

Ex. No.: 10

Date: 20/12/2021

Verification of Step-Up and Step-Down Transformer

Aim:

To simulate the Transformer on step down and step-up mode using OrCAD capture CIS and find the input and output voltage both simulation and analytical calculation.

Apparatus:

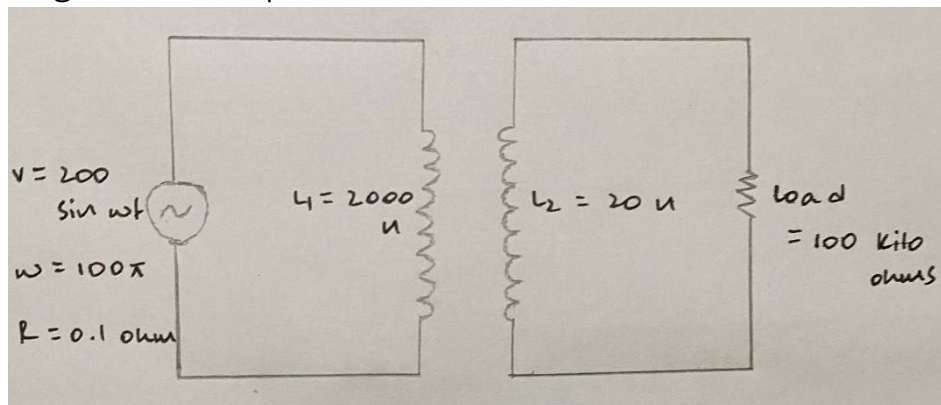
ORCAD / Capture CIS: Analog Library – R

Design Cache – VSIN, XFRM_LINEAR

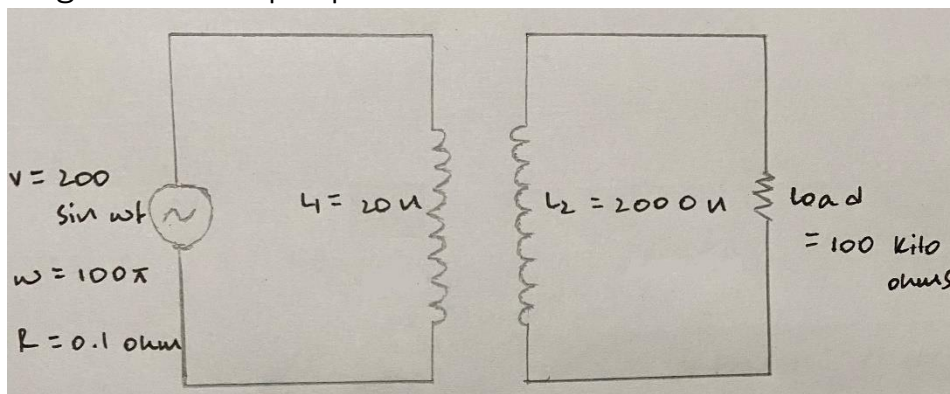
Ground (GND) – 0 (zero)

Simulation Settings: Analysis Type – Time Domain (Transient)

Circuit Diagram for Step-Down Transformer:



Circuit Diagram for Step-Up Transformer:



Statement:

A transformer is a machine that works by changing the output voltage by manipulating the input voltage using inductors. A step-up voltage increases the voltage while a step-down voltage decreases the voltage.

Analytic Calculation:

$$\text{Transformation ratio} = \frac{N_1}{N_2} = \left(\frac{L_1}{L_2} \right)^{1/2}$$

Voltage transformation:

$$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \sqrt{\frac{L_1}{L_2}}$$

For step-up transformer:

$$L_1 = 20$$

$$L_2 = 2000$$

$$V_1 = 200$$

$$\therefore \frac{V_1}{V_2} = \left(\frac{20}{2000} \right)^{1/2}$$

$$\Rightarrow V_2 = 10 V_1$$

$$\Rightarrow V_2 = 2000 \text{ V}$$

For step-down transformer:

$$L_1 = 2000$$

$$L_2 = 20$$

$$V_1 = 200$$

$$\therefore \frac{V_1}{V_2} = \left(\frac{L_1}{L_2} \right)^{1/2}$$

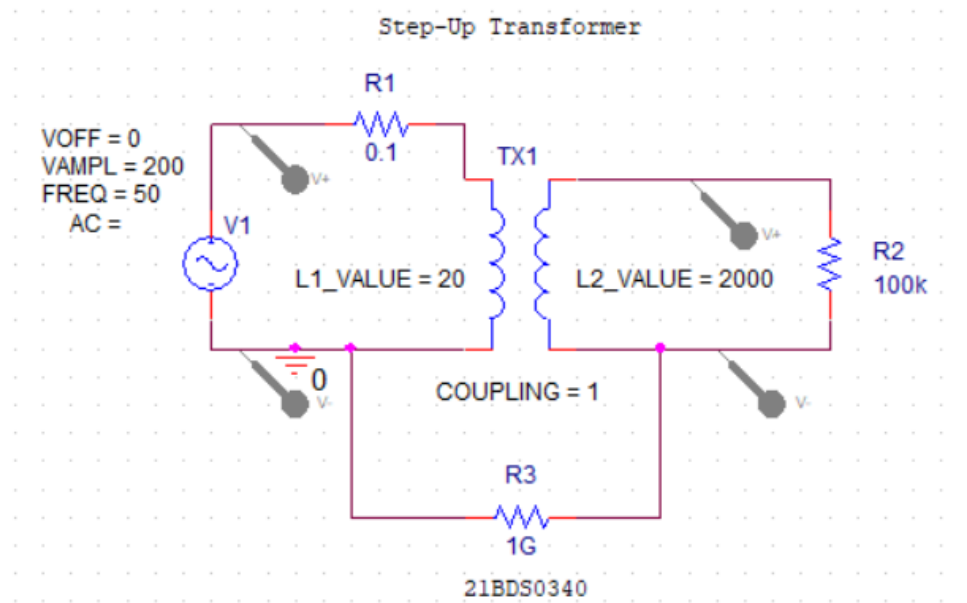
$$\Rightarrow \frac{V_1}{V_2} = \left(\frac{1}{100} \right)^{1/2}$$

$$\Rightarrow V_2 = \frac{V_1}{10}$$

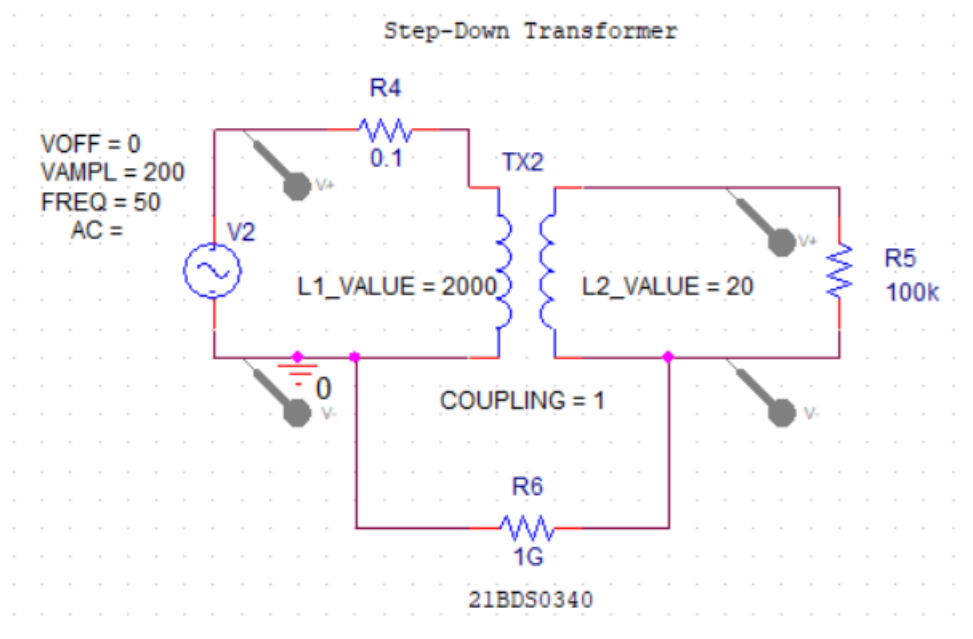
$$\Rightarrow V_2 = 20 \text{ V}$$

Simulation Circuit:

Step-Up Transformer:



Step-Down Transformer:



Simulation Profile Settings:

Analysis Type:
Time Domain (Transient)

Options:

- ☒ General Settings
- ☐ Monte Carlo/Worst Case
- ☐ Parametric Sweep
- ☐ Temperature (Sweep)
- ☐ Save Bias Point
- ☐ Load Bias Point
- ☐ Save Check Point
- ☐ Restart Simulation

Run To Time : seconds (TSTOP)

Start saving data after : seconds

Transient options:

Maximum Step Size seconds

☐ Skip initial transient bias point calculation (SKIPBP)

☐ Run in resume mode

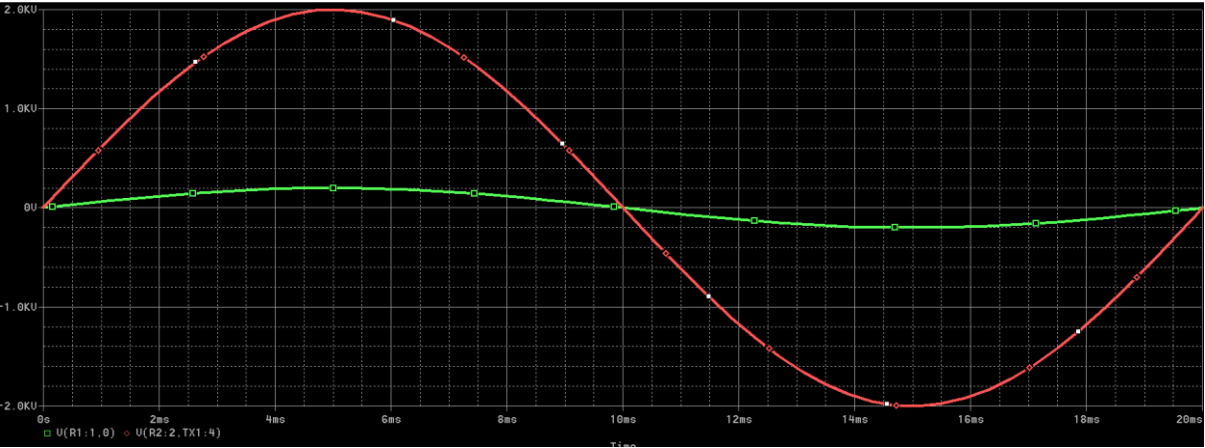
[Output File Options...](#)

Procedure:

1. Press 'P' to place a part
2. Type 'R' and place 3 resistors
3. Type 'vcin' and place 1
4. Type 'XFORM - LINEAR' and place 1
5. Assign the correct values referring to the circuit diagram
6. Place voltage checkers on each side of the transformer
7. Create a new simulation and keep it at the 'Time Domain' setting.
8. Set 'Run to Time' as 20ms
9. Run the simulation to collect the data.

Result:

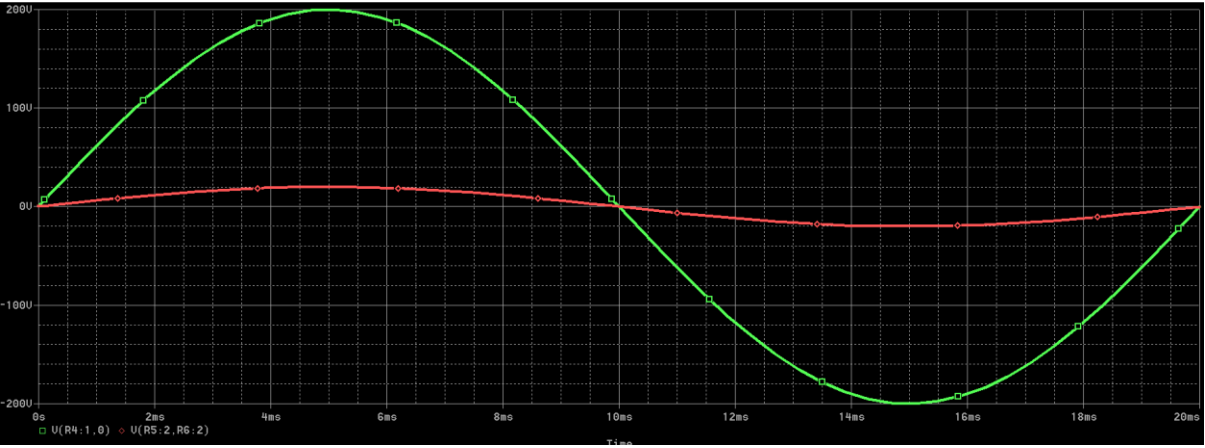
Step-Up Transformer Graph:



Red line – output voltage, **2000V**

Green line – input voltage, **200V**

Step-Down Transformer Graph:



Red line – output voltage, **20V**

Green line – input voltage, **200V**

NOTATION	Transformer Output	
	MANUAL CALCULATIONS	SIMULATED RESULT
STEP-DOWN OUTPUT VOLTAGE	20	20
STEP-UP OUTPUT VOLTAGE	2000	2000

Inference:

By the manual calculations and the simulation circuit, both answers are coming the same. Therefore, the transformer works as expected.