Objectives

- To study the operation of the Integrator using op-amp
- Trace the output wave forms for sine
- Trace the output of the square wave inputs.

Theory

The integrator Op-amp produces an output voltage that is both proportional to the amplitude and duration of the input signal. As its name implies, the Op-amp Integrator is an operational amplifier circuit that performs the mathematical operation of Integration, that is we can cause the output to respond to changes in the input voltage over time as the op-amp integrator produces an output voltage which is proportional to the integral of the input voltage.

In the practical integrator shown in Figure 1, to reduce the error voltage at the output, a resistor RF is connected across the feedback capacitor CF. Thus, RF limits the low-frequency gain and hence minimizes the variations in the output voltage.

Integrator has wide applications in

1. Analog computers used for solving differential equations in simulation arrangements.
2. A/D Converters.
3. Signal wave shaping.

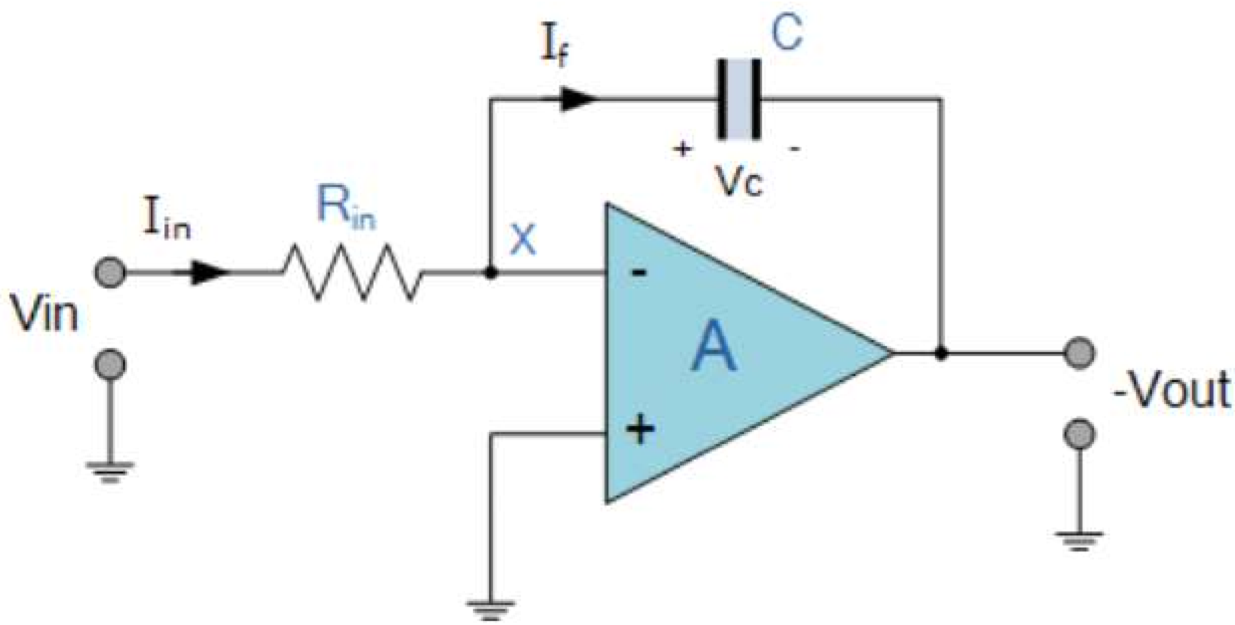

Figure 1

Voutput Formula

$$V_o = -\frac{1}{R_1 C_F}\int V_{in}\,dt$$

Equipment

1. Oscilloscope
2. AC Function Generator
3. Digital Multimeter\

Components

1. Resistors: 10kΩ, 22kΩ
2. Capacitor 0.1µF
3. Op-amp 741

Procedure

1. Connect the components/equipment as shown in the circuit diagram Figure.

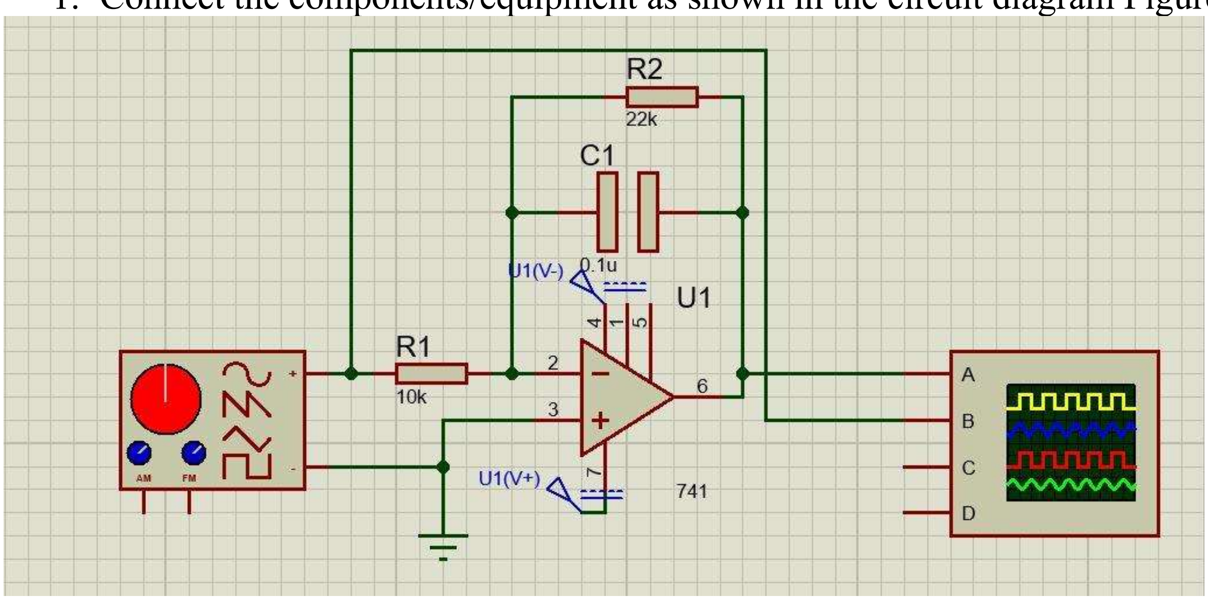

Figure 2: Schamtics

2. Switch ON the power supply.
3. Apply sine wave at the input terminals of the circuit using function Generator.
4. Connect channel-1 of CRO at the input terminals and channel-2 at the output terminals.
5. Observe the output of the circuit on the CRO which is a cosine wave (90o phase shifted from the
1. sine wave input) and note down the position, the amplitude and the time period of Vin & Vo.
6. Now apply the square wave as input signal.
7. Observe the output of the circuit on the CRO which is a triangular wave and note down the
2. position, the amplitude and the time period of Vin & Vo.
8. Plot the output voltages corresponding to sine and square wave inputs as shown in the Figure below.

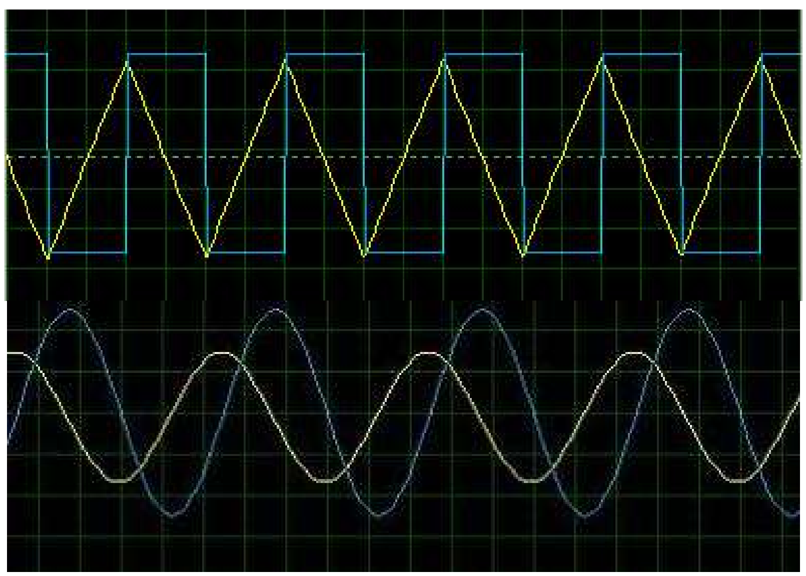

Figure 3: Output Wavefrom

Data Table

		Theoretical	Experimental	
Vin	**Frequency**	**Vo**	**Vo**	**%error**
1	1000	0.159 V	0.159 V	0
2	1000	0.317 V	0.31 V	±2
1	2000	0.076 V	0.075 V	±1
2	1500	0.215 V	0.21 V	±2
2.5	2500	0.165 V	0.16 V	±3

Data Reading Table

Proteus Implementation

Reading for Vin = 1, frequency = 1K Hz

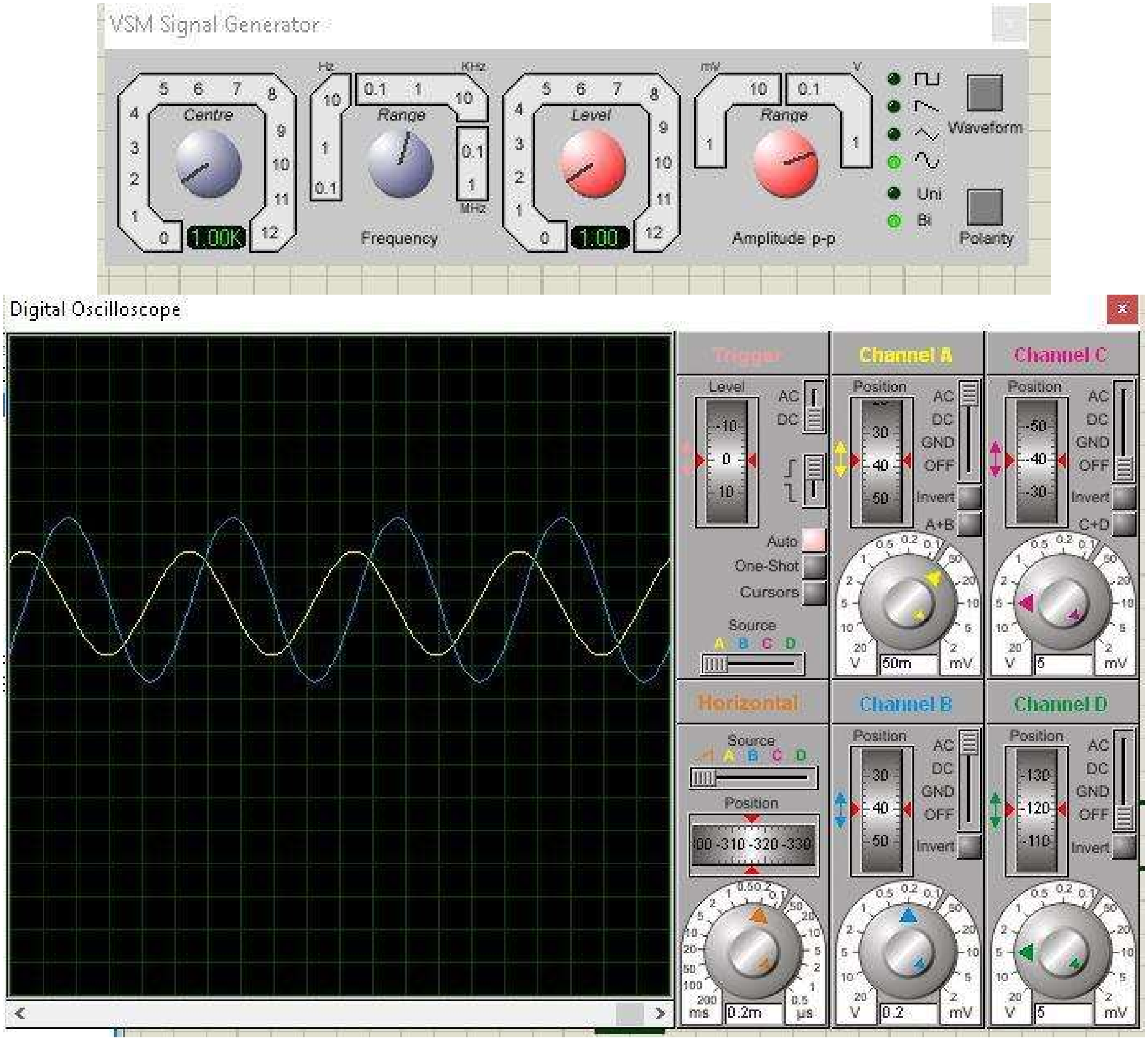

Figure 4

Reading for Vin = 2 , Frequency = 1K Hz

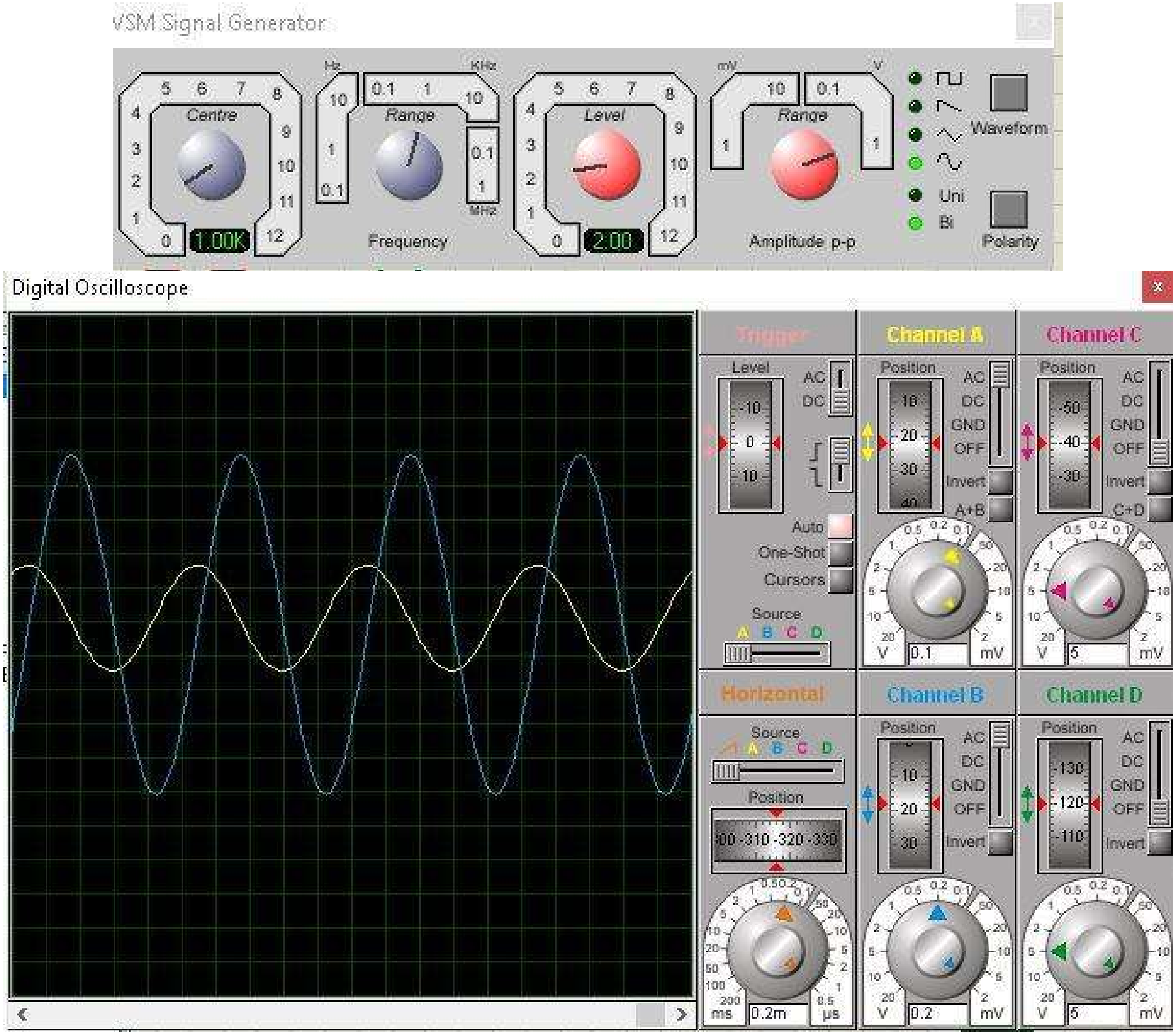

Figure 5

Reading for Vin = 1, frequency = 2K Hz

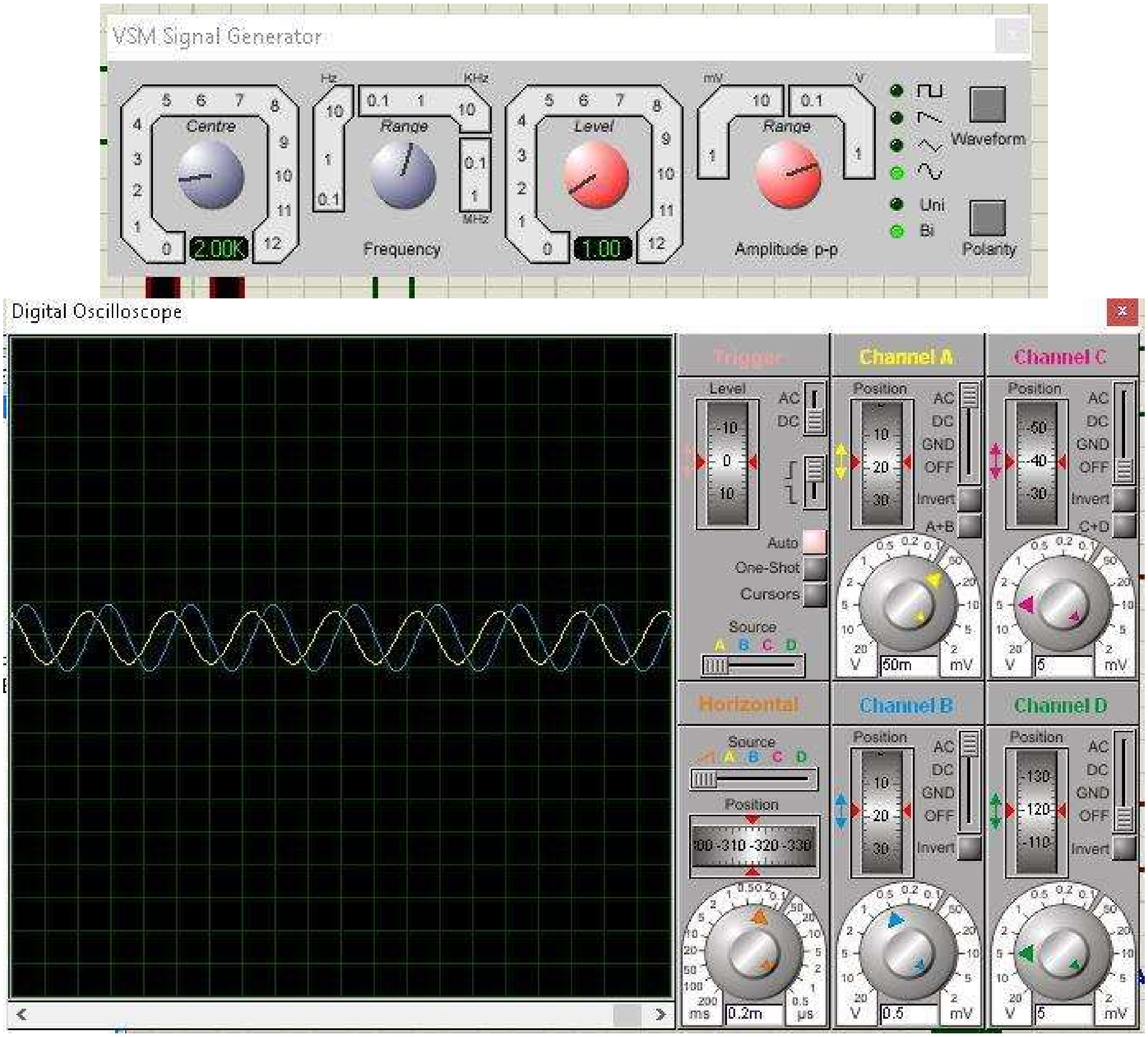

Figure 6

Reading for Vin = 2, frequency = 1500 Hz

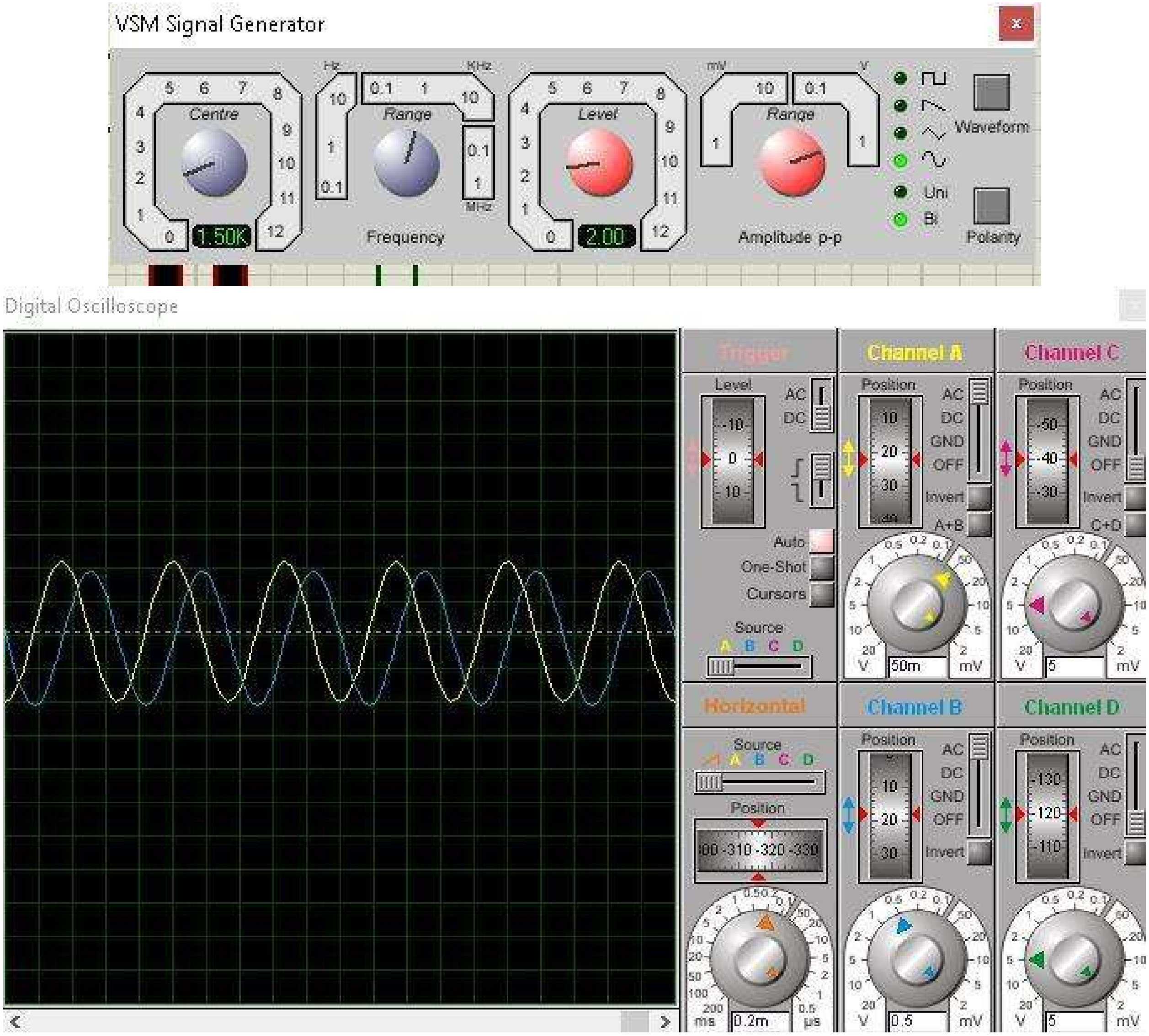

Figure 7

Square Wave Input:

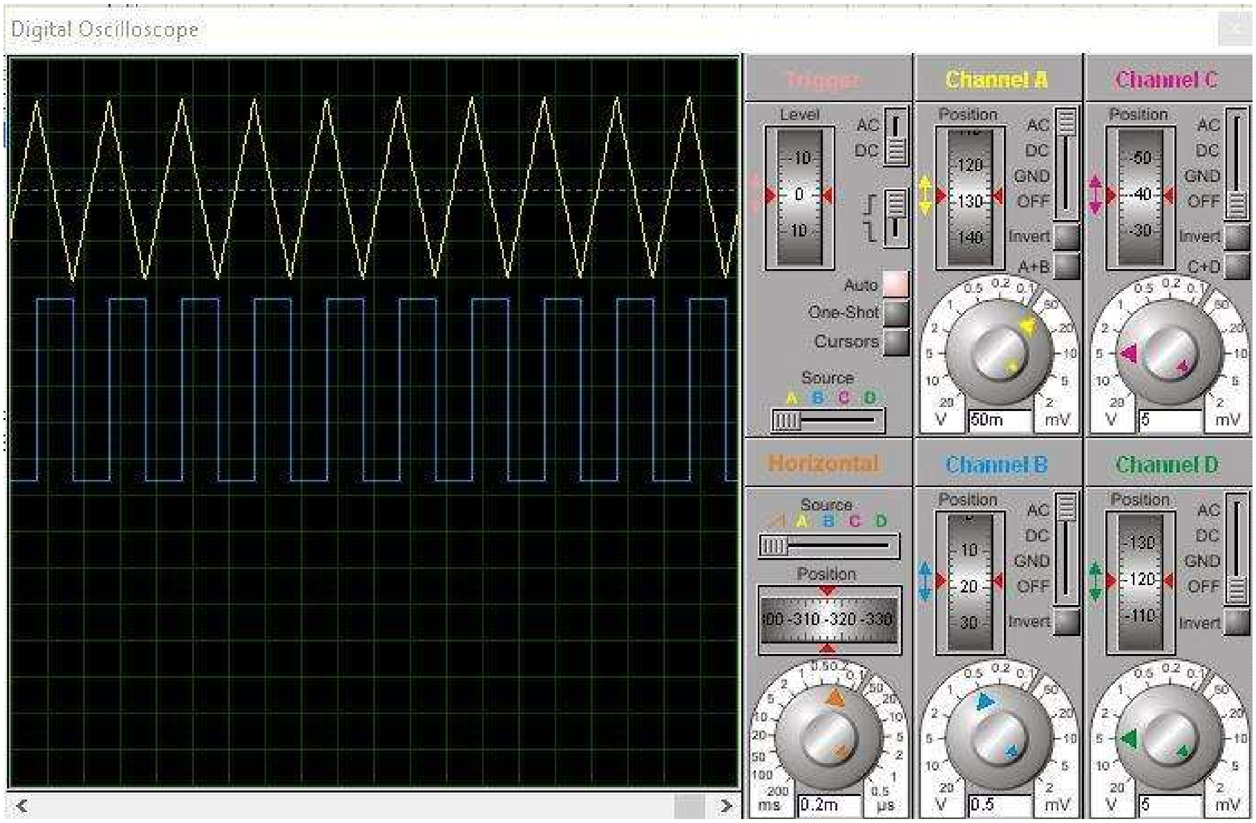

Figure 8: Square Wave