

Lab1 of ICS

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Lab1 of ICS

Purpose

Principles

Procedure

Result

Purpose

1. To write a program in LC-3 machine language that counts how many 1 are in the lower B bits of a given number A, and stores the output in memory.
2. To master how to use LC-3 tool.
3. To understand the principle of LC-3 code.
4. To know the characters of LC-3 code.
5. To have a good command of writing LC-3 code.

Principles

- Use as less instructions, memories, time as possible.

先将 A 和 B 赋给 $R5$ 和 $R3$, 从 $R5$ 的最后一位开始往前, 每次检验 $R5$ 的一位, 为1则 $R0++$, 每次 $R3--$, 当 $R3=0$ 时结束程序

详细过程见程序

Procedure

1	0011 0000 0000 0000	; 从 x3000 开始
2	0010 101 011111111	; R5 <- A (位于 x3100)
3	0010 011 011111111	; R3 <- B (位于 x3101)
4	0101 000 000 1 00000	; R0 <- 16'b0 & R0 (R0 <- 0)
5	0101 111 111 1 00000	; R7 <- 16'b0 & R7 (R7 <- 0)
6	0001 110 111 1 00001	; R6 <- 16'b1 AND R7 (R6 <- 16'b1)
7	0101 100 101 0 00 110	; R4 <- R5 & R6
8	0000 010 0 00000001	; 当 R4 为 0 时跳过下一步, 即 R5 的从右往左数第 i 位
9	0001 000 000 1 00001	; R0 <- R0 + 1
10	0001 110 110 0 00 110	; R6 <- R6 * 2
11	0001 011 011 1 11111	; R3 <- R3 - 1
12	0000 001 111111010	; 当 R3 > 0 时回跳至 x3005
13	0011 000 011110110	; 存储结果到 x3102
14	1111 0000 0010 0101	; 终止程序

1	0011 0000 0000 0000	; 从 x3000 开始
2	0010 101 011111111	;x3000 LD: R5 <- A (位于 x3100)
3	0010 011 011111111	;x3001 LD: R3 <- B (位于 x3101)
4	0101 000 000 1 00000	;x3002 AND: R0 <- 16'b0 & R0 (R0 <- 0)
5	0101 111 111 1 00000	;x3003 AND: R7 <- 16'b0 & R7 (R7 <- 0)
6	0001 110 111 1 00001	;x3004 ADD: R6 <- 16'b1 + R7 (R6 <- 16'b1)
7	0101 100 101 0 00 110	;x3005 AND: R4 <- R5 & R6
8	0000 010 0 00000001	;x3006 BR: 当 R4 为 0 时跳过下一步
9	0001 000 000 1 00001	;x3007 ADD: R0 <- R0 + 1
10	0001 110 110 0 00 110	;x3008 ADD: R6 <- R6 * 2
11	0001 011 011 1 11111	;x3009 ADD: R3 <- R3 - 1 (执行 B 次)
12	0000 001 111111010	;x300A BR: 当 R3 > 0 时回跳至 x3005
13	0011 000 011110110	;x300B ST: 存储 R0 结果到 x3102
14	1111 0000 0010 0101	;x300C 终止程序

Result

1. $A = 13, B = 3$

exit之前寄存器状态

LC3Tools

<>⚙️

Registers

R0	x0002	2
R1	x0000	0
R2	x0000	0
R3	x0000	0
R4	x0004	4
R5	x000D	13
R6	x0008	8
R7	x0000	0
PSR	x8002	32770CC: Z
PC	x300C	12300
MCR	x0000	0

Console (click to focus)

--- Halting the LC-3 ---

--- Halting the LC-3 ---

--- Halting the LC-3 ---

--- Halting the LC-3 ---

warning: 2347612: Skipping 'Updating Keyboard' scheduled for 2347610
warning: 2347612: Skipping 'Updating Display' scheduled for 2347610
warning: 2347612: Skipping 'No interrupt of higher priority pending' scheduled for 2347611
0

Memory

1	▶	x3001	x26FF	9983	0010011011111111
1	▶	x3002	x5020	20512	0101000000100000
1	▶	x3003	x5FE0	24544	0101111111100000
1	▶	x3004	x1DE1	7649	000110111100001
1	▶	x3005	x5946	22854	0101100101000110
1	▶	x3006	x0401	1025	0000010000000001
1	▶	x3007	x1021	4129	0001000000100001
1	▶	x3008	x1D86	7558	0001110110000110
1	▶	x3009	x16FF	5887	0001011011111111
1	▶	x300A	x03FA	1018	000000111111010
1	▶	x300B	x30F6	12534	0011000011110110
1	▶	x300C	xF025	61477	1111000000100101
1	▶	x300D	x0000	0	
1	▶	x300E	x0000	0	
1	▶	x300F	x0000	0	
1	▶	x3010	x0000	0	
1	▶	x3011	x0000	0	
1	▶	x3012	x0000	0	
1	▶	x3013	x0000	0	
1	▶	x3014	x0000	0	
1	▶	x3015	x0000	0	
1	▶	x3016	x0000	0	
1	▶	x3017	x0000	0	
1	▶	x3018	x0000	0	
1	▶	x3019	x0000	0	
1	▶	x301A	x0000	0	
1	▶	x301B	x0000	0	
1	▶	x301C	x0000	0	

x3100

PC←←→→

LC3Tools

<>⚙️

Registers

R0	x0002	2
R1	x0000	0
R2	x0000	0
R3	x0000	0
R4	x0004	4
R5	x000D	13
R6	x0008	8
R7	x0000	0
PSR	x8002	32770CC: Z
PC	x300C	12300
MCR	x0000	0

Console (click to focus)

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warning: 2347612: Skipping 'Updating Keyboard' scheduled for 2347610
warning: 2347612: Skipping 'Updating Display' scheduled for 2347610
warning: 2347612: Skipping 'No interrupt of higher priority pending' scheduled for 2347611
0

Memory

1	▶	x3100	x000D	13	
1	▶	x3101	x0003	3	
1	▶	x3102	x0002	2	
1	▶	x3103	x0000	0	
1	▶	x3104	x0000	0	
1	▶	x3105	x0000	0	
1	▶	x3106	x0000	0	
1	▶	x3107	x0000	0	
1	▶	x3108	x0000	0	
1	▶	x3109	x0000	0	
1	▶	x310A	x0000	0	
1	▶	x310B	x0000	0	
1	▶	x310C	x0000	0	
1	▶	x310D	x0000	0	
1	▶	x310E	x0000	0	
1	▶	x310F	x0000	0	
1	▶	x3110	x0000	0	
1	▶	x3111	x0000	0	
1	▶	x3112	x0000	0	
1	▶	x3113	x0000	0	
1	▶	x3114	x0000	0	
1	▶	x3115	x0000	0	
1	▶	x3116	x0000	0	
1	▶	x3117	x0000	0	
1	▶	x3118	x0000	0	
1	▶	x3119	x0000	0	
1	▶	x311A	x0000	0	
1	▶	x311B	x0000	0	

x3100

PC←←→→

如上图所示：

初始化程序时：

$$R5 = A = 13 = 0b1101$$

$$R3 = B = 3$$

$$R6 = 0b1$$

而后每一步：

R6 依次变成 0b10, 0b100, 从此检验了 A 的后 B 位。

2. $A = 167, B = 6$

exit前寄存器的状态

LC3Tools

Registers

R0	x0004	4
R1	x0000	0
R2	x0000	0
R3	x0000	0
R4	x0020	32
R5	x00A7	167
R6	x0040	64
R7	x0000	0
PSR	x8002	32770 CC: Z
MCR	x300C	12300
	x0000	0

Memory

x3001	x26FF	9983	0010011011111111
x3002	x5020	20512	0101000000100000
x3003	x5FE0	24544	0101111111000000
x3004	x1DE1	7649	0001110111100001
x3005	x5946	22854	0101100101000110
x3006	x0401	1025	0000010000000001
x3007	x1021	4129	0001000000100001
x3008	x1D86	7558	0001110110000110
x3009	x16FF	5887	0001011011111111
x300A	x03FA	1018	0000001111111010
x300B	x30F6	12534	0011000011110110
x300C	xF025	61477	1111000000100101
x300D	x0000	0	
x300E	x0000	0	
x300F	x0000	0	
x3010	x0000	0	
x3011	x0000	0	
x3012	x0000	0	
x3013	x0000	0	
x3014	x0000	0	
x3015	x0000	0	
x3016	x0000	0	
x3017	x0000	0	
x3018	x0000	0	
x3019	x0000	0	
x301A	x0000	0	
x301B	x0000	0	
x301C	x0000	0	

Console (click to focus)

```

warning: 2348074: Skipping 'No interrupt of higher
priority pending' scheduled for 2348071

--- Halting the LC-3 ---

--- Halting the LC-3 ---

--- Halting the LC-3 ---

warning: 2371856: Skipping 'Updating Keyboard' scheduled
for 2371850
warning: 2371856: Skipping 'Updating Display' scheduled
for 2371850
warning: 2371856: Skipping 'No interrupt of higher
priority pending' scheduled for 2371851

```

x3100

PC

Registers

R0	x0000	0	
R1	x7FFF	32767	
R2	x0000	0	
R3	x0000	0	
R4	x4000	16384	
R5	x7FFF	32767	
R6	x2FFE	12286	
R7	x0000	0	
PSR	x0002	2	CC: Z
PC	x036C	876	
MCR	x0000	0	

Memory

0	▶	x3100	x7FFF	32767
0	▶	x3101	x000F	15
0	▶	x3102	x000F	15
0	▶	x3103	x0000	0
0	▶	x3104	x0000	0
0	▶	x3105	x0000	0
0	▶	x3106	x0000	0
0	▶	x3107	x0000	0
0	▶	x3108	x0000	0
0	▶	x3109	x0000	0
0	▶	x310A	x0000	0
0	▶	x310B	x0000	0
0	▶	x310C	x0000	0
0	▶	x310D	x0000	0
0	▶	x310E	x0000	0
0	▶	x310F	x0000	0
0	▶	x3110	x0000	0
0	▶	x3111	x0000	0
0	▶	x3112	x0000	0
0	▶	x3113	x0000	0
0	▶	x3114	x0000	0
0	▶	x3115	x0000	0
0	▶	x3116	x0000	0
0	▶	x3117	x0000	0
0	▶	x3118	x0000	0
0	▶	x3119	x0000	0
0	▶	x311A	x0000	0
0	▶	x311B	x0000	0

Console (click to focus)

```
--- Halting the LC-3 ---

--- Halting the LC-3 ---

--- Halting the LC-3 ---

--- Halting the LC-3 ---

--- Halting the LC-3 ---

0
```

x3100

PC

