

# Report of Project Checkpoint 3

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## 1. Screenshots for compilation

```
misubrian@misubrian-Katana-15-B13VFK:~/OS/project/CP3/misu$ make clean
rm *.hex *.ihx *.lnk *.lst *.map *.mem *.rel *.rst *.sym *.asm *.lk
rm: 無法刪除 '*.ihx': 沒有此一檔案或目錄
rm: 無法刪除 '*.lnk': 沒有此一檔案或目錄
make: *** [Makefile:25: clean] 錯誤 1
misubrian@misubrian-Katana-15-B13VFK:~/OS/project/CP3/misu$ make
sdcc -c testpreempt.c
sdcc -c preemptive.c
preemptive.c:214: warning 85: in function ThreadCreate unreferenced function argument : 'fp'
sdcc -o testpreempt.hex testpreempt.rel preemptive.rel
misubrian@misubrian-Katana-15-B13VFK:~/OS/project/CP3/misu$
```

## 2.

Addresses:

Producer: 0x001D

Consumer: 0x007F

Semaphore full: 0x3C

Semaphore empty: 0x3D

Semaphore mutex: 0x3E

### (a)

(I) Producer starts running. Initially, full = 0, empty = 3, mutex = 1.

System Clock (MHz) 11.0592 | 1000 | Update Freq.

SBUF

R/O	W/O	TH0	TL0	R7	0x00	B	0x00
0x00	0x00	0x03	0x15	R6	0x00	ACC	0x00
RXD	TXD	TH0D	0x20	R5	0x00	PSW	0x08
1	1	TCON	0xD0	R4	0x00	IP	0x00
SCON	0x50			R3	0x00	IE	0x82
				R2	0x80	PCON	0x00
				R1	0x01	DPH	0x00
				R0	0x08	DPL	0x00
						SP	0x4F

pins bits | TH1 | TL1

0xFF	0xFF	P3	0xFA	0xFE
0xFF	0xFF	P2		
0xFF	0xFF	P1		
0xFF	0xFF	P0		

PC 8051 | 0x001D | PSW 00000100

Data Memory

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	38	01	00	00	02	01	01	08	01	80	00	00	00	00	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	04	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	01	02	01	00	00	00	46	56	00	00	00	00	03	01	00
40	93	00	00	00	01	00	80	37	37	01	00	00	02	01	01	00
50	1D	00	00	00	00	00	09	00	00	00	00	00	00	00	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	00	00	00	00	00	00	00	00	00	00	00

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Time: 9ms 26us - Instructions: 5016

```

001D* MOV 3BH, #41H
0020 MOV A, 3DH
0022 JB 0E7H, 0FBH
0025 JZ 0F9H
0027 DEC 3DH
0029 MOV A, 3EH
002B JB 0E7H, 0FBH
002E JZ 0F9H
0030 DEC 3EH
0032 SETB 00H
0034 JBC 0AFH, 02H
0037 CLR 00H
0039 MOV A, 76H
003B ADD A, #34H
003D MOV R0, A
003E MOV @R0, 3BH
0040 MOV R6, 76H
0042 MOV R7, #00H
0044 MOV 82H, R6
0046 MOV 83H, R7
0048 INC DPTR
0049 MOV 08H, #03H
004C MOV 09H, R7
004E LCALL 0322H
0051 MOV R6, 82H

```

(ii) Producer is in its critical section because mutex = 0.

It has gotten out of “wait(empty)”, therefore, “empty” has been minus one. Now full = 2, and empty = 0.

System Clock (MHz) 11.0592 | 100 | Update Freq.

SBUF

R/O	W/O	TH0	TL0	R7	0x00	B	0xFF
0x00	0x43	0x0D	0x0C	R6	0x02	ACC	0xFF
RXD	TXD	TH0D	0x20	R5	0x00	PSW	0xC8
1	1	TCON	0xD0	R4	0x00	IP	0x00
SCON	0x50			R3	0x00	IE	0x02
				R2	0x01	PCON	0x00
				R1	0x00	DPH	0x00
				R0	0x06	DPL	0x03
						SP	0x53

pins bits | TH1 | TL1

0xFF	0xFF	P3	0xFA	0xFB
0xFF	0xFF	P2		
0xFF	0xFF	P1		
0xFF	0xFF	P0		

PC 8051 | 0x02F7 | PSW 11001000

Data Memory

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	38	00	00	00	02	00	00	06	00	01	00	00	00	02	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	07	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	01	02	01	44	45	46	46	56	00	00	4	02	00	00	00
40	93	00	00	00	00	00	80	37	36	00	00	00	02	00	00	00
50	51	00	49	03	00	00	08	38	00	00	00	00	00	44	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	00	02	00	00	00	00	00	00	00	00	00

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Time: 27ms 141us - Instructions: 14653

```

02C8 POP 02H
02CC POP 0F0H
02CE POP 0E0H
02D0 POP 0D0H
02D2 MOV 0AFH, C
02D4 RET
02D5 MOV A, 08H
02D7 ORL A, 09H
02D9 JZ 46H
02DB MOV R2, #01H
02DD MOV A, 08H
02DF ADD A, 0E0H
02E1 MOV 08H, A
02E3 MOV A, 09H
02E5 RLC A
02E6 JC 12H
02E8 MOV 09H, A
02EA MOV A, 82H
02EC SUBB A, 08H
02EE MOV A, 83H
02F0 SUBB A, 09H
02F2 JC 03H
02F4 INC R2
02F5 SJMP 0E6H
02F7 CLR C

```

(iii) The mutex has been unlocked.

System Clock (MHz)11.0592100Update Freq.

SBUF

R/O W/O TH0 TL0

0x00 0x43 0x0E 0x17

R7 0x00 B 0x00

R6 0x00 ACC 0x01

R5 0x00 PSW 0x89

R4 0x00 IP 0x00

R3 0x00 IE 0x82

R2 0x00 PCON 0x00

R1 0x00 DPH 0x00

R0 0x01 DPL 0x00

SP 0x4F

RXD TXD

1 1

TH0D 0x20

SCON 0x50 TCON 0xD0

pins bits TH1 TL1

0xFF 0xFF P3 0xFA 0xFC

0xFF 0xFF P2

0xFF 0xFF P1

0xFF 0xFF P0

PC 0x005D

PSW 1 0 0 0 1 0 0 1

Modify RAM

addr 0x00 0x00 value

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	38	00	00	00	02	00	00	01	00	00	00	00	00	00	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	07	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	01	02	01	44	45	46	46	56	00	00	46	02	00	01	00
40	93	00	00	00	00	00	80	37	36	00	00	00	02	00	00	00
50	51	00	49	03	00	00	08	38	00	00	00	00	00	44	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	00	00	00	00	00	00	00	00	00	00	00

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Remove All Breakpoints

RST Step Run New Load Save CPY Paste BP

Executed 0x005B: INC 3EH | Time: 27ms 188us

0051| MOV R6, 82H

0053| MOV R7, 83H

0055| MOV 76H, R6

0057| MOV C, 00H

0059| MOV 0AFH, C

005B| INC 3EH

005D| INC 3CH

005F| MOV A, #5AH

0061| CJNE A, 3BH, 03H

0064| SETB C

0065| SJMP 01H

0067| CLR C

0068| MOV 00H, C

006A| JC 0BH

006C| MOV R7, 3BH

006E| INC R7

006F| MOV A, R7

0070| MOV R6, A

0071| RLC A

0072| SUBB A, 0E0H

0074| MOV R7, A

0075| SJMP 04H

0077| MOV R6, #41H

0079| MOV R7, #00H

007B| MOV 3BH, 06

(iv) After signal(full), full = 3.

System Clock (MHz)11.0592100Update Freq.

SBUF

R/O W/O TH0 TL0

0x00 0x43 0x0E 0x18

R7 0x00 B 0x00

R6 0x00 ACC 0x01

R5 0x00 PSW 0x89

R4 0x00 IP 0x00

R3 0x00 IE 0x82

R2 0x00 PCON 0x00

R1 0x00 DPH 0x00

R0 0x01 DPL 0x00

SP 0x4F

RXD TXD

1 1

TH0D 0x20

SCON 0x50 TCON 0xD0

pins bits TH1 TL1

0xFF 0xFF P3 0xFA 0xFD

0xFF 0xFF P2

0xFF 0xFF P1

0xFF 0xFF P0

PC 0x005F

PSW 1 0 0 0 1 0 0 1

Modify RAM

addr 0x00 0x00 value

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	38	00	00	00	02	00	00	01	00	00	00	00	00	00	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	07	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	01	02	01	44	45	46	46	56	00	00	46	03	00	01	00
40	93	00	00	00	00	00	80	37	36	00	00	00	02	00	00	00
50	51	00	49	03	00	00	08	38	00	00	00	00	00	44	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	00	00	00	00	00	00	00	00	00	00	00

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Remove All Breakpoints

RST Step Run New Load Save CPY Paste BP

Executed 0x005D: INC 3CH | Time: 27ms 189us

0051| MOV R6, 82H

0053| MOV R7, 83H

0055| MOV 76H, R6

0057| MOV C, 00H

0059| MOV 0AFH, C

005B| INC 3EH

005D| INC 3CH

005F| MOV A, #5AH

0061| CJNE A, 3BH, 03H

0064| SETB C

0065| SJMP 01H

0067| CLR C

0068| MOV 00H, C

006A| JC 0BH

006C| MOV R7, 3BH

006E| INC R7

006F| MOV A, R7

0070| MOV R6, A

0071| RLC A

0072| SUBB A, 0E0H

0074| MOV R7, A

0075| SJMP 04H

0077| MOV R6, #41H

0079| MOV R7, #00H

007B| MOV 3BH, 06

(v) After a while, producer is running now, but it gets stuck due to full = 3, i.e. buffer is full now.

System Clock (MHz) 11.0592 | 1000 | Update Freq.

SBUF

R/O	W/O	TH0	TL0	R7	0x00	B	0x00
0x00	0x4F	0xCE	0x12	R6	0x53	ACC	0x00
RXD	TXD	THOD	0x20	R5	0x00	PSW	0x08
1	1	TCON	0xD0	R4	0x00	IP	0x00
SCON	0x50			R3	0x00	IE	0x82
				R2	0x00	PCON	0x00
pins	bits	TH1	TL1	R1	0x00	DPH	0x00
0xFF	0xFF	0xFA	0xFB	R0	0x01	DPL	0x00
0xFF	0xFF					SP	0x4F
0xFF	0xFF						

PC 8051 | PSW 00000100

Data Memory		Modify RAM	
addr	0x00	0x00	value
0	37	38	00 00 02 00 01 00 00 00 00 00 00 00 00 53 00
10	00	00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
20	06	00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
30	03	01	02 01 50 51 52 46 56 00 00 53 03 00 01 00
40	93	00	00 00 00 00 80 37 36 00 00 00 00 00 00 00 00
50	51	00	49 03 00 00 08 38 00 00 00 00 00 00 50 00 00
60	00	00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
70	00	42	00 4F 00 00 00 00 00 00 00 00 00 00 00 00 00

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Executed 0x0020: MOV A,3DH | Time: 104ms 96

```

001D* MOV 3BH,#41H
0020| MOV A,3DH
0022| JB 0E7H,0FBH
0025| JZ 0F9H
0027| DEC 3DH
0029| MOV A,3EH
002B| JB 0E7H,0FBH
002E| JZ 0F9H
0030| DEC 3EH
0032| SETB 00H
0034| JBC 0AFH,02H
0037| CLR 00H
0039| MOV A,76H
003B| ADD A,#34H
003D| MOV R0,A
003E| MOV @R0,3BH
0040| MOV R6,76H
0042| MOV R7,#00H
0044| MOV 82H,R6
0046| MOV 83H,R7
0048| INC DPTR
0049| MOV 08H,#03H
004C| MOV 09H,R7
004E| LCALL 0322H
0051| MOV R6,82H

```

2. (b)

(I) Consumer starts running. Initially, full = 0, empty = 3, and mutex = 1.

System Clock (MHz) 11.0592 | 1000 | Update Freq.

SBUF

R/O	W/O	TH0	TL0	R7	0x01	B	0x00
0x00	0x00	0x08	0x0F	R6	0x01	ACC	0x38
RXD	TXD	THOD	0x00	R5	0x02	PSW	0x81
1	1	TCON	0x10	R4	0x00	IP	0x00
SCON	0x00			R3	0x00	IE	0x82
				R2	0x01	PCON	0x00
pins	bits	TH1	TL1	R1	0x37	DPH	0x00
0xFF	0xFF	0x00	0x00	R0	0x38	DPL	0x01
0xFF	0xFF					SP	0x3F
0xFF	0xFF						

PC 8051 | PSW 10000001

Data Memory		Modify RAM	
addr	0x00	0x00	value
0	38	37	01 00 00 02 01 01 08 01 80 00 00 00 00 00 00
10	00	00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
20	04	00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
30	03	00	00 01 00 00 46 56 00 00 00 00 00 00 00 00 00
40	EC	00	80 00 00 00 00 00 00 00 00 00 00 00 00 00 00
50	1D	00	00 00 00 00 09 00 00 00 00 00 00 00 00 00 00
60	00	00	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
70	00	42	00 4F 00 00 00 00 00 00 00 00 00 00 00 00 00

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Time: 304us - Instructions: 186

```

0070| MOV R6,A
0071| RLC A
0072| SUBB A,0E0H
0074| MOV R7,A
0075| SJMP 04H
0077| MOV R6,#41H
0079| MOV R7,#00H
007B| MOV 3BH,R6
007D| SJMP 0A1H
007F* CLR 0AFH
0081| ORL 89H,#20H
0084| MOV 8DH,#0FAH
0087| MOV 98H,#50H
008A| SETB 8EH
008C| SETB 0AFH
008E| MOV A,3CH
0090| JB 0E7H,0FBH
0093| JZ 0F9H
0095| DEC 3CH
0097| MOV A,3EH
0099| JB 0E7H,0FBH
009C| JZ 0F9H
009E| DEC 3EH
00A0| SETB 01H

```

(ii) Consumer is in its critical section because mutex = 0.



It has gotten out of “wait(full)”, therefore, full has been minus one. Now full = 0, and empty = 2.

System Clock (MHz) 11.0592 | 100 | Update Freq.

8051

PC 0x00C1

PSW 1 0 0 0 0 0 0 1

Data Memory

addr	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	36	00	00	00	02	00	00	01	00	00	00	00	00	44	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	06	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	00	01	01	41	42	43	46	56	00	00	44	00	02	00	00
40	BF	00	49	03	01	00	80	37	37	01	00	00	02	01	01	00
50	20	00	00	00	00	00	08	38	00	00	00	00	00	44	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	02	00	00	00	00	00	00	00	00	00	00

Remove All Breakpoints

Assembly Code:

```

00BF | MOV R6, 82H
00C1 | MOV R7, 83H
00C3 | MOV 75H, R6
00C5 | MOV C, 01H
00C7 | MOV 0AFH, C
00C9 | INC 3EH
00CB | INC 3DH
00CD | JBC 99H, 0BEH
00D0 | SJMP 0FBH
00D2 | SETB 02H
00D4 | JBC 0AFH, 02H
00D7 | CLR 02H
00D9 | MOV 3DH, #03H
00DC | MOV 3CH, #00H
00DF | MOV 3EH, #01H
00E2 | MOV C, 02H
00E4 | MOV 0AFH, C
00E6 | MOV DPTR, #001DH
00E9 | LCALL 011DH
00EC | LJMP 007FH
00EF | LJMP 00FAH
00F2 | RET
00F3 | RET
00F4 | RET

```

(iii) After exiting critical section, empty becomes 3 and mutex becomes 1.

System Clock (MHz) 11.0592 | 100 | Update Freq.

8051

PC 0x00CD

PSW 1 0 0 0 0 0 0 1

Data Memory

addr	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	36	00	00	00	02	00	00	01	00	00	00	00	00	44	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	06	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	00	01	01	41	42	43	46	56	00	00	44	00	03	01	00
40	BF	00	49	03	01	00	80	37	37	01	00	00	03	03	03	00
50	20	00	00	00	00	00	08	38	00	00	00	00	00	44	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	00	00	00	00	00	00	00	00	00	00	00

Remove All Breakpoints

Assembly Code:

```

00BF | MOV R6, 82H
00C1 | MOV R7, 83H
00C3 | MOV 75H, R6
00C5 | MOV C, 01H
00C7 | MOV 0AFH, C
00C9 | INC 3EH
00CB | INC 3DH
00CD | JBC 99H, 0BEH
00D0 | SJMP 0FBH
00D2 | SETB 02H
00D4 | JBC 0AFH, 02H
00D7 | CLR 02H
00D9 | MOV 3DH, #03H
00DC | MOV 3CH, #00H
00DF | MOV 3EH, #01H
00E2 | MOV C, 02H
00E4 | MOV 0AFH, C
00E6 | MOV DPTR, #001DH
00E9 | LCALL 011DH
00EC | LJMP 007FH
00EF | LJMP 00FAH
00F2 | RET
00F3 | RET
00F4 | RET

```

(iv) After a while, consumer is running but gets stuck, because the buffer is empty now. (empty = 3)

System Clock (MHz) 11.0592

1000 Update Freq.

SBUF

R/O W/O TH0 TL0 R7 0x00 B 0x00  
0x00 0x58 0xF5 0x1B R6 0x00 ACC 0x00

RXD TXD TH0D 0x20 R5 0x02 PSW 0x80  
1 1 TCON 0xD0 R4 0x00 IP 0x00  
SCON 0x50 R3 0x00 IE 0x82  
R2 0x00 PCON 0x00

pins bits TH1 TL1 R1 0x36 DPH 0x00  
0xFF 0xFF P3 0xFA 0xFC R0 0x37 DPL 0x00  
0xFF 0xFF P2 PC 8051 SP 0x3F  
0xFF 0xFF P1 0x0090 i PSW 1 0 0 0 0 0 0 0  
0xFF 0xFF P0

Data Memory

Modify RAM

addr 0x00 0x00 value

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
00	37	36	00	00	00	02	00	00	01	00	00	00	00	00	59	00
10	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
20	06	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
30	03	00	01	01	56	57	58	46	56	00	00	50	00	03	01	00
40	BF	00	49	03	00	00	80	37	36	00	00	00	00	00	00	00
50	20	00	00	00	00	00	08	38	00	00	00	00	00	59	00	00
60	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
70	00	42	00	4F	00	00	00	00	00	00	00	00	00	00	00	00

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Remove All Breakpoints

RST Step Run New Load Save CPY Paste BP

Executed 0x008E: MOV A,3CH | Time: 150ms 76

```
0070| MOV R6,A
0071| RLC A
0072| SUBB A,0E0H
0074| MOV R7,A
0075| SJMP 04H
0077| MOV R6,#41H
0079| MOV R7,#00H
007B| MOV 3BH,R6
007D| SJMP 0A1H
007F* CLR 0AFH
0081| ORL 89H,#20H
0084| MOV 8DH,#0FAH
0087| MOV 98H,#50H
008A| SETB 8EH
008C| SETB 0AFH
008E| MOV A,3CH
0090| JB 0E7H,0FBH
0093| JZ 0F9H
0095| DEC 3CH
0097| MOV A,3EH
0099| JB 0E7H,0FBH
009C| JZ 0F9H
009E| DEC 3EH
00A0| SETB 01H
```