

# Checkpoint 4 Report

## Testpreempt.c

In this file, I will two variables from the previous checkpoints: buffer and token. Buffer is used for the shared buffer between the producer and consumer. Token is used to generate characters from A to Z for the producer. There are also other additional variables : head and tail to keep track of the circular queue, mutex, full and empty for the semaphore variables.

In the main function, Token is initialized to A. Main will spawn consumer thread, while main itself calls producer. This is done to not waste main's thread, more economical. We also need to create three new semaphores : full, mutex and empty. Set full to 0, mutex to 1, and empty to 3 (since we have 3 deep buffer). I followed the materials taught during the lectures. Then we set head and tail to 0 to indicate that both of them point to the initial position of the 3 deep buffer.

In the producer function, before it enters the infinite loop, I initialized the token to 'A' first, to make sure that token is really initialized to 'A'. After it enters the loop, it will perform semaphorewaitbody for empty and mutex to check whether there is still an empty space in the buffer and whether it's the producer turn. Buffer will take the value in token, then update the value in token. When buffer is taking the value of token, it should be in critical section since SDCC suggests that you can surround the code fragment where they access the shared variable, in this case it's buffer, to ensure that the shared variables are accessed atomically. Updating the tail value should also be inside the critical section since if it's not, then interrupt might interrupt it before tails could update its index position and this might cause an unwanted error. Then signal the mutex to indicate that it's the consumer turn and signal full to indicate that buffer has been fully filled.

In the consumer function, before it enters the infinite loop, we initialize Tx for polling. After it enters the loop, it will semaphorewaitbody the full and mutex semaphores to check whether the data in buffer have been consumed and it's the consumer turn. SBUF(reading or writing register) will take the value in buffer, then we update the value of head, then we signal the mutex and empty semaphores for the producer, then we check if Tx is busy (serial port hasn't finished writing it yet), then we keep polling again. Finally, we reset It to 0 again.

## Preemptive.h

I added a semaphore API to this file.

The SemaphoreCreate function the semaphore s to the value n.

The SemaphoreSignal only increment the value in the semaphore variable.

The SemaphoreWait basically reads the value of S into ACC then checks if ACC is <= 0 o not.

## Test3threads.c

This file is mainly based on the test3threads.c. Here we have two producer functions, one function will produce an output from 'A' to 'Z' and the other will output '0' to '9'. At first, before I fixed this semaphore

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thing, if I placed the producer1 above producer 2, then it will only output producer 1, and if I placed producer 2 above producer 1, then it wil output only producer 2.

Therefore, in main function, we need two more semaphores called producer1\_ready which is initialized to 1 so that producer 1 will run first and producer2\_ready which is initialized to 0 so that producer 2 will not run before producer 1 finish. Token2 is initialized to 0. Then we create two threads for producer 1 and producer 2.

In producer1, it's basically the same as the previous checkpoints, it's just now we add semaphorewaitbody producer\_1 ready to check whether it's producer 1's turn. After we finish, then we signal producer\_2 ready to indicate that now it's producer2's turn.

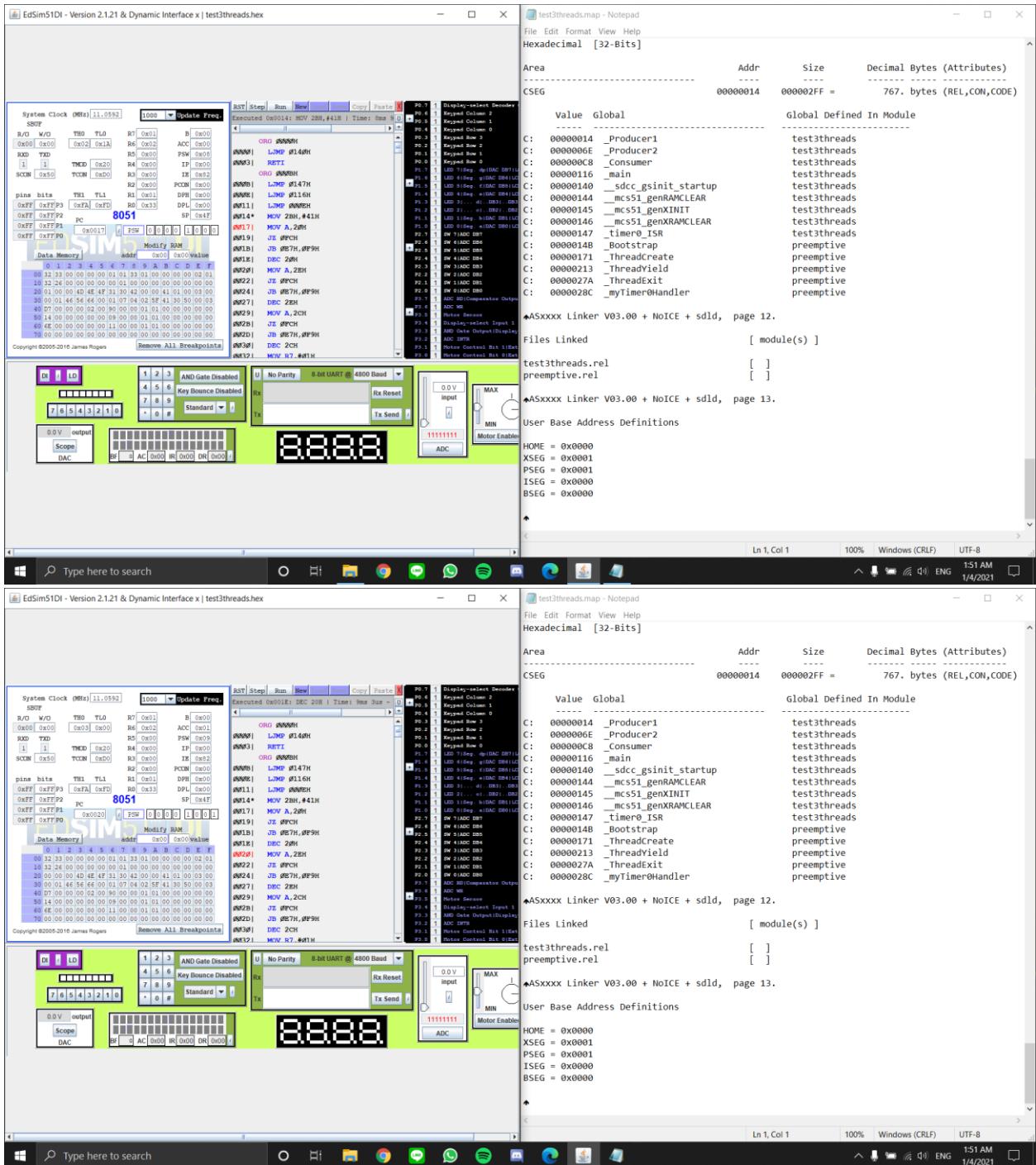
In producer2, it's also the same idea as producer 1. We add semaphorewaitbody for producer\_2 to check whether now it's producer 2's turn or not. After we finish all, then we signal producer\_1 ready to give the turn to producer 1.

The rest are the same as checkpoint 3.

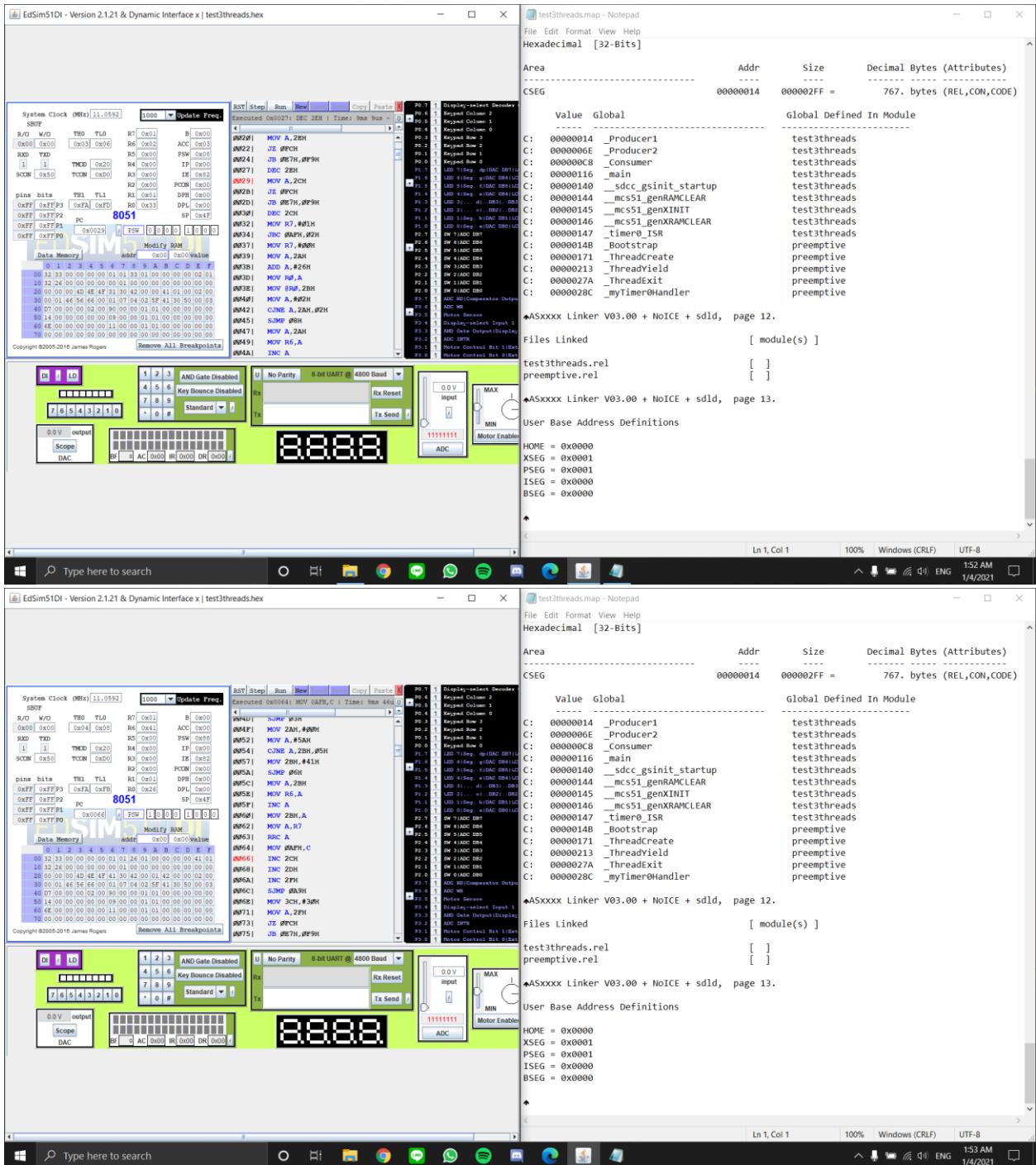
### **Breakpoints**

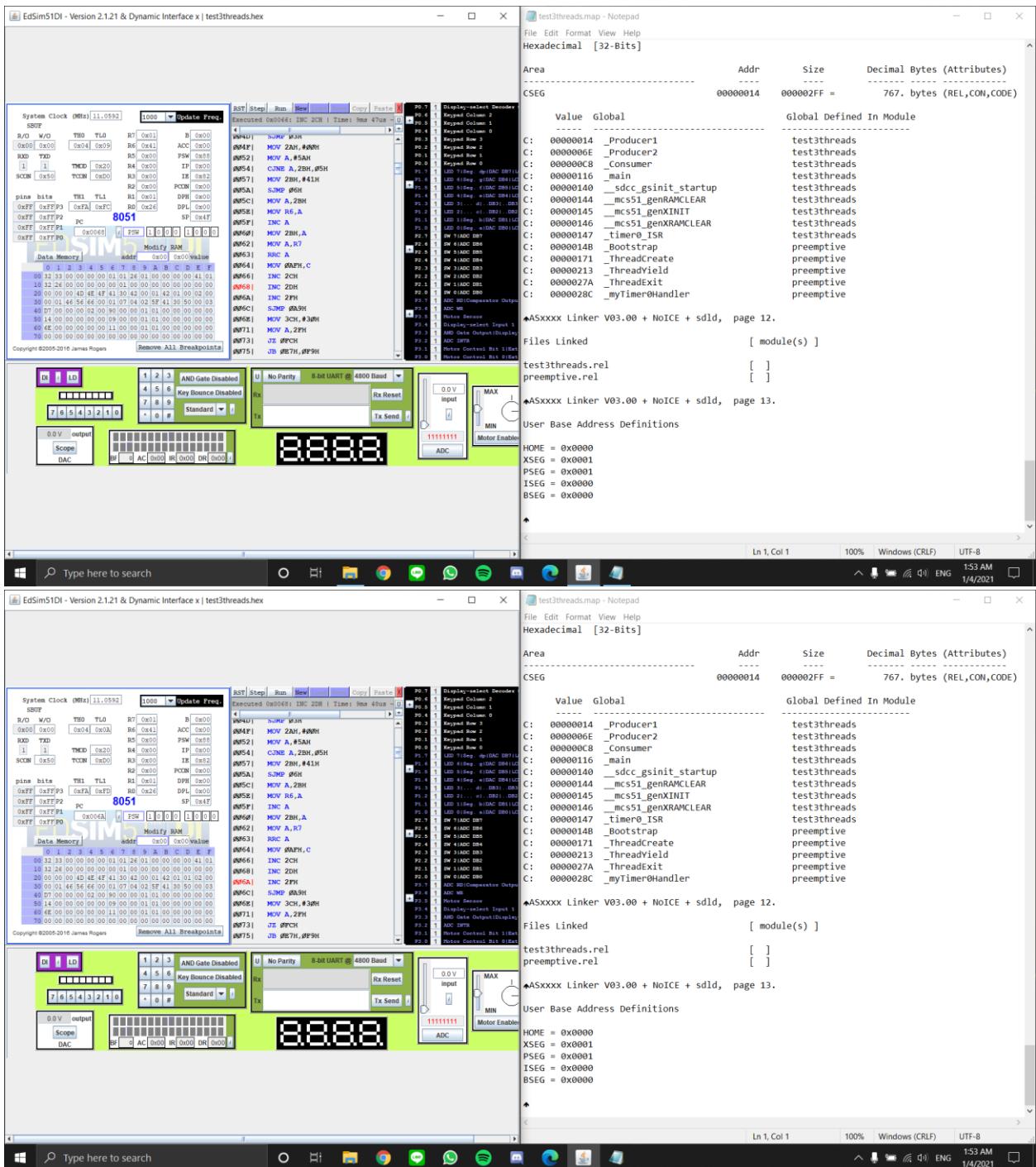
1. Producer1 is running and show semaphore changes

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2. Producer 2 is running and show semaphore changes

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**EdSim51DI - Version 2.1.21 & Dynamic Interface x | test3threads.hex**

**test3threads.map - Notepad**

Area	Addr	Size	Decimal Bytes (Attributes)
CSEG	00000014	000002FF =	767. bytes (REL,CON,CODE)

Value	Global	Global Defined In Module
C: 00000014 _Producer1		test3threads
C: 0000006E _Producer2		test3threads
C: 000000C8 _Consumer		test3threads
C: 00000116 _main		test3threads
C: 00000140 __sdc_gsinit_startup		test3threads
C: 00000144 __mcs51_genRAMCLEAR		test3threads
C: 00000145 __mcs51_genXINIT		test3threads
C: 00000146 __mcs51_genRAMCLEAR		test3threads
C: 00000147 timer0_ISR		test3threads
C: 0000014B _Bootstrap		preemptive
C: 00000171 _ThreadCreate		preemptive
C: 00000213 _ThreadYield		preemptive
C: 0000027A _ThreadExit		preemptive
C: 0000028C _myTimer0Handler		preemptive

◆ASXXX Linker V03.00 + NoICE + sdld, page 12.

Files Linked [ module(s) ]

- test3threads.rel [ ]
- preemptive.rel [ ]

◆ASXXX Linker V03.00 + NoICE + sdld, page 13.

User Base Address Definitions

```

HOME = 0x0000
XSEG = 0x0001
PSEG = 0x0001
ISEG = 0x0000
BSEG = 0x0000

```

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C: 00000147 timer0_ISR		test3threads
C: 0000014B _Bootstrap		preemptive
C: 00000171 _ThreadCreate		preemptive
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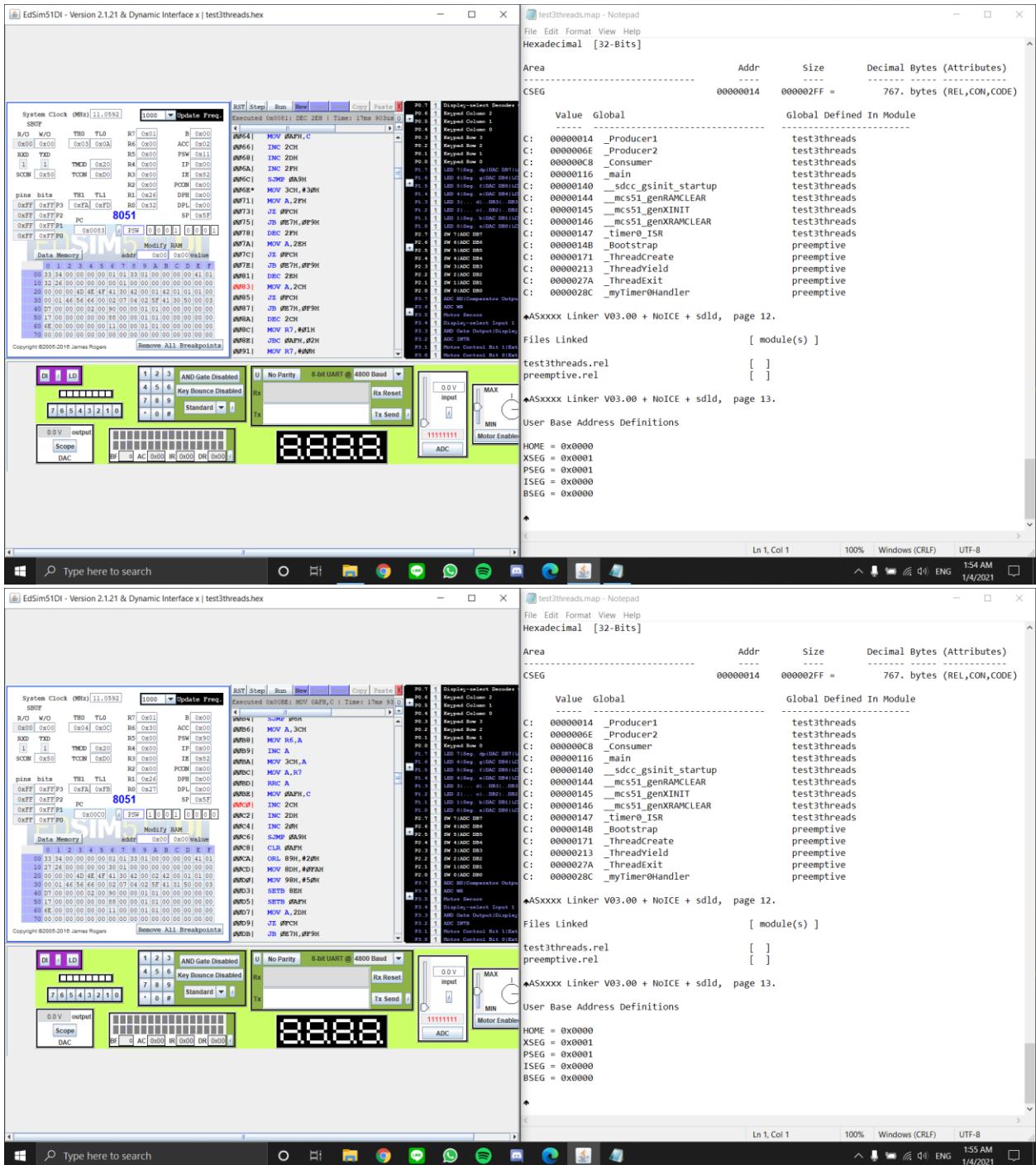
User Base Address Definitions

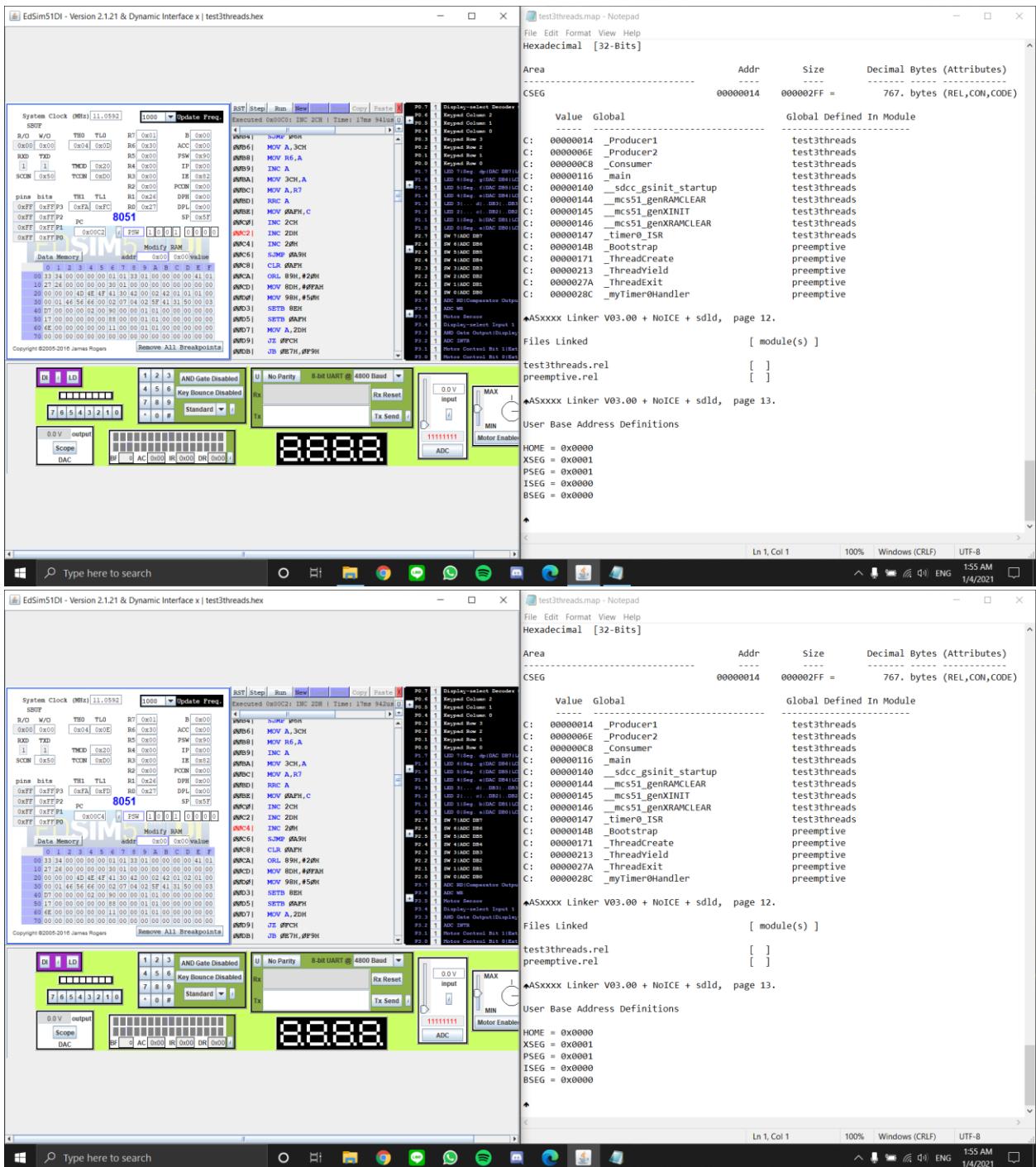
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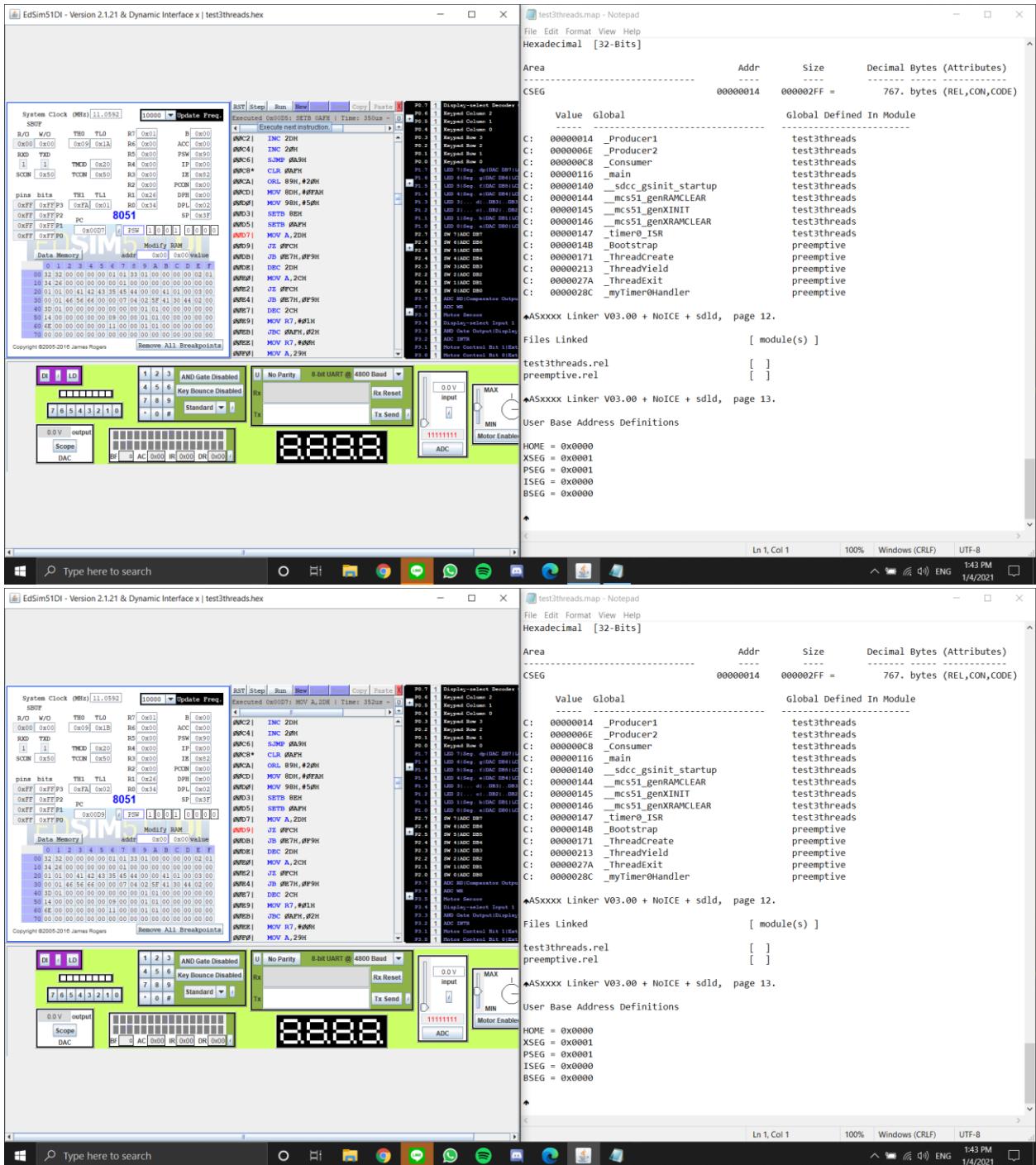
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3. Consumer is running and show semaphore changes

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**EdSim51DI - Version 2.1.21 & Dynamic Interface x | test3threads.hex**

**test3threads.map - Notepad**

Area	Addr	Size	Decimal Bytes (Attributes)
CSEG	00000014	000002FF =	767. bytes (REL,CON,CODE)

**Global Defined In Module**

```

Value Global
C: 00000014 _Producer1
C: 00000006 _Producer2
C: 00000008 _Consumer
C: 00000016 __main
C: 00000140 __sdcc_gsinit_startup
C: 00000144 __mcs51_genRAMCLEAR
C: 00000145 __mcs51_genINIT
C: 00000146 __mcs51_genRAMCLEAR
C: 00000147 timer0_ISR
C: 00000148 _Bootstrap
C: 00000171 _ThreadCreate
C: 00000213 _ThreadYield
C: 0000027A _ThreadExit
C: 0000028C _myTimerHandler

```

◆ASXXX Linker V03.00 + Noice + sdld, page 12.

**Files Linked**

- [ module(s) ]
- test3threads.rel [ ]
- preemptive.rel [ ]

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◆ASXXX Linker V03.00 + Noice + sdld, page 12.

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**test3threads.map - Notepad**

File Edit Format View Help  
Hexadecimal [32-Bits]

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Value Global

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C: 000000C8 _Consumer
C: 00000116 __main
C: 00000140 __sdc_gsinit_startup
C: 00000144 __mcs51_genRAMCLEAR
C: 00000145 __mcs51_genINIT
C: 00000146 __mcs51_genRAMCLEAR
C: 00000147 timer0_ISR
C: 0000014B _Bootstrap
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Global Defined In Module

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**test3threads.map - Notepad**

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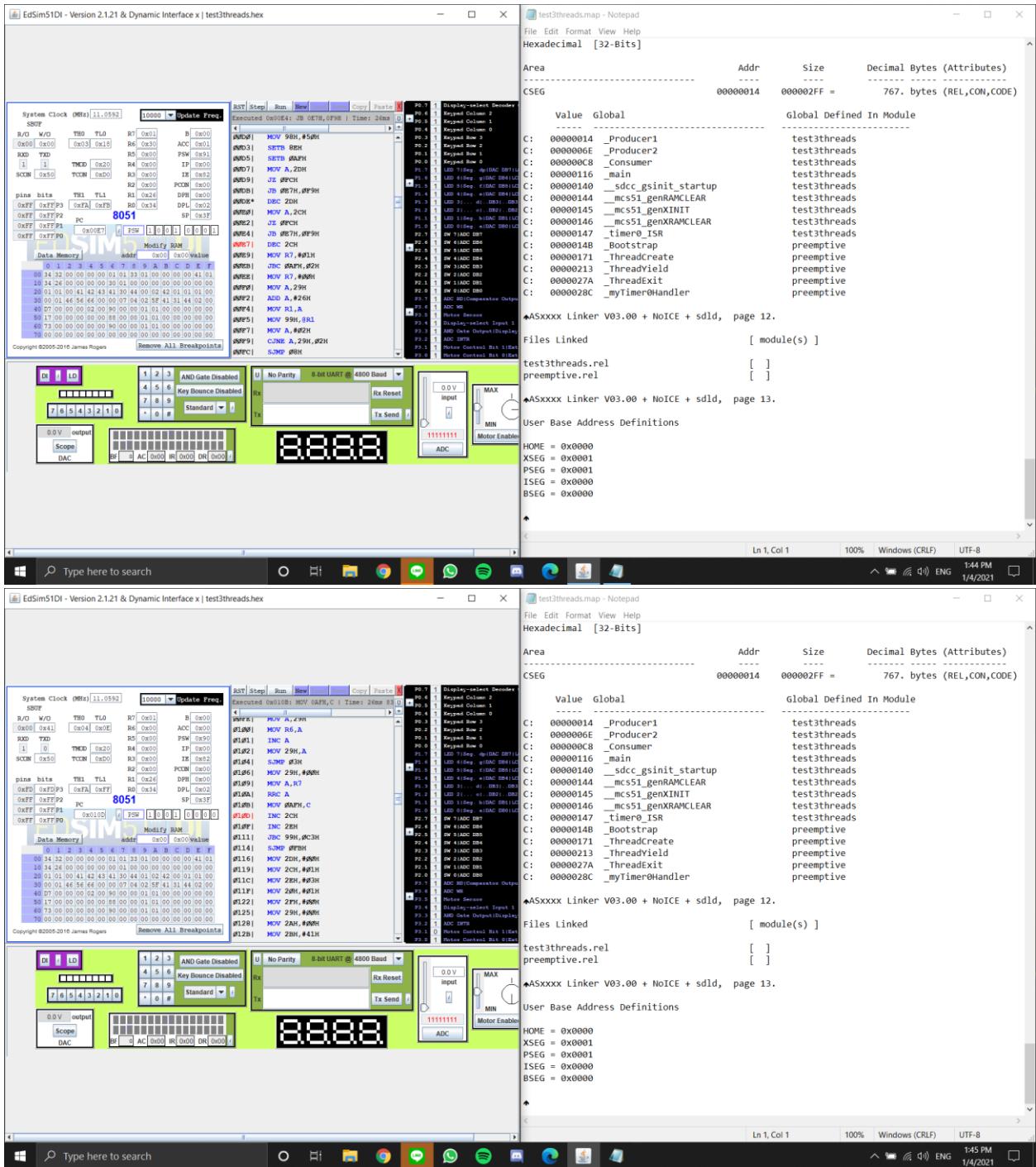
```

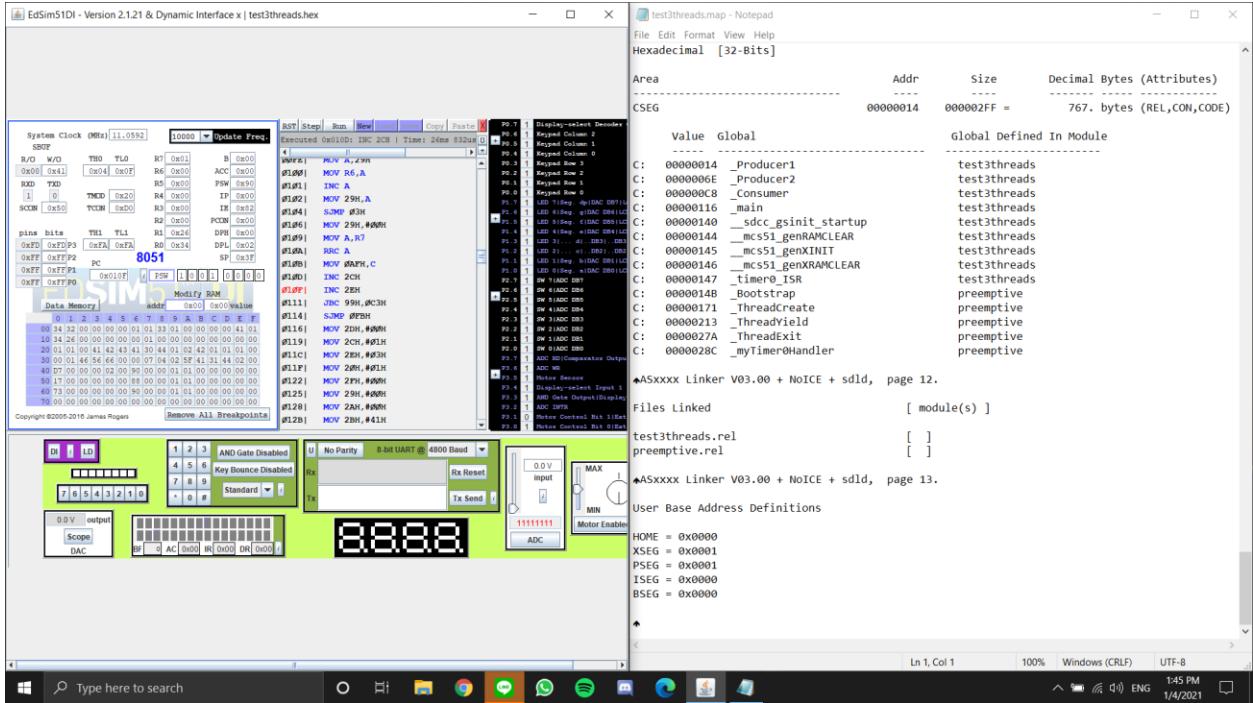
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PSEG = 0x0001
ISEG = 0x0000
BSEG = 0x0000

```

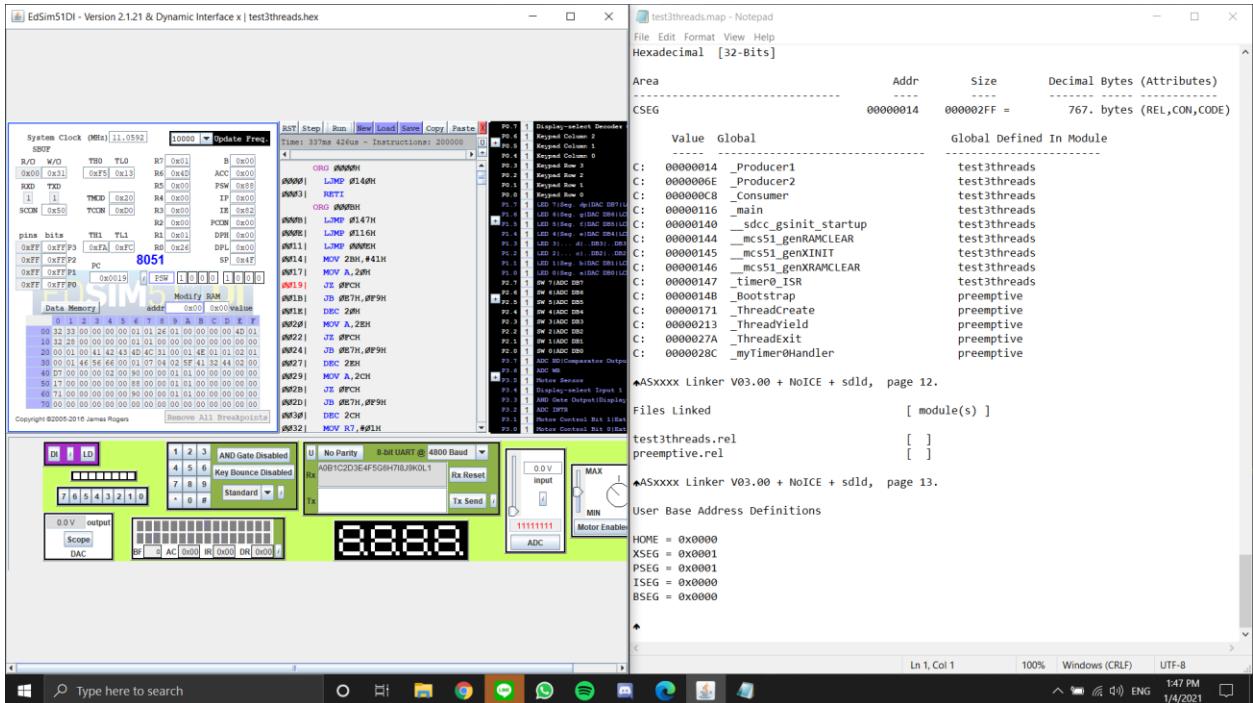
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#### 4. Show and explain UART output to show the fair version.



As you can see, the producer1 and producer2 gets equal chance to output data as the data shown is A0B1C2... This can be done due to using two semaphores of producer1\_ready and producer2\_ready. After producer1 has produced, it will signal producer2\_ready so that the next turn, it's the producer2's turn, not producer1 again, and we will have to wait for producer2 to finish and signal producer1\_ready In order for producer 1 to be able to output again.