Lab Report

School of Manufacturing Science and Engineering

Course Name	**Microcontroller: Principles and Interfacing Technology**						
Name of the Experiment	**Implementation of a Mathematical Function using Microcontroller**						
Name	**Yin Sikai**	Student No.	**2014141441168**	Department	**Wu Yuzhang Honors College**	Class No.	**NO.1**
Date	**2016.11.23**			Location	**C204, Basic Teaching Building**		
Teacher	**Pro. Yu Deping**			Grade	**100**		

1. Problem description

The main objective of this experiment is to apply the learned knowledge on the hardware and software of 8051 microcontrollers and propose solutions to implement a mathematical function using microcontroller. The problem is closely linked with the knowledge about arithmetic operations as well as the Jump and Call operations. Generally, the problem requires the program to finish function of a piecewise function as below:

$$y = \begin{cases} -1, x < 0 \\ 0, 0 \le x \le 2 \\ 1, x > 2 \end{cases}$$

In order to return the correct result as output, the program must be able to recognize and judge the input value for the function. So this program requires careful design.

2. Experimental procedure

2.1 Problem Analysis

In order to address this problem, we have to think about the function of piecewise function. As the output y of this function just includes -1,0 or 1, it is not really difficult to realize the result of any part of it using MOV assigns. The result of this function, however, is predetermined by its input range. For negative inputs, the output is -1 and for input range from 0 to 2, the output is 2. The outputs for larger inputs are the same 1. According to this analysis, it is easy to discern that we must **design two comparisons for the function inputs** before dealing with its output. The two comparison are made between input x and 0 as well as x and 2.

2.2 Draw the Flow Chart for the mathematical function

Based on the problem analysis above, we could form the whole picture of this problem with the flow chart illustration. First we would move the function input into the register A. Then we would utilize the comparison between A and 0 to find its positive or negative feature. After implementing this, the comparison between A and 3 is conducted so that the result could be classified into the final result

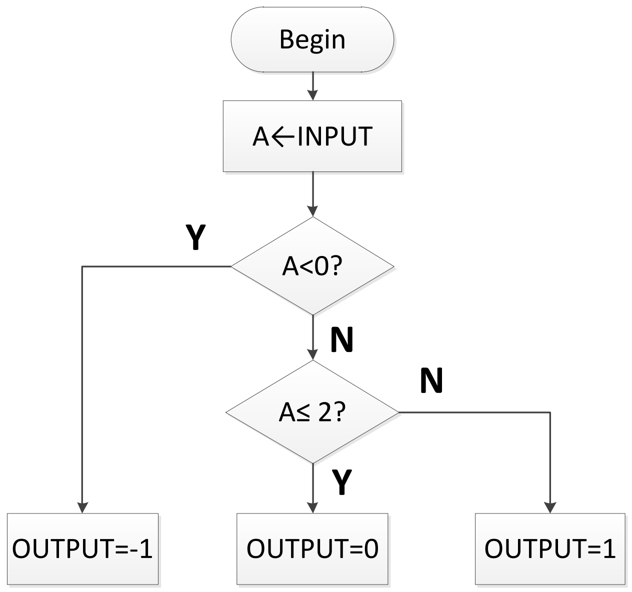


Fig. 1 Problem Flow Chart

2.3 Turn the Flow Chart into Assembly Language Chart

Implementing the knowledge learnt through this course, we can turn the flow chart of the problem above into ASM language code chart as below. As the negative number in PC are stored as its complement form. So the recognition into negative numbers could be achieved through comparing it seventh bit(ACC.7) with 0 though JNB.

Note that the comparison between A and 2 is succeeded by JNC code. Because 2-2=0 result has no Carry Flag=1, so the comparison must be justified into the comparison between A and 3. If A is greater than 2, then the output equals 1. So when input=2, the result is still 0 as given by the problem.

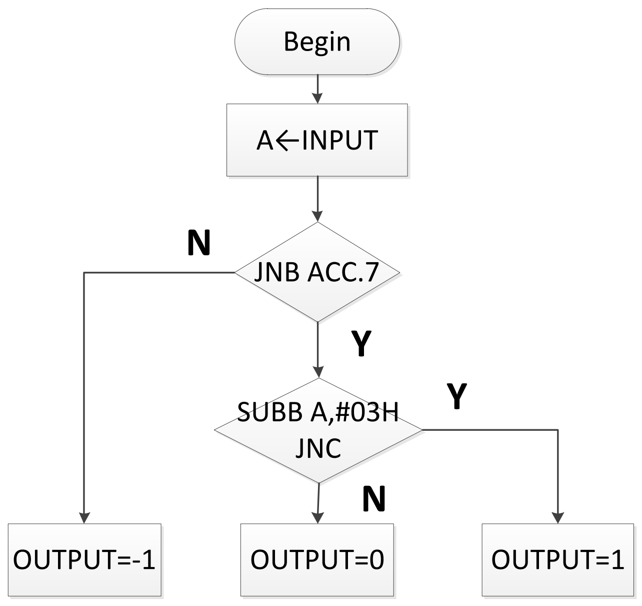
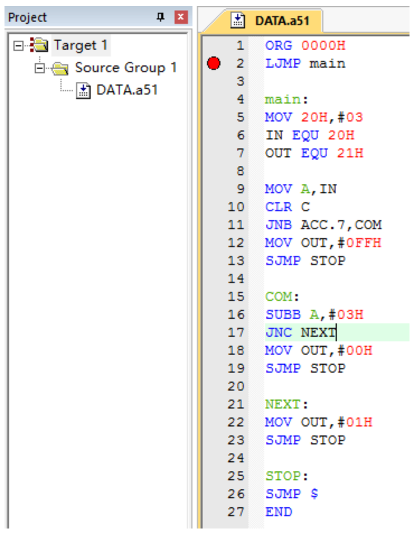


Fig. 2 Problem Flow Chart in Code Form

2.4 Program the Code with Keil uvision4 Software Platform

With the preparations above, we could create the a51 project in Keil software platform and program our full codes. As we have to debug the program, the start codes and Stop codes must be added into the program.

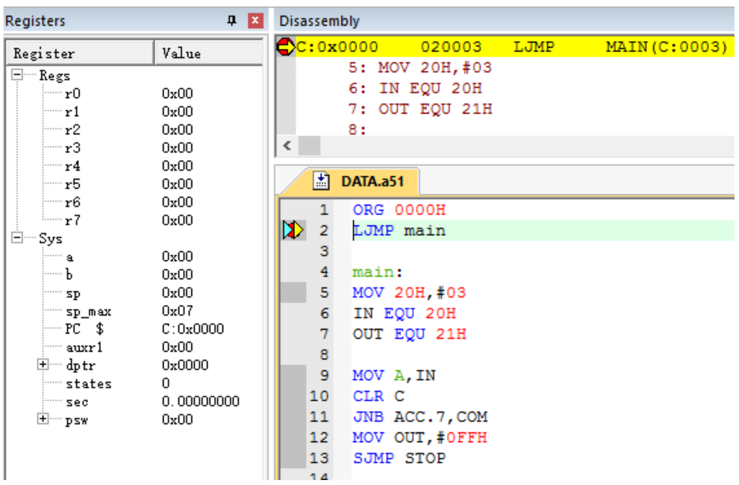


```
ORG 0000H
LJMP main

main:
MOV 20H,#03
IN EQU 20H
OUT EQU 21H

MOV A,IN
CLR C
JNB ACC.7,COM
MOV OUT,#0FFH
SJMP STOP

COM:
SUBB A,#03H
JNC NEXT
MOV OUT,#00H
SJMP STOP

NEXT:
MOV OUT,#01H
SJMP STOP

STOP:
SJMP $
END
```

Fig. 3 Program File on Keil Software Platform

2.5 Debug and Test the Program Designed

Finally we compiled the code in Keil and debugged it. The testing inputs could be changed through moving different numbers in binary forms into 20H where stores our INPUT number. The results could be watched through the window into the Memory 1 window with the address set at d:0020h. The state of different registers could also be watched under the step one line mode.



Registers

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

Disassembly

```
C:0x0000    020003   LJMP    MAIN(C:0003)
     5: MOV 20H,#03
     6: IN EQU 20H
     7: OUT EQU 21H
     8:
```

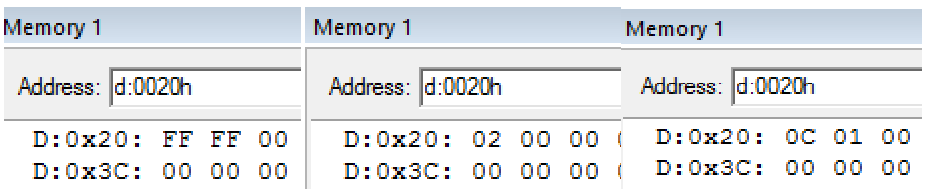
DATA.a51

```
ORG 0000H
LJMP main

main:
MOV 20H,#03
IN EQU 20H
OUT EQU 21H

MOV A,IN
CLR C
JNB ACC.7,COM
MOV OUT,#0FFH
SJMP STOP
```

Fig. 4 Testing and Debugging Process

3. Experimental results

The final results of this experiment is achieving the given function. Here we used -1(0FFH), 2(02H) and 12(0C0H) as example. The result for each is given by the picture. The 20H stores input number and 21H stores the result respectively.



```
Memory 1
Address: d:0020h
D:0x20:  FF FF 00
D:0x3C:  00 00 00

Memory 1
Address: d:0020h
D:0x20:  02 00 00
D:0x3C:  00 00 00

Memory 1
Address: d:0020h
D:0x20:  0C 01 00
D:0x3C:  00 00 00
```

Fig. 4 Test Results for Inputs -1, 2 and 12

4. Source code with comments(Assembly language and Chinese comments)

```
ORG 0000H
LJMP main

main:
MOV 20H,#02
IN EQU 20H
OUT EQU 21H

MOV A,IN
CLR C
JNB ACC.7,COM
MOV OUT,#0FFH
```

```
SJMP STOP

COM:
SUBB A,#03H
JNC NEXT
MOV OUT,#00H
SJMP STOP

NEXT:
MOV OUT,#01H

STOP:
SJMP $
END
```

5. Conclusions, suggestions and comments on the experiments

Through this interesting lab about Data Moving, I got much more familiar with the 8051 microcontrollers. Through writing the basic assembly language codes about the mathematical function, I successfully controlled the results. The microcontroller is really significant in converting the program into the control signals to electronic devices and let them function as the designer wanted. The experiment greatly improved my programming ability and computer skills. More importantly, it greatly aroused my interest towards programming. I wish to accomplish more interesting and inspiring projects like this.As for the suggestions and comments on the experiments, I think we can prolong the time of experiment and achieve more mathematical functions.

That was all the knowledge and ideas that I obtained through today’s experiment, actually I can not wait for the next one. I will do more active individual learning and interdisciplinary studies based on my major afterwards with the platform and I hope I can get more interesting results. Also, I want to express my gratitude to our tutor for your patient guidance on this experiment. Thank you very much!