STEP-DOWN & STEP-UP TRANSFORMERS IN PROTEUS IDE

230 Volts to 12 Volts Step-down Transformer

230 Volts to 15 Volts Step-down Transformer

12 Volts to 230 Volts Step-Up Transformer

15 Volts to 230 Volts Step-Up Transformer

230 Volts to 12 Volts Step-down Center-Tapped Transformer

230 Volts to 15 Volts Step-down Center-Tapped Transformer

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Turns Ratio:

Turns Ration (n) is the ratio of the number of turns on the secondary coil (N_{sec}) of an electrical transformer to the number of turns on the primary coil (N_{pri}), or vice versa.

$$\text{Turns Ratio } (n) = \frac{V_{sec}}{V_{pri}} = \frac{N_{sec}}{N_{pri}} = \frac{I_{pri}}{I_{sec}} = \sqrt{\frac{L_{sec}}{L_{pri}}}$$

1. The voltage ratio of an ideal transformer is directly related to the turn's ratio.
2. The current ratio of an ideal transformer is inversely related to the turn's ratio.
3. The turn's ratio of an ideal transformer by inductance is the square root of the inductance ratio values

Open-Circuit Voltage Ratio by Inductance:

$$\frac{V_{sec}}{V_{pri}} \; (\text{open circuit}) = \frac{M}{L_{pri}}$$

$$\text{MUTUAL INDUCTANCE } (M) = K\sqrt{L_{pri}\, L_{sec}}$$

Then,

$$\frac{V_{sec}}{V_{pri}}\ (\ open\ circuit) \ = \frac{K\ \sqrt{L_{pri}\ L_{sec}}}{L_{pri}}$$

Max-Coupled Voltage Ratio by Inductance:

If the ratio of all the flux is coupled to the ratio of the turns, then

$$\frac{V_{sec}}{V_{pri}}(\ max - coupled) \ = \frac{K\ \sqrt{L_{sec}}}{\sqrt{L_{pri}}}$$

K - Coupling Coefficient

Ideal transformer has a coupling coefficient equal to 1 (unity).

$$\frac{V_{sec}}{V_{pri}} = \sqrt{\frac{L_{sec}}{L_{pri}}}$$

Then,

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

Proteus: Step-down Transformer Design

230 Volts to 12 Volts Step-down Transformer

$$\frac{L_{sec}}{L_{pri}} = \left(\frac{V_{sec}}{V_{pri}}\right)^2$$

Let's assume,

$L_{pri} = 1\ Henry,$

$V_{pri} = 230\ Volts$ (Applied Input RMS Voltage – It depends on available Source Voltage)

$V_{sec} = 12\ Volts$ (Required step-down Voltage)

$$\frac{L_{sec}}{L_{pri}} = \left(\frac{V_{sec}}{V_{pri}}\right)^2$$

$$L_{sec} = \left(\frac{V_{sec}}{V_{pri}}\right)^2\ x\ L_{pri}$$

$$L_{sec} = \left(\frac{12}{230}\right)^2 x\ 1$$

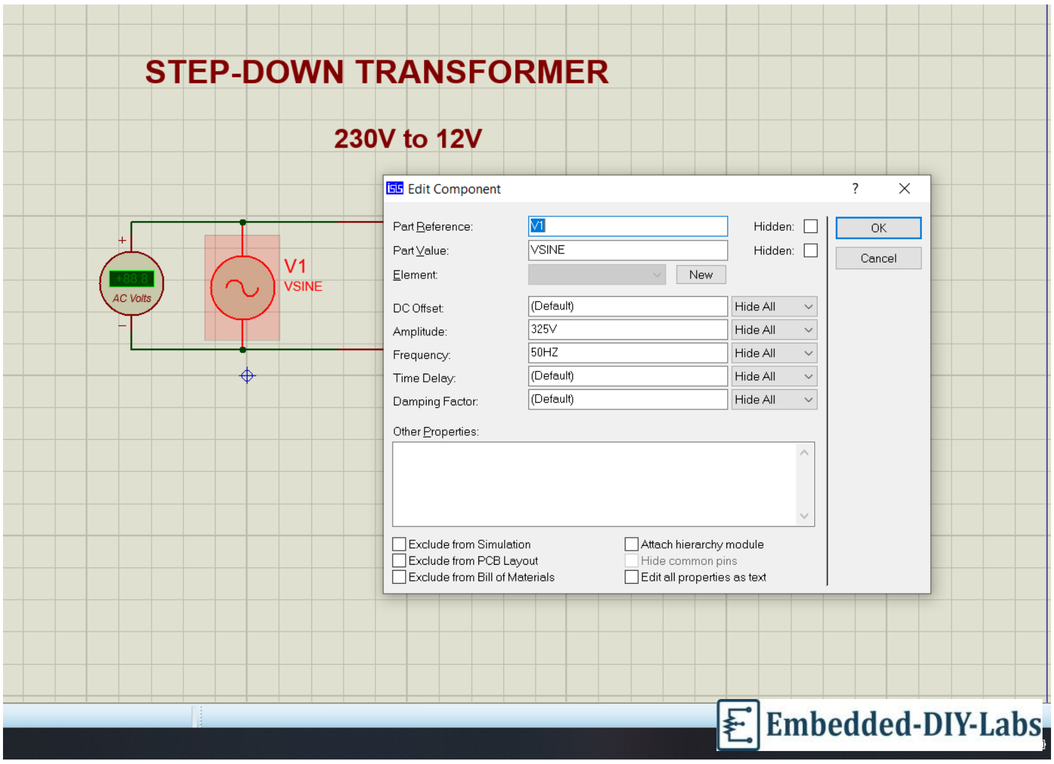
$$L_{sec} = 0.002722\ Henry$$

Proteus Transformer Design

INPUT

Step-1:

In AC Source, enter Peak Voltage.



So, Peak Voltage of RMS Input Voltage = 230 V is,

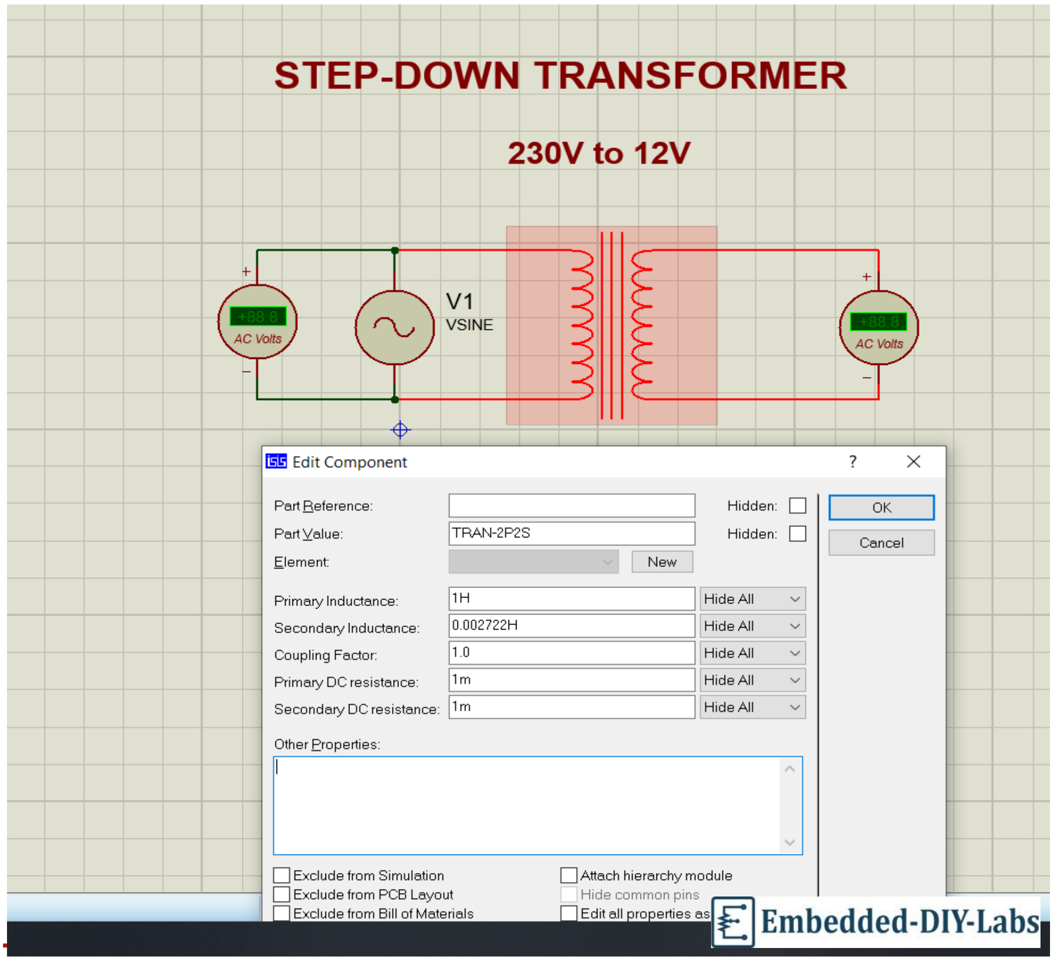
$$PEAK.V_{pri} = 1.414\ x\ 230\ V$$

$$PEAK.V_{pri} = 325\ V$$

$$FREQUENCY = 50\ HZ$$

Step-2:

In Transformer,



$$L_{pri} = 1\ Henry$$

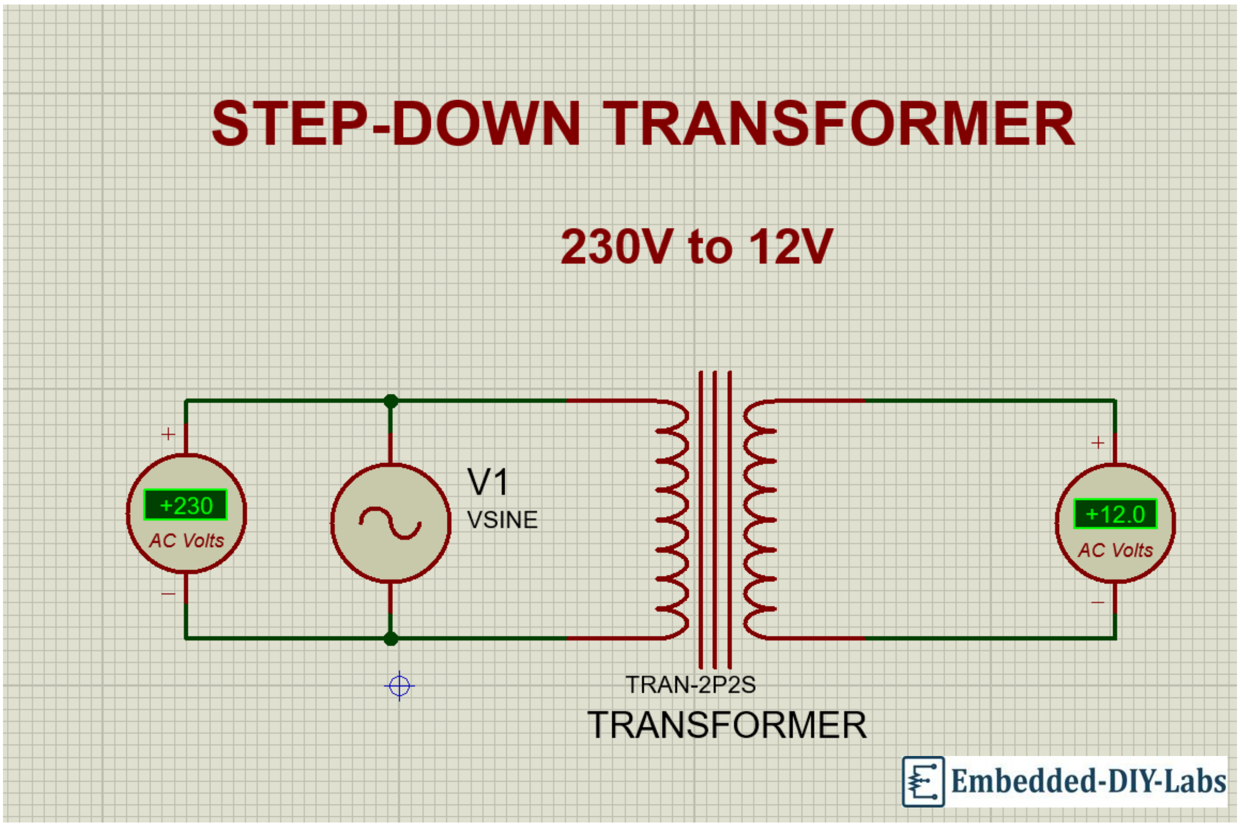
$$L_{sec} = 0.002722\ Henry$$

Coupling Factor (K) = 1

For ideal Transformer Coupling Factor (K) is 1 (Unity).

OUTPUT

Step-3:



230 Volts to 15 Volts Step-down Transformer

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

Let's assume,

$L_{pri} = 1\ Henry,$

$V_{pri} = 230\ Volts$ (Applied Input RMS Voltage – It depends on available Source Voltage)

$V_{sec} = 15\ Volts$ (Required step-down Voltage)

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

$$L_{sec} = (\frac{V_{sec}}{V_{pri}})^2\ x\ L_{pri}$$

$$L_{sec} = (\frac{15}{230})^2\ x\ 1$$

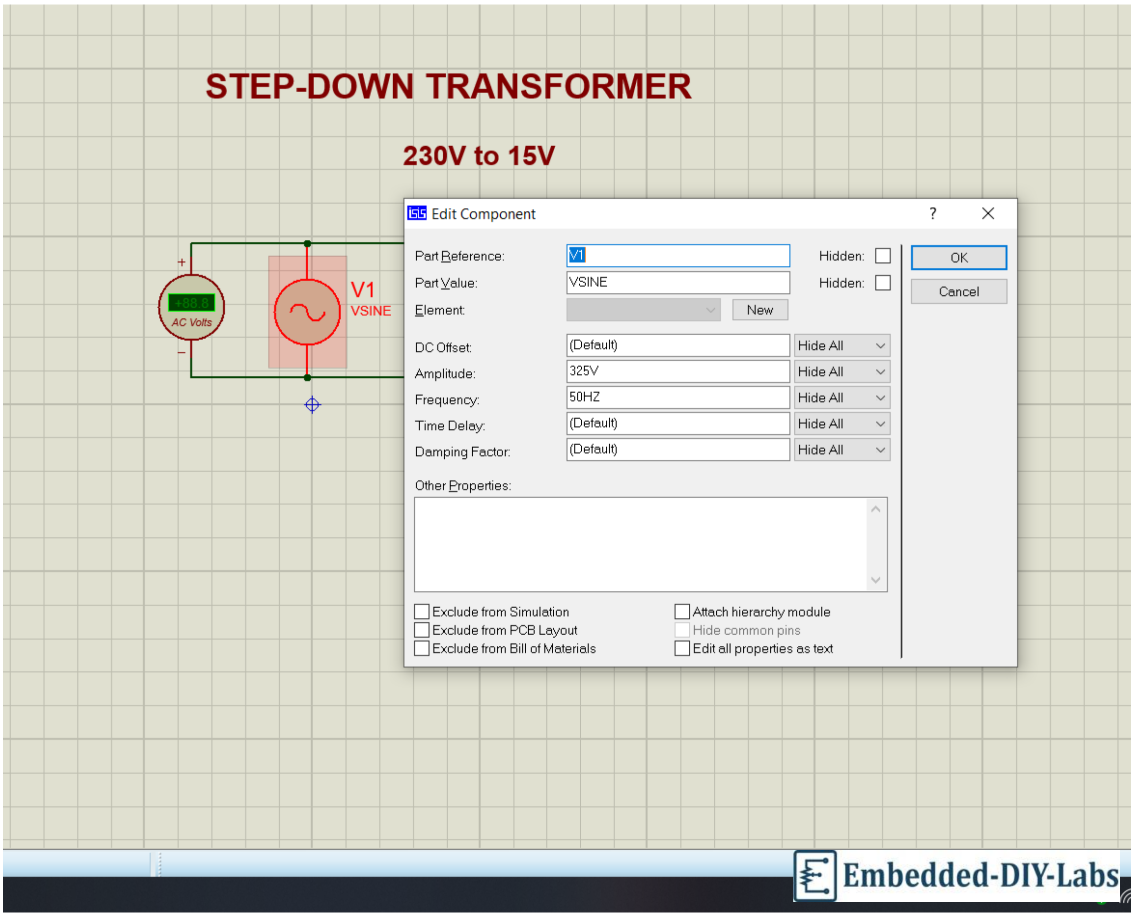
$$L_{sec} = 0.004253\ Henry$$

Proteus Transformer Design

INPUT

Step-1:

In AC Source, enter Peak Voltage.



So, Peak Voltage of RMS Input Voltage = 230 V is,

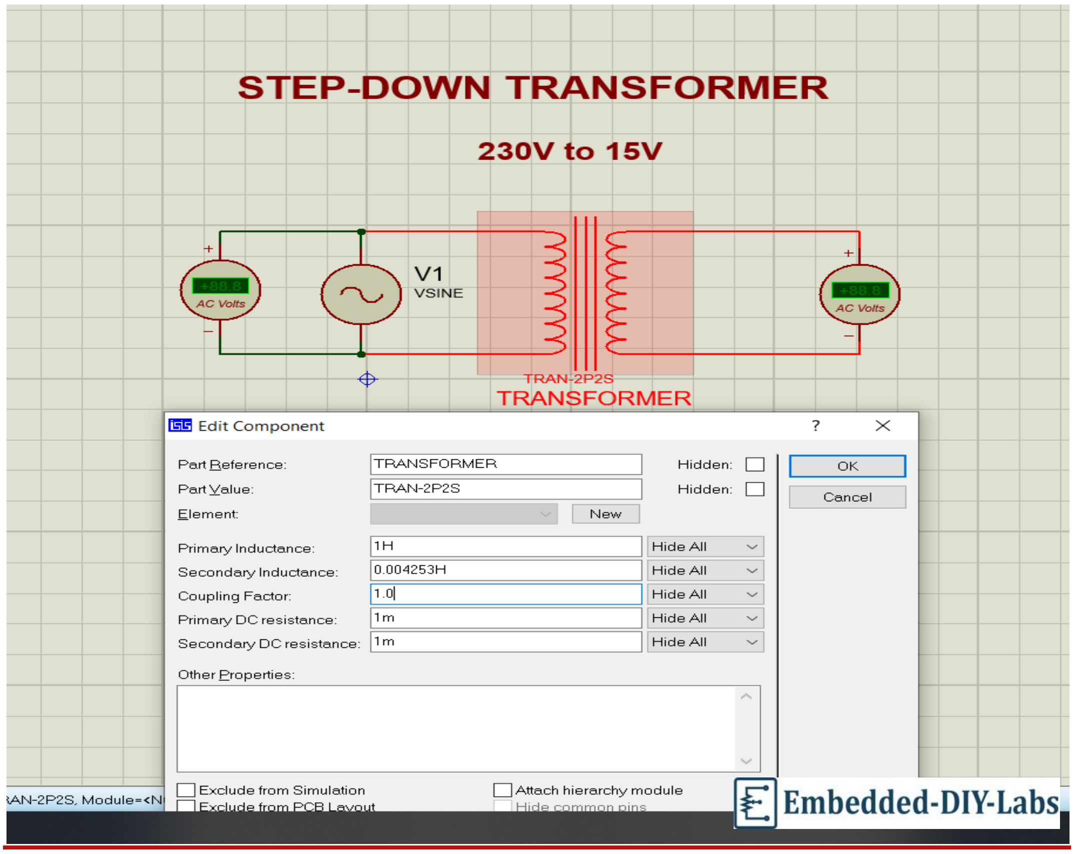
$$PEAK.V_{pri} = 1.414\ x\ 230\ V$$

$$PEAK.V_{pri} = 325\ V$$

$$FREQUENCY = 50\ HZ$$

Step-2:

In Transformer,



$$L_{pri} = 1\ Henry$$

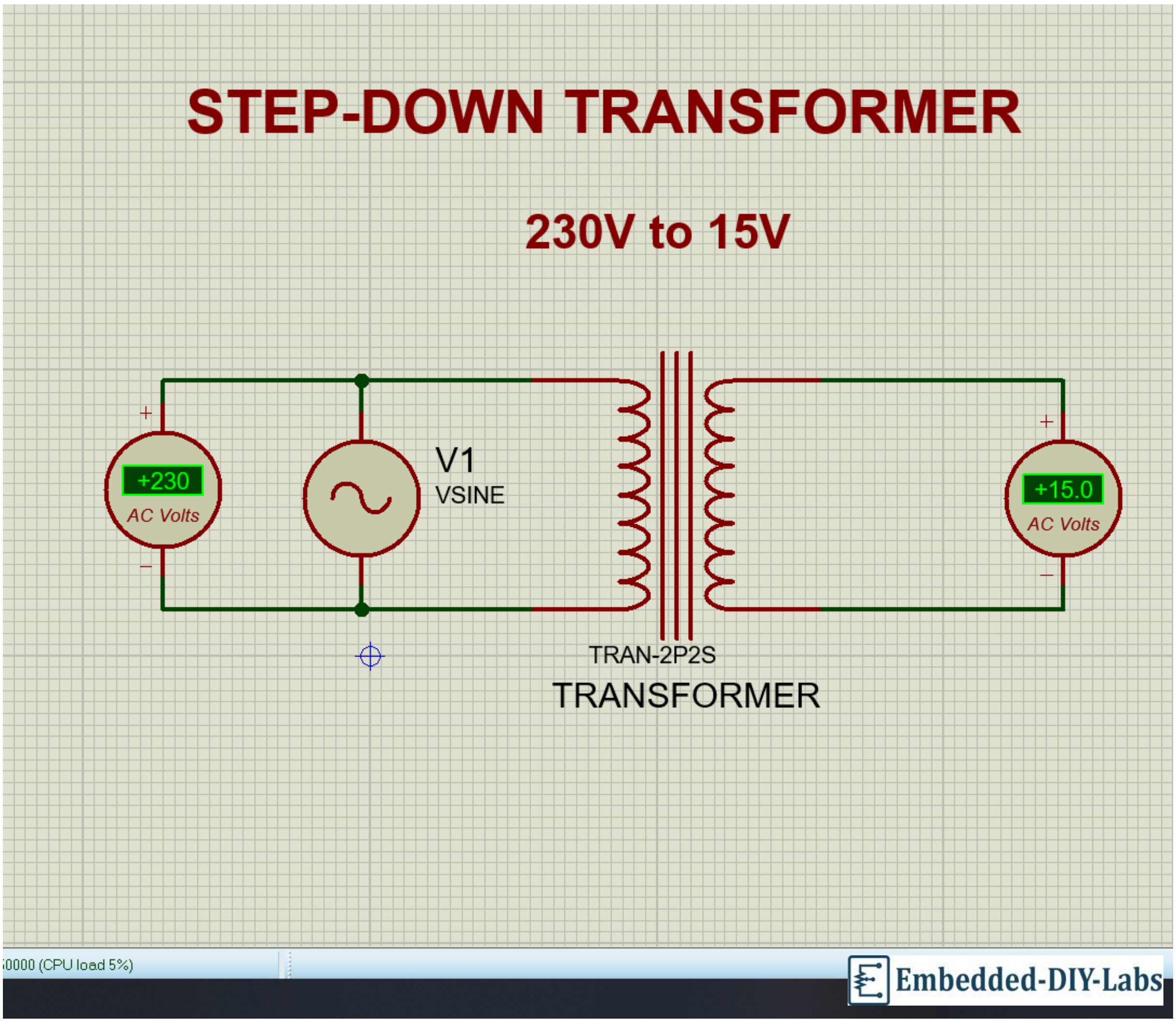
$$L_{sec} = 0.004253\ Henry$$

Coupling Factor (K) = 1

For ideal Transformer Coupling Factor (K) is 1 (Unity).

OUTPUT

Step-3:



Proteus: Step-Up Transformer Design

12 Volts to 230 Volts Step-Up Transformer

$$\frac{L_{sec}}{L_{pri}} = \left(\frac{V_{sec}}{V_{pri}}\right)^2$$

Let's assume,

$L_{pri} = 1\ Henry,$

$V_{pri} = 12\ Volts$ (Applied Input RMS Voltage – It depends on available Source Voltage)

$V_{sec} = 230\ Volts$ (Required step-Up Voltage)

$$\frac{L_{sec}}{L_{pri}} = \left(\frac{V_{sec}}{V_{pri}}\right)^2$$

$$L_{sec} = \left(\frac{V_{sec}}{V_{pri}}\right)^2\ x\ L_{pri}$$

$$L_{sec} = \left(\frac{230}{12}\right)^2 x\ 1$$

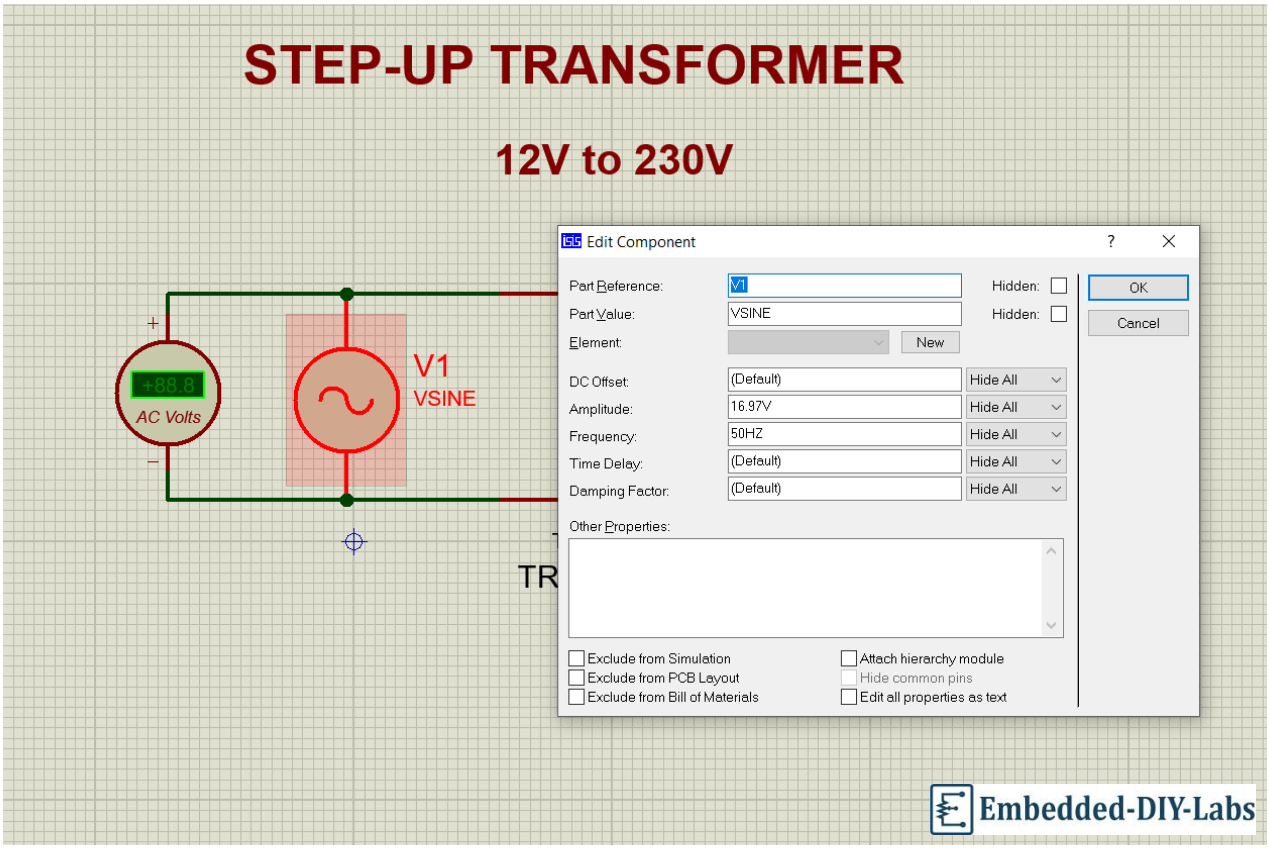
$$L_{sec} = 367.36\ Henry$$

Proteus Transformer Design

INPUT

Step-1:

In AC Source, enter Peak Voltage.



So, Peak Voltage of RMS Input Voltage = 12 V is,

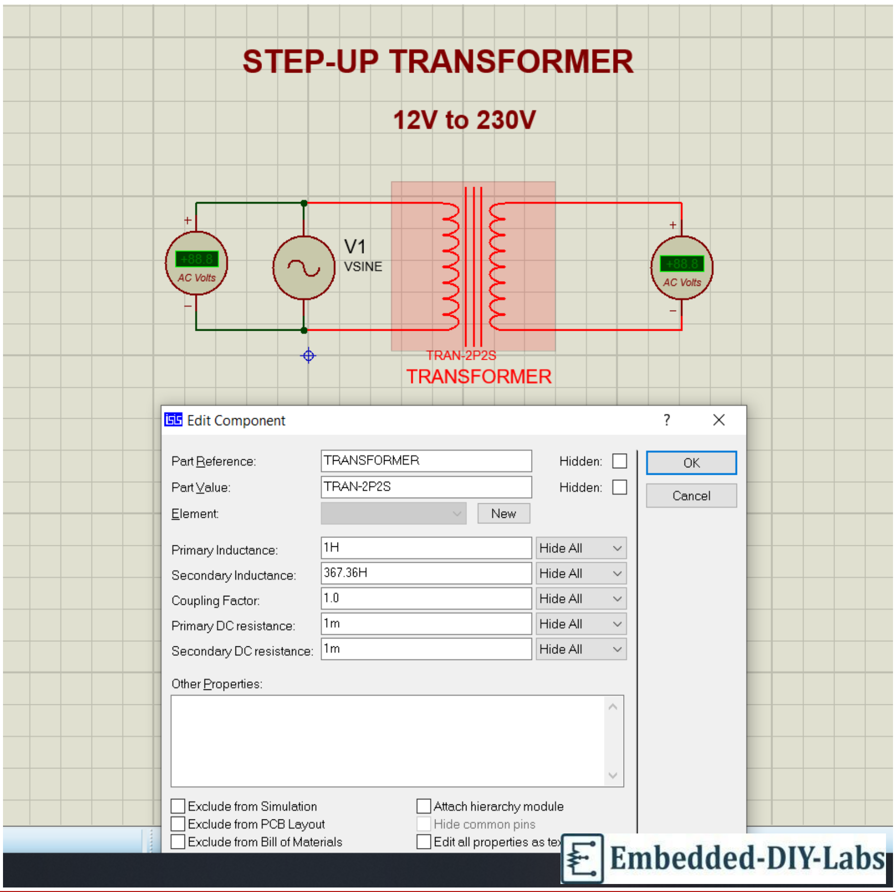
$$PEAK.V_{pri} = 1.414\ x\ 12\ V$$

$$PEAK.V_{pri} = 16.97\ V$$

$$FREQUENCY = 50\ HZ$$

Step-2:

In Transformer,



$$L_{pri} = 1\ Henry$$

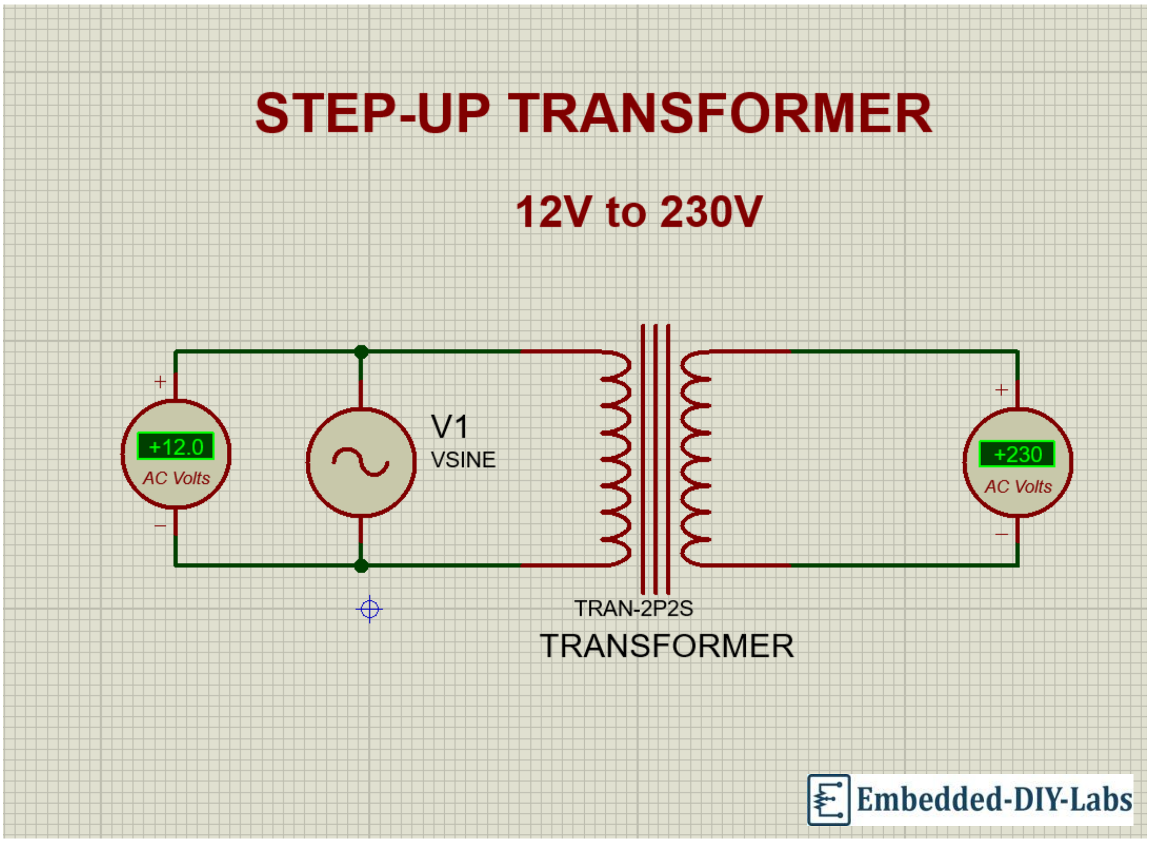
$$L_{sec} = 367.36\ Henry$$

Coupling Factor (K) = 1

For ideal Transformer Coupling Factor (K) is 1 (Unity).

OUTPUT

Step-3:



15 Volts to 230 Volts Step-Up Design

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

Let's assume,

$L_{pri} = 1\ Henry,$

$V_{pri} = 15\ Volts$ (Applied Input RMS Voltage – It depends on available Source Voltage)

$V_{sec} = 230\ Volts$ (Required step-Up Voltage)

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

$$L_{sec} = (\frac{V_{sec}}{V_{pri}})^2\ x\ L_{pri}$$

$$L_{sec} = (\frac{230}{15})^2\ x\ 1$$

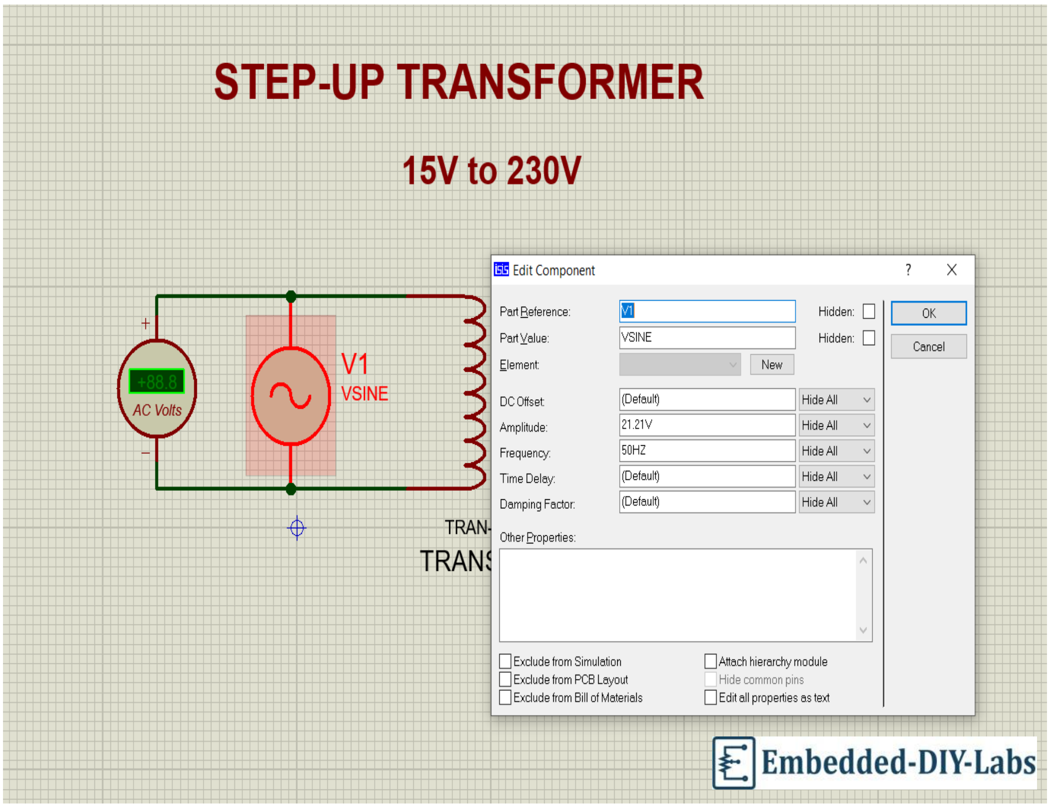
$$L_{sec} = 235.11\ Henry$$

Proteus Transformer Design

INPUT

Step-1:

In AC Source, enter Peak Voltage.



So, Peak Voltage of RMS Input Voltage = 15 V is,

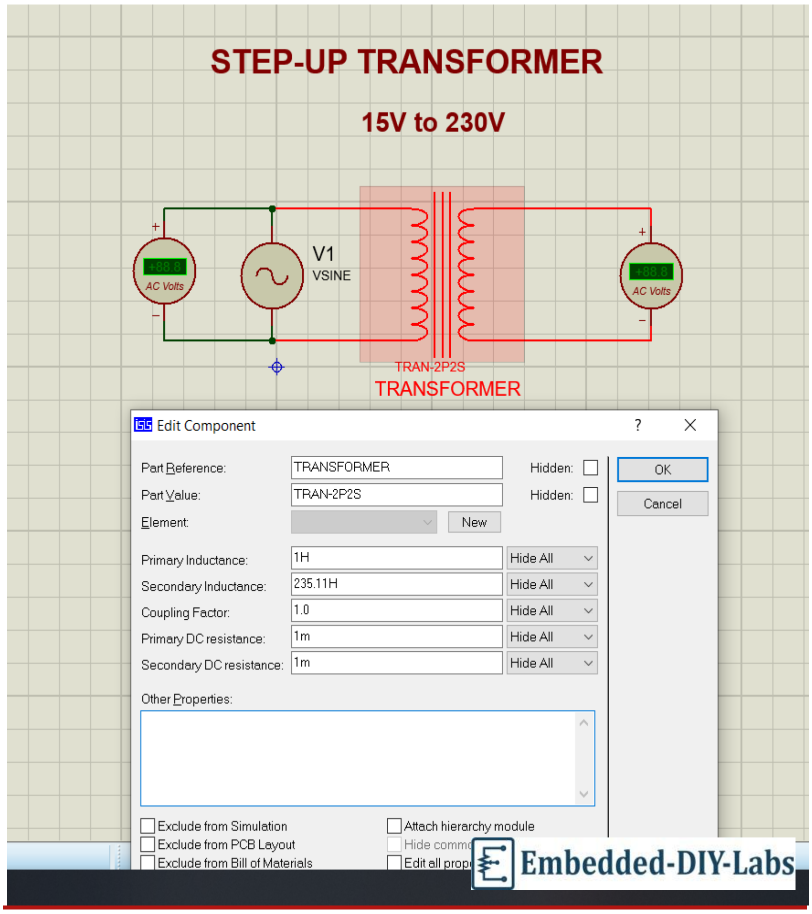
$$PEAK.V_{pri} = 1.414 \, x \, 15 \, V$$

$$PEAK.V_{pri} = 21.21 \, V$$

$$FREQUENCY = 50 \, HZ$$

Step-2:

In Transformer,



$$L_{pri} = 1\ Henry$$

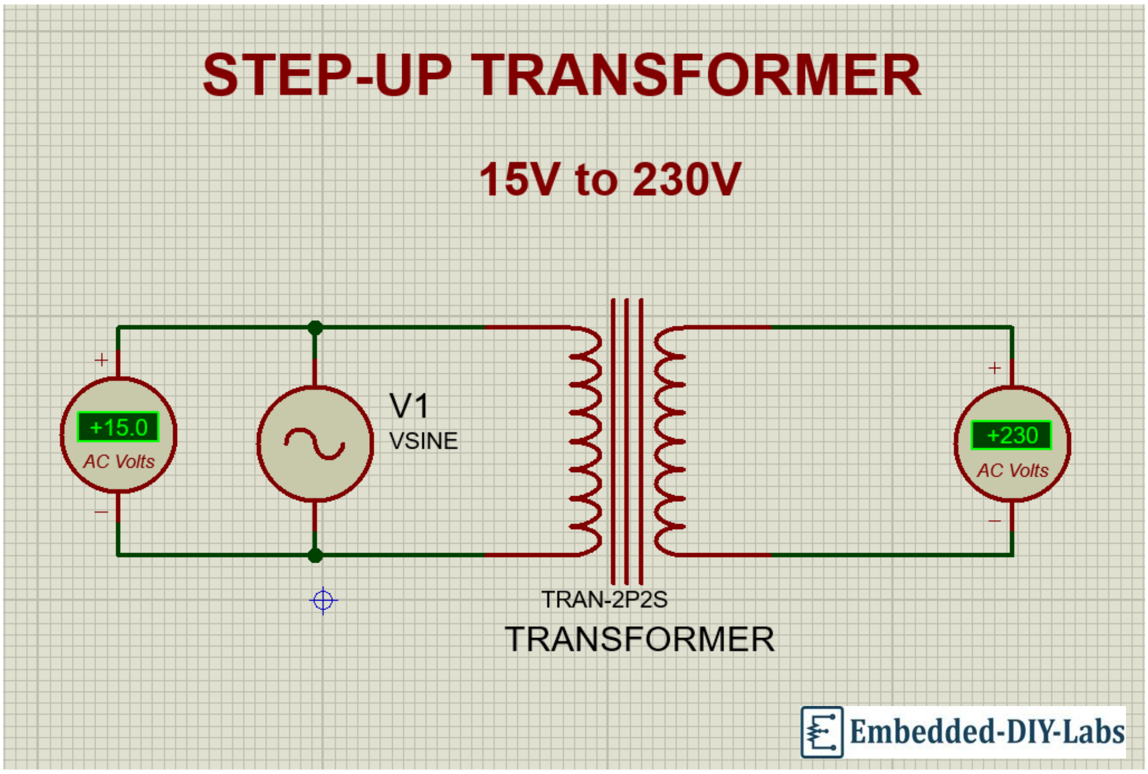
$$L_{sec} = 235.11\ Henry$$

Coupling Factor (K) = 1

For ideal Transformer Coupling Factor (K) is 1 (Unity).

OUTPUT

Step-3:



Proteus: Step-down Center - Tapped Transformer Design

230 Volts to 12 Volts Step-down Center - Tapped Transformer

$$\frac{L_{sec}}{L_{pri}} = \left(\frac{V_{sec}}{V_{pri}}\right)^2$$

Let's assume,

$L_{pri} = 1\ Henry,$

$V_{pri} = 230\ Volts$ (Applied Input RMS Voltage – It depends on available Source Voltage)

$V_{sec} = 12\ Volts$ (Required step-down Voltage)

$$\frac{L_{sec}}{L_{pri}} = \left(\frac{V_{sec}}{V_{pri}}\right)^2$$

$$L_{sec} = \left(\frac{V_{sec}}{V_{pri}}\right)^2\ x\ L_{pri}$$

$$L_{sec} = \left(\frac{12}{230}\right)^2 x\ 1$$

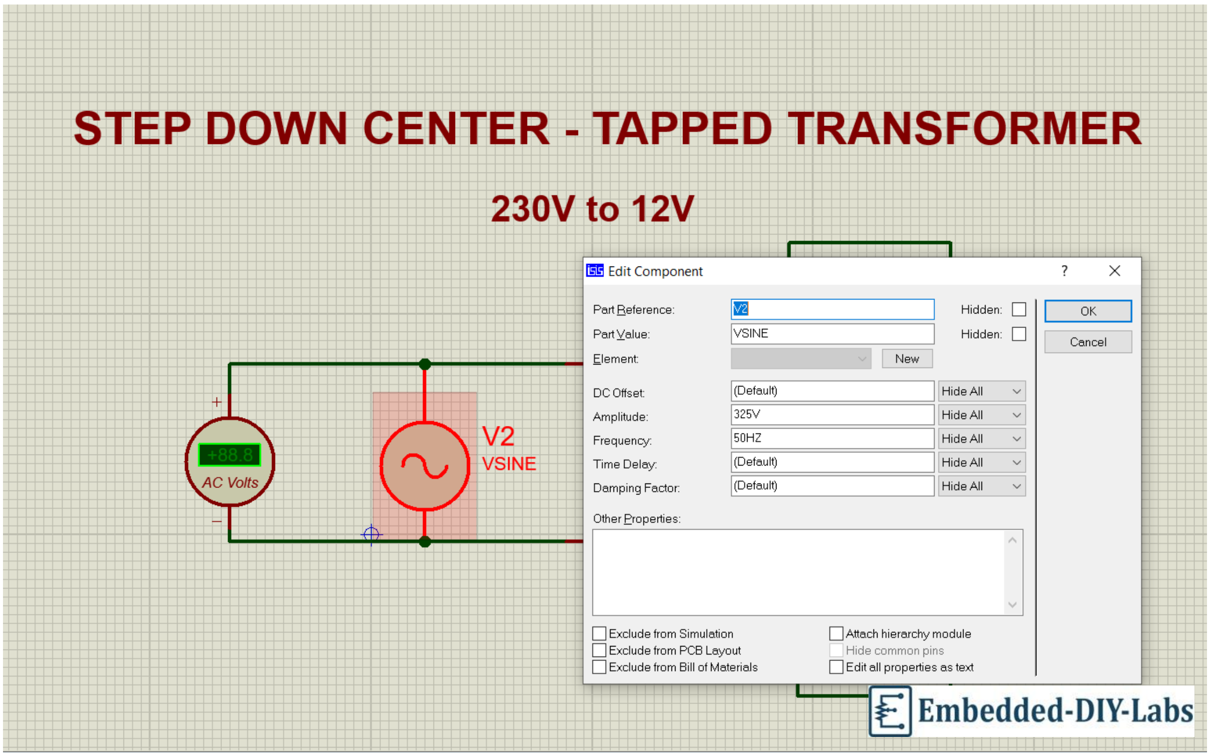
$$L_{sec} = 0.002722\ Henry$$

Proteus Transformer Design

INPUT

Step-1:

In AC Source, enter Peak Voltage.



So, Peak Voltage of RMS Input Voltage = 230 V is,

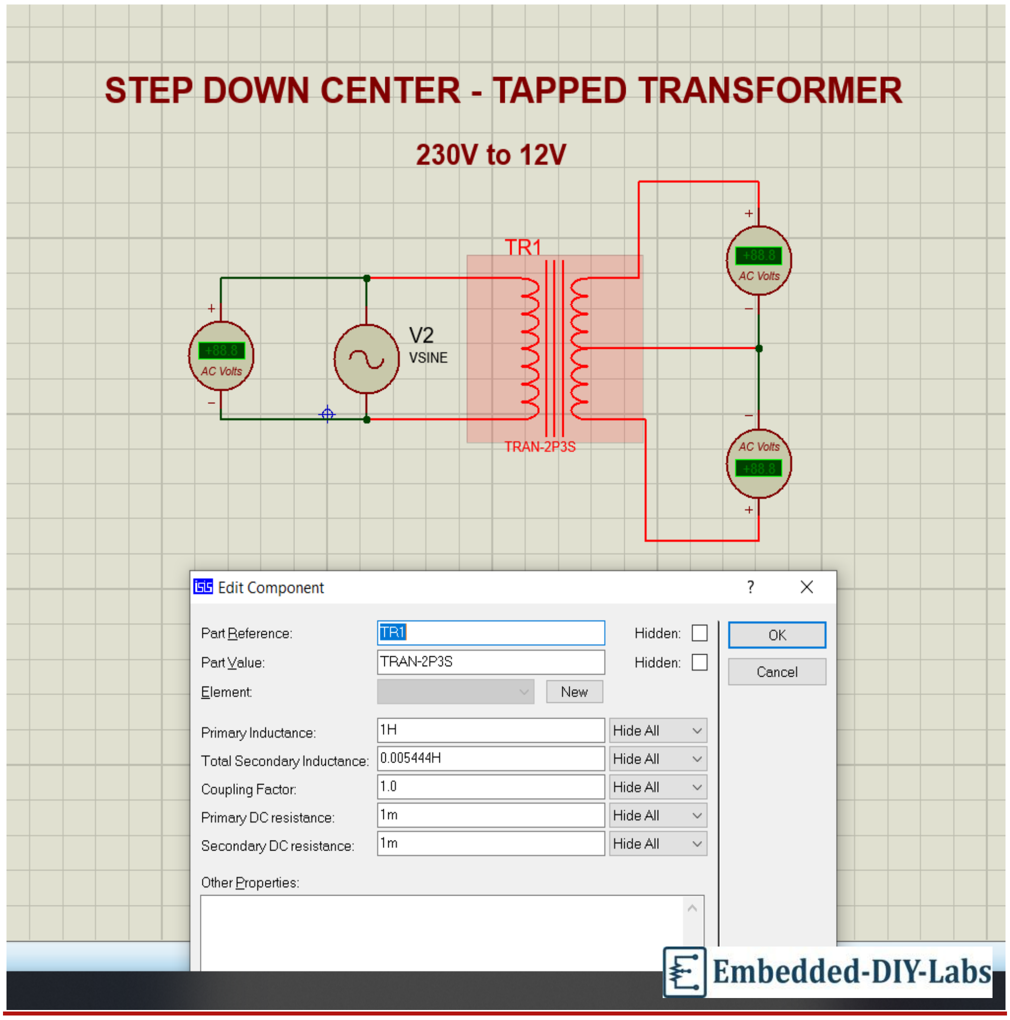
$$PEAK.V_{pri} = 1.414\ x\ 230\ V$$

$$PEAK.V_{pri} = 325\ V$$

$$FREQUENCY = 50\ HZ$$

Step-2:

In Transformer,



$$L_{pri} = 1\ Henry$$

Since it's a center – tapped we have to apply

$$L_{sec} = 2\ x\ 0.002722\ Henry$$

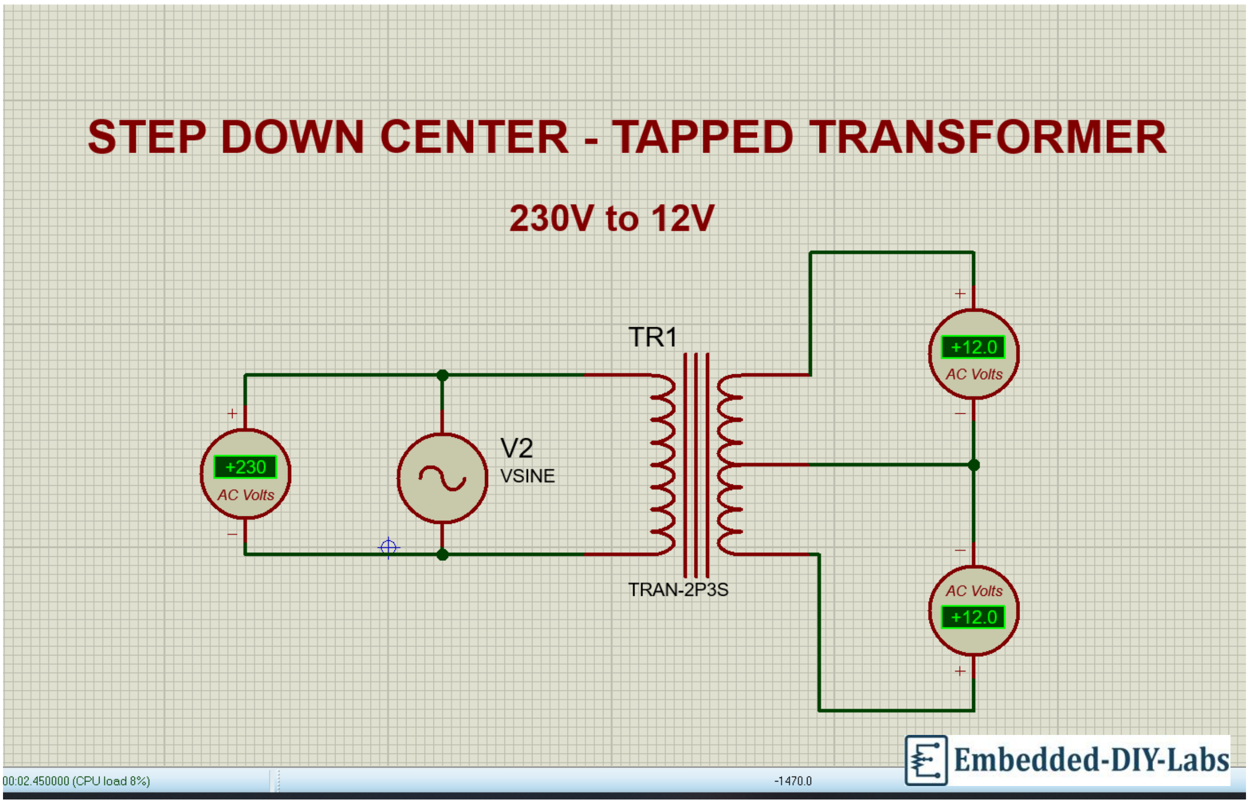
$$L_{sec} = 0.005444\ Henry$$

Coupling Factor (K) = 1

For ideal Transformer Coupling Factor (K) is 1 (Unity).

OUTPUT

Step-3:



230 Volts to 15 Volts Step-down Center - Tapped Transformer

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

Let's assume,

$L_{pri} = 1\ Henry,$

$V_{pri} = 230\ Volts$ (Applied Input RMS Voltage – It depends on available Source Voltage)

$V_{sec} = 15\ Volts$ (Required step-down Voltage)

$$\frac{L_{sec}}{L_{pri}} = (\frac{V_{sec}}{V_{pri}})^2$$

$$L_{sec} = (\frac{V_{sec}}{V_{pri}})^2\ x\ L_{pri}$$

$$L_{sec} = (\frac{15}{230})^2\ x\ 1$$

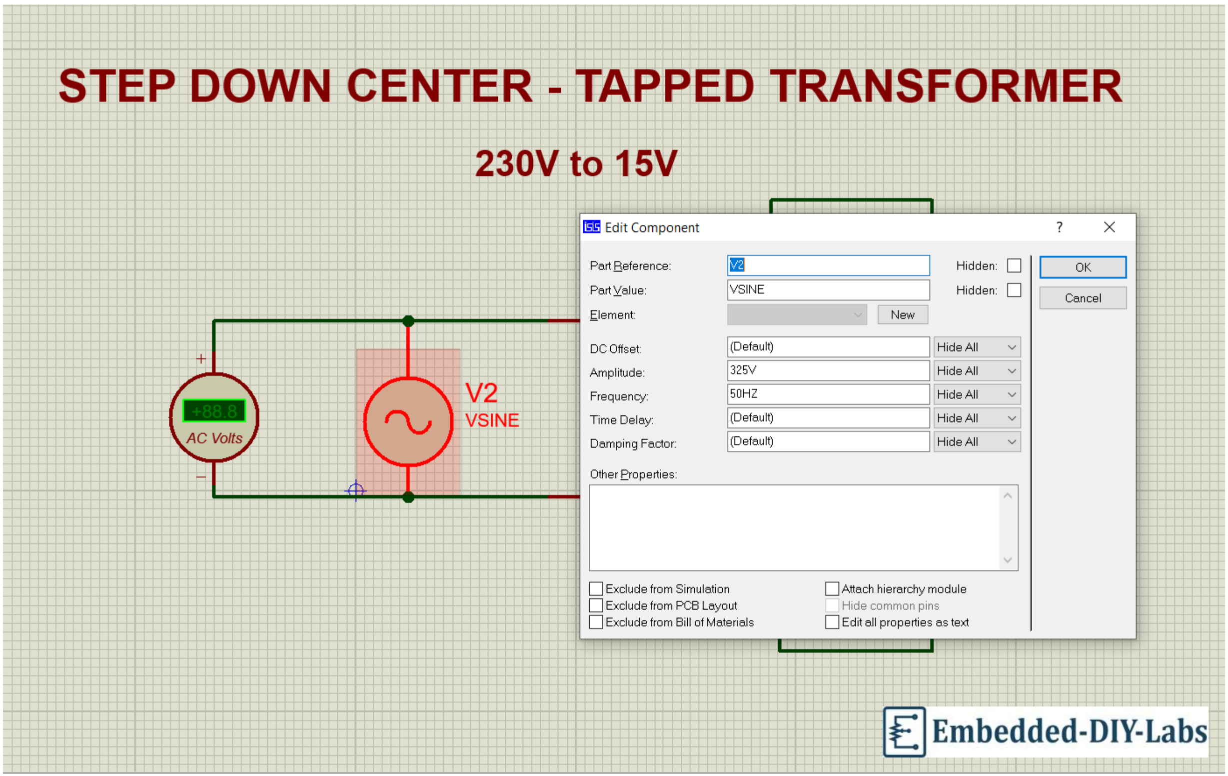
$$L_{sec} = 0.004253\ Henry$$

Proteus Transformer Design

INPUT

Step-1:

In AC Source, enter Peak Voltage.



So, Peak Voltage of RMS Input Voltage = 230 V is,

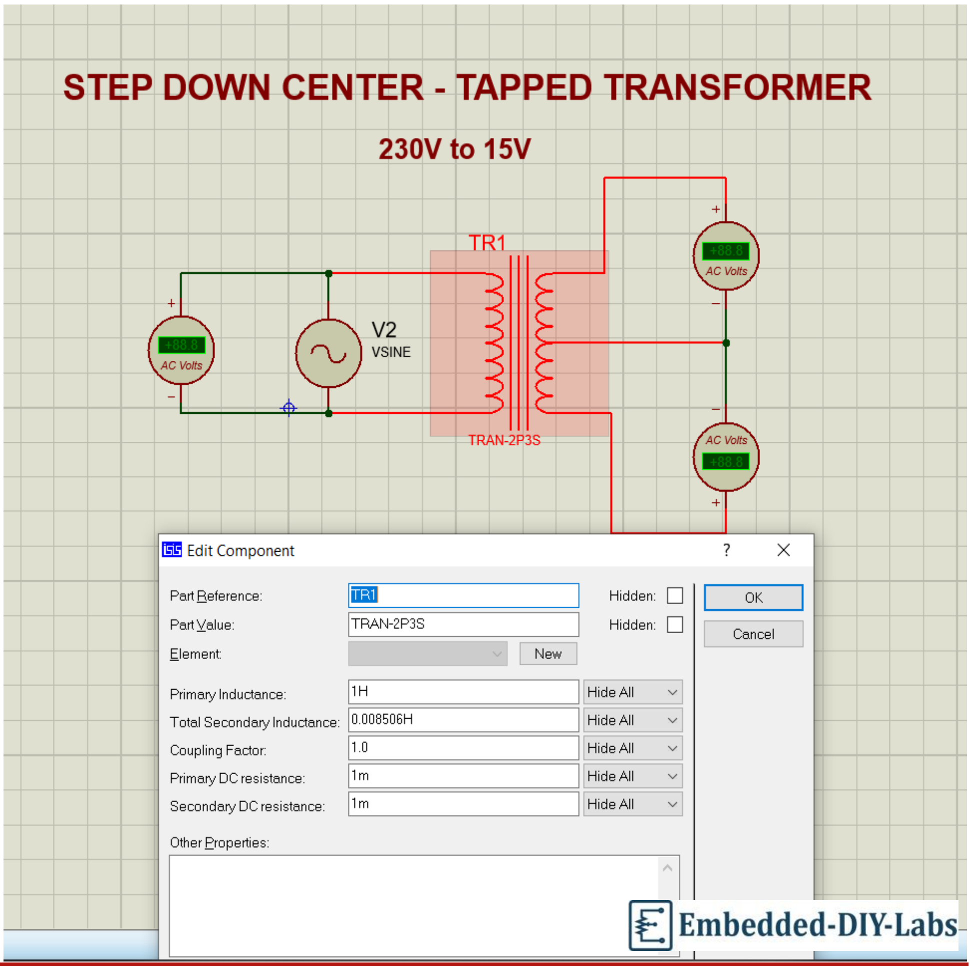
$$PEAK.V_{pri} = 1.414 \, x \, 230 \, V$$

$$PEAK.V_{pri} = 325 \, V$$

$$FREQUENCY = 50 \, HZ$$

Step-2:

In Transformer,



$$L_{pri} = 1\ Henry$$

Since it's a center – tapped we have to apply

$$L_{sec} = 2\ x\ 0.004253\ Henry$$

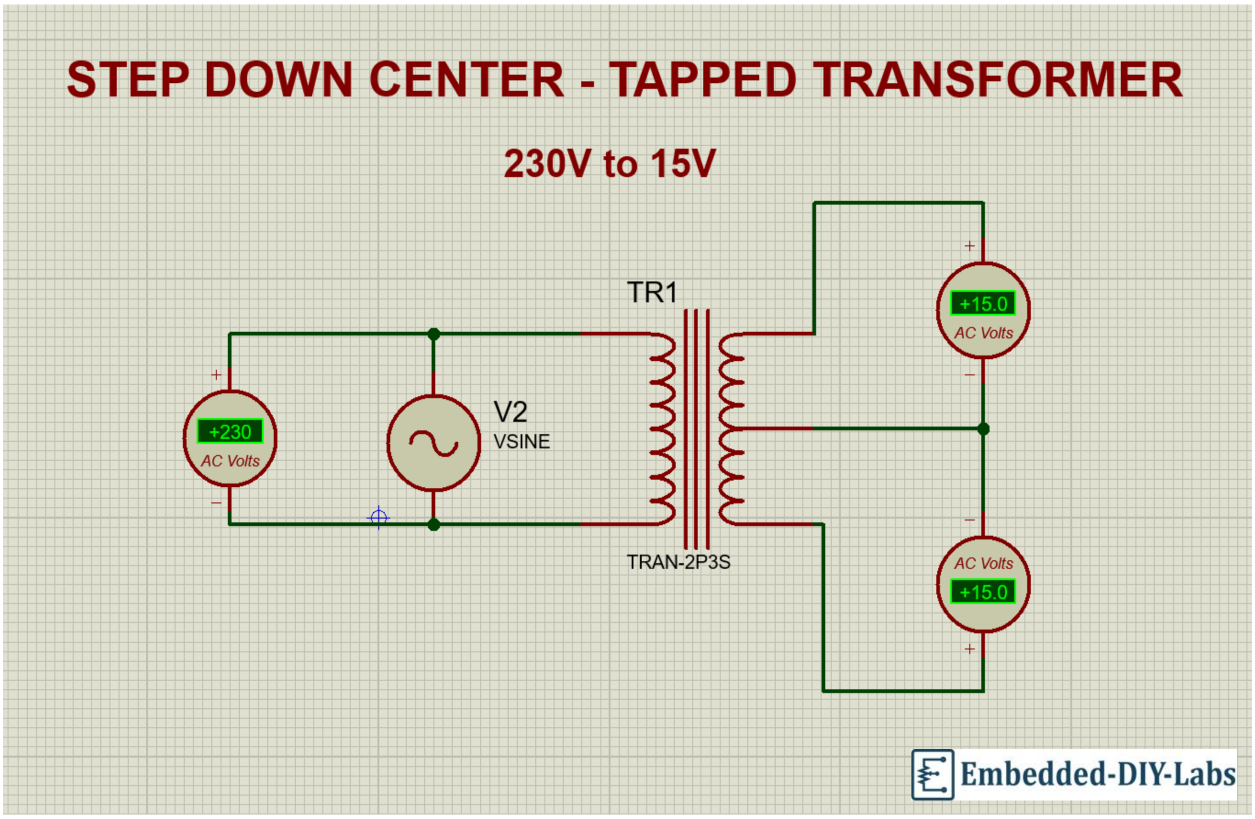
$$L_{sec} = 0.008506\ Henry$$

Coupling Factor (K) = 1

For ideal Transformer Coupling Factor (K) is 1 (Unity).

OUTPUT

Step-3:



Important-Note:

In Step-Up Transformer Design, We Can also apply the Respective Step-down Inductor Values Vice-Versa.

i.e.,

Step-1: Step-down L_{pri} Value to L_{sec} Value of step-up

Step-2: Step-down L_{sec} Value to L_{pri} Value of step-up

This can be achieved by finding the $\mathbf{L_{pri}}$ Value instead of $\mathbf{L_{sec}}$ by keeping $\mathbf{L_{sec}}$ Value as 1 Henry instead of $\mathbf{L_{pri}}$ Value as 1 Henry by default.

$$L_{pri} = \left(\frac{V_{pri}}{V_{sec}}\right)^{2} x \; L_{sec}$$

THANK-YOU!

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Note: Incase of any queries, Comment Us!