第16次實習課

學生：林培瑋

2024 Advanced Mixed-Operation System (AMOS) Lab.

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GPIO-LED

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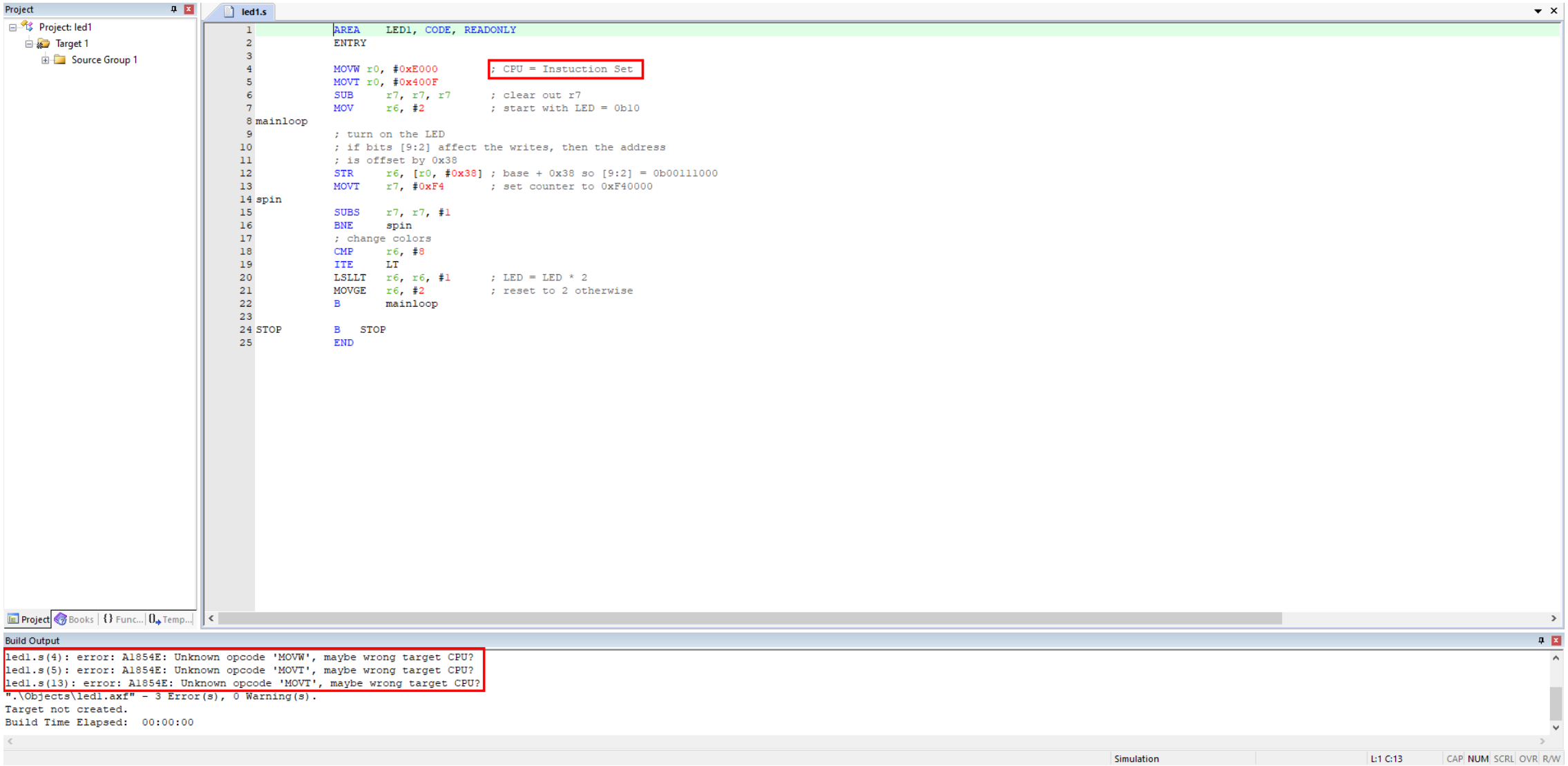
Multicolor LED (P360 16.4.4)

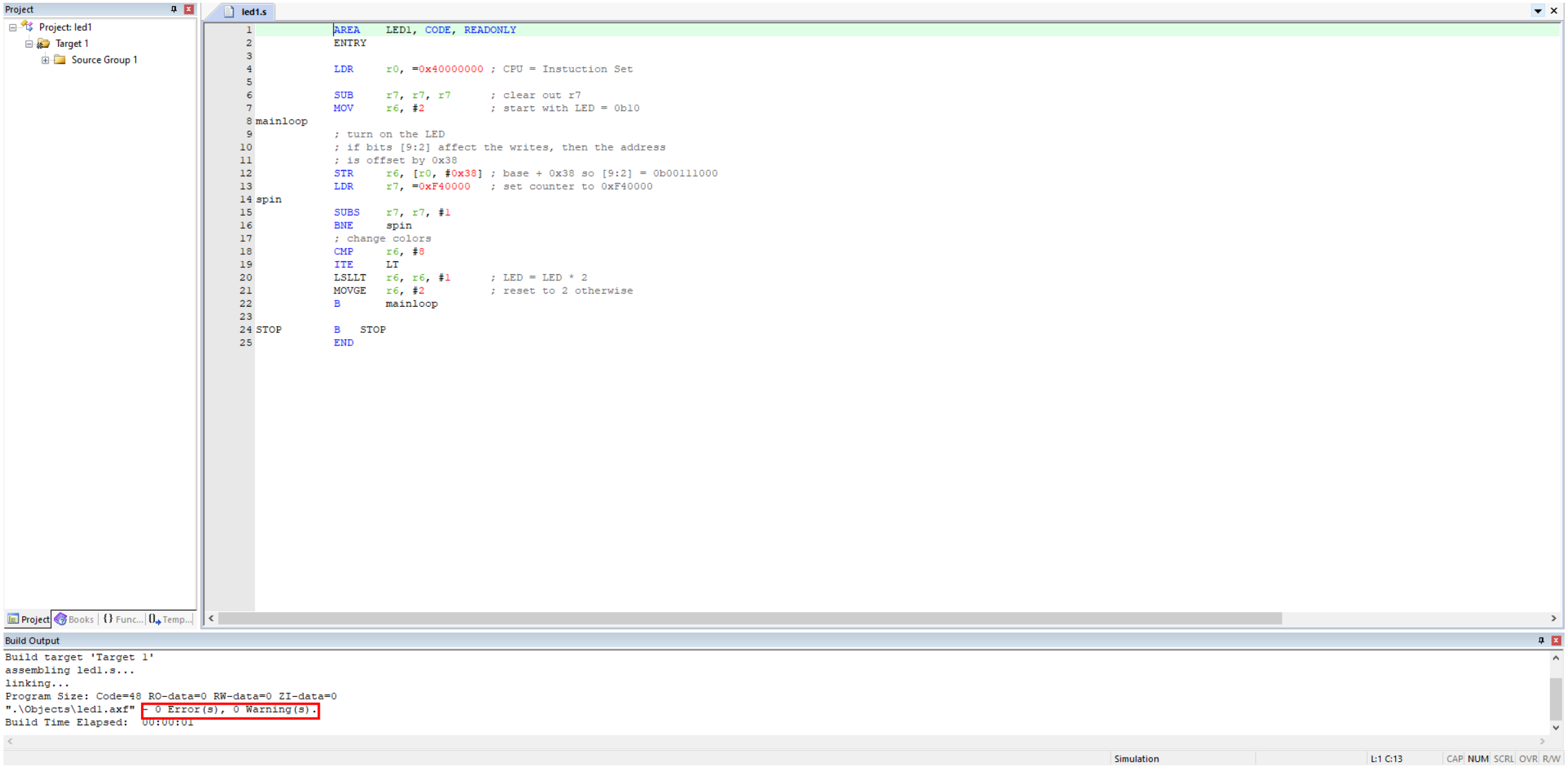
The Tiva Launchpad board has a multi-colored LED that is controlled through three GPIO lines on Port F, one for red, one for green, and one for blue. The red LED is attached to line **PF1**, the green LED is attached to line **PF2**, and the blue LED is attached to line **PF3**.Write a program to showcase all three colors by create a loop that selects one color at a time, cycling through all three (in the cycle of **red, green, blue**) by changing the value being written to the port. (Hint: Related base address 0x40000000 and offset 0x38 and **be sure to show the delay time between two lights and try to set the delay time to ?)**

0b00000010 ➔ 紅 → 0x02
0b00000100 ➔ 綠 → 0x04
0b00001000 ➔ 藍 → 0x08

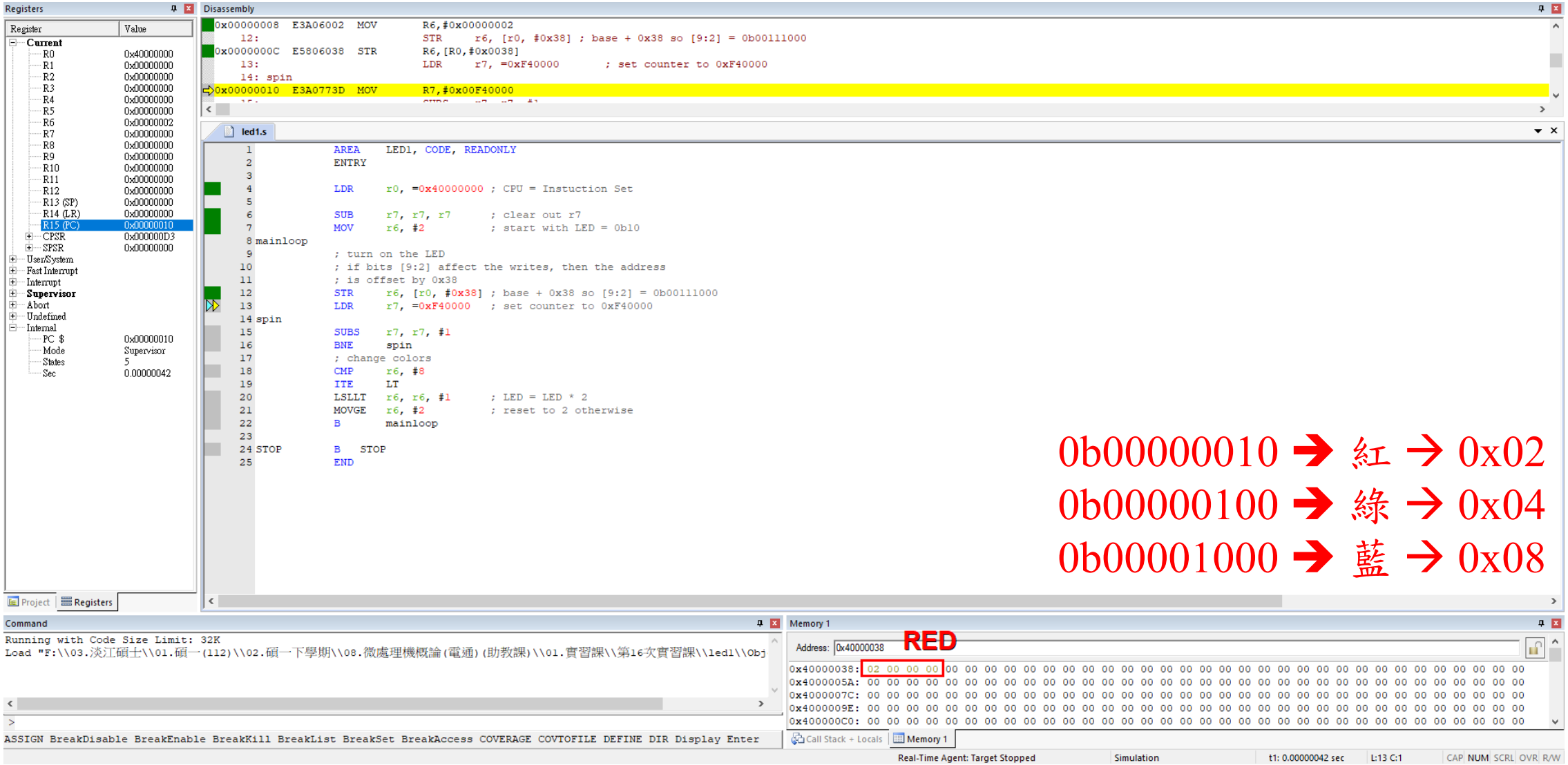
KEIL TOOL(MOVW、MOVT on LPC2104 → ERROR)



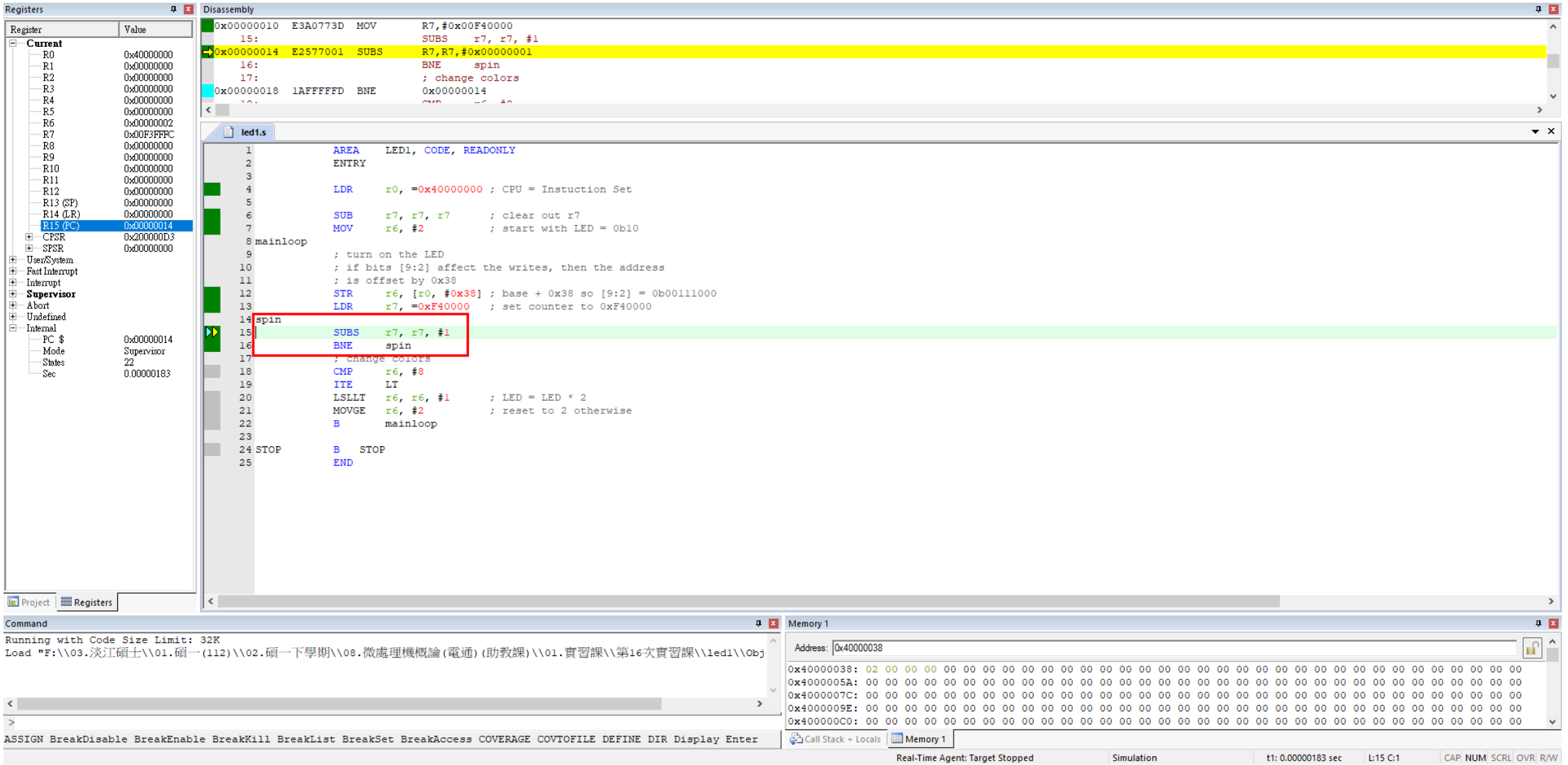
KEIL TOOL(改成LDR)



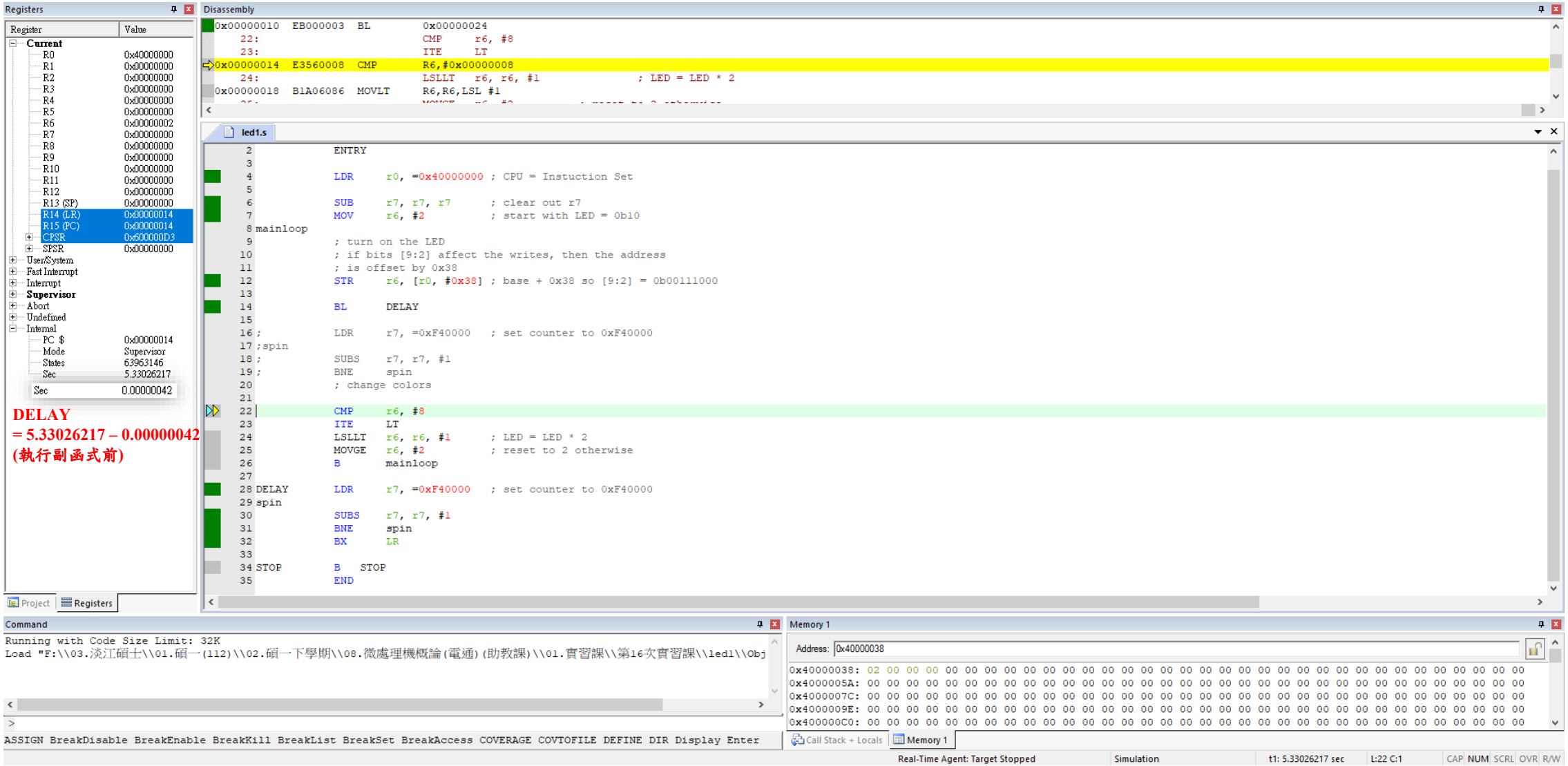
執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000002
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
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 0.00000042
Project
Registers
Disassembly
0x00000008 E3A06002 MOV R6,#0x00000002
12: STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
0x0000000C E5806038 STR R6,[R0,#0x0038]
13: LDR r7, =0xF40000 ; set counter to 0xF40000
14: spin
0x00000010 E3A0773D MOV R7,#0x00F40000
led1.s
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13 LDR r7, =0xF40000 ; set counter to 0xF40000
14 spin
15 SUBS r7, r7, #1
16 BNE spin
17 ; change colors
18 CMP r6, #8
19 ITE LT
20 LSLLT r6, r6, #1 ; LED = LED * 2
21 MOVGE r6, #2 ; reset to 2 otherwise
22 B mainloop
23
24 STOP B STOP
25 END
0b00000010 → 紅 → 0x02
0b00000100 → 綠 → 0x04
0b00001000 → 藍 → 0x08
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
RED
0x40000038: 02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000042 sec
L:13 C:1
CAP NUM SCRL OVR R/W

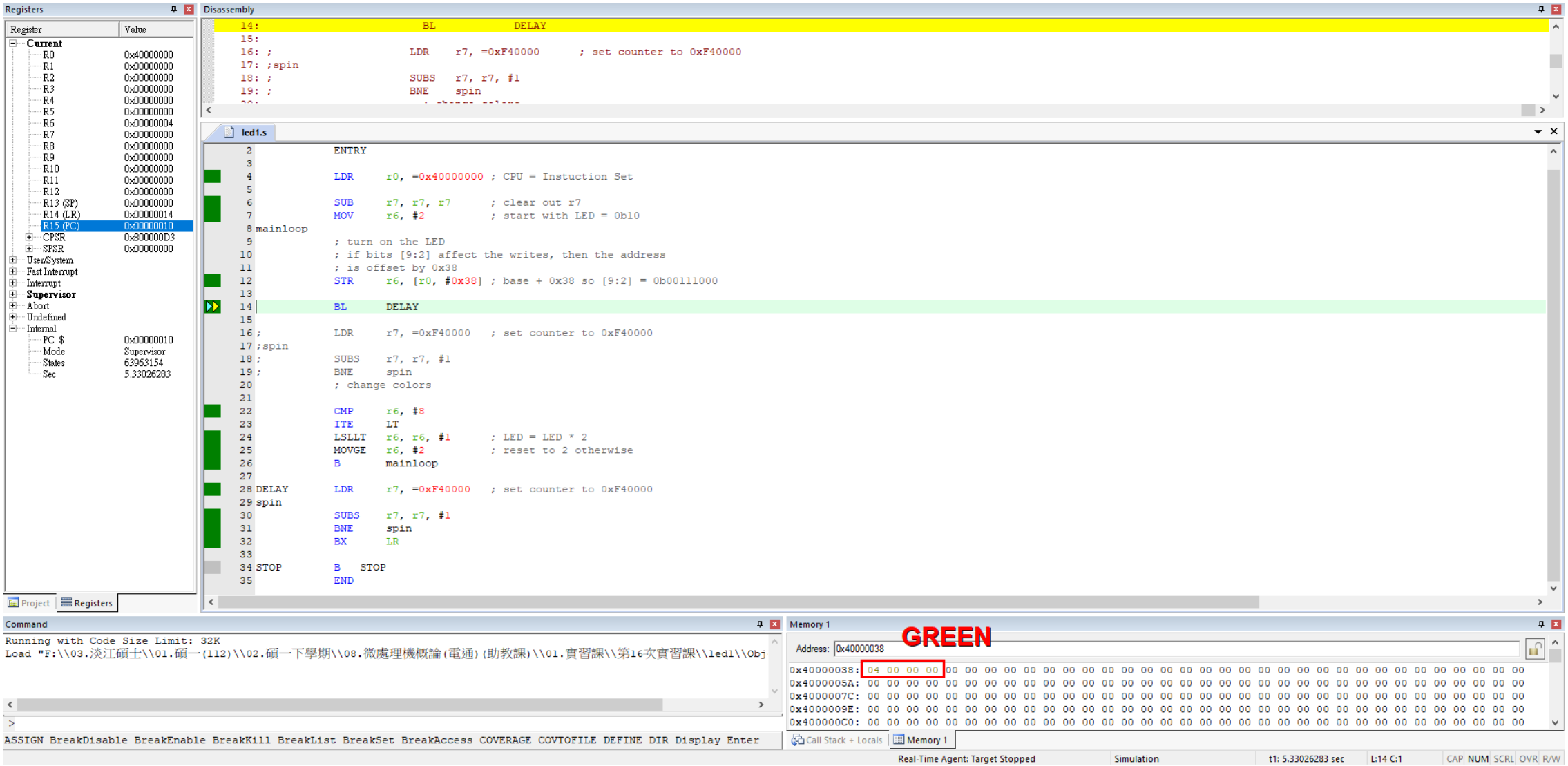
按F11問題→卡在spin



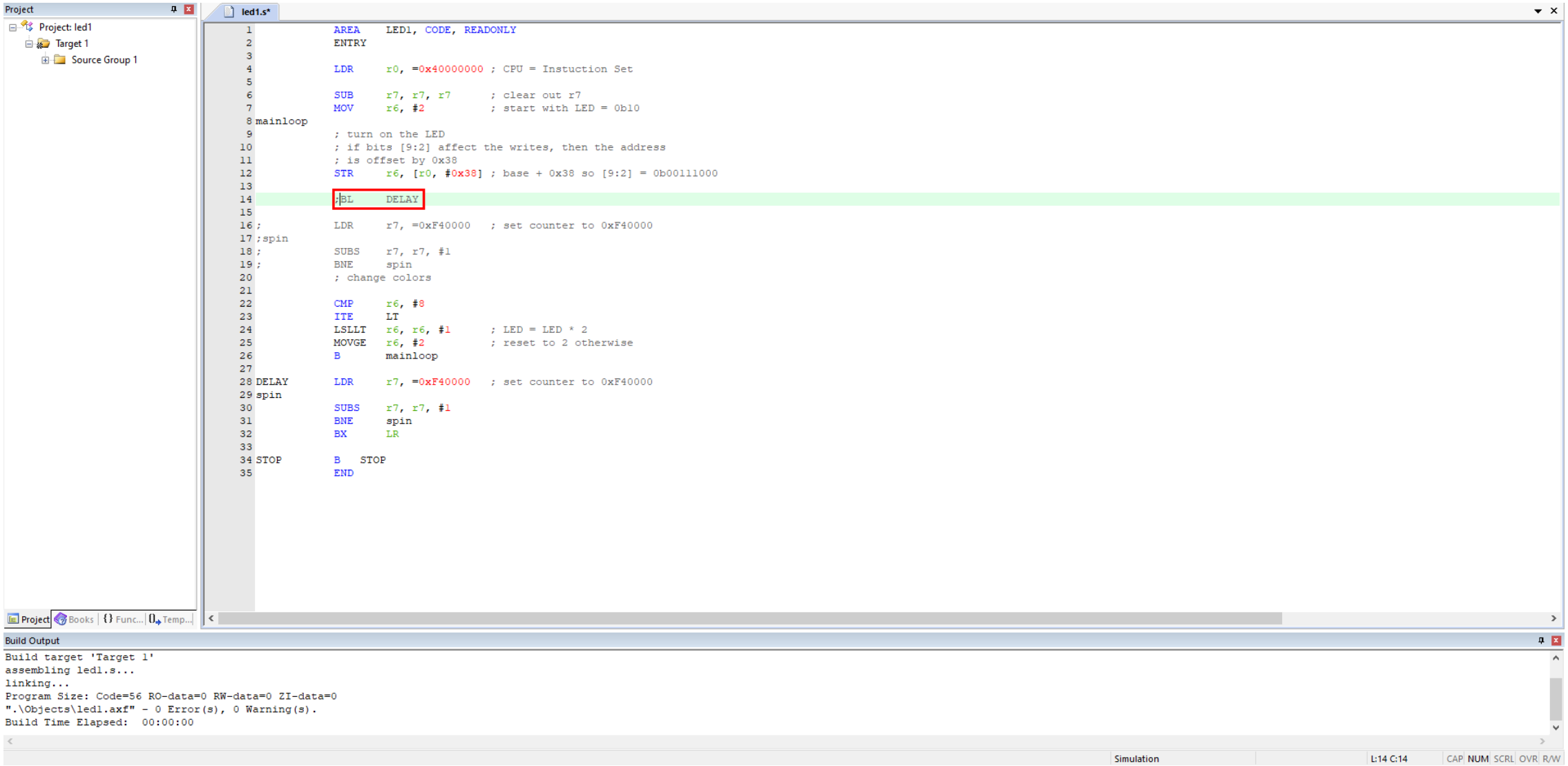
解決方法：設副函式，按F10



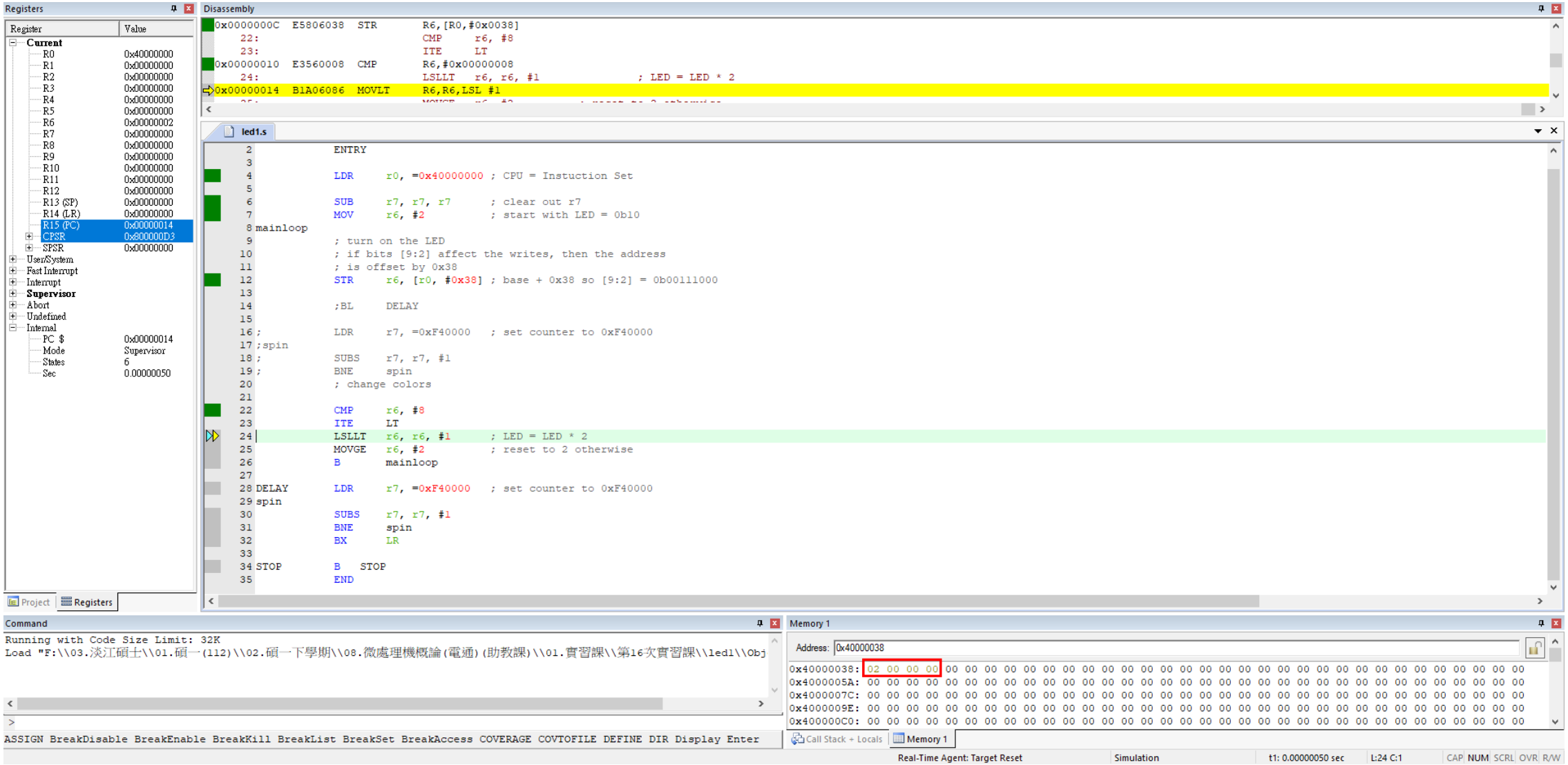
執行結果(GREEN)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000014
R15 (PC) 0x00000010
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 63963154
Sec 5.33026283
Project
Registers
Disassembly
14: BL DELAY
15:
16: ; LDR r7, =0xF40000 ; set counter to 0xF40000
17: ;spin
18: ; SUBS r7, r7, #1
19: ; BNE spin
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #8
23 ITE LT
24 LSLLT r6, r6, #1 ; LED = LED * 2
25 MOVGE r6, #2 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
GREEN
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 5.33026283 sec
L:14 C:1
CAP NUM SCRL OVR R/W

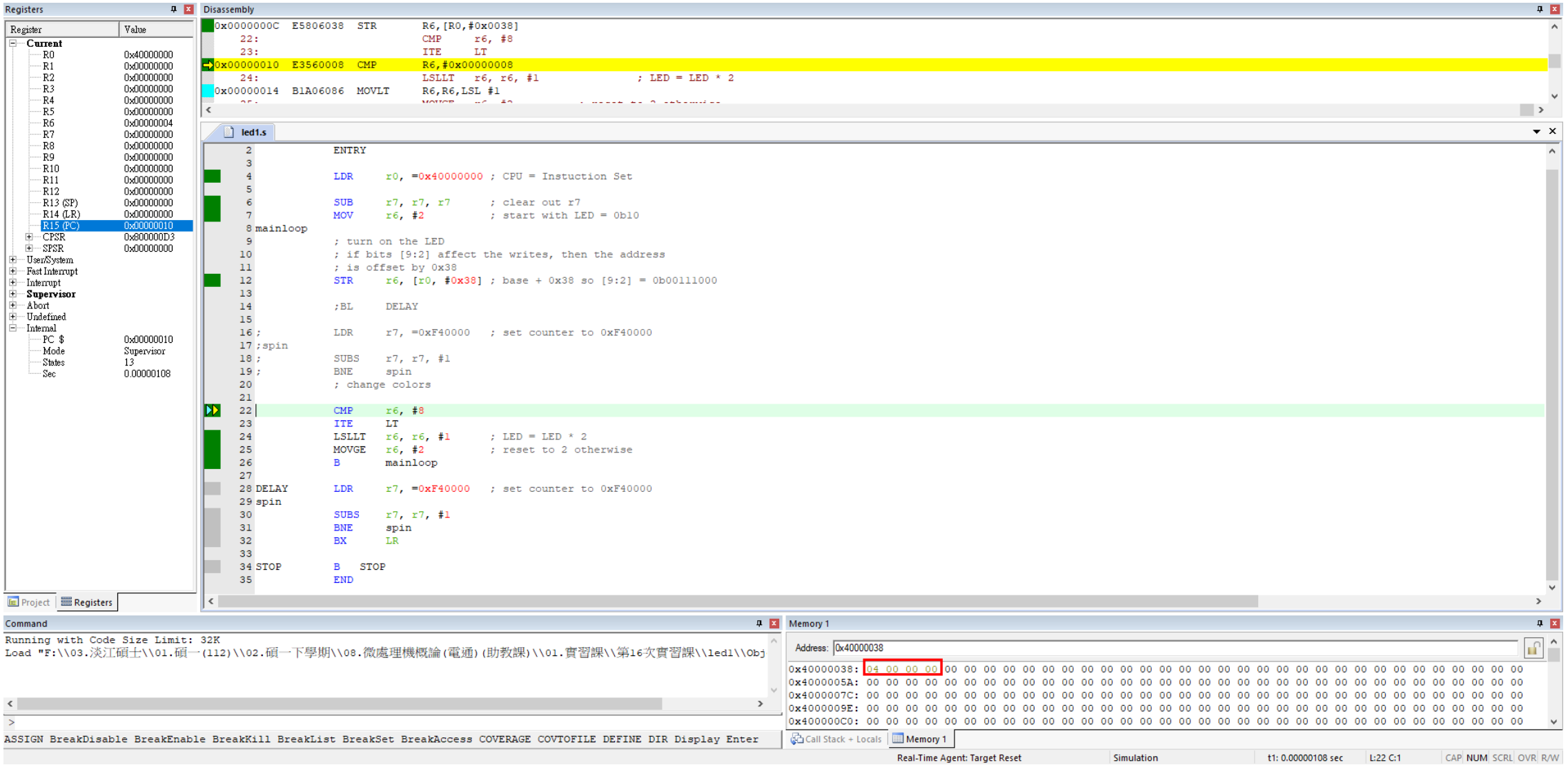
將BL DELAY註解


Project
Project: led1
Target 1
Source Group 1
led1.s*
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #8
23 ITE LT
24 LSLLT r6, r6, #1 ; LED = LED * 2
25 MOVGE r6, #2 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Project Books Func... Temp...
Build Output
Build target 'Target 1'
assembling led1.s...
linking...
Program Size: Code=56 RO-data=0 RW-data=0 ZI-data=0
".\Objects\led1.axf" - 0 Error(s), 0 Warning(s).
Build Time Elapsed: 00:00:00
Simulation
L:14 C:14
CAP NUM SCRL OVR R/W

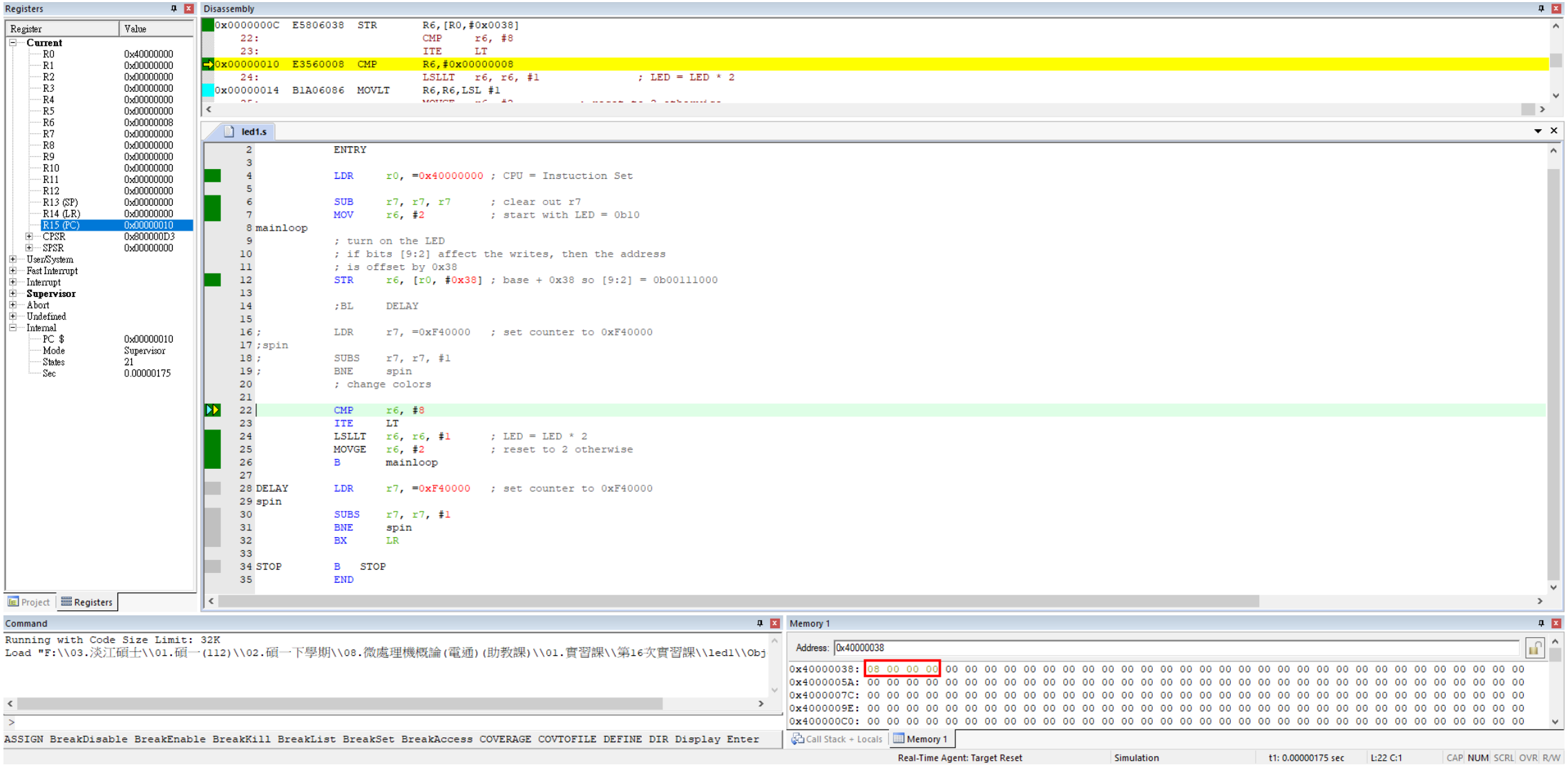
執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000002
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 6
Sec 0.00000050
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #8
23: ITE LT
0x00000010 E3560008 CMP R6,#0x00000008
24: LSLLT r6, r6, #1 ; LED = LED * 2
0x00000014 B1A06086 MOVLT R6,R6,LSL #1
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #8
23 ITE LT
24 LSLLT r6, r6, #1 ; LED = LED * 2
25 MOVGE r6, #2 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000050 sec
L:24 C:1
CAP NUM SCRL OVR R/W

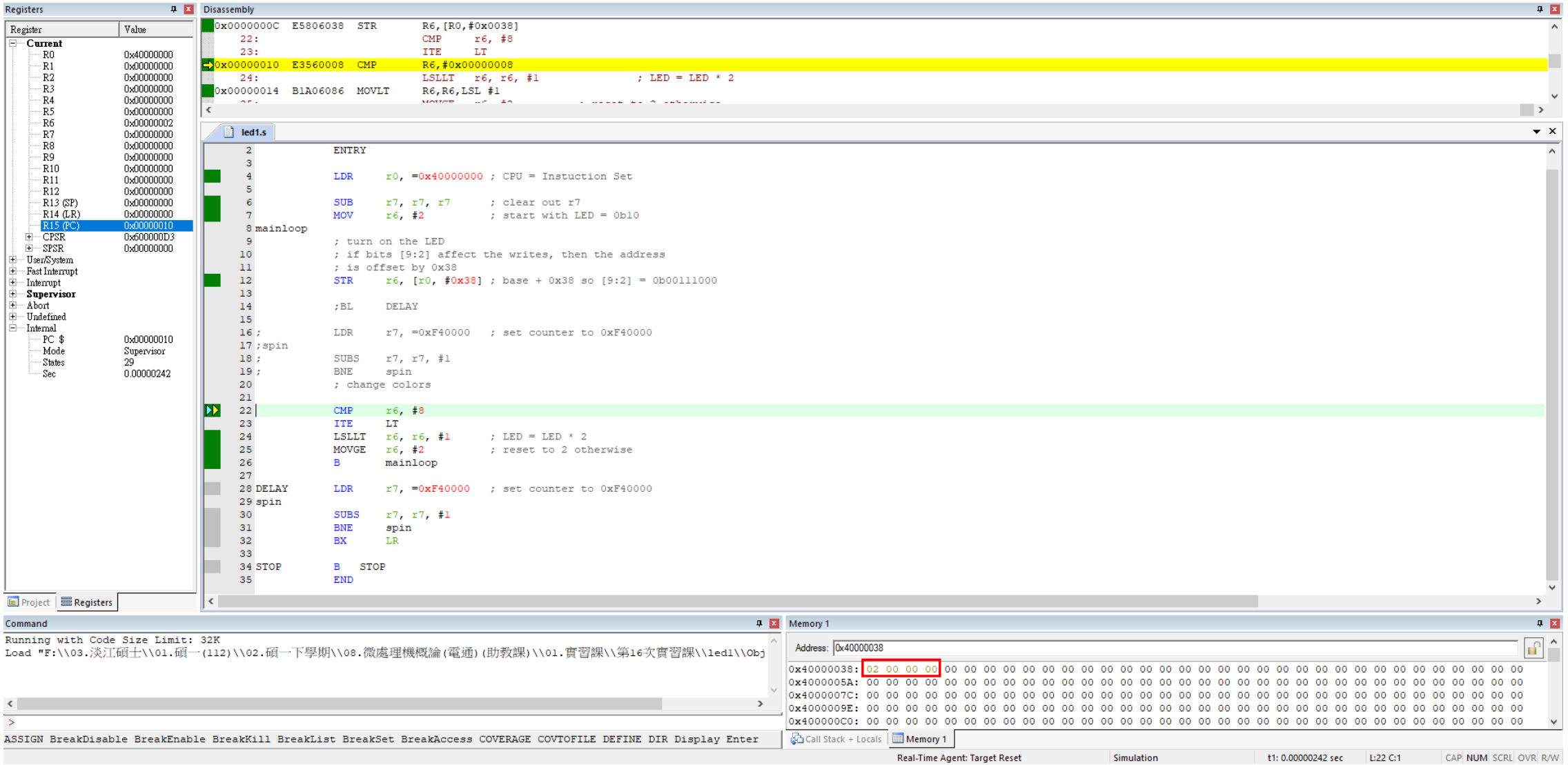
執行結果(GREEN)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 13
Sec 0.00000108
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #8
23: ITE LT
0x00000010 E3560008 CMP R6,#0x00000008
24: LSLLT r6, r6, #1 ; LED = LED * 2
0x00000014 B1A06086 MOVLT R6,R6,LSL #1
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #8
23 ITE LT
24 LSLLT r6, r6, #1 ; LED = LED * 2
25 MOVGE r6, #2 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000108 sec
L:22 C:1
CAP NUM SCRL OVR R/W

執行結果(BLUE)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000008
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 21
Sec 0.00000175
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #8
23: ITE LT
0x00000010 E3560008 CMP R6,#0x00000008
24: LSLLT r6, r6, #1 ; LED = LED * 2
0x00000014 B1A06086 MOVLT R6,R6,LSL #1
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #8
23 ITE LT
24 LSLLT r6, r6, #1 ; LED = LED * 2
25 MOVGE r6, #2 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 08 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000175 sec
L:22 C:1
CAP NUM SCRL OVR R/W

執行結果(RED)

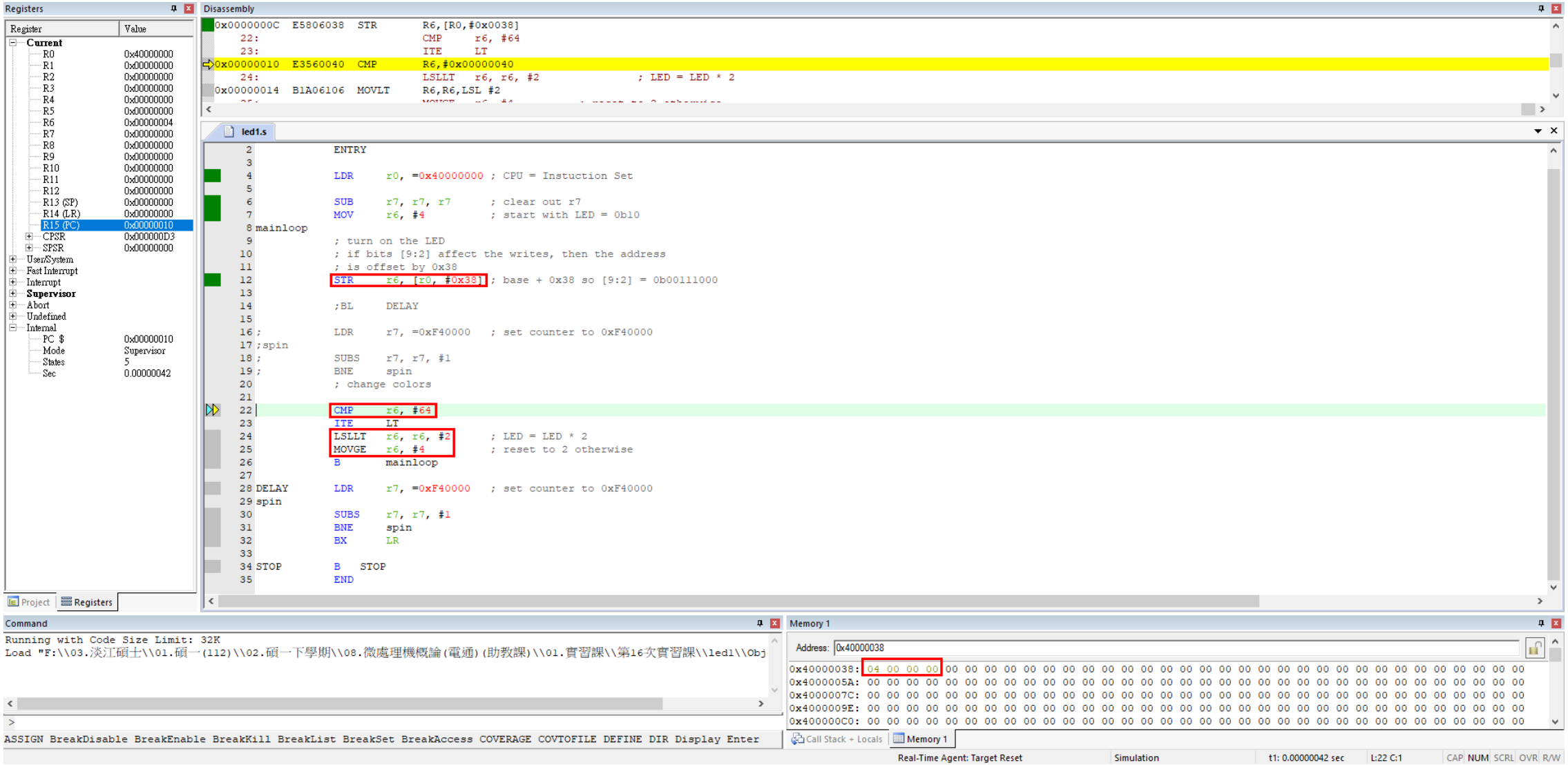

Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000002
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x600000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 29
Sec 0.00000242
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #8
23: ITE LT
0x00000010 E3560008 CMP R6,#0x00000008
24: LSLLT r6, r6, #1 ; LED = LED * 2
0x00000014 B1A06086 MOVLT R6,R6,LSL #1
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #2 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #8
23 ITE LT
24 LSLLT r6, r6, #1 ; LED = LED * 2
25 MOVGE r6, #2 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 02 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000242 sec
L:22 C:1
CAP NUM SCRL OVR R/W

Multicolor LED (P360 16.4.4)(改PF)

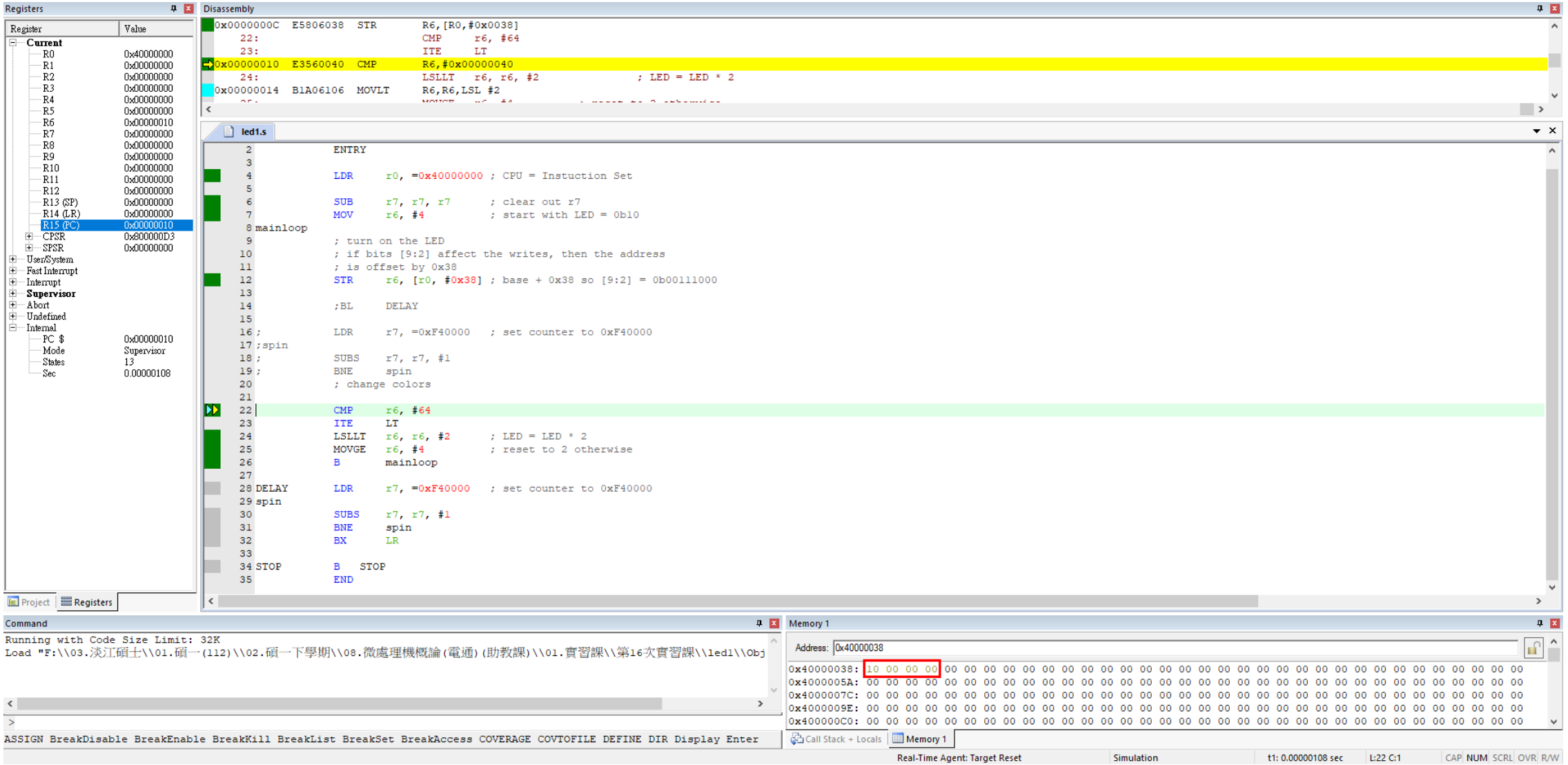
The Tiva Launchpad board has a multi-colored LED that is controlled through three GPIO lines on Port F, one for red, one for green, and one for blue. The red LED is attached to line **PF2**, the green LED is attached to line **PF4**, and the blue LED is attached to line **PF6**.Write a program to showcase all three colors by create a loop that selects one color at a time, cycling through all three (in the cycle of **red, green, blue**) by changing the value being written to the port. (Hint: Related base address 0x40000000 and offset 0x38 and **be sure to show the delay time between two lights and try to set the delay time to ?)**

0b00000100 ➔ 紅 → 0x04
0b00010000 ➔ 綠 → 0x10
0b01000000 ➔ 藍 → 0x40

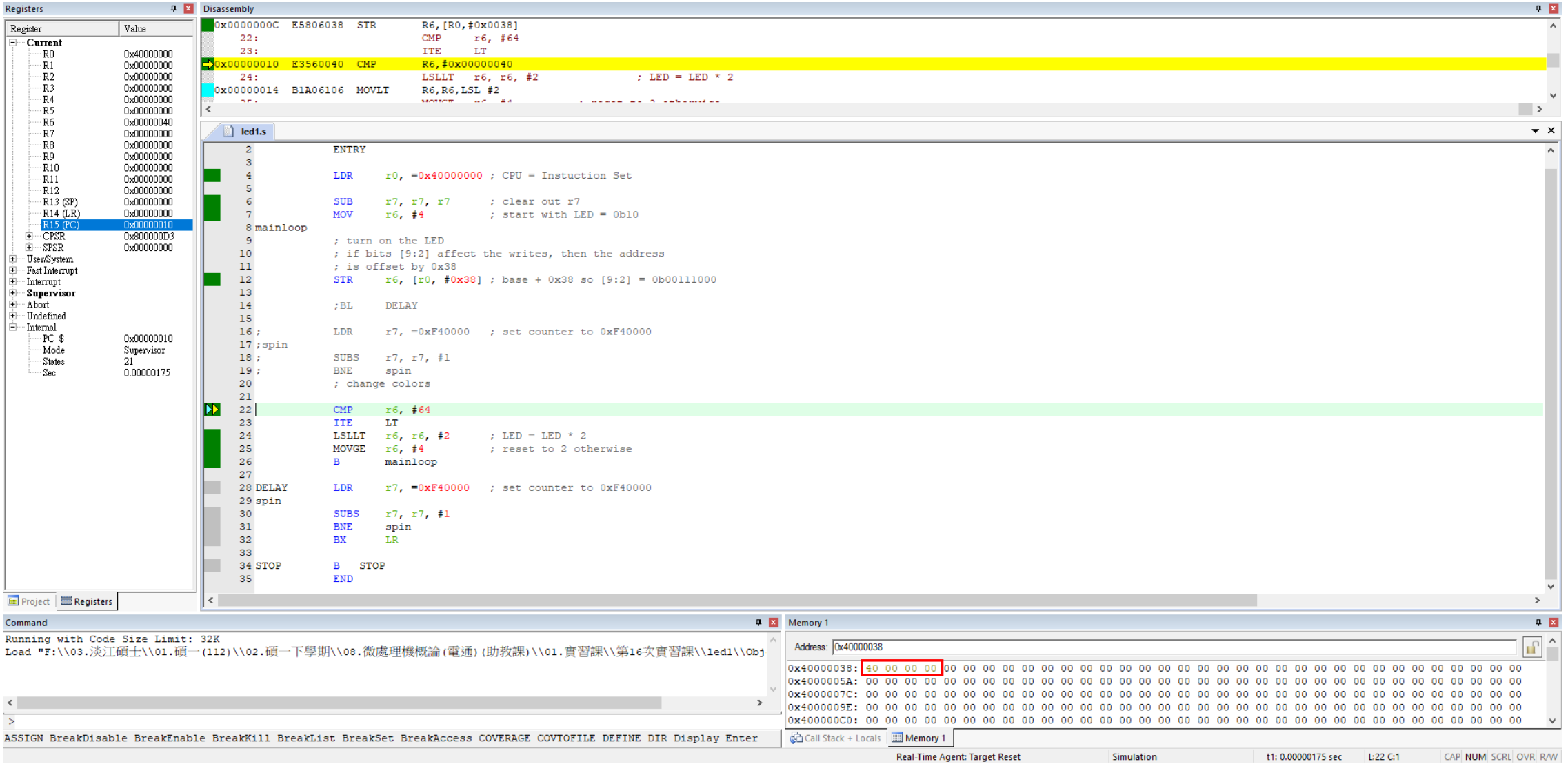
執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
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 0.00000042
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #64
23: ITE LT
0x00000010 E3560040 CMP R6,#0x00000040
24: LSLLT r6, r6, #2 ; LED = LED * 2
0x00000014 B1A06106 MOVLT R6,R6,LSL #2
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #64
23 ITE LT
24 LSLLT r6, r6, #2 ; LED = LED * 2
25 MOVGE r6, #4 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000042 sec
L:22 C:1
CAP NUM SCRL OVR R/W

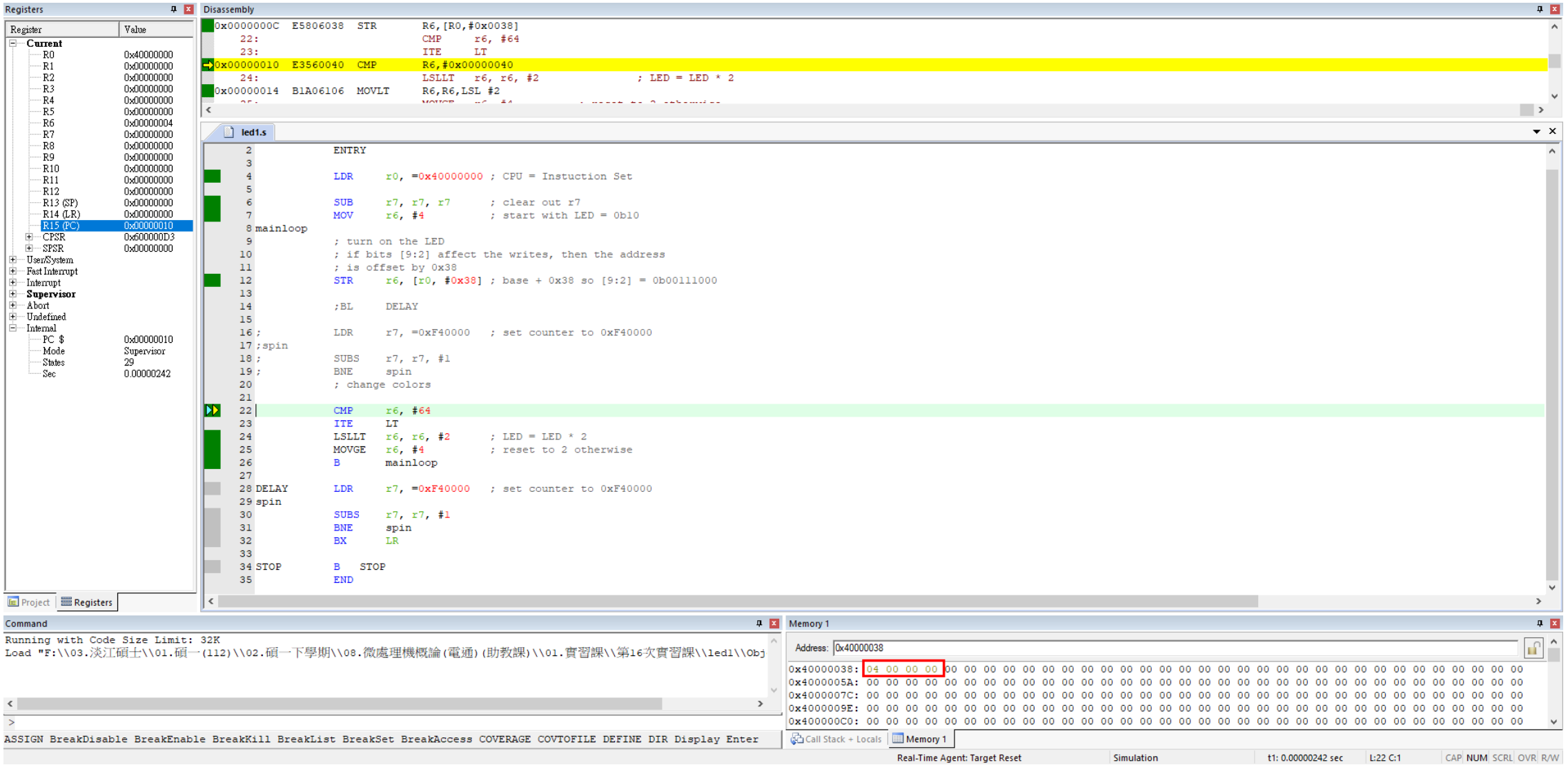
執行結果(GREEN)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000010
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 13
Sec 0.00000108
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #64
23: ITE LT
0x00000010 E3560040 CMP R6,#0x00000040
24: LSLLT r6, r6, #2 ; LED = LED * 2
0x00000014 B1A06106 MOVLT R6,R6,LSL #2
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #64
23 ITE LT
24 LSLLT r6, r6, #2 ; LED = LED * 2
25 MOVGE r6, #4 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000108 sec
L:22 C:1
CAP NUM SCRL OVR R/W

執行結果(BLUE)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000040
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 21
Sec 0.00000175
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #64
23: ITE LT
0x00000010 E3560040 CMP R6,#0x00000040
24: LSLLT r6, r6, #2 ; LED = LED * 2
0x00000014 B1A06106 MOVLT R6,R6,LSL #2
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #64
23 ITE LT
24 LSLLT r6, r6, #2 ; LED = LED * 2
25 MOVGE r6, #4 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000175 sec
L:22 C:1
CAP NUM SCRL OVR R/W

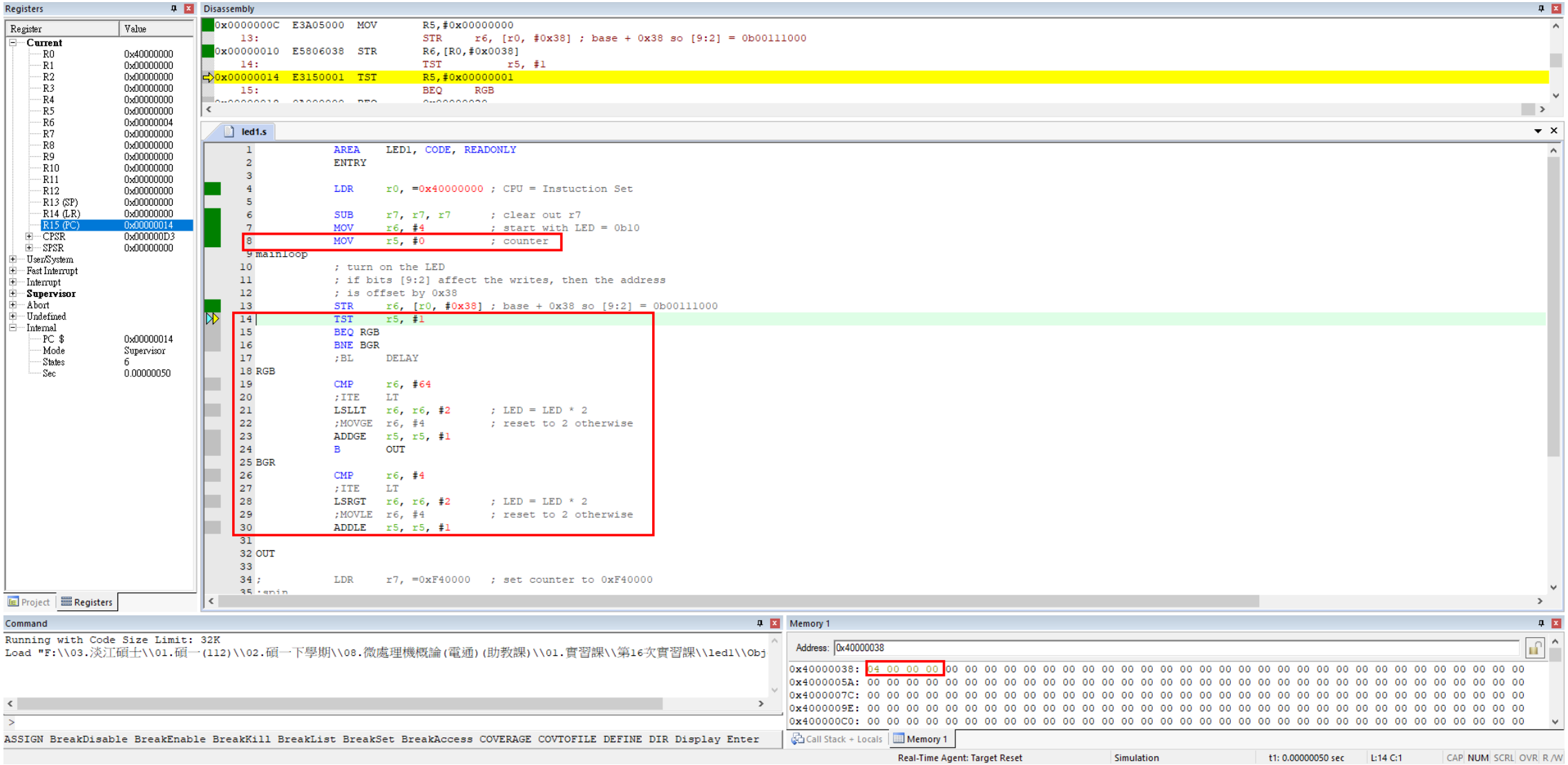
執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000010
CPSR 0x600000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000010
Mode Supervisor
States 29
Sec 0.00000242
Project
Registers
Disassembly
0x0000000C E5806038 STR R6,[R0,#0x0038]
22: CMP r6, #64
23: ITE LT
0x00000010 E3560040 CMP R6,#0x00000040
24: LSLLT r6, r6, #2 ; LED = LED * 2
0x00000014 B1A06106 MOVLT R6,R6,LSL #2
led1.s
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 mainloop
9 ; turn on the LED
10 ; if bits [9:2] affect the writes, then the address
11 ; is offset by 0x38
12 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
13
14 ;BL DELAY
15
16 ; LDR r7, =0xF40000 ; set counter to 0xF40000
17 ;spin
18 ; SUBS r7, r7, #1
19 ; BNE spin
20 ; change colors
21
22 CMP r6, #64
23 ITE LT
24 LSLLT r6, r6, #2 ; LED = LED * 2
25 MOVGE r6, #4 ; reset to 2 otherwise
26 B mainloop
27
28 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
29 spin
30 SUBS r7, r7, #1
31 BNE spin
32 BX LR
33
34 STOP B STOP
35 END
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000242 sec
L:22 C:1
CAP NUM SCRL OVR R/W

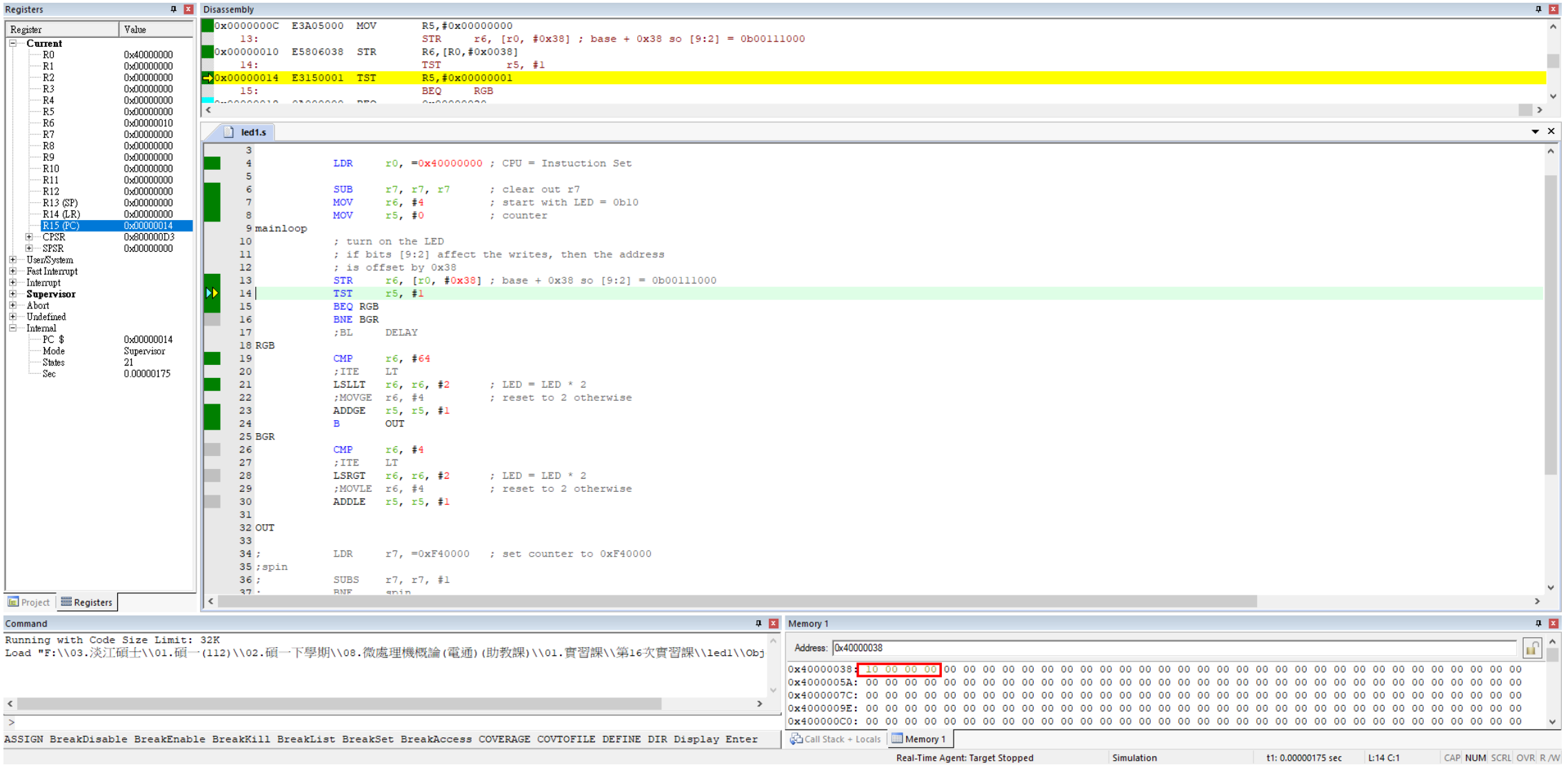
Multicolor LED (P360 16.4.4)(改閃爍順序)

The Tiva Launchpad board has a multi-colored LED that is controlled through three GPIO lines on Port F, one for red, one for green, and one for blue. The red LED is attached to line **PF2**, the green LED is attached to line **PF4**, and the blue LED is attached to line **PF6**.Write a program to showcase all three colors by create a loop that selects one color at a time, cycling through all three (in the cycle of **red, green, blue, blue, green, red**) by changing the value being written to the port. (Hint: Related base address 0x40000000 and offset 0x38 and **be sure to show the delay time between two lights and try to set the delay time to ?)**

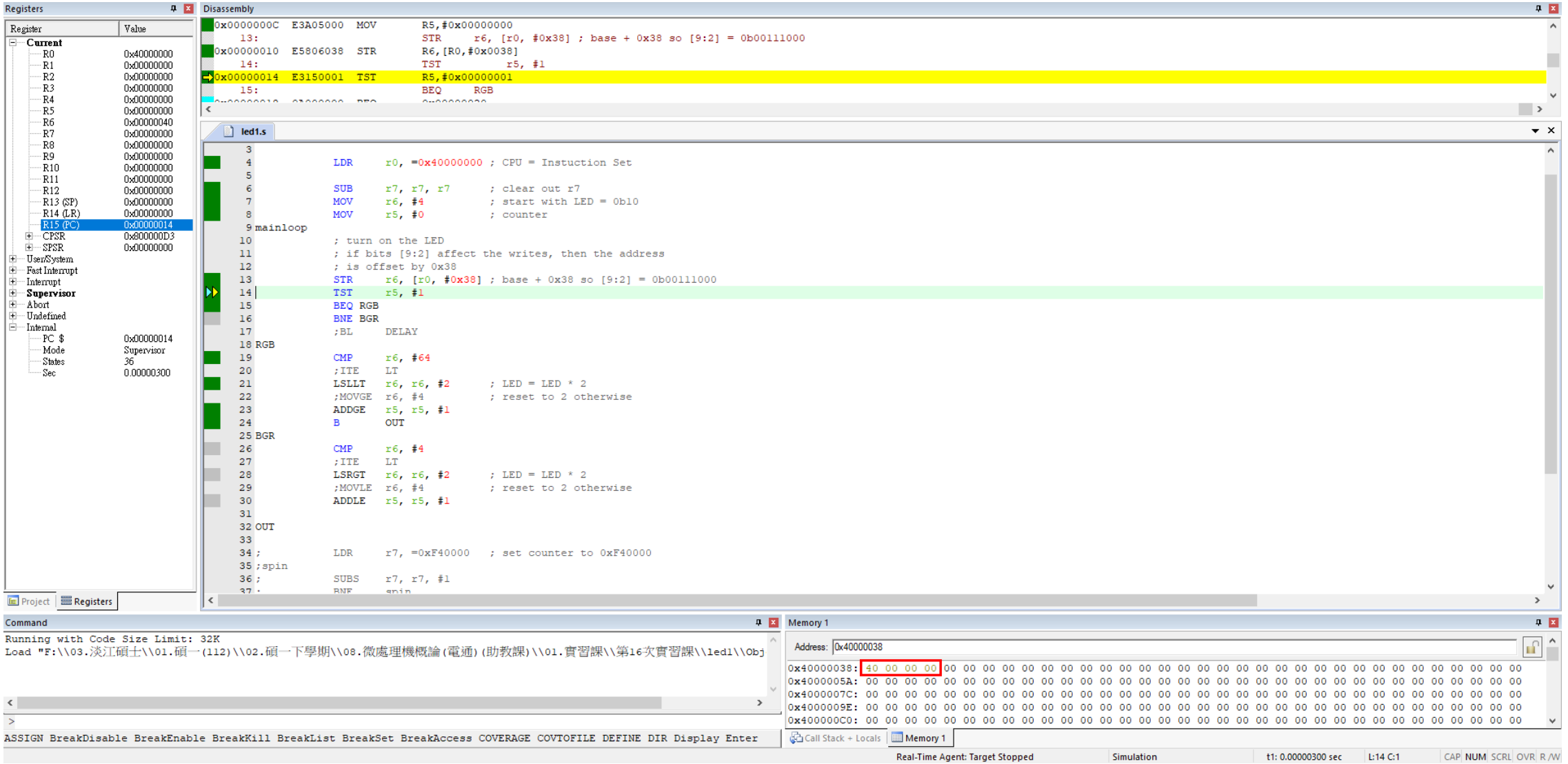
執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x000000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 6
Sec 0.00000050
Project
Registers
Disassembly
0x0000000C E3A05000 MOV R5,#0x00000000
13: STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
0x00000010 E5806038 STR R6,[R0,#0x0038]
14: TST r5, #1
0x00000014 E3150001 TST R5,#0x00000001
15: BEQ RGB
led1.s
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Reset
Simulation
t1: 0.00000050 sec
L:14 C:1
CAP NUM SCRL OVR R/W

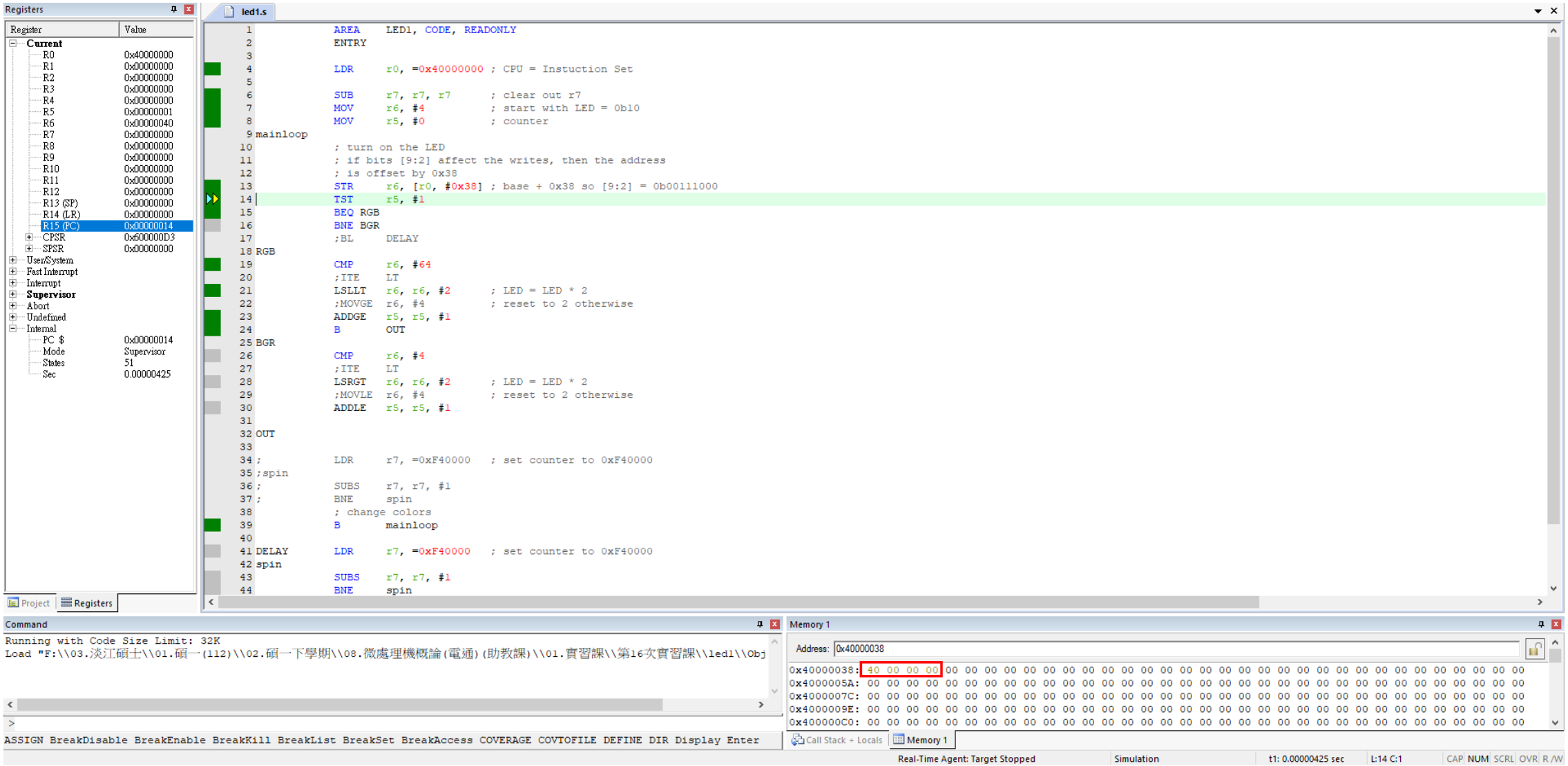
執行結果(GREEN)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000010
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 21
Sec 0.00000175
Project
Registers
Disassembly
0x0000000C E3A05000 MOV R5,#0x00000000
13: STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
0x00000010 E5806038 STR R6,[R0,#0x0038]
14: TST r5, #1
0x00000014 E3150001 TST R5,#0x00000001
15: BEQ RGB
led1.s
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
35 ;spin
36 ; SUBS r7, r7, #1
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000175 sec
L:14 C:1
CAP NUM SCRL OVR R/W

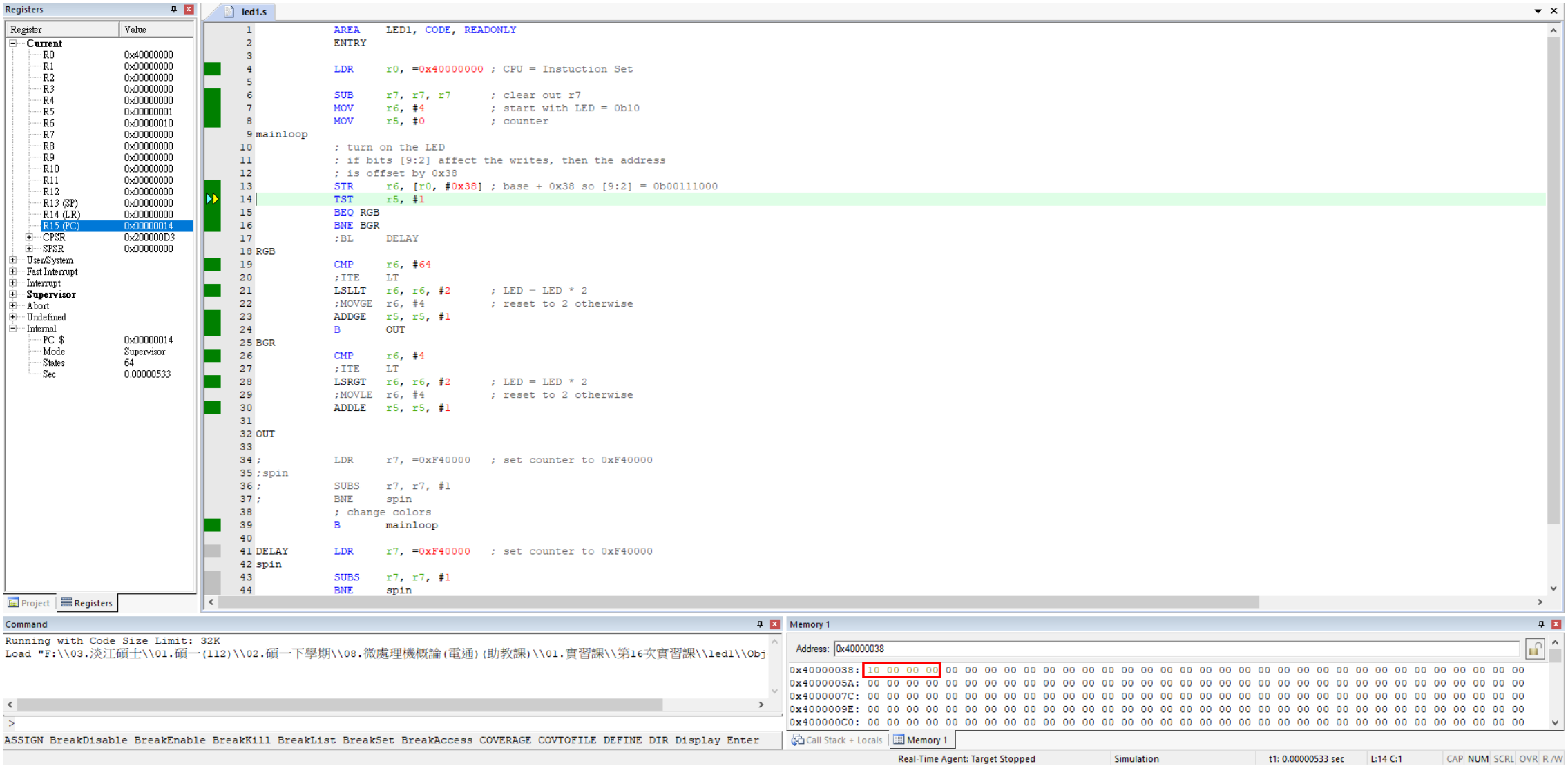
執行結果(BLUE)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000000
R6 0x00000040
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x800000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 36
Sec 0.00000300
Project
Registers
Disassembly
0x0000000C E3A05000 MOV R5,#0x00000000
13: STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
0x00000010 E5806038 STR R6,[R0,#0x0038]
14: TST r5, #1
0x00000014 E3150001 TST R5,#0x00000001
15: BEQ RGB
led1.s
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
35 ;spin
36 ; SUBS r7, r7, #1
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000300 sec
L:14 C:1
CAP NUM SCRL OVR R/W

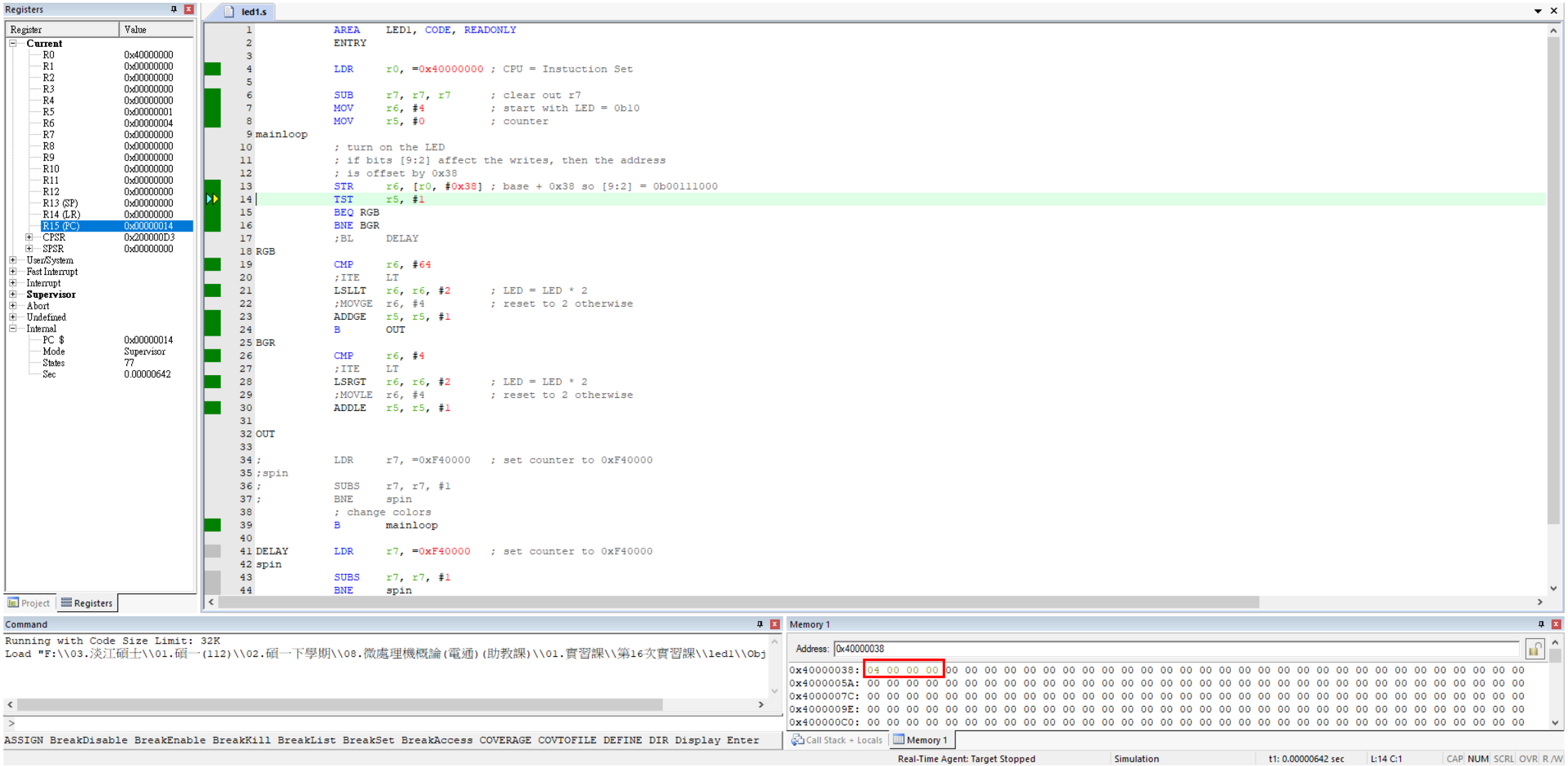
執行結果(BLUE)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000001
R6 0x00000040
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x600000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 51
Sec 0.00000425
Project
Registers
led1.s
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
35 ;spin
36 ; SUBS r7, r7, #1
37 ; BNE spin
38 ; change colors
39 B mainloop
40
41 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
42 spin
43 SUBS r7, r7, #1
44 BNE spin
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 40 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000425 sec
L:14 C:1
CAP NUM SCRL OVR R/W

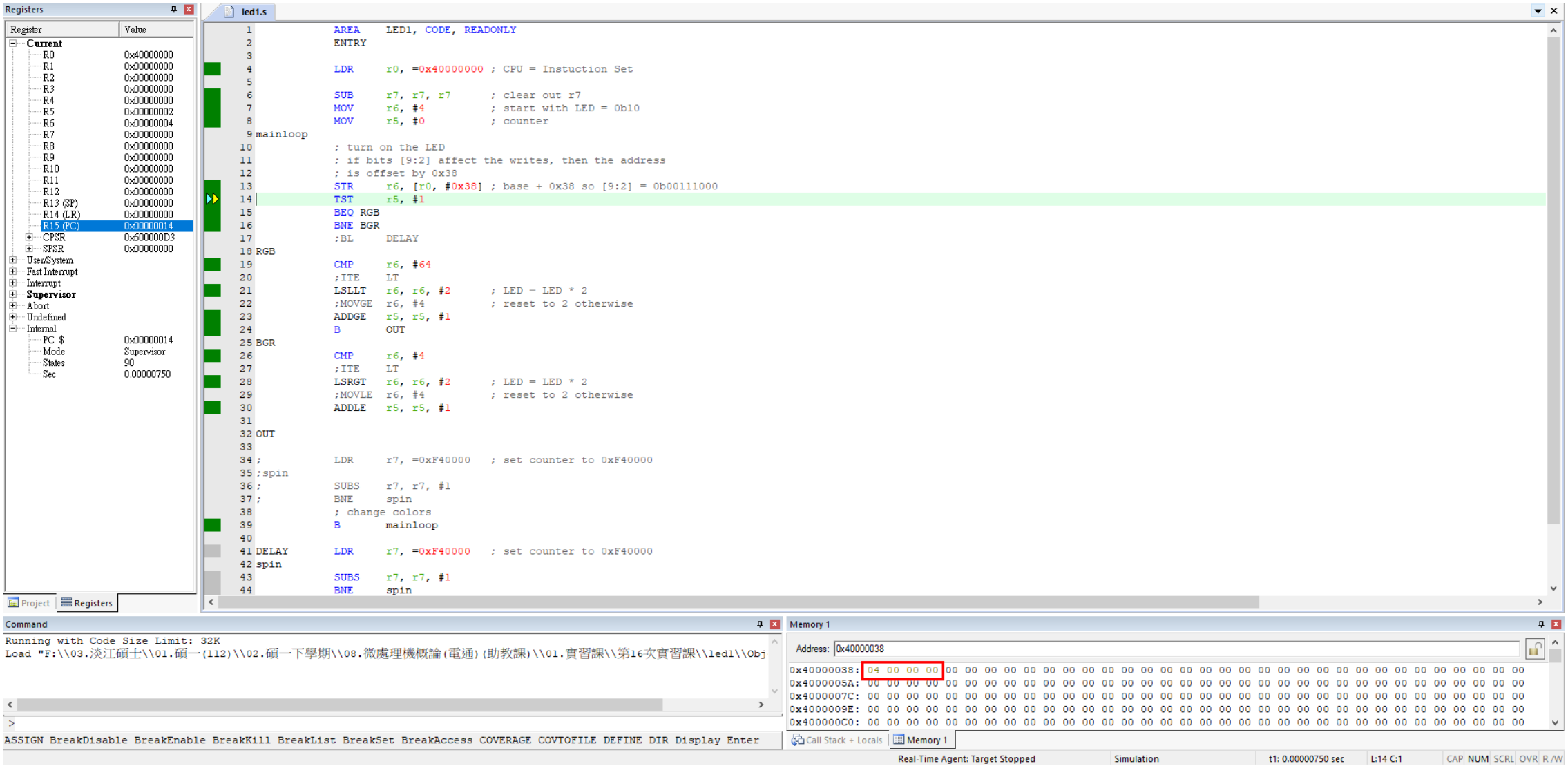
執行結果(GREEN)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000001
R6 0x00000010
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x200000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 64
Sec 0.00000533
Project
Registers
led1.s
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
35 ;spin
36 ; SUBS r7, r7, #1
37 ; BNE spin
38 ; change colors
39 B mainloop
40
41 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
42 spin
43 SUBS r7, r7, #1
44 BNE spin
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 10 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000533 sec
L:14 C:1
CAP NUM SCRL OVR R/W

執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000001
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x200000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 77
Sec 0.00000642
Project
Registers
led1.s
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
35 ;spin
36 ; SUBS r7, r7, #1
37 ; BNE spin
38 ; change colors
39 B mainloop
40
41 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
42 spin
43 SUBS r7, r7, #1
44 BNE spin
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000642 sec
L:14 C:1
CAP NUM SCRL OVR R/W

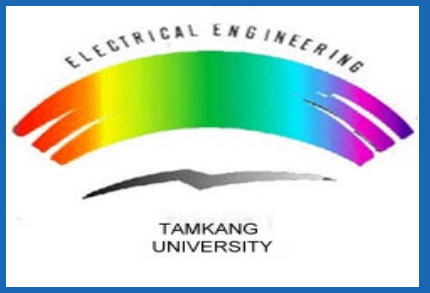
執行結果(RED)


Registers
Register
Value
Current
R0 0x40000000
R1 0x00000000
R2 0x00000000
R3 0x00000000
R4 0x00000000
R5 0x00000002
R6 0x00000004
R7 0x00000000
R8 0x00000000
R9 0x00000000
R10 0x00000000
R11 0x00000000
R12 0x00000000
R13 (SP) 0x00000000
R14 (LR) 0x00000000
R15 (PC) 0x00000014
CPSR 0x600000D3
SPSR 0x00000000
User/System
Fast Interrupt
Interrupt
Supervisor
Abort
Undefined
Internal
PC $ 0x00000014
Mode Supervisor
States 90
Sec 0.00000750
Project
Registers
led1.s
1 AREA LED1, CODE, READONLY
2 ENTRY
3
4 LDR r0, =0x40000000 ; CPU = Instuction Set
5
6 SUB r7, r7, r7 ; clear out r7
7 MOV r6, #4 ; start with LED = 0b10
8 MOV r5, #0 ; counter
9 mainloop
10 ; turn on the LED
11 ; if bits [9:2] affect the writes, then the address
12 ; is offset by 0x38
13 STR r6, [r0, #0x38] ; base + 0x38 so [9:2] = 0b00111000
14 TST r5, #1
15 BEQ RGB
16 BNE BGR
17 ;BL DELAY
18 RGB
19 CMP r6, #64
20 ;ITE LT
21 LSLLT r6, r6, #2 ; LED = LED * 2
22 ;MOVGE r6, #4 ; reset to 2 otherwise
23 ADDGE r5, r5, #1
24 B OUT
25 BGR
26 CMP r6, #4
27 ;ITE LT
28 LSRGT r6, r6, #2 ; LED = LED * 2
29 ;MOVLE r6, #4 ; reset to 2 otherwise
30 ADDLE r5, r5, #1
31
32 OUT
33
34 ; LDR r7, =0xF40000 ; set counter to 0xF40000
35 ;spin
36 ; SUBS r7, r7, #1
37 ; BNE spin
38 ; change colors
39 B mainloop
40
41 DELAY LDR r7, =0xF40000 ; set counter to 0xF40000
42 spin
43 SUBS r7, r7, #1
44 BNE spin
Command
Running with Code Size Limit: 32K
Load "F:\\03.淡江碩士\\01.碩一(112)\\02.碩一下學期\\08.微處理機概論(電通)(助教課)\\01.實習課\\第16次實習課\\led1\\Obj
ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE COVTOFILE DEFINE DIR Display Enter
Memory 1
Address: 0x40000038
0x40000038: 04 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000005A: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000007C: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x4000009E: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0x400000C0: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Call Stack + Locals
Memory 1
Real-Time Agent: Target Stopped
Simulation
t1: 0.00000750 sec
L:14 C:1
CAP NUM SCRL OVR R/W

Bit-Banded Memory

2024 Advanced Mixed-Operation System (AMOS) Lab.

Tamkang University
Department of Electrical and Computer Engineering
No.151, Yingzhuan Rd., Tamsui Dist., New Taipei City 25137, Taiwan (R.O.C.)



P96 FIGURE 5.6

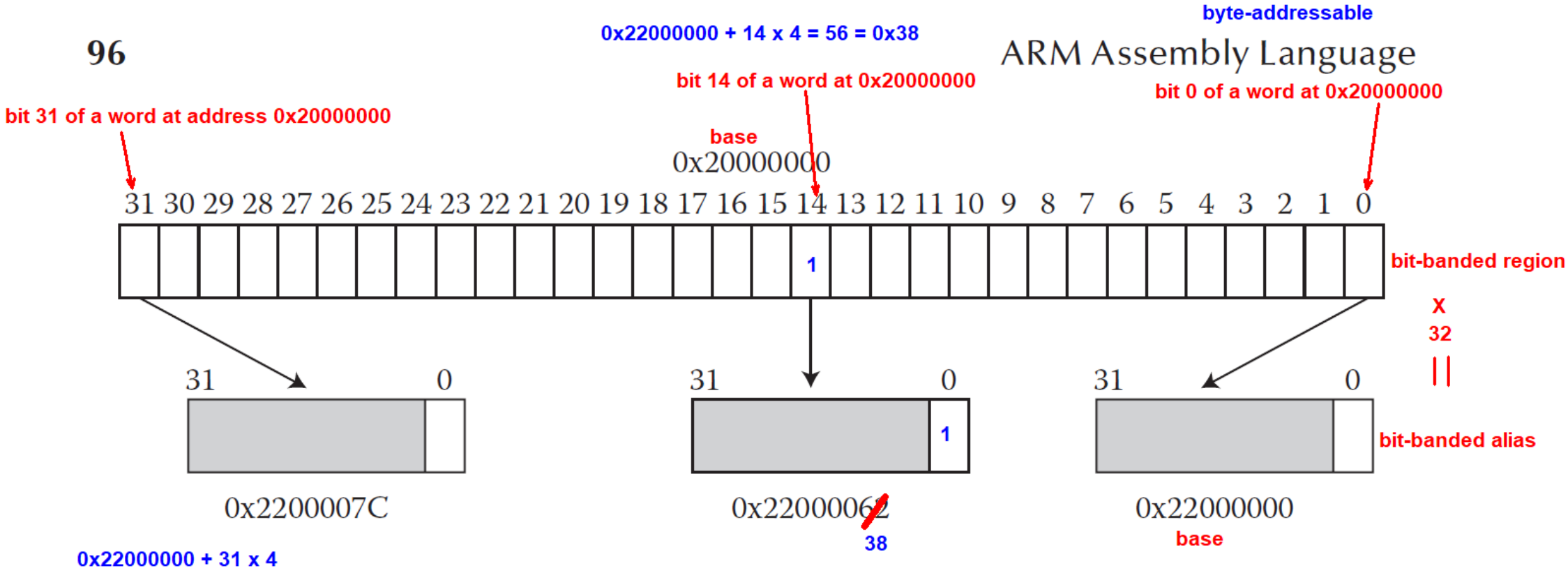


FIGURE 5.6 Mapping bit-banded regions.

the regions. Going back to the earlier CAN example, we could set bit 7 using just a single store operation:

of a word at address 0x40040000

```
LDR     r3, =0x4280001C
MOV     r4, #1
STR     r4, [r3]        ; set bit 7 of the CAN Control Register
```

The address 0x4280001C is derived from

$$\begin{aligned}\text{bit-band alias} &= \text{bit-band base} + (\text{byte offset} \times 32) + (\text{bit number} \times 4)\\ &= 0x42000000 + (0x40000 \times 0x20) + (7 \times 4)\\ &= 0x42000000 + 0x800000 + 0x1C\end{aligned}$$

As another example, if bit 1 at address 0x40038000 (the ADC 0 peripheral) is to be modified, the bit-band alias is calculated as:

$$0x42000000 + (0x38000 \times 0x20) + (1 \times 4) = 0x42700004$$

What immediately becomes obvious is that you would need a considerable number of addresses to make a one-to-one mapping of addresses to individual bits. In fact, if you do the math, to have each bit in a 32KB section of memory given its own address, with each address falling on a word boundary, i.e., ending in either 0, 4, 8, or C, you would need

$$32{,}768 \text{ bytes} \times 8 \text{ bits/byte} \times 4 \text{ bytes/bit} = 1\text{MB}$$

The trade-off then becomes an issue of how much address space can be sacrificed to support this feature, but given that microcontrollers never use all 4GB of their address space, and that large swaths of the memory map currently go unused, this is possible. Perhaps in ten years, it might not be.

考題方向(1/2)

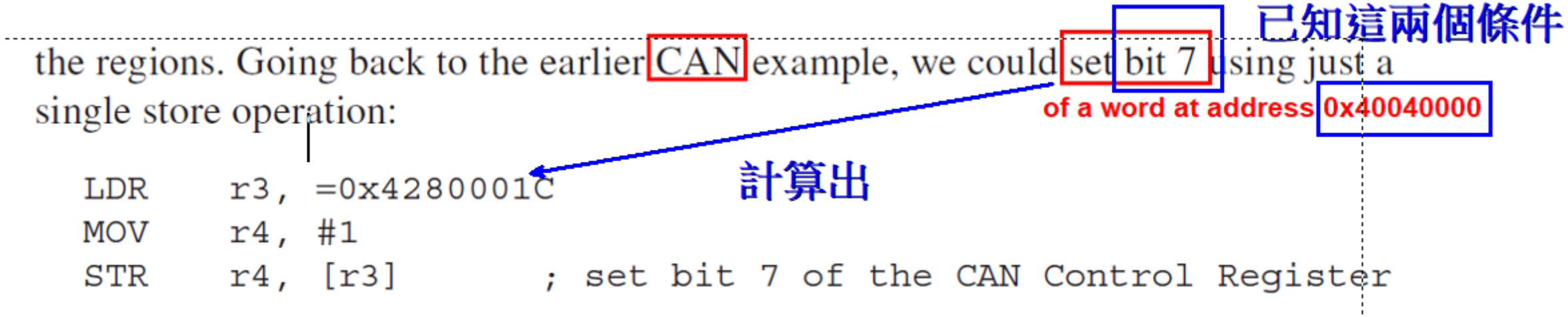
Assume

the address of a word in bit-banded region is given in R1

the bit number in the word to be accessed is given in R2

write a sequence of instructions to

computes the address of bit-banded alias and puts it in R0



考題方向(2/2)

the regions. Going back to the earlier CAN example, we could set bit 7 using just a single store operation:

of a word at address 0x40040000

```
LDR     r3, =0x4280001C
MOV     r4, #1
STR     r4, [r3]          ; set bit 7 of the CAN Control Register
```

計算出

已知

Q&A

Thanks for your attention !!