Homework 6 – SystemC AMS Modeling - ELN

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I. Introduction

In this homework, we are about to make a Band-Pass Filter using *SystemC-AMS* ELN elements. This is done by combining a low-pass filter and a high-pass filter.

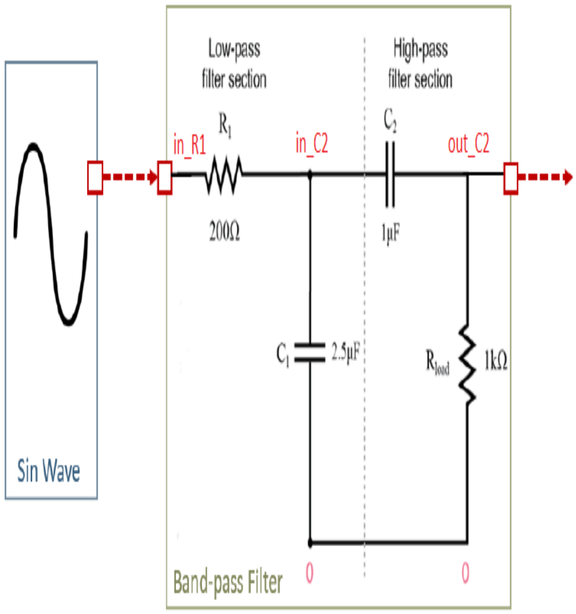

Figure 1 – An overall view of the system

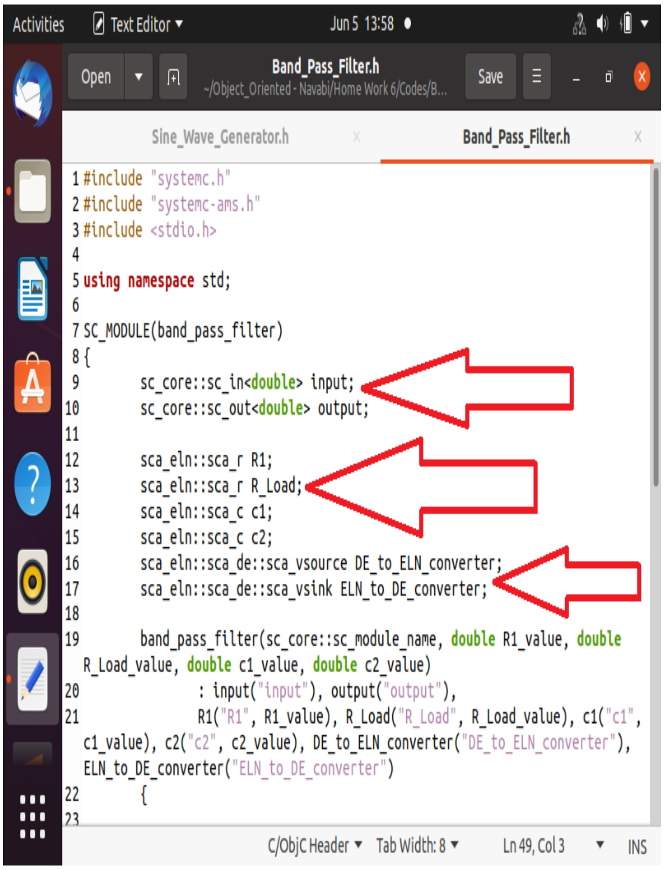

Fig. 2 *Band-Pass Filter SystemC-AMS*

II. Band pass filter implementation

A. Band-Pass Filter in SystemC-AMS

To design the *Band-Pass Filter*, first R1, R_{load}, C1 and C2 are defined. Input and output of this filter are DE double signals, so a DE to ELN source converter and an ELN to DE sink converter are declared to convert the DE input signal to ELN and convert the ELN filter output to DE double signal.

Then simply we connect n and p (negative and positive) nodes of these elements to form the *Band-Pass Filter*. The DE to ELN converter must be connected to the input of the filter and the ELN to DE converter must be connected to the output of the filter. Gnd reference node and internal nodes (input node of R1, input node of C2, output node of C2) are defined as private ELN nodes.

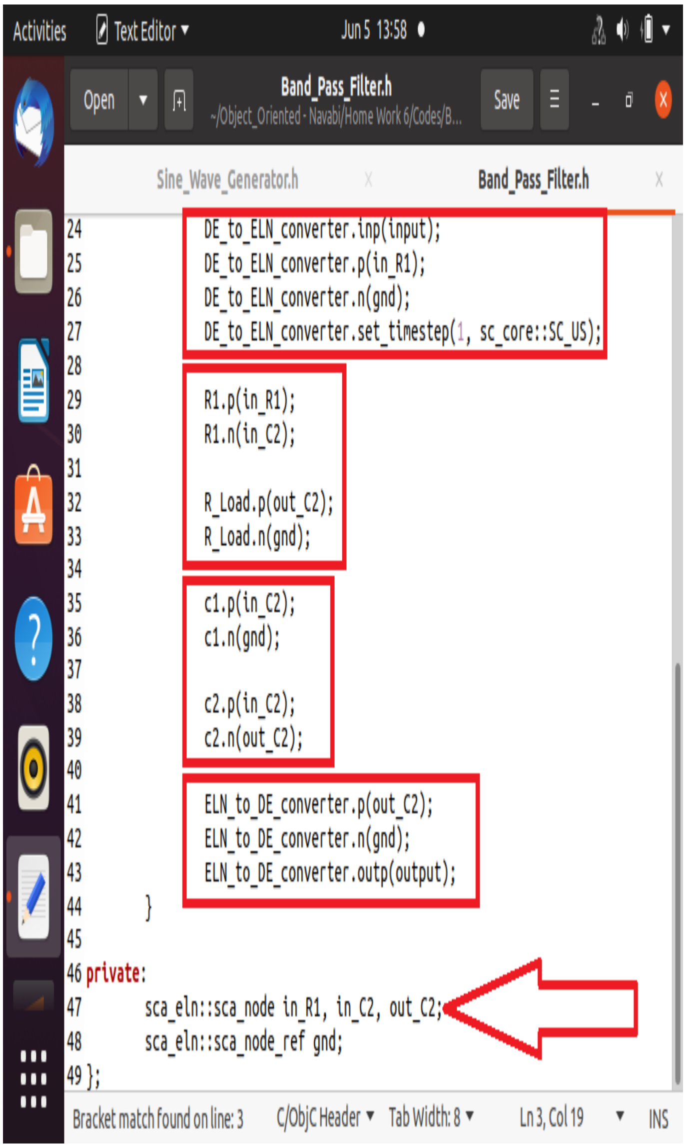

Fig. 3 *Band-Pass Filter SystemC-AMS*

B. *Sine Wave Generator in SystemC-AMS*

A double variable '*t*' is defined to represent the time in the simulation. In a loop, time is advanced by *wait()*, then sin(2πft) is calculated and written in the output, in the end due to *wait()*, time of the simulation is advanced so '*t*' must be increased (1 micro second indicates the sine wave resolution and time step. It can be lager (so the resolution of the sine wave will decrease) or smaller (so the resolution of the sine wave will increase) so we decided to have 1 micro second time step to have enough resolution for sine wave generation.

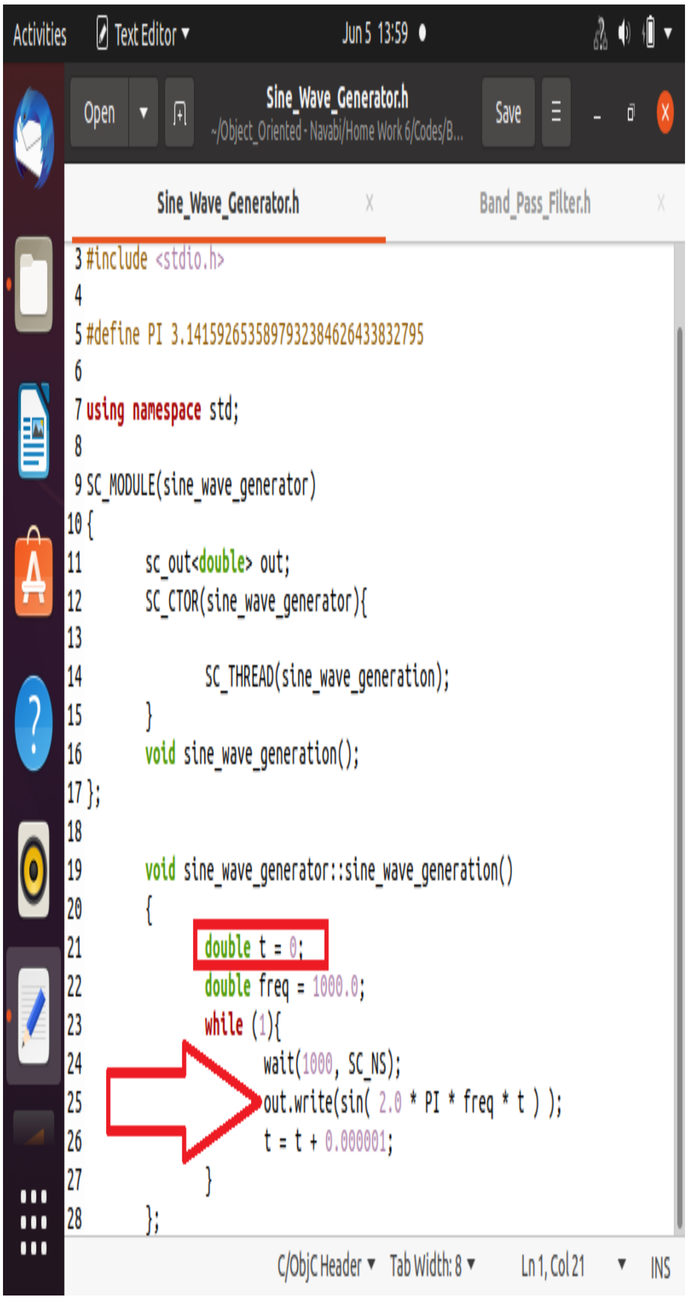

Fig. 4 *Sine Wave Generator SystemC-AMS*

C. *Band-Pass Filter Test Bench*

To test the designed *Band-Pass Filter*, first time resolution (time step) is set to 10 nano second. Then *Vin* (input DE double signal of the *Band-Pass Filter*) and *Vout* (output DE double signal of the *Band-Pass Filter*) are defined, in the end an instance of *Sine_Wave_Generator* and *Band_Pass_Filter* are taken (200, 1000, 2.5e-6 and 1e-6 are the values of R1, R_{load}, C1 and C2) and a VCD file is created to trace the input and output signals of the filter (*Vin* and *Vout*).

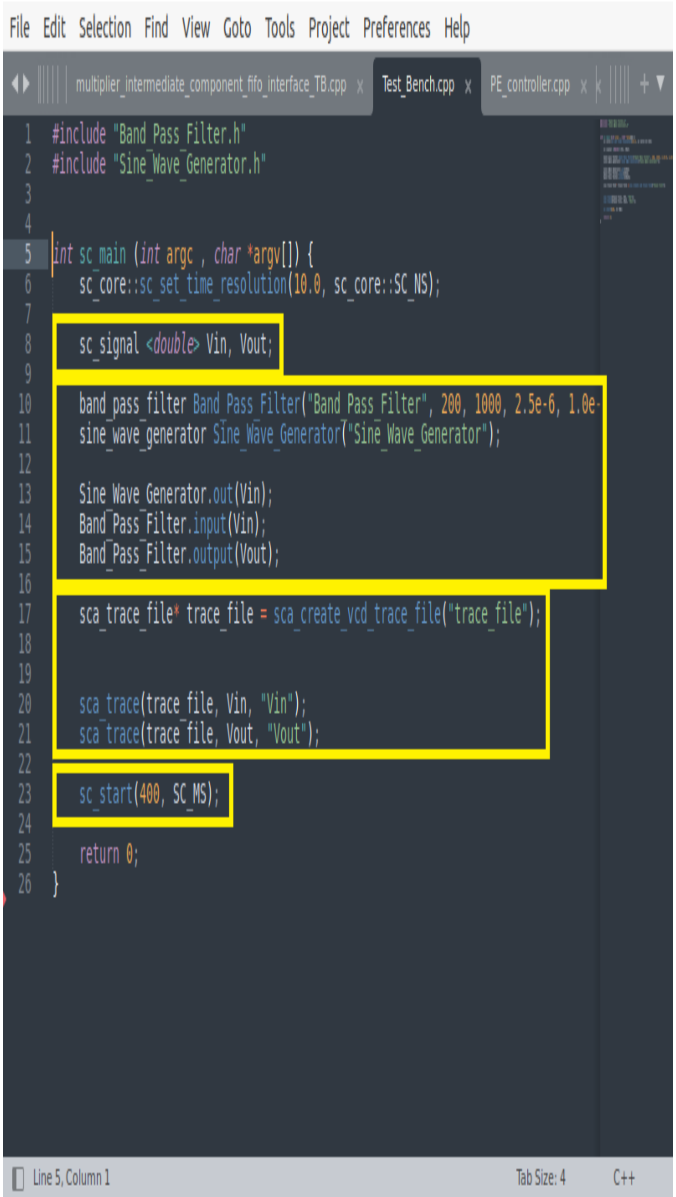

Fig. 5 *Band-Pass Filter Test Bench*

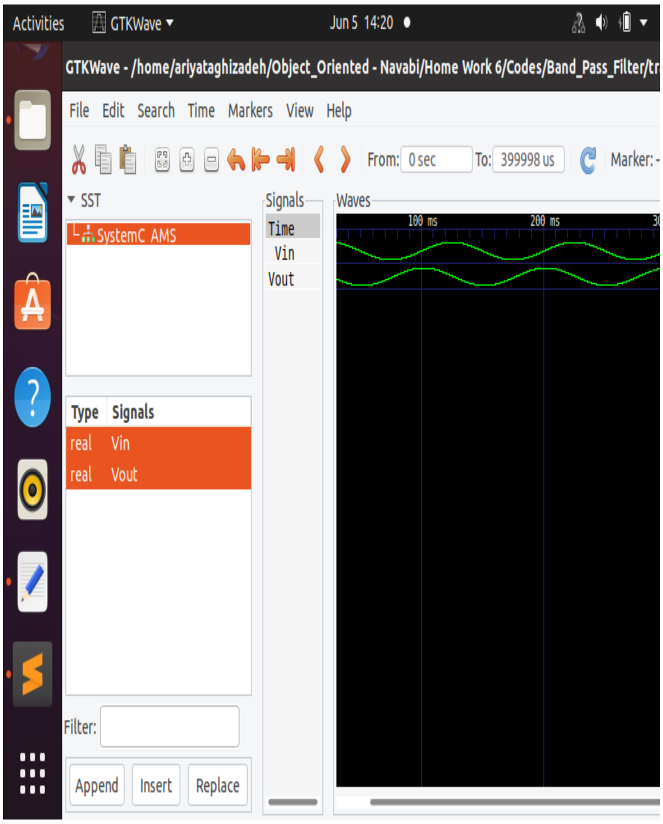

Fig. 6 *Band-Pass Filter Test Bench Results (10 Hz sine wave)*

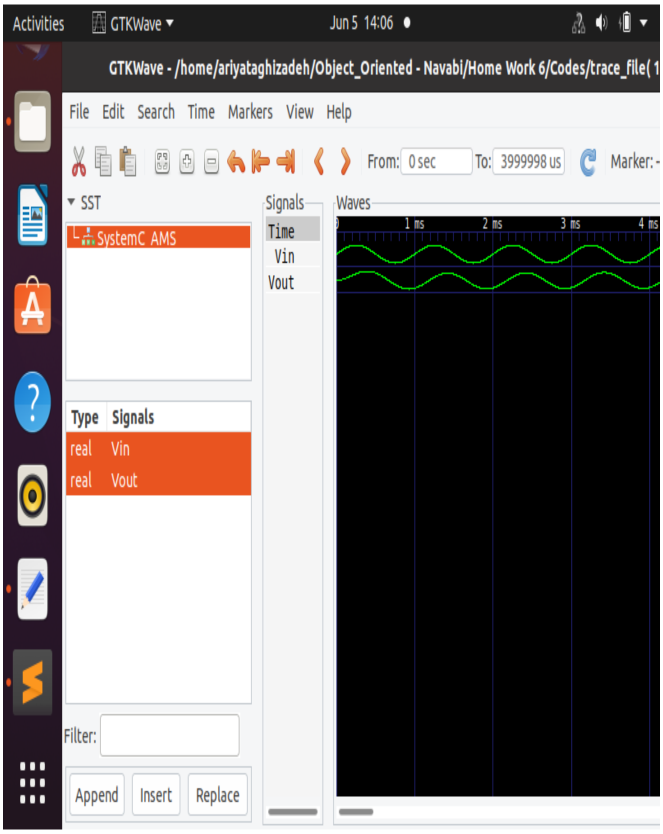

Fig. 7 *Band-Pass Filter Test Bench Results (1 KHz sine wave)*

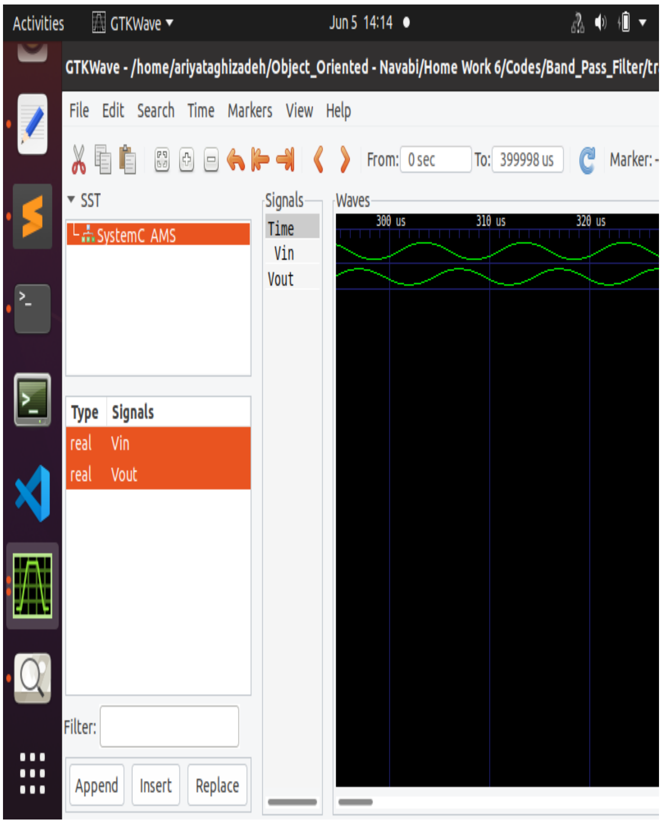

Fig. 8 *Band-Pass Filter Test Bench Results (100 KHz sine wave)*

According to the above results, the output signal (*Vout*) is shifted version of the input signal (*Vin*) which has lower amplitude (about 0.1 of the input sine wave's amplitude), for 10 Hz sine wave, this shift is negative, which makes the output comes before the input signal and have lag. For 1 KHz sine wave, this shift is positive, which makes the output comes after the input signal. For 100 KHz sine wave, this shift is more positive. This is what a Band-Pass filter does to a single ton sine wave in time domain.