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```
__data __at (0x30) char saved_SP[MAXTHREADS];
__data __at (0x34) ThreadID cur_ID;
__data __at (0x35) char bitmap_ID;
__data __at (0x36) char temp_SP;
__data __at (0x37) ThreadID new_ID;
__data __at (0x38) char producer;

__data __at (0x39) char head;
__data __at (0x3A) char tail;
__data __at (0x3B) char nextChar;
__data __at (0x3C) char nextNum;
__data __at (0x3D) char buffer[3];

__data __at (0x20) Semaphore mutex;
__data __at (0x21) Semaphore full;
__data __at (0x22) Semaphore empty;
```

Set some parameters on manually allocated memory.

```
void myTimer0Handler(void) {
    EA = 0;
    SAVESTATE;
    //P1 = cur_ID;
    if(&bitmap_ID) {
        P1 = cur_ID;
        if (cur_ID == 0) {
            if(producer == 1) {
                cur_ID = 1;
                producer = 0;
            }
            else if(producer == 0){
                cur_ID = 2;
                producer = 1;
            }
        }
        else{
            cur_ID = 0;
        }
    }
    RESTORESTATE;
    EA = 1;
    __asm
    RETI
    __endasm;
}
```

Use P1 for debugging.

EA = 0; marks the start of a **critical section**.

If the current thread is the Consumer (cur\_ID == 0):

Then choose the next thread according to the producer

Else if current thread is not consumer then switch to consumer

EA = 1; End of critical section

Screenshots for compilation :

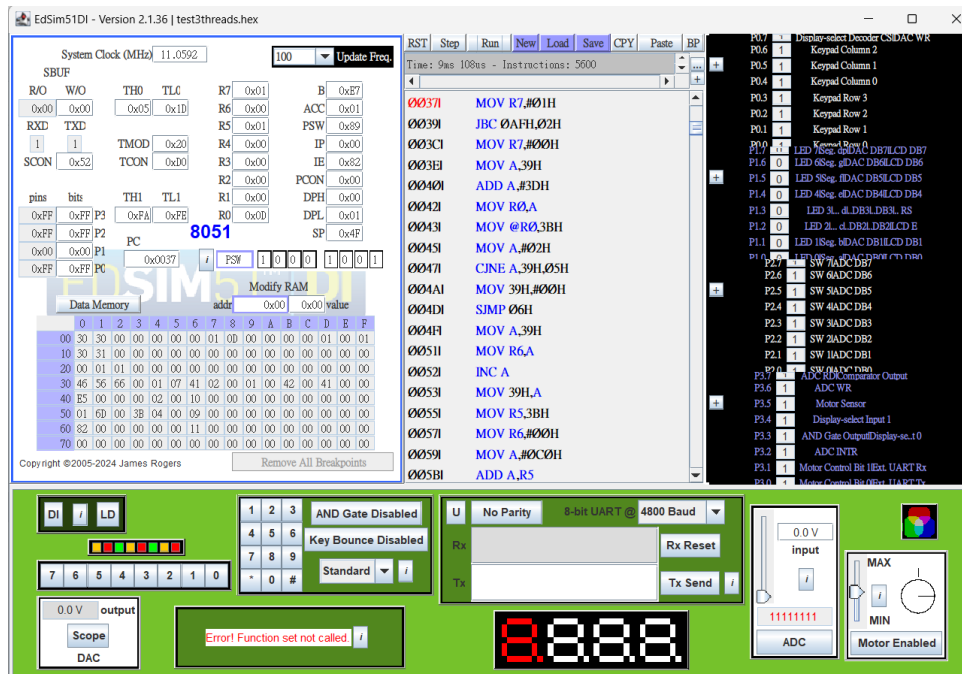
```
dylan@LAPTOP-S5F0LV5V ~/os/ppc4
$ make clean
rm *.hex *.ihx *.lnk *.lst *.map *.mem *.rel *.rst *.sym
rm: cannot remove '*.ihx': No such file or directory
rm: cannot remove '*.lnk': No such file or directory
make: *** [clean] Error 1

dylan@LAPTOP-S5F0LV5V ~/os/ppc4
$ make
sdcc -c test3threads.c
sdcc -c preemptive.c
preemptive.c:164: warning 85: in function ThreadCreate unreferenced function argument : 'fp'
sdcc -o test3threads.hex test3threads.rel preemptive.rel
```

Screenshots and explanation:

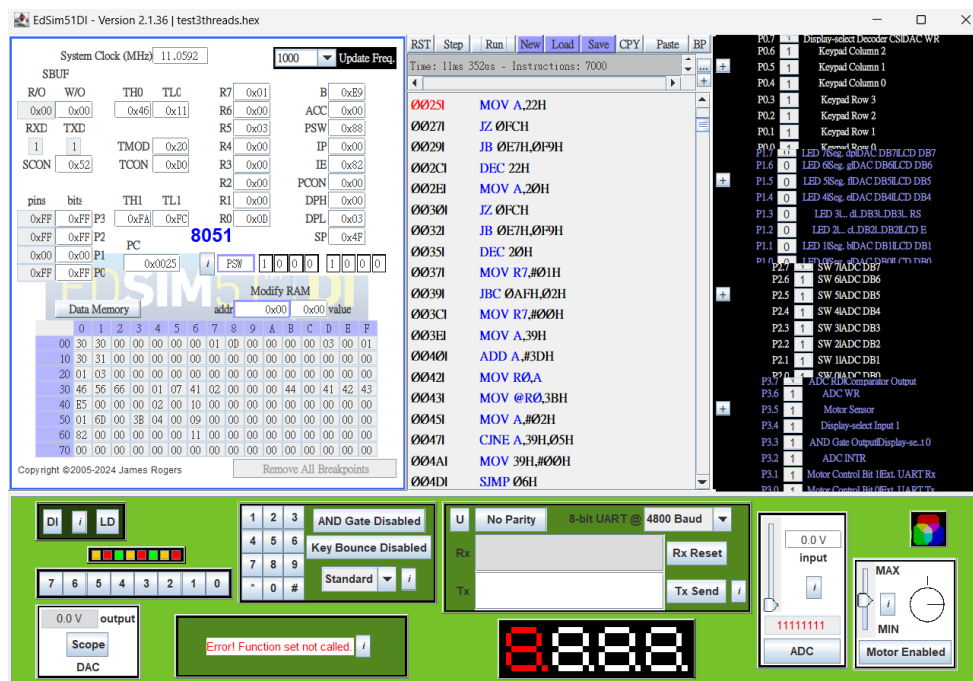
Cur\_ID (34H) is 1, which means producer1 is running.

And now our mutex = 0, full = 1, empty = 1 ◦



After 1400 iteration, cur\_ID(34H) is still 1

But now our mutex = 1, full = 3, empty = 0 ◦ Which means semaphore changes



Cur\_ID (34H) is 2, which means producer2 is running.

And now our mutex = 0, full = 0, empty = 2 ◦

The screenshot shows the EdSim51DI v2.1.36 interface. The assembly window displays the following code:

```
03A7I SIMP 08H
03A9I MOV A,35H
03ABE JNB 0E2H,03H
03AEI MOV 34H,#02H
03B1I MOV A,34H
03B3I ADD A,#30H
03B5I MOV R1,A
03B6I MOV 81H,@R1
03B8I POP 0D0H
03BAI POP 83H
03BCI POP 82H
03BEI POP 0F0H
03C0I POP 0E0H
03C2I MOV A,R7
03C3I RRC A
03C4I MOV 0AFH,C
03C6I RET
03C7I MOV A,08H
03C9I ORL A,09H
```

The hardware simulation at the bottom shows a green background with various components: a DAC, a scope, a keyboard, a display showing '8888', an ADC, and a motor. A red error message 'Error! Function set not called' is visible in the center.

After 1000 iteration, cur\_ID(34H) is still 2

But now our mutex = 1, full = 3, empty = 0 ◦ Which means semaphore changes

The screenshot shows the EdSim51DI v2.1.36 interface. The assembly window displays the following code:

```
0085I MOV A,22H
0087I JZ 0FCH
0089I JB 0E7H,0F9H
008CI DEC 22H
008EI MOV A,20H
0090I JZ 0FCH
0092I JB 0E7H,0F9H
0095I DEC 20H
0097I MOV R7,#01H
0099I JBC 0AFH,02H
009CI MOV R7,#00H
009EI MOV A,39H
00AAI ADD A,#3DH
00A2I MOV R0,A
00A3I MOV @R0,3CH
00A5I MOV A,#02H
00A7I CJNE A,39H,05H
00AAI MOV 39H,#00H
00ADI SIMP 06H
```

The hardware simulation at the bottom shows the same components as the previous screenshot, but the error message is no longer present.

Cur\_ID (34H) is 0, which means consumer is running.

And now our mutex = 0, full = 1, empty = 1 ◦

EdSim51DI - Version 2.1.36 | test3threads.hex

System Clock (MHz): 11.0592

100 Update Freq.

RST Step Run New Load Save CPY Paste BP

Time: 18us 67ns - Instructions: 11100

Assembly Code:

```
00D3 MOV A,#30H
00D5 ADD A,R5
00D6 MOV 3CH,A
00D8 MOV A,R7
00D9 RRC A
00DA MOV 0AFH,C
00DC INC 20H
00DE INC 21H
00E0 SIMP 0A3H
00E2 LCALL 0014H
00E5 MOV A,21H
00E7 JZ 0FCH
00E9 JB 0E7H,0F9H
00EC DEC 21H
00EE MOV A,20H
00F0 JZ 0FCH
00F2 JB 0E7H,0F9H
00F5 DEC 20H
00F7 JNB 99H,0FDH
```

Hardware Panel:

- DI: 7, LD
- AND Gate Disabled
- Key Bounce Disabled
- Standard
- U: No Parity, 8-bit UART @ 4800 Baud
- Rx: [ ] Rx Reset
- Tx: [ ] Tx Send
- 0.0V output, Scope, DAC
- Error! Function set not called.
- 7-segment display: 8888
- 0.0V input, ADC: 11111111
- MAX, MIN, Motor Enabled

After 1900 iteration, cur\_ID(34H) is still 0

But now our mutex = 1, full = 0, empty = 3 ◦ Which means semaphore changes

EdSim51DI - Version 2.1.36 | test3threads.hex

System Clock (MHz): 11.0592

100 Update Freq.

RST Step Run New Load Save CPY Paste BP

Time: 22us 83us - Instructions: 13000

Assembly Code:

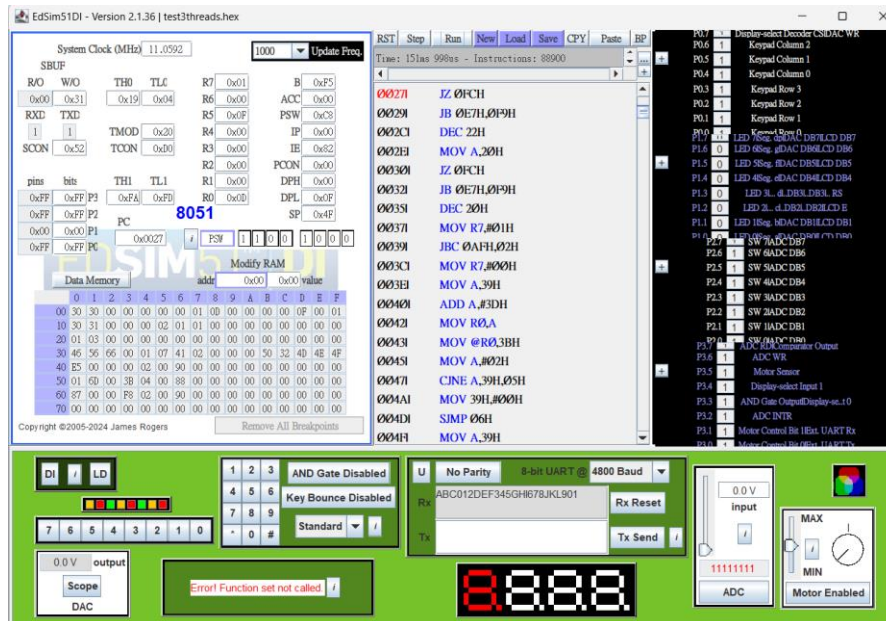
```
00D3 MOV A,#30H
00D5 ADD A,R5
00D6 MOV 3CH,A
00D8 MOV A,R7
00D9 RRC A
00DA MOV 0AFH,C
00DC INC 20H
00DE INC 21H
00E0 SIMP 0A3H
00E2 LCALL 0014H
00E5 MOV A,21H
00E7 JZ 0FCH
00E9 JB 0E7H,0F9H
00EC DEC 21H
00EE MOV A,20H
00F0 JZ 0FCH
00F2 JB 0E7H,0F9H
00F5 DEC 20H
00F7 JNB 99H,0FDH
```

Hardware Panel:

- DI: 7, LD
- AND Gate Disabled
- Key Bounce Disabled
- Standard
- U: No Parity, 8-bit UART @ 4800 Baud
- Rx: AB Rx Reset
- Tx: [ ] Tx Send
- 0.0V output, Scope, DAC
- Error! Function set not called.
- 7-segment display: 8888
- 0.0V input, ADC: 11111111
- MAX, MIN, Motor Enabled

## Fair Version:

At the start, it is producer1's turn. Producer1 produces 3 alphabets, after which the consumer outputs these 3 alphabets. Then, the turn switches to producer2, which produces 3 numbers, and the consumer outputs these 3 numbers. The two producers alternate turns after producing 3 alphabets or numbers each.



## Unfair Version:

At the start, it is producer1's turn. Producer1 produces 3 alphabets, and then the turn switches to producer2. However, since mutex = 1, full = 3, and empty = 0, the buffer is already full. As a result, when the turn switches to the consumer, it can only output 3 alphabets and cannot output 3 numbers.

