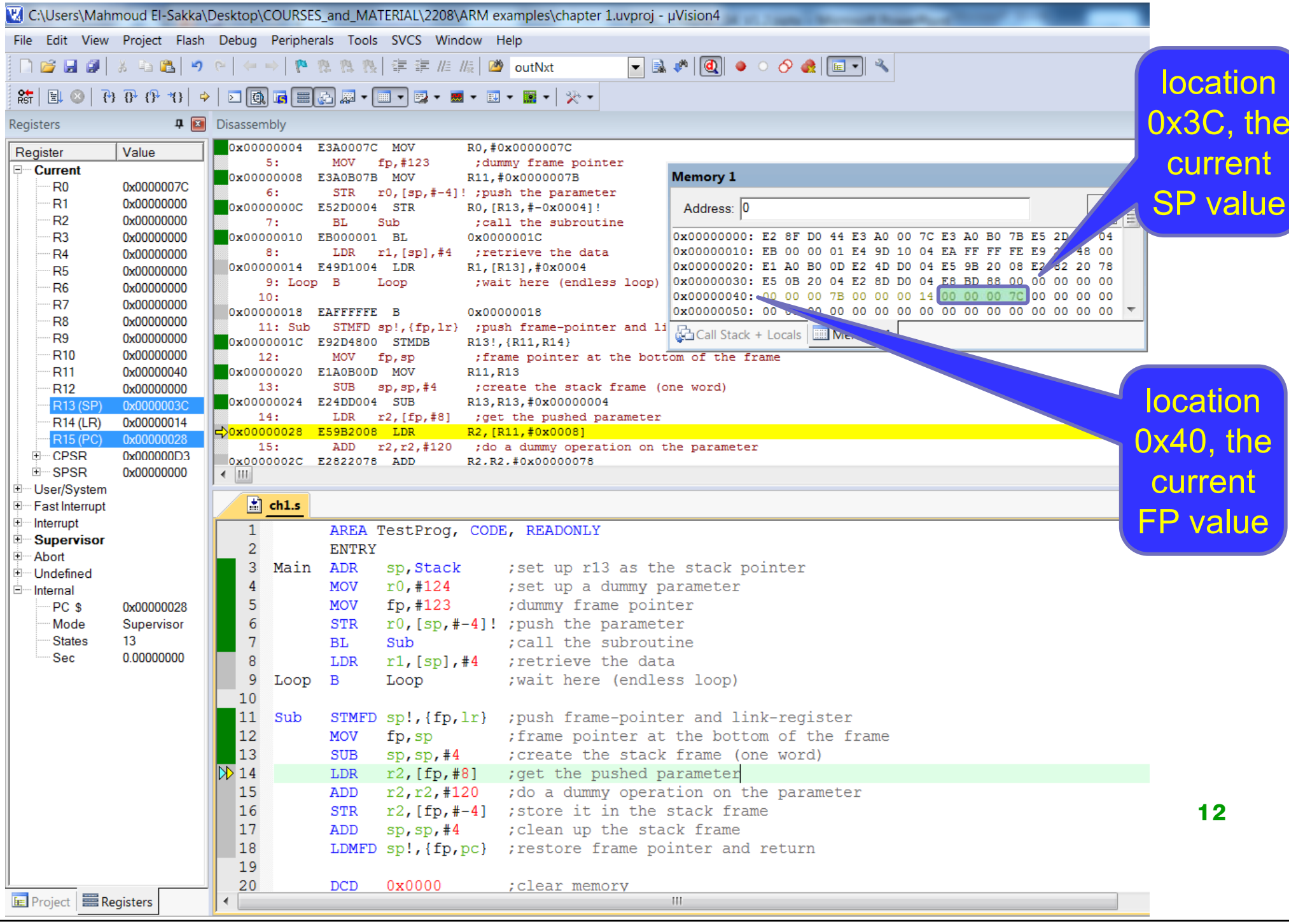
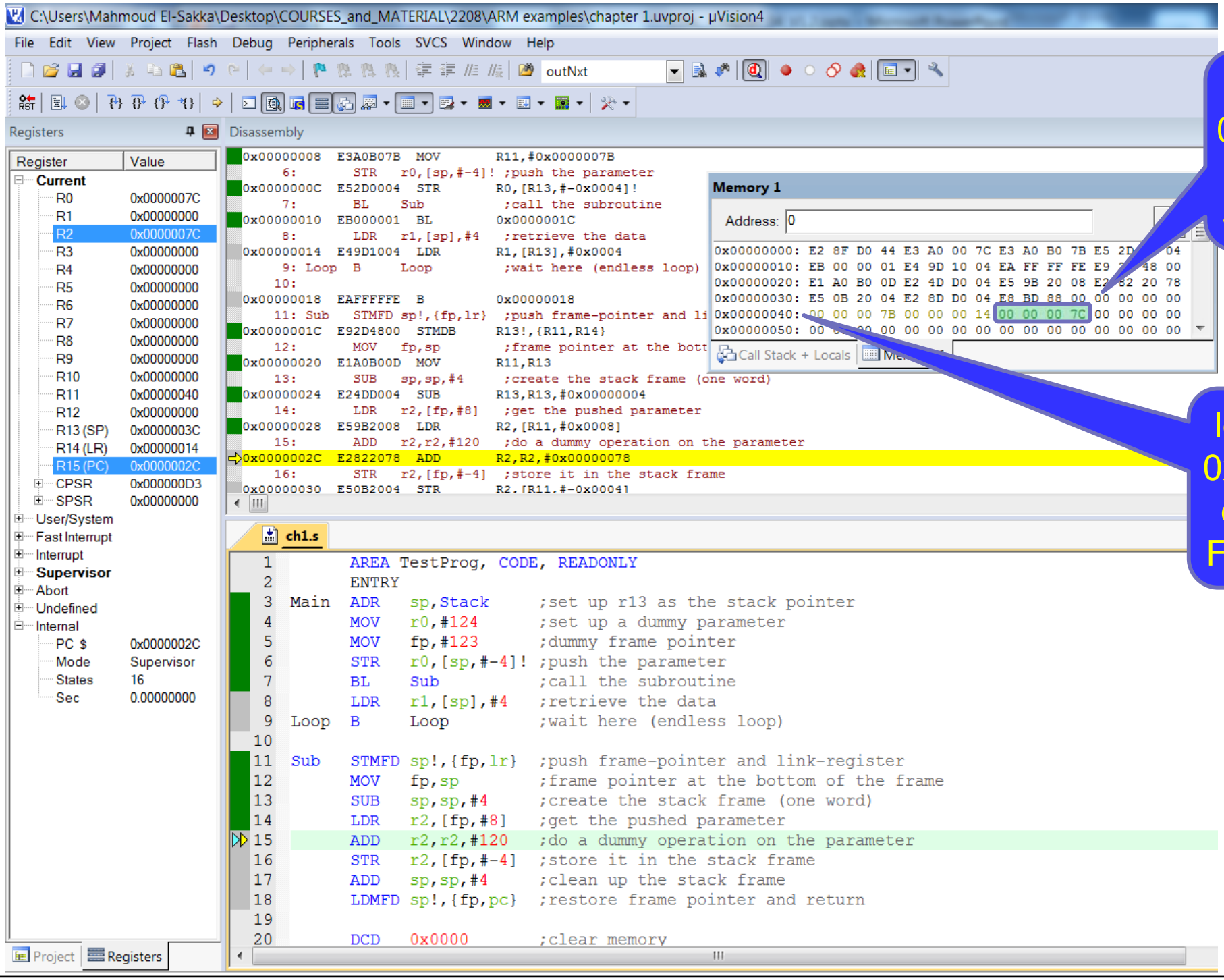
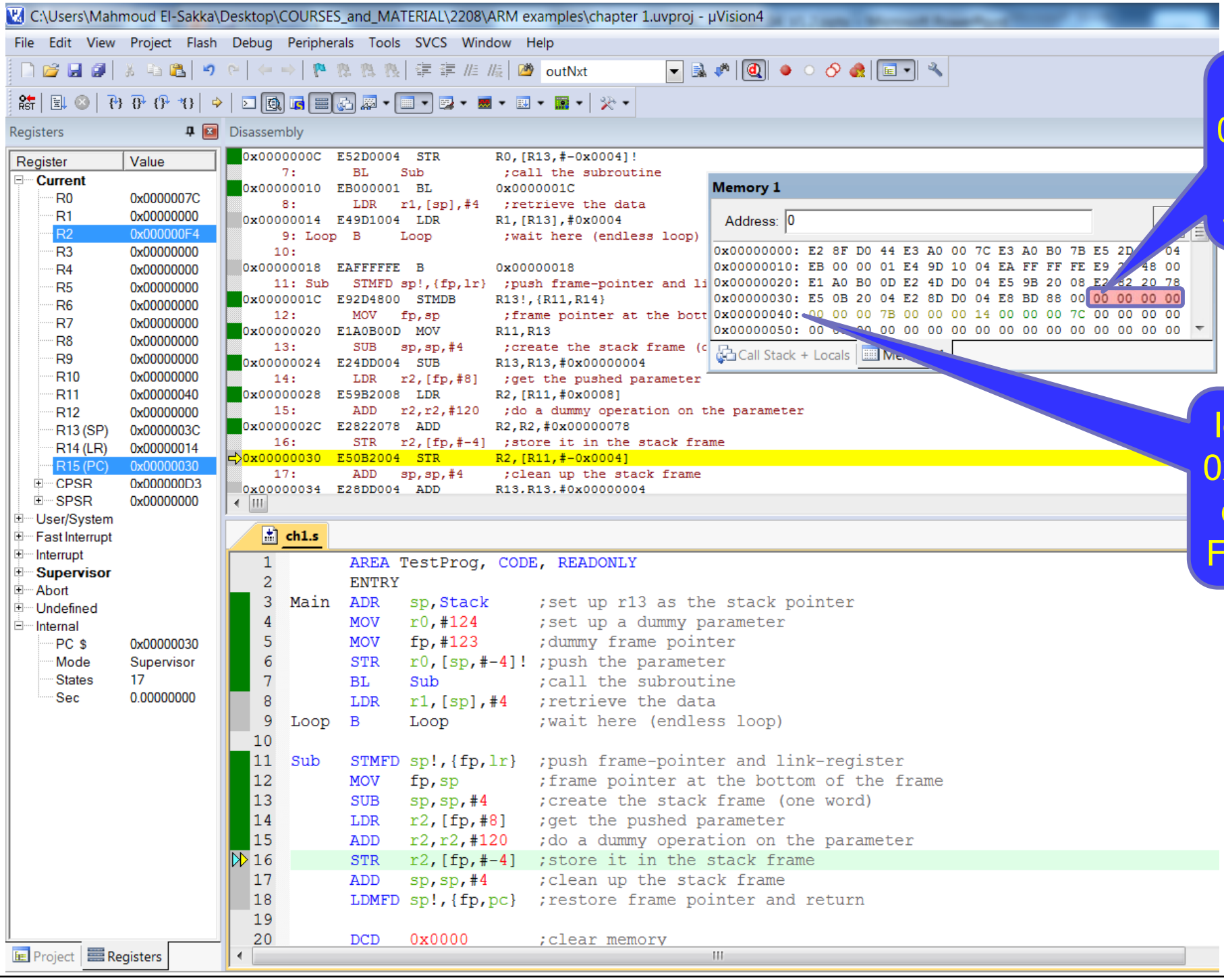
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers

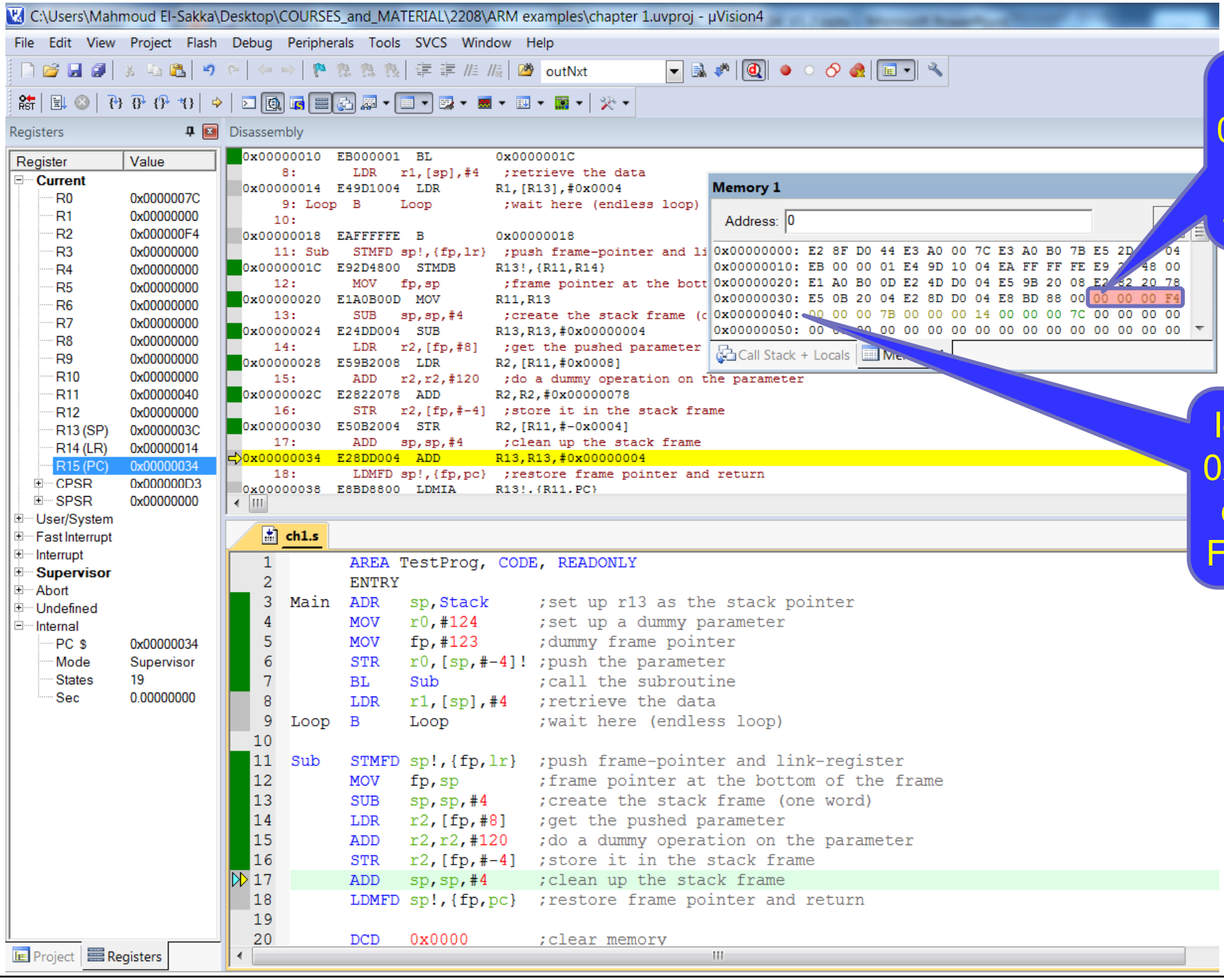

C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x0000007B
R12 0x00000000
R13 (SP) 0x00000040
R14 (LR) 0x00000014
R15 (PC) 0x00000020
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000020
Mode Supervisor
States 11
Sec 0.00000000
Project
Registers
3: Main ADR sp,Stack ;set up r13 as the stack pointer
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
5: MOV fp,#123 ;dummy frame pointer
0x00000008 E3A0B07B MOV R11,#0x0000007B
6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bottom of the frame
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (one word)
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D 00 04
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2D 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 00
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
location 0x40, the current SP value

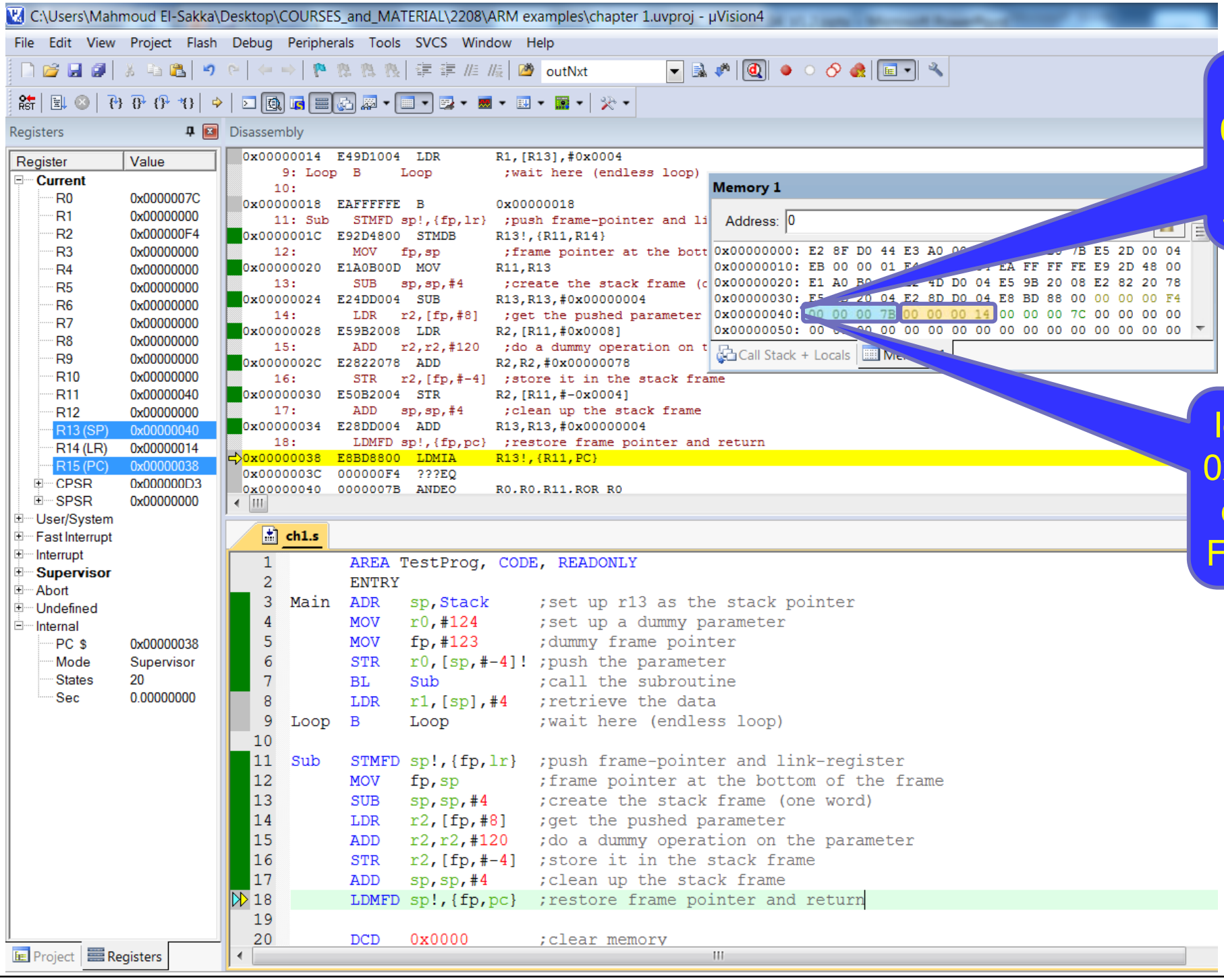

C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000040
R12 0x00000000
R13 (SP) 0x00000040
R14 (LR) 0x00000014
R15 (PC) 0x00000024
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000024
Mode Supervisor
States 12
Sec 0.00000000
0x00000000 E28FD044 ADD R13,PC,#0x00000044
4: MOV r0,#124 ;set up a dummy parameter
0x00000004 E3A0007C MOV R0,#0x0000007C
5: MOV fp,#123 ;dummy frame pointer
0x00000008 E3A0B07B MOV R11,#0x0000007B
6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bottom of the frame
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (one word)
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D 00 04
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2D 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 00
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers
location 0x40, the current FP value
location 0x40, the current SP value

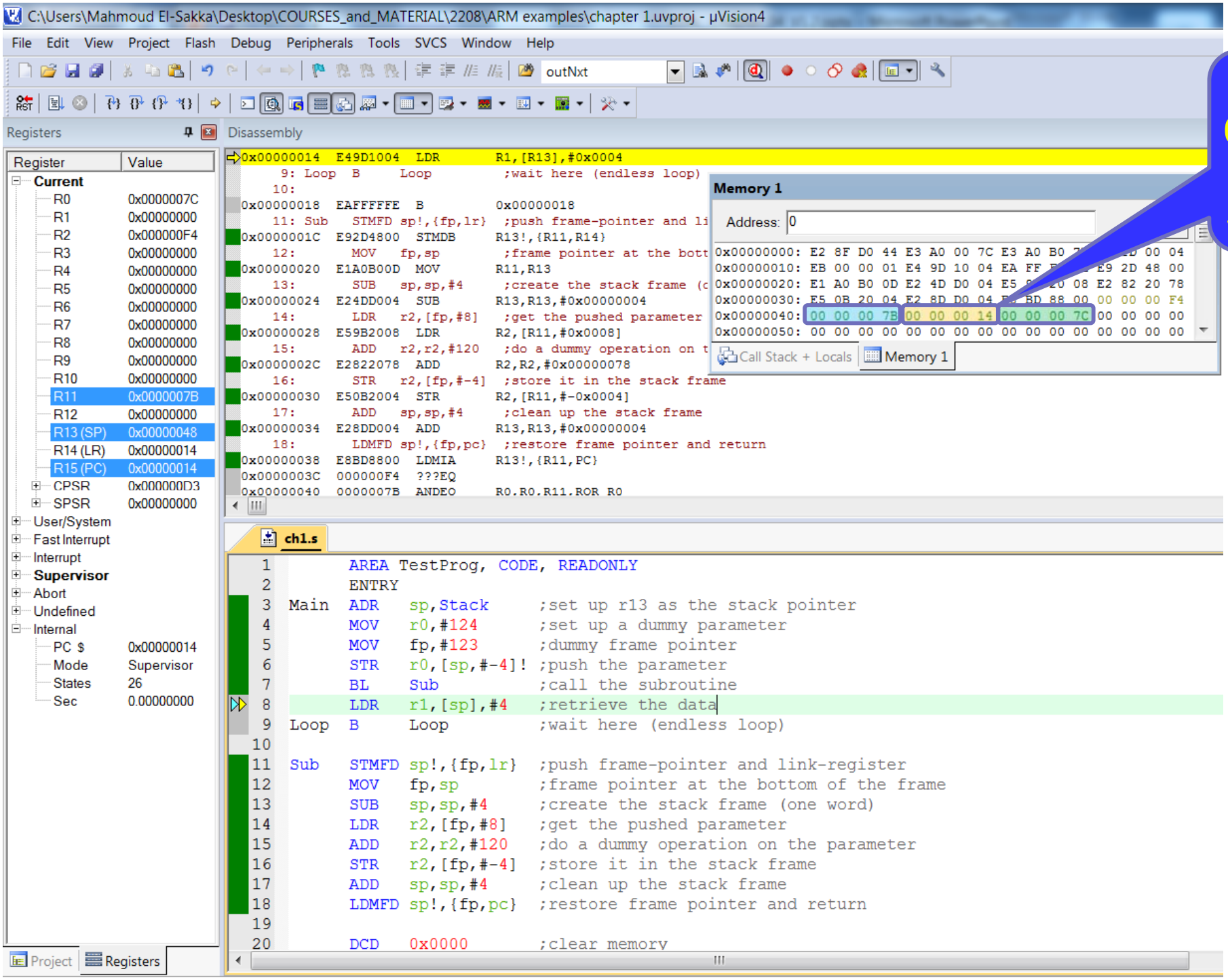

C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000040
R12 0x00000000
R13 (SP) 0x0000003C
R14 (LR) 0x00000014
R15 (PC) 0x00000028
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000028
Mode Supervisor
States 13
Sec 0.00000000
0x00000004 E3A0007C MOV R0,#0x0000007C
5: MOV fp,#123 ;dummy frame pointer
0x00000008 E3A0B07B MOV R11,#0x0000007B
6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bottom of the frame
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (one word)
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on the parameter
0x0000002C E2822078 ADD R2.R2.#0x00000078
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 00
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00
Call Stack + Locals
location 0x3C, the current SP value
location 0x40, the current FP value
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers

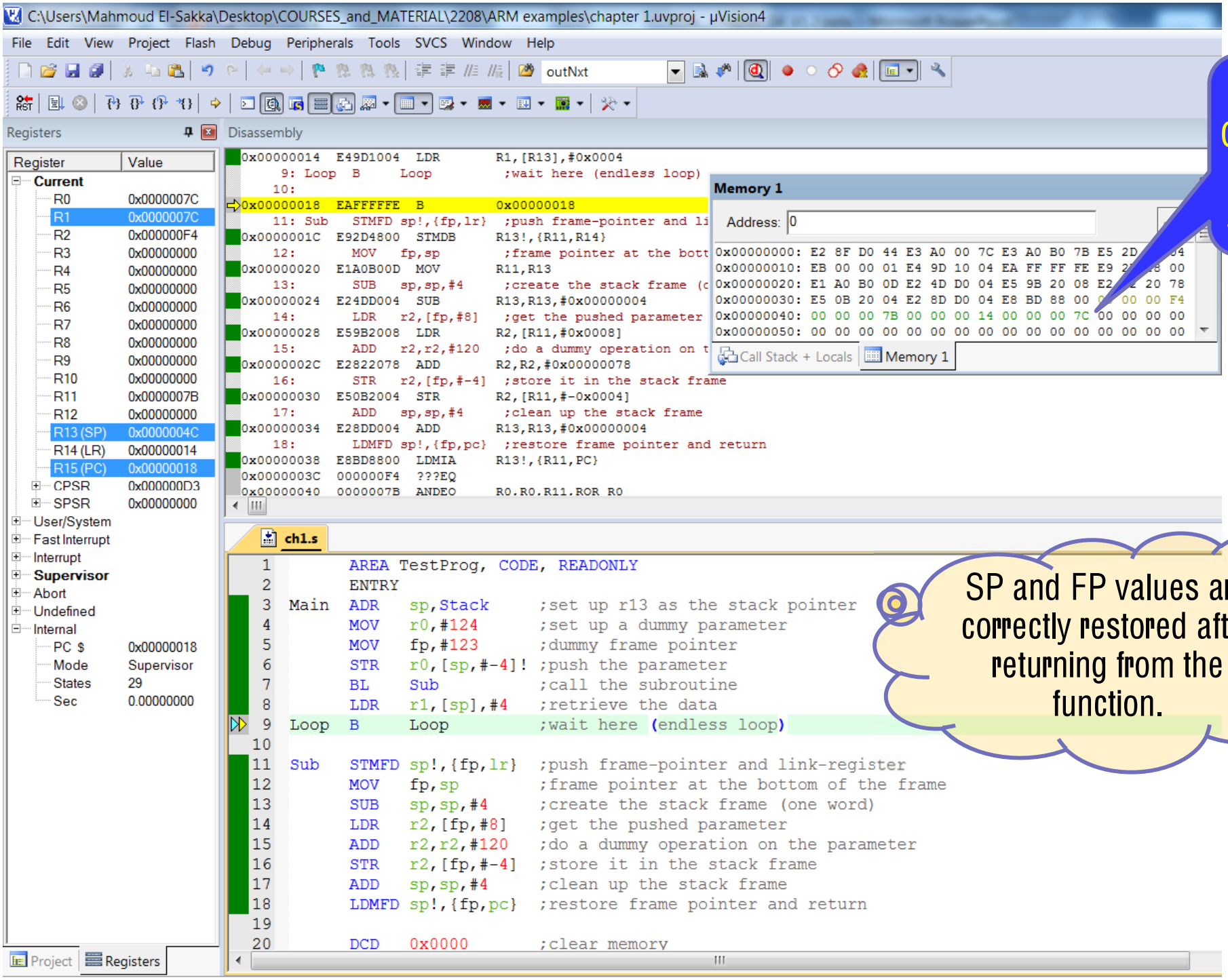

C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x0000007C
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000040
R12 0x00000000
R13 (SP) 0x0000003C
R14 (LR) 0x00000014
R15 (PC) 0x0000002C
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x0000002C
Mode Supervisor
States 16
Sec 0.00000000
0x00000008 E3A0B07B MOV R11,#0x0000007B
6: STR r0,[sp,#-4]! ;push the parameter
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bott
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (one word)
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on the parameter
0x0000002C E2822078 ADD R2,R2,#0x00000078
16: STR r2,[fp,#-4] ;store it in the stack frame
0x00000030 E50B2004 STR R2,[R11,#-0x0004]
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D 04
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 00
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
location 0x3C, the current SP value
location 0x40, the current FP value
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers


C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x000000F4
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000040
R12 0x00000000
R13 (SP) 0x0000003C
R14 (LR) 0x00000014
R15 (PC) 0x00000030
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000030
Mode Supervisor
States 17
Sec 0.00000000
0x0000000C E52D0004 STR R0,[R13,#-0x0004]!
7: BL Sub ;call the subroutine
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bott
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (c
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on the parameter
0x0000002C E2822078 ADD R2,R2,#0x00000078
16: STR r2,[fp,#-4] ;store it in the stack frame
0x00000030 E50B2004 STR R2,[R11,#-0x0004]
17: ADD sp,sp,#4 ;clean up the stack frame
0x00000034 E28DD004 ADD R13,R13,#0x00000004
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D 04
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 00
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
location 0x3C, the current SP value
location 0x40, the current FP value
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers


C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x000000F4
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000040
R12 0x00000000
R13 (SP) 0x0000003C
R14 (LR) 0x00000014
R15 (PC) 0x00000034
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000034
Mode Supervisor
States 19
Sec 0.00000000
0x00000010 EB000001 BL 0x0000001C
8: LDR r1,[sp],#4 ;retrieve the data
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bott
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (c
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on the parameter
0x0000002C E2822078 ADD R2,R2,#0x00000078
16: STR r2,[fp,#-4] ;store it in the stack frame
0x00000030 E50B2004 STR R2,[R11,#-0x0004]
17: ADD sp,sp,#4 ;clean up the stack frame
0x00000034 E28DD004 ADD R13,R13,#0x00000004
18: LDMFD sp!,{fp,pc} ;restore frame pointer and return
0x00000038 E8BD8800 LDMIA R13!,{R11,PC}
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D 04
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2 48 00
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2 82 20 78
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00 00 00 00 F4
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00
Call Stack + Locals
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers
location 0x3C, the current SP value
location 0x40, the current FP value


C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x000000F4
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000040
R12 0x00000000
R13 (SP) 0x00000040
R14 (LR) 0x00000014
R15 (PC) 0x00000038
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000038
Mode Supervisor
States 20
Sec 0.00000000
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bott
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (c
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on t
0x0000002C E2822078 ADD R2,R2,#0x00000078
16: STR r2,[fp,#-4] ;store it in the stack frame
0x00000030 E50B2004 STR R2,[R11,#-0x0004]
17: ADD sp,sp,#4 ;clean up the stack frame
0x00000034 E28DD004 ADD R13,R13,#0x00000004
18: LDMFD sp!,{fp,pc} ;restore frame pointer and return
0x00000038 E8BD8800 LDMIA R13!,{R11,PC}
0x0000003C 000000F4 ???EQ
0x00000040 0000007B ANDEQ R0,R0,R11,ROR R0
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 0
0x00000010: EB 00 00 01 E
0x00000020: E1 A0 B
0x00000030: E5
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00
Call Stack + Locals
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers
location 0x40, the current SP value
location 0x40, the current FP value


C:\Users\Mahmoud El-Sakka\Desktop\COURSES_and_MATERIAL\2208\ARM examples\chapter 1.uvproj - µVision4
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x00000000
R2 0x000000F4
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x0000007B
R12 0x00000000
R13 (SP) 0x00000048
R14 (LR) 0x00000014
R15 (PC) 0x00000014
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 26
Sec 0.00000000
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bott
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (c
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on t
0x0000002C E2822078 ADD R2,R2,#0x00000078
16: STR r2,[fp,#-4] ;store it in the stack frame
0x00000030 E50B2004 STR R2,[R11,#-0x0004]
17: ADD sp,sp,#4 ;clean up the stack frame
0x00000034 E28DD004 ADD R13,R13,#0x00000004
18: LDMFD sp!,{fp,pc} ;restore frame pointer and return
0x00000038 E8BD8800 LDMIA R13!,{R11,PC}
0x0000003C 000000F4 ???EQ
0x00000040 0000007B ANDEQ R0,R0,R11,ROR R0
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF F
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 2
0x00000030: E5 0B 20 04 E2 8D D0 04 E
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
location 0x48, the current SP value
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
Project
Registers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File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
outNxt
Registers
Disassembly
Register Value
Current
R0 0x0000007C
R1 0x0000007C
R2 0x000000F4
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000000
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x0000007B
R12 0x00000000
R13 (SP) 0x0000004C
R14 (LR) 0x00000014
R15 (PC) 0x00000018
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000018
Mode Supervisor
States 29
Sec 0.00000000
0x00000014 E49D1004 LDR R1,[R13],#0x0004
9: Loop B Loop ;wait here (endless loop)
10:
0x00000018 EAFFFFFE B 0x00000018
11: Sub STMFD sp!,{fp,lr} ;push frame-pointer and li
0x0000001C E92D4800 STMDB R13!,{R11,R14}
12: MOV fp,sp ;frame pointer at the bott
0x00000020 E1A0B00D MOV R11,R13
13: SUB sp,sp,#4 ;create the stack frame (c
0x00000024 E24DD004 SUB R13,R13,#0x00000004
14: LDR r2,[fp,#8] ;get the pushed parameter
0x00000028 E59B2008 LDR R2,[R11,#0x0008]
15: ADD r2,r2,#120 ;do a dummy operation on t
0x0000002C E2822078 ADD R2,R2,#0x00000078
16: STR r2,[fp,#-4] ;store it in the stack frame
0x00000030 E50B2004 STR R2,[R11,#-0x0004]
17: ADD sp,sp,#4 ;clean up the stack frame
0x00000034 E28DD004 ADD R13,R13,#0x00000004
18: LDMFD sp!,{fp,pc} ;restore frame pointer and return
0x00000038 E8BD8800 LDMIA R13!,{R11,PC}
0x0000003C 000000F4 ???EQ
0x00000040 0000007B ANDEQ R0,R0,R11,ROR R0
Memory 1
Address: 0
0x00000000: E2 8F D0 44 E3 A0 00 7C E3 A0 B0 7B E5 2D
0x00000010: EB 00 00 01 E4 9D 10 04 EA FF FF FE E9 2
0x00000020: E1 A0 B0 0D E2 4D D0 04 E5 9B 20 08 E2
0x00000030: E5 0B 20 04 E2 8D D0 04 E8 BD 88 00
0x00000040: 00 00 00 7B 00 00 00 14 00 00 00 7C 00 00 00 00
0x00000050: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
location 0x4C, the current SP value
ch1.s
1 AREA TestProg, CODE, READONLY
2 ENTRY
3 Main ADR sp,Stack ;set up r13 as the stack pointer
4 MOV r0,#124 ;set up a dummy parameter
5 MOV fp,#123 ;dummy frame pointer
6 STR r0,[sp,#-4]! ;push the parameter
7 BL Sub ;call the subroutine
8 LDR r1,[sp],#4 ;retrieve the data
9 Loop B Loop ;wait here (endless loop)
10
11 Sub STMFD sp!,{fp,lr} ;push frame-pointer and link-register
12 MOV fp,sp ;frame pointer at the bottom of the frame
13 SUB sp,sp,#4 ;create the stack frame (one word)
14 LDR r2,[fp,#8] ;get the pushed parameter
15 ADD r2,r2,#120 ;do a dummy operation on the parameter
16 STR r2,[fp,#-4] ;store it in the stack frame
17 ADD sp,sp,#4 ;clean up the stack frame
18 LDMFD sp!,{fp,pc} ;restore frame pointer and return
19
20 DCD 0x0000 ;clear memory
SP and FP values are correctly restored after returning from the function.
Project
Registers