Lab 1 Report

实验目的

- 使用LC3机器码编写程序：统计A的二进制表示低B位中1的个数

实验原理

- 统计二进制位中有多少个1，可以使用“二进制指针移位试探法”，即令一个16位的1不断左移，与原数按位与，如果结果不为0，则该位是1
- 有了这个基本思路，我们需要解决几个问题：
  - 指针的构造：使用二进制数1即可
  - 左移：即乘2，也就是自加，只需要使用ADD Rx, Rx, Rx类指令即可
  - 记录1的个数，使用一个寄存器，若按位与结果不为0，则自增1即可

实验过程

```
0011 0000 0000 0000     ; start the program at location x3000
0010 000 011111111      ; LD R0, x3001 + 255
0010 001 011111111      ; LD R1, x3002 + 255
1110 010 011111111      ; LEA R2, x3102
0101 011 011 1 00000    ; AND R3, R3, #0
0001 011 011 1 00001    ; ADD R3, R3, #1
0101 111 111 1 00000    ; AND R7, R7, #0

0001 001 001 1 11111    ; ADD R1, R1, -1
0000 100 000000101      ; BRn #5
0101 101 000 0 00011    ; AND R5, R0, R3
0000 010 000000001      ; BRz #1
0001 111 111 1 00001    ; ADD R7, R7, #1
0001 011 011 0 00011    ; ADD R3, R3, R3
0000 111 111111001      ; BR #-8
0111 111 010 000000     ; STR R7, R2, #0
```

每一行代码的注释已经在代码中标出。

- 先将两个参数从内存中加载到R0和R1中，之后计算出需要存储的地址x3102存入R2。之后，将R3载入1，用作二进制指针，并用R7来记录1的个数
- 进入主体循环，使用R1作计数器，不断递减。如果R1已经小于0，那么跳出循环存储结果。否则执行循环体内指令。
- 在循环体内，首先将R0和R3按位与。如果结果为0，则跳过R7递增这行命令。通过这个循环，最终可以正确的统计出1的个数

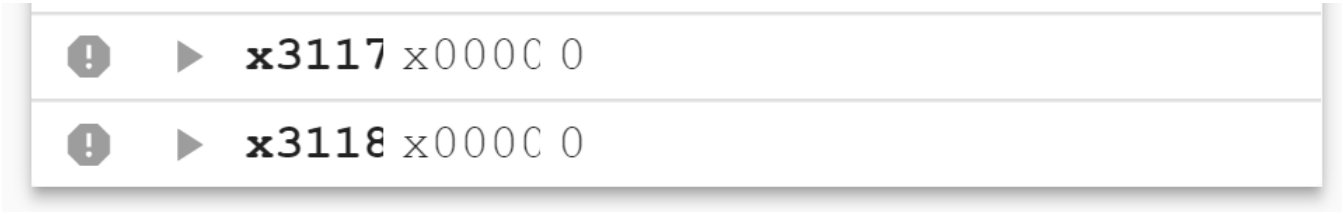
实验结果

- 统计32767低15位中1的个数：

实验数据：

Memory

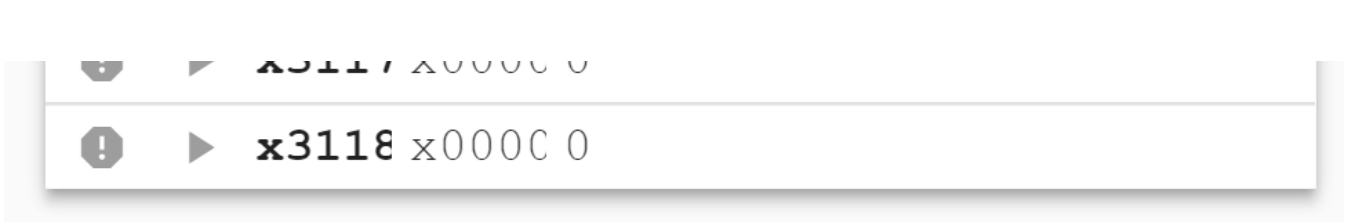
▶	x3100	x7FFF	32767
▶	x3101	x000F	15
▶	x3102	x000C	0
▶	x3103	x000C	0
▶	x3104	x000C	0
▶	x3105	x000C	0
▶	x3106	x000C	0
▶	x3107	x000C	0
▶	x3108	x000C	0
▶	x3109	x000C	0
▶	x310A	x000C	0
▶	x310B	x000C	0
▶	x310C	x000C	0
▶	x310D	x000C	0
▶	x310E	x000C	0
▶	x310F	x000C	0
▶	x3110	x000C	0
▶	x3111	x000C	0
▶	x3112	x000C	0
▶	x3113	x000C	0
▶	x3114	x000C	0
▶	x3115	x000C	0
▶	x3116	x000C	0



执行结果：

Memory

▶	x3100	x7FFF	32767
▶	x3101	x000F	15
▶	x3102	x000F	15
▶	x3103	x000C	0
▶	x3104	x000C	0
▶	x3105	x000C	0
▶	x3106	x000C	0
▶	x3107	x000C	0
▶	x3108	x000C	0
▶	x3109	x000C	0
▶	x310A	x000C	0
▶	x310B	x000C	0
▶	x310C	x000C	0
▶	x310D	x000C	0
▶	x310E	x000C	0
▶	x310F	x000C	0
▶	x3110	x000C	0
▶	x3111	x000C	0
▶	x3112	x000C	0
▶	x3113	x000C	0
▶	x3114	x000C	0
▶	x3115	x000C	0
▶	x3116	x000C	0
▶	x3117	x000C	0



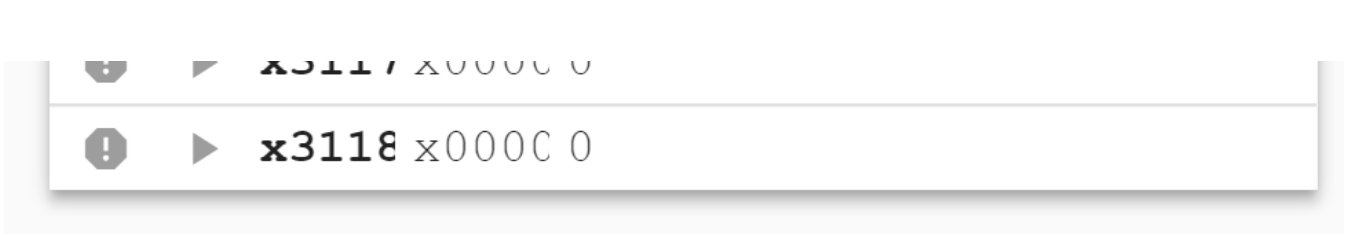
实验结果正确

- 统计75低10位中1的个数：

实验数据：

Memory

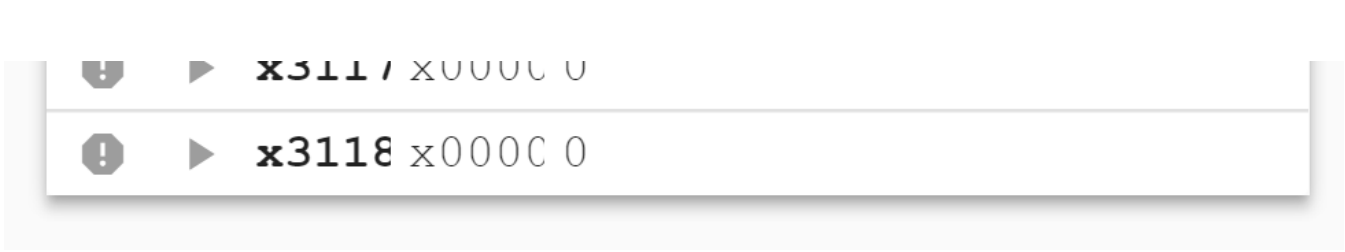
!	▶	x310C	x004E 75
!	▶	x3101	x0004 4
!	▶	x3102	x000C 0
!	▶	x3103	x000C 0
!	▶	x3104	x000C 0
!	▶	x3105	x000C 0
!	▶	x3106	x000C 0
!	▶	x3107	x000C 0
!	▶	x3108	x000C 0
!	▶	x3109	x000C 0
!	▶	x310A	x000C 0
!	▶	x310B	x000C 0
!	▶	x310C	x000C 0
!	▶	x310D	x000C 0
!	▶	x310E	x000C 0
!	▶	x310F	x000C 0
!	▶	x3110	x000C 0
!	▶	x3111	x000C 0
!	▶	x3112	x000C 0
!	▶	x3113	x000C 0
!	▶	x3114	x000C 0
!	▶	x3115	x000C 0
!	▶	x3116	x000C 0
!	▶	x3117	x000C 0



运行结果：

Memory

▶	x3100	x004E	75
▶	x3101	x0004	4
▶	x3102	x0003	3
▶	x3103	x000C	0
▶	x3104	x000C	0
▶	x3105	x000C	0
▶	x3106	x000C	0
▶	x3107	x000C	0
▶	x3108	x000C	0
▶	x3109	x000C	0
▶	x310A	x000C	0
▶	x310B	x000C	0
▶	x310C	x000C	0
▶	x310D	x000C	0
▶	x310E	x000C	0
▶	x310F	x000C	0
▶	x3110	x000C	0
▶	x3111	x000C	0
▶	x3112	x000C	0
▶	x3113	x000C	0
▶	x3114	x000C	0
▶	x3115	x000C	0
▶	x3116	x000C	0
▶	x3117	x000C	0



实验结果正确