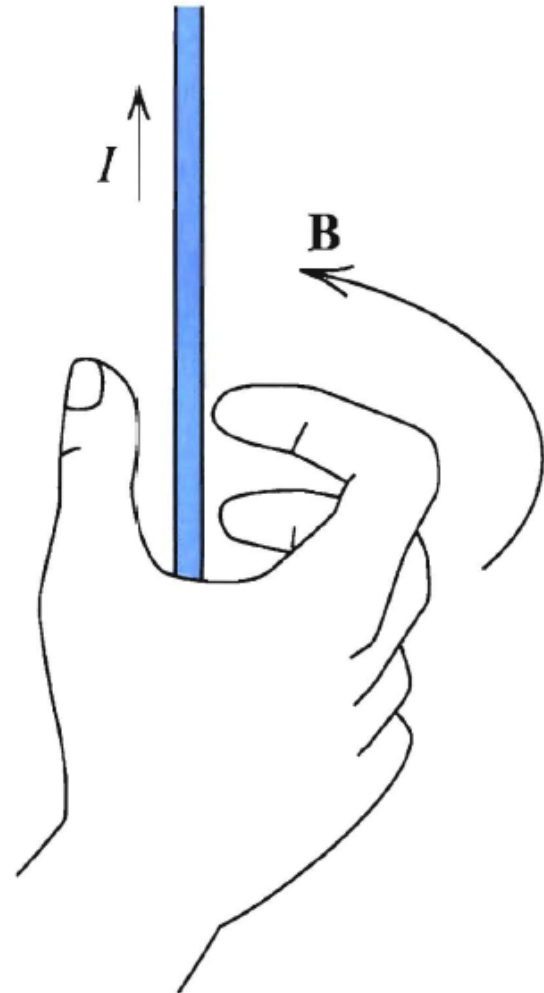


# Transformers

And Load Box Testing

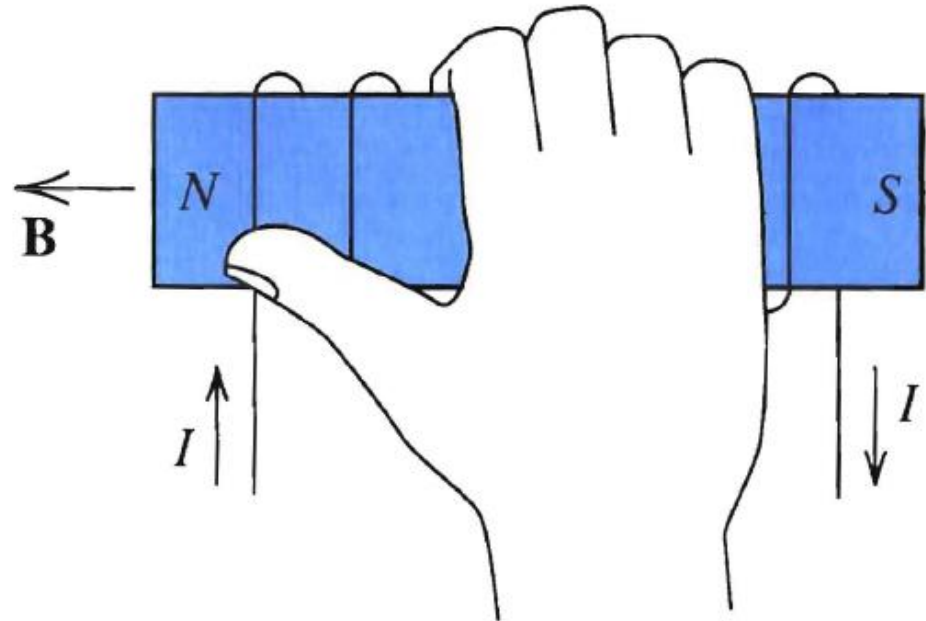
# Right Hand Rule

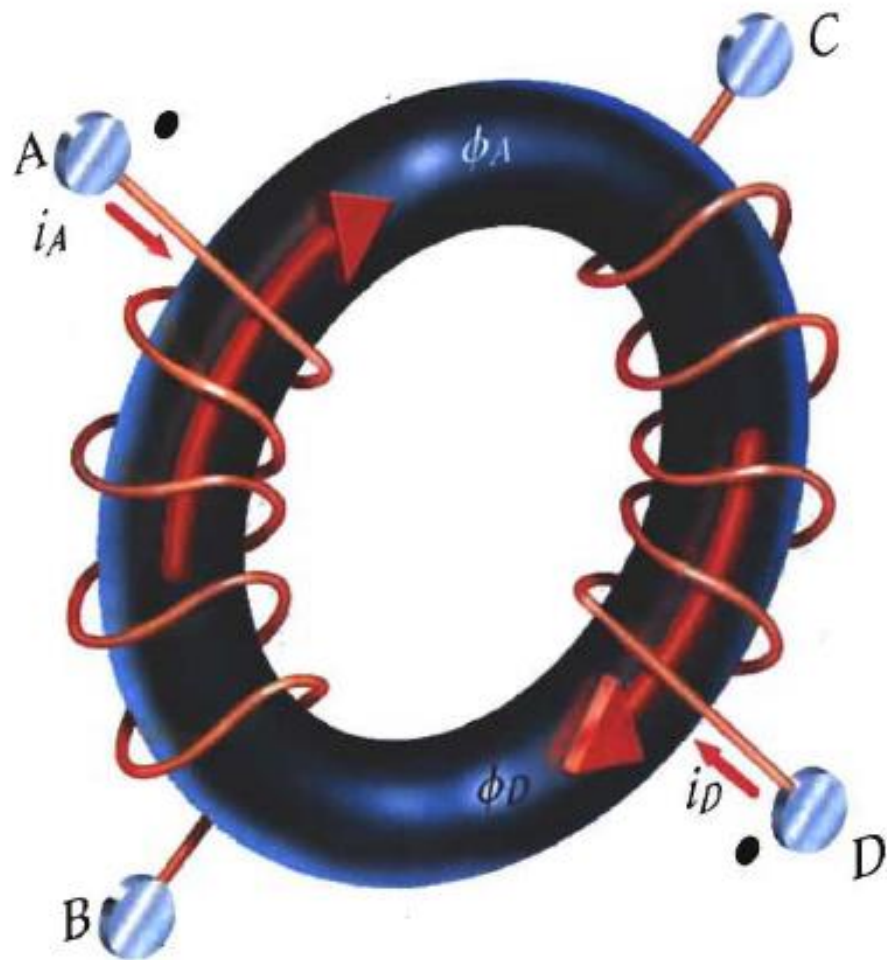
Grasp a straight wire with your thumb pointing in the direction of the current. Your fingers curl in the direction of the magnetic field.



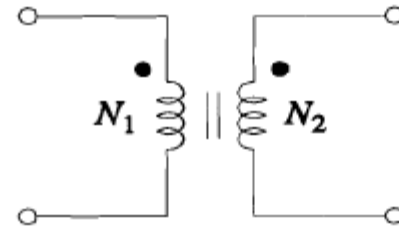
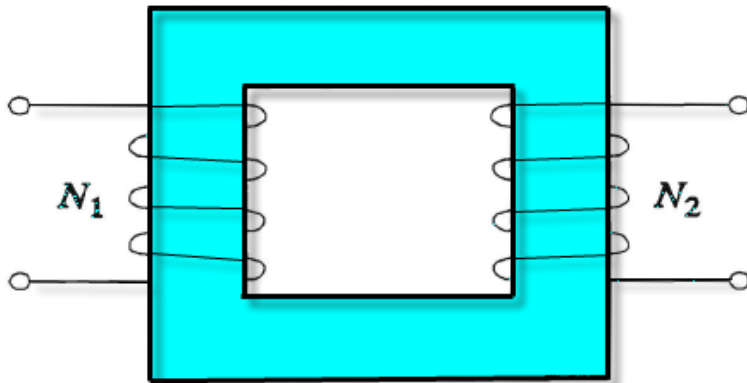
## Right Hand Rule

Grasp a coil of wire with your fingers curling in the direction of the windings. Your thumb points in the direction of the magnetic field.





Two electric circuits linked by a magnetic circuit.



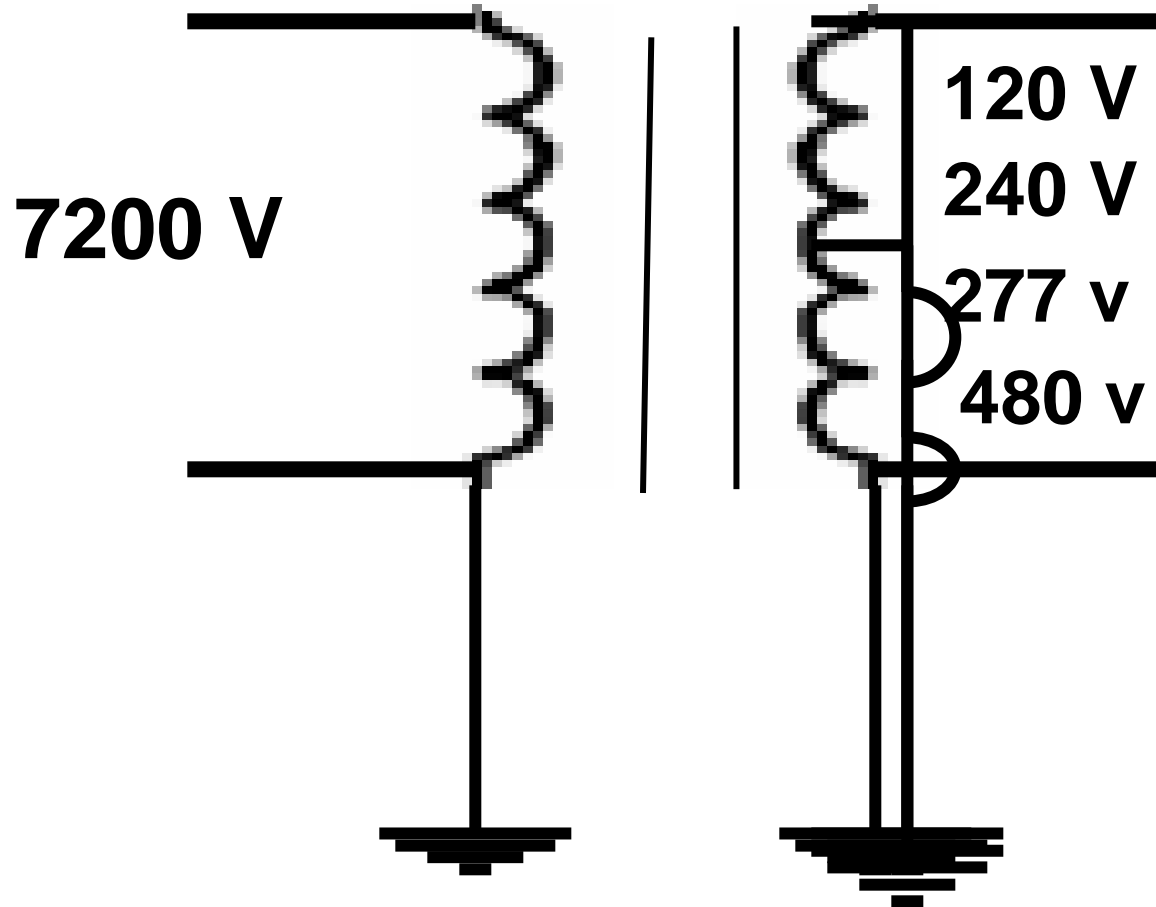
$$v_1 = N_1 \frac{d\phi}{dt} \quad \text{and} \quad v_2 = N_2 \frac{d\phi}{dt}$$

$$\frac{\hat{V}_2}{\hat{V}_1} = \frac{N_2}{N_1} = n$$

$$v_1 i_1 = v_2 i_2$$

$$\frac{\hat{I}_1}{\hat{I}_2} = \frac{\hat{V}_2}{\hat{V}_1} = \frac{N_2}{N_1} = n$$

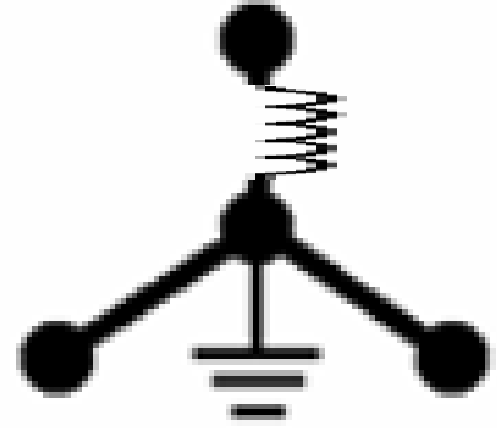
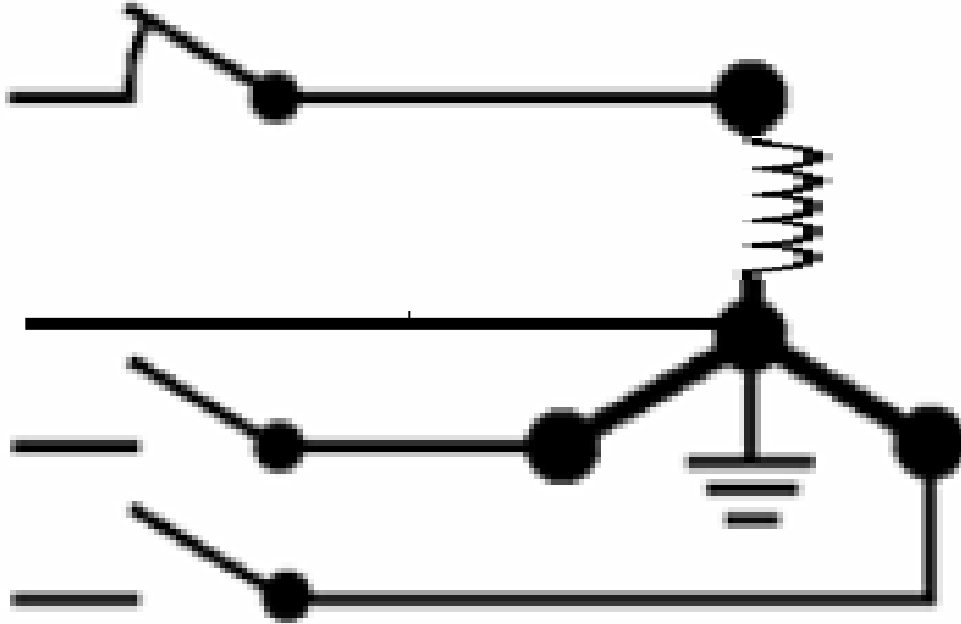
**60:1**  
**30:1**  
**26:1**  
**15:1**

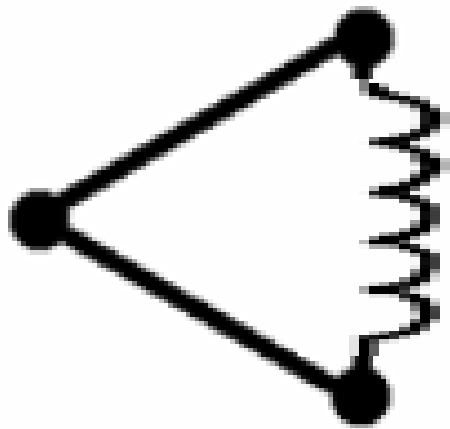
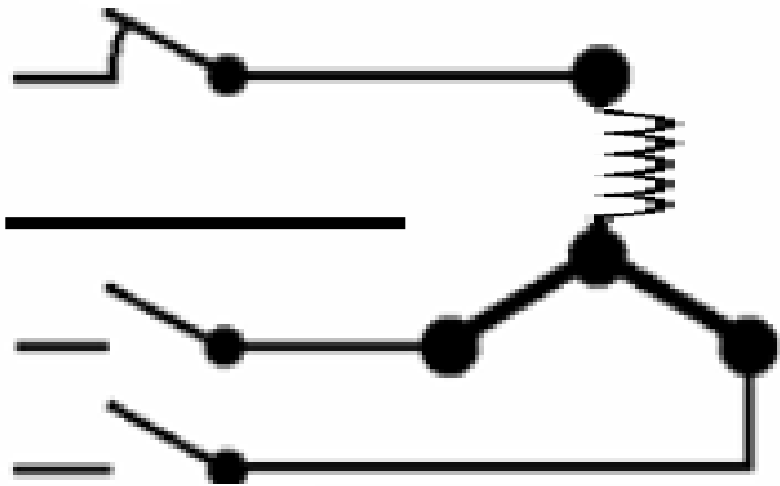


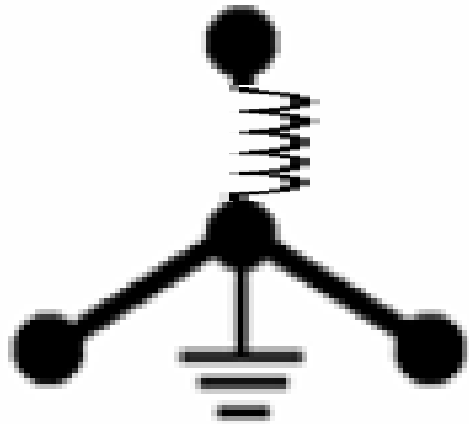
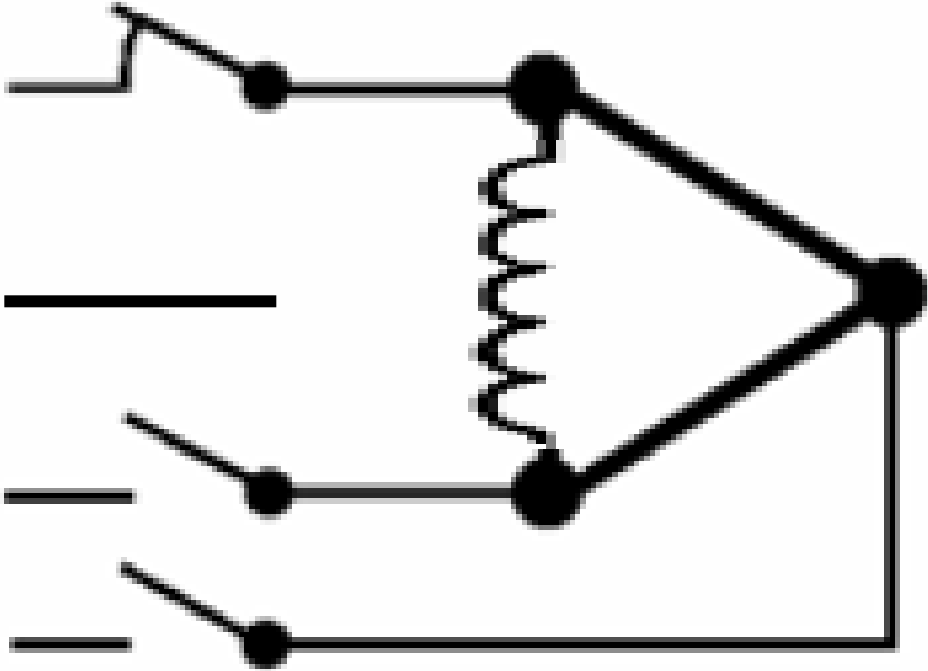
- The relationship between the primary and secondary winding is the ratio and polarity.
- Either winding can be left ungrounded, or grounded at any point without affecting the grounding or the voltage of the other winding.

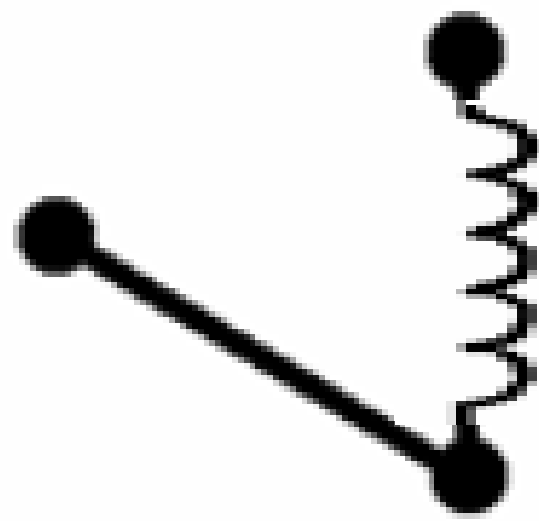
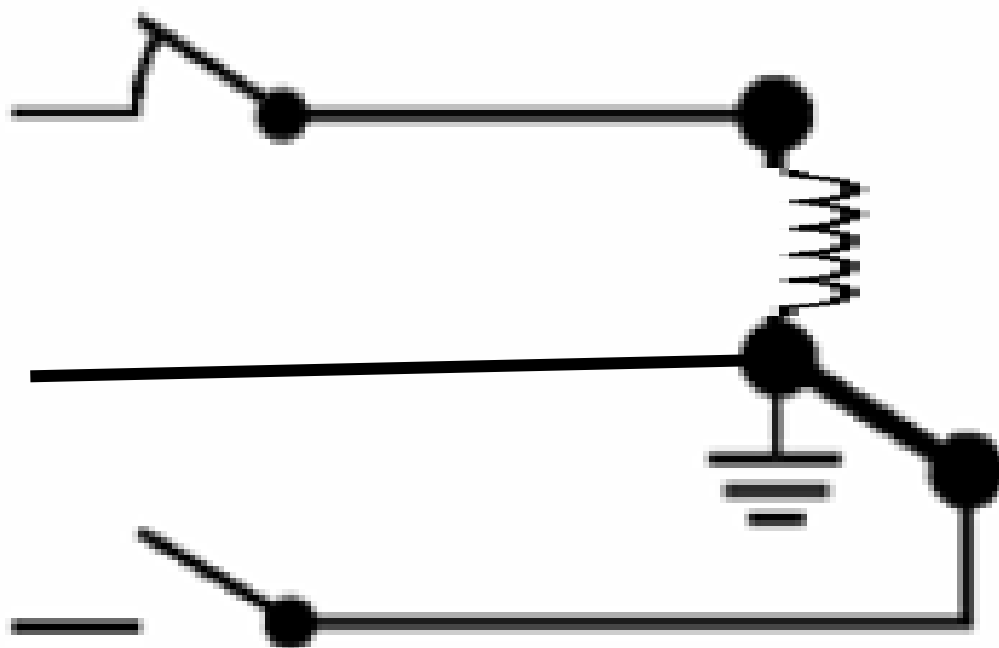
Transformers can be interconnected together in a variety of ways to get a variety of three phase secondary voltages.

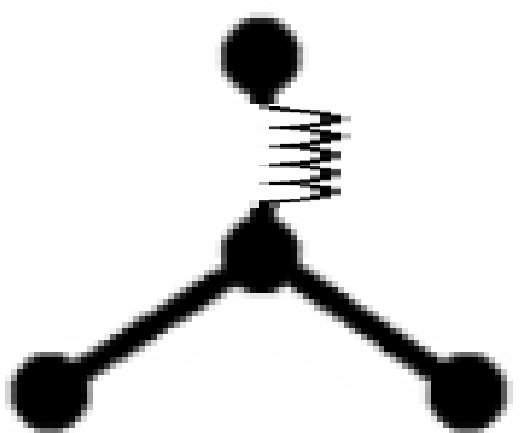
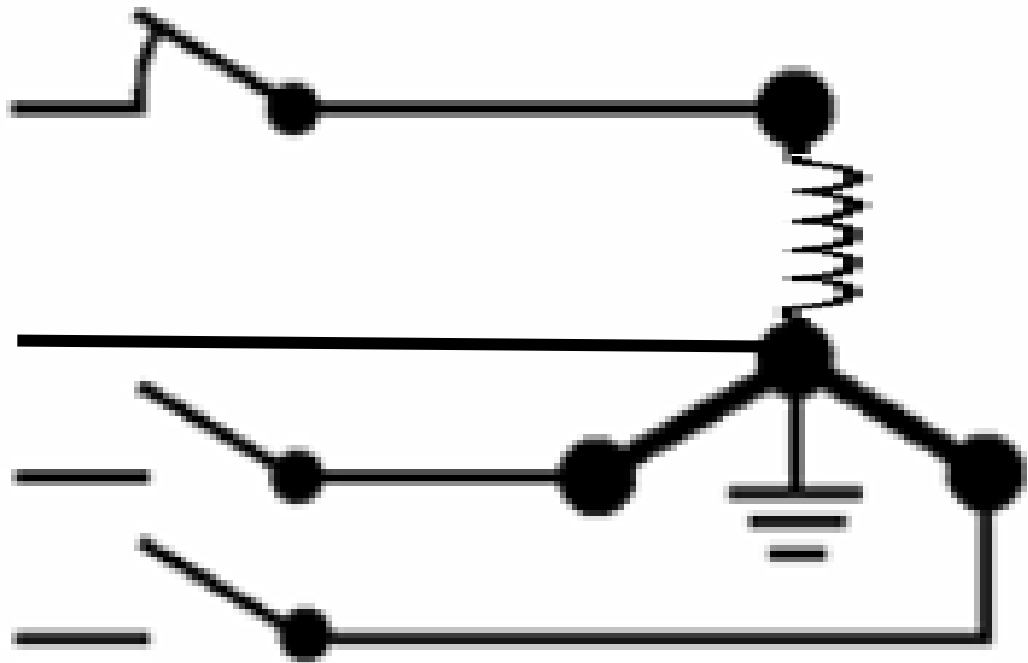






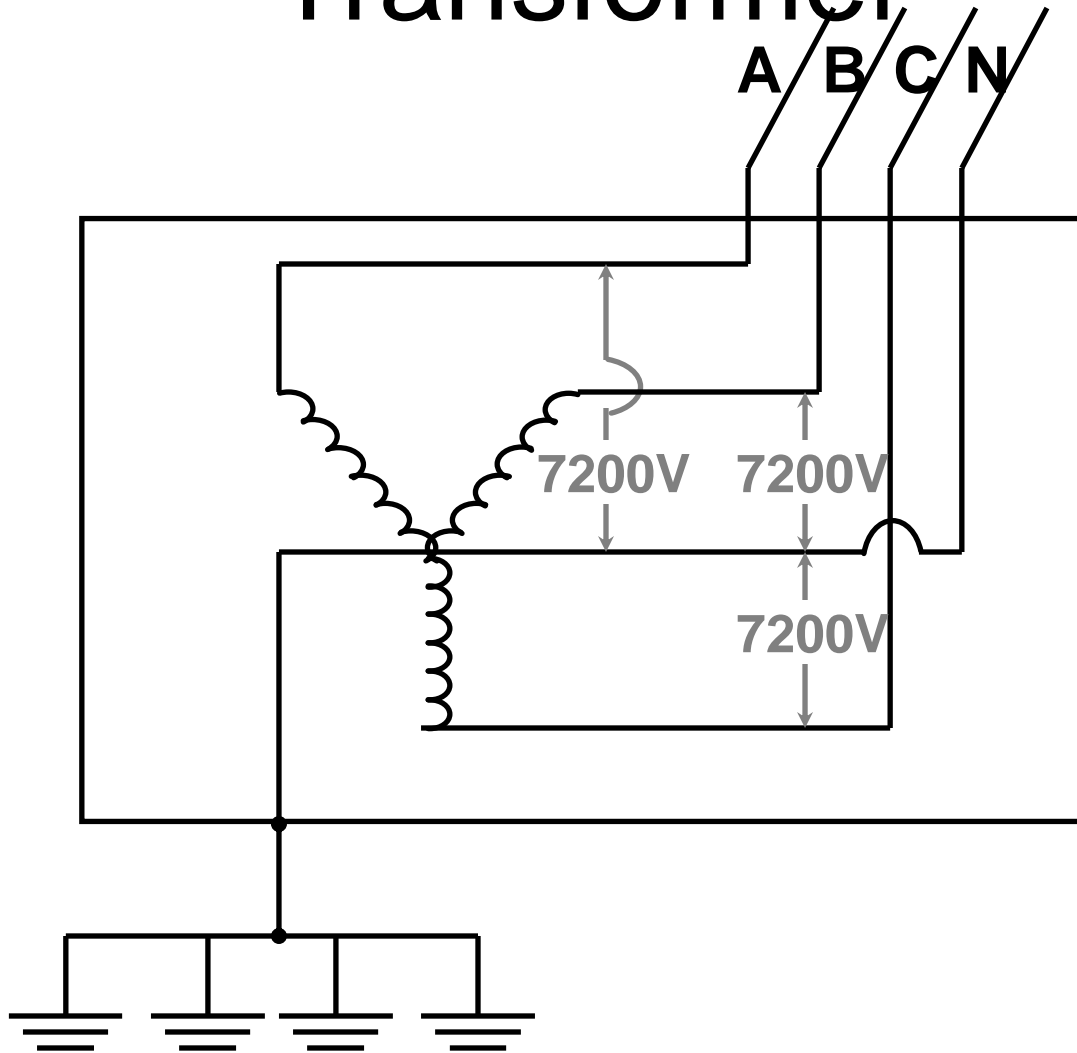






# Distribution Systems

# Typical Substation Transformer



# Delta Distribution System

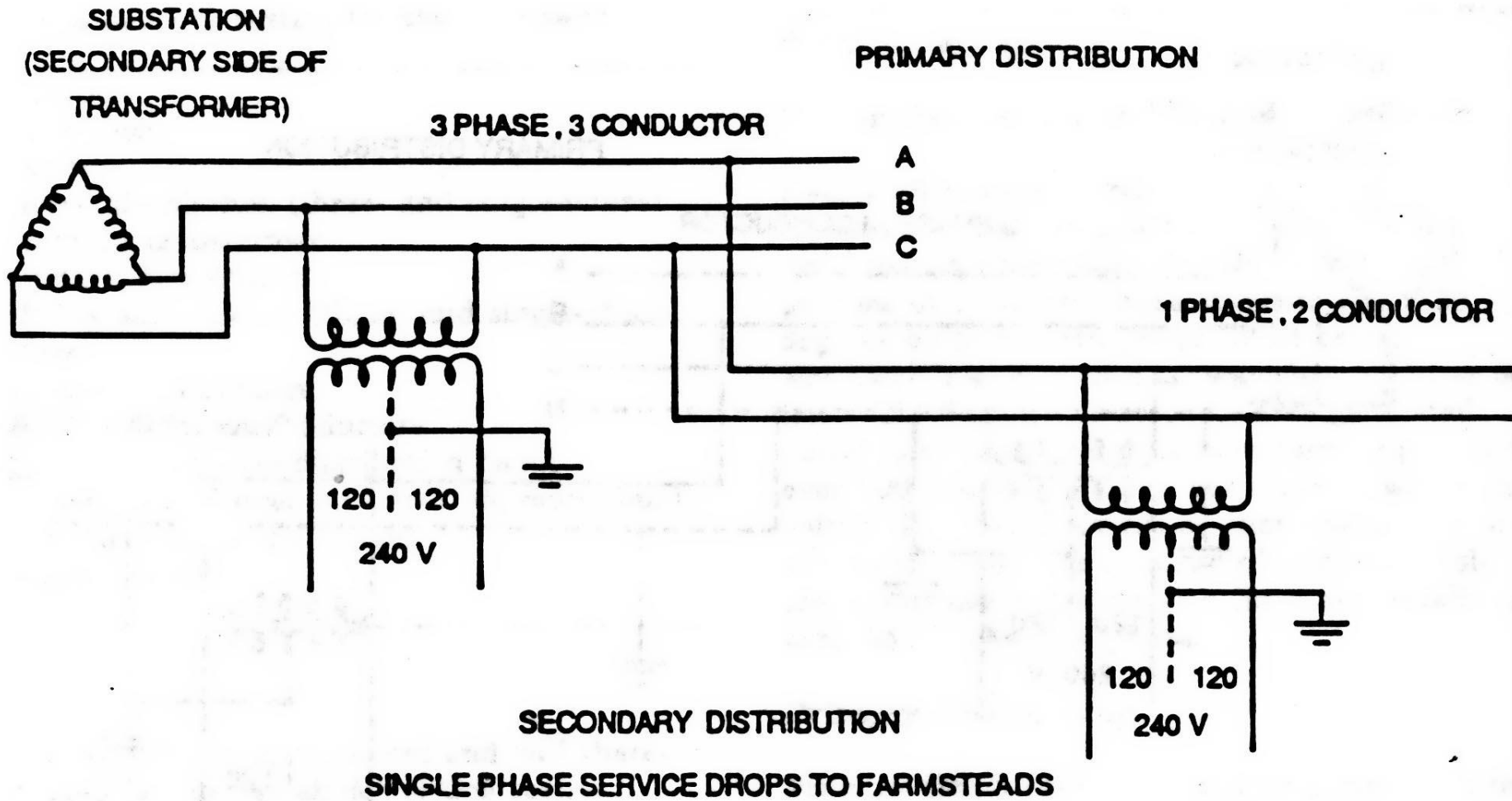
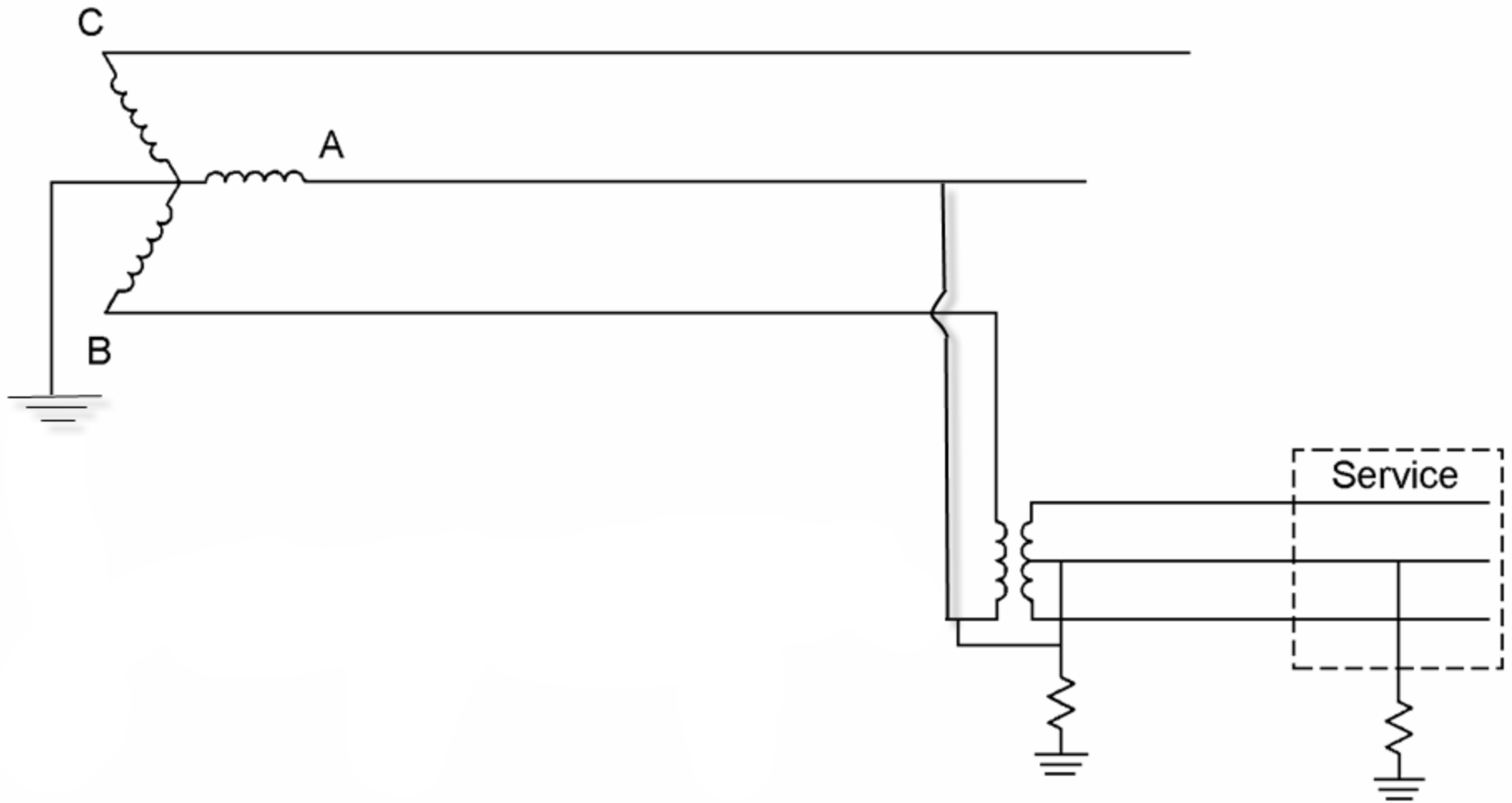


Figure 2-14. Delta distribution system.



## Three Phase Unigrounded Wye System



**The Transformer  
Connection is (somewhat)  
Independent of the type of  
distribution system.**

# Four Wire Multi-Grounded System

- Ungrounded Wye Primary Transformer Bank
- Grounded Wye Primary Transformer Bank
- Delta Primary Transformer Bank
- Open Wye (Primary) – Open Delta (Secondary) Transformer Bank

**The secondary (low voltage) side of the three phase banks can be interconnected in a variety of manners, independently of the connection on the primary (high voltage) side.**



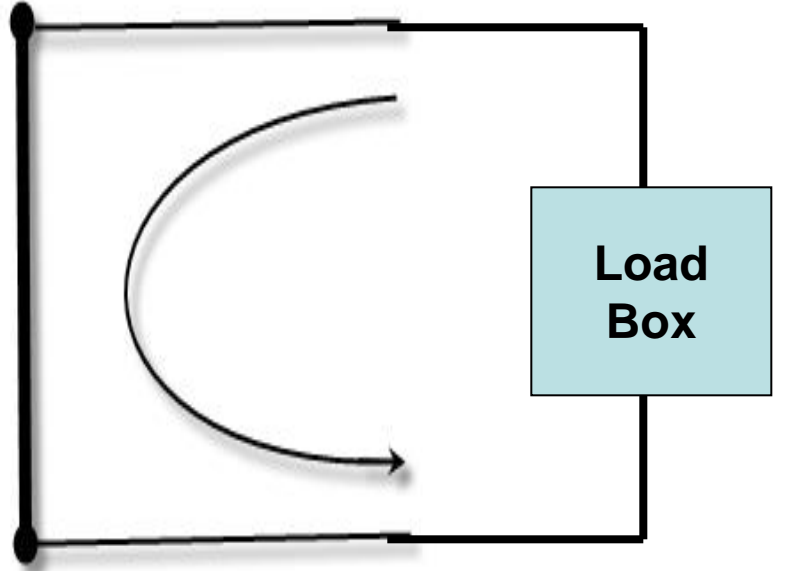
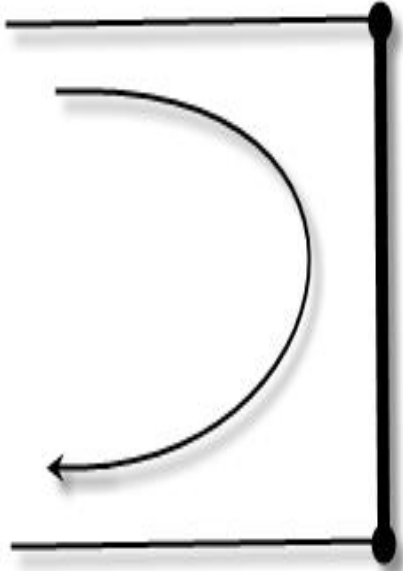
# LOAD BOX TEST

Intended to examine the condition of the distribution primary neutral and the farm grounding system by measuring the resistance of the farm and primary neutral. It also measures the cow contact voltage in response to the primary neutral voltage.

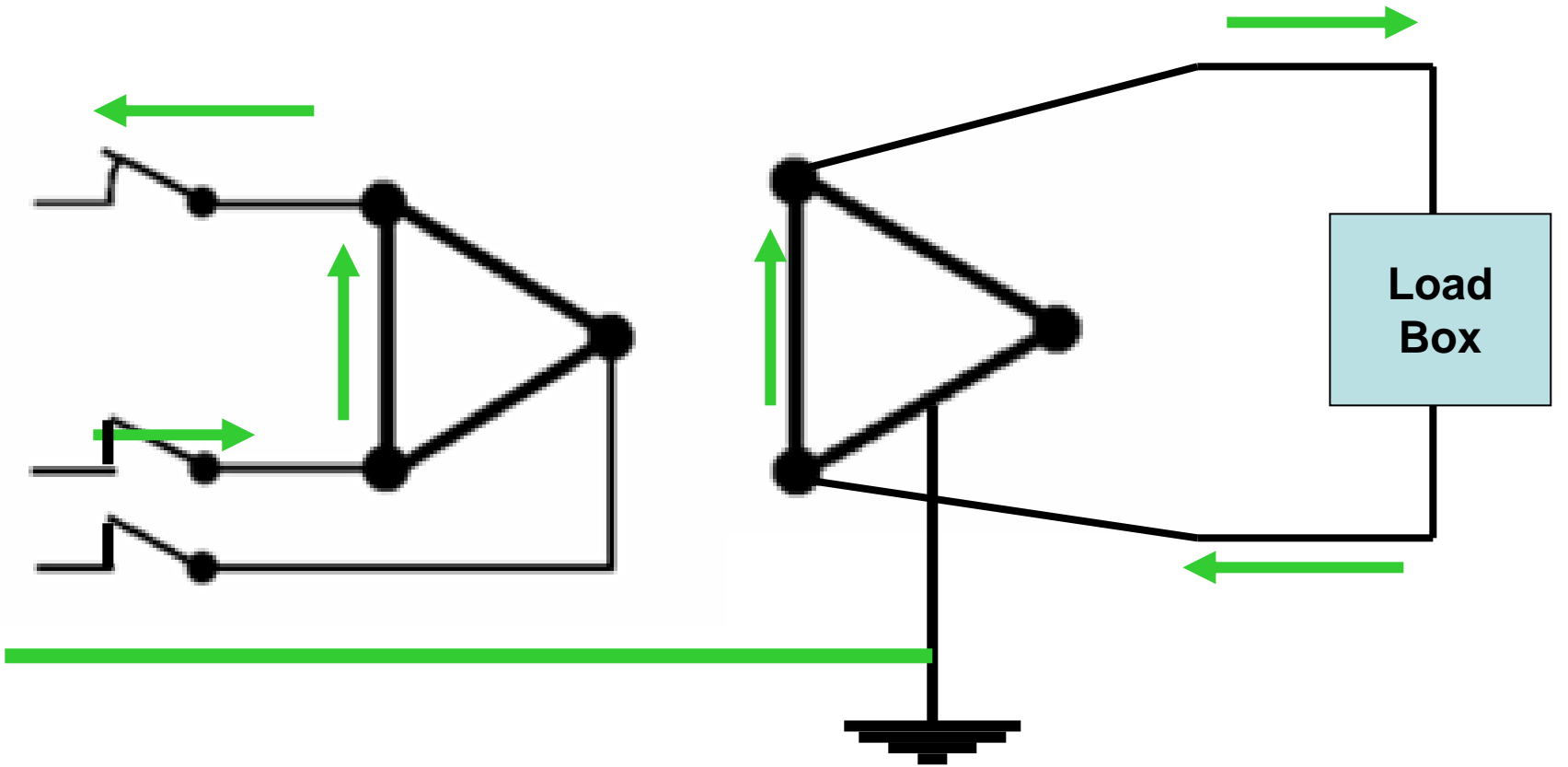
# Load Box Test

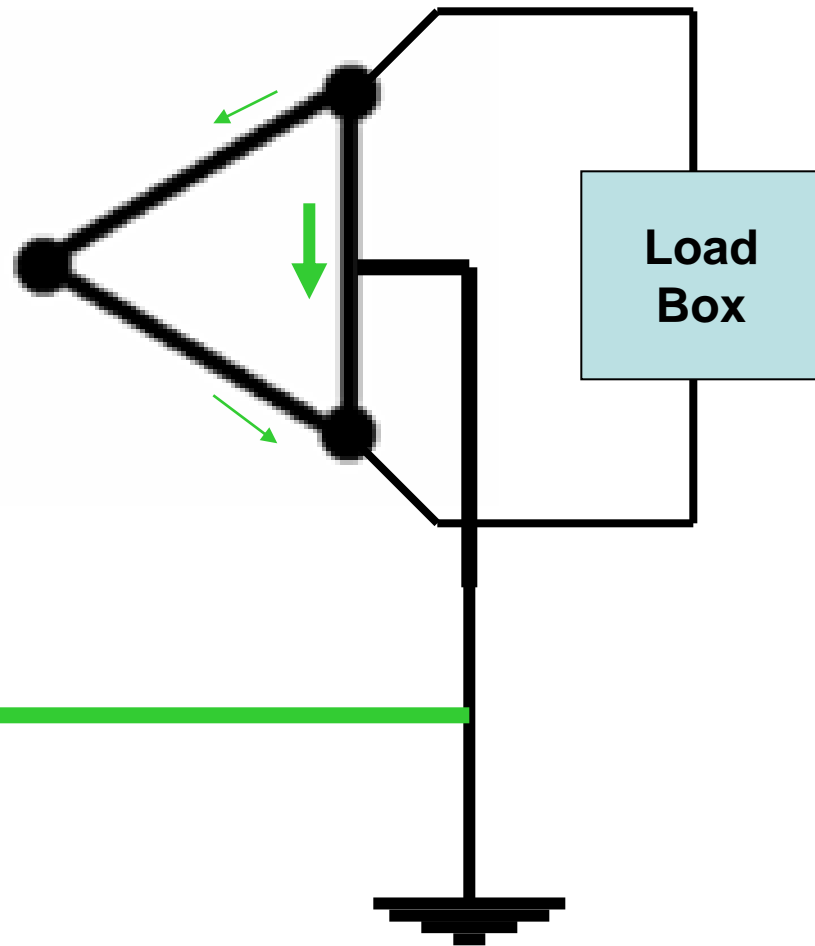
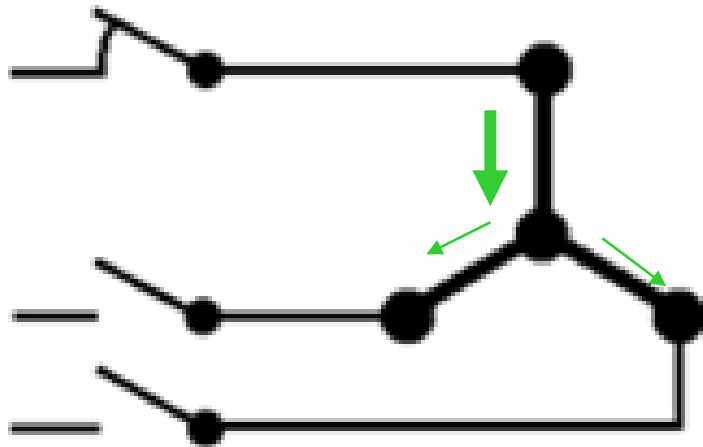
Inject a current into the neutral system, measure the voltage rise, measure the current into the farm and the primary neutral, and determine the resistance of each with the formula

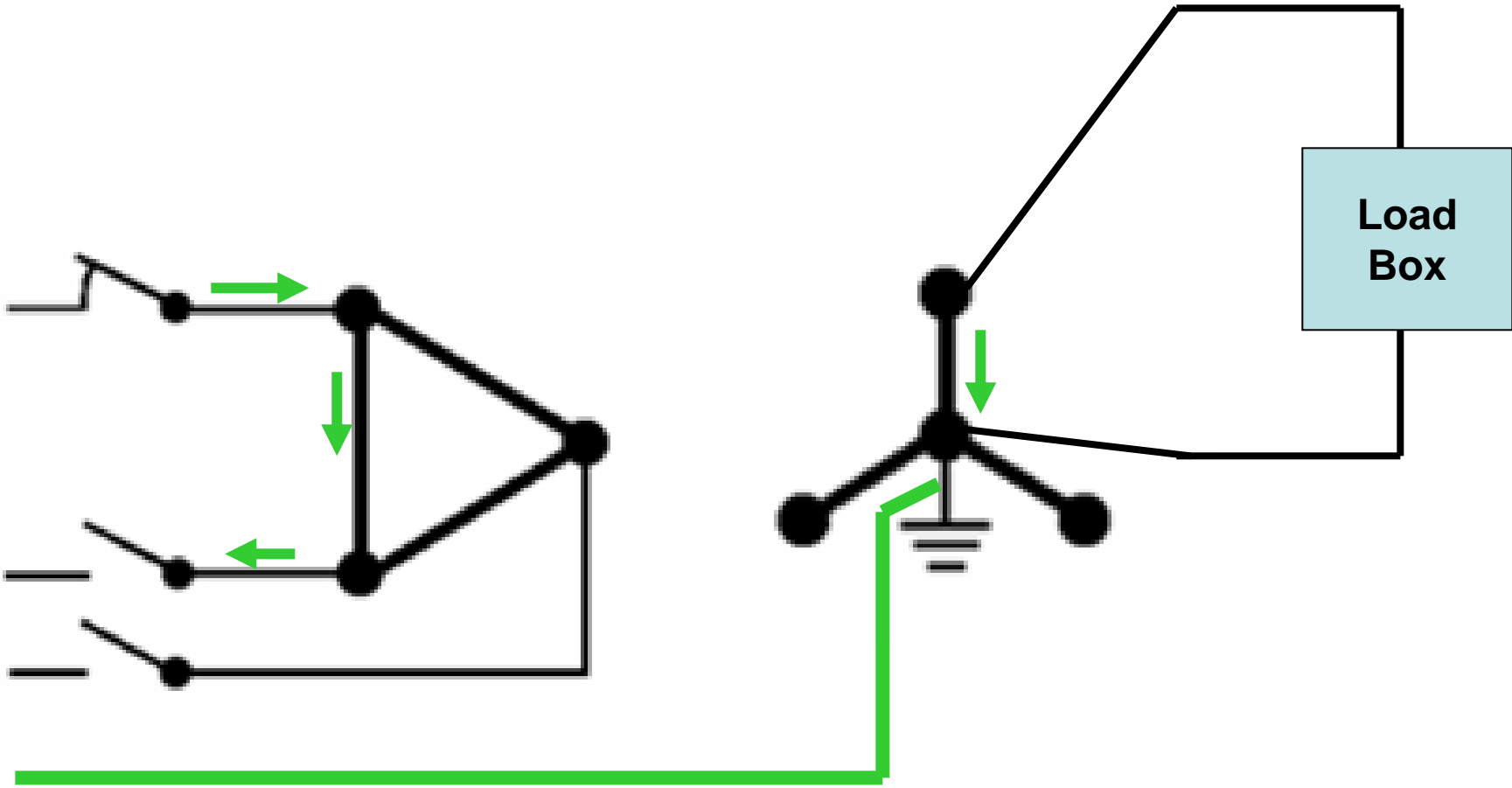
$$R = V / I$$

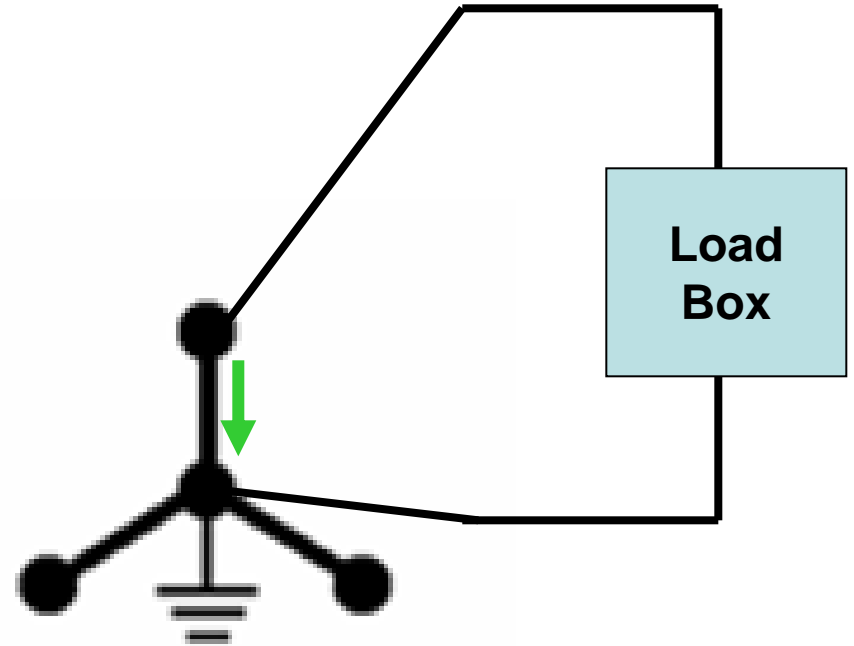
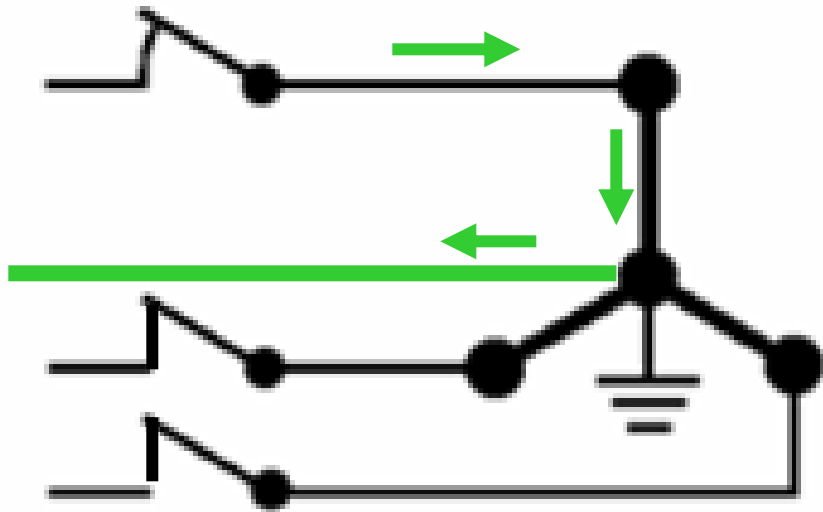


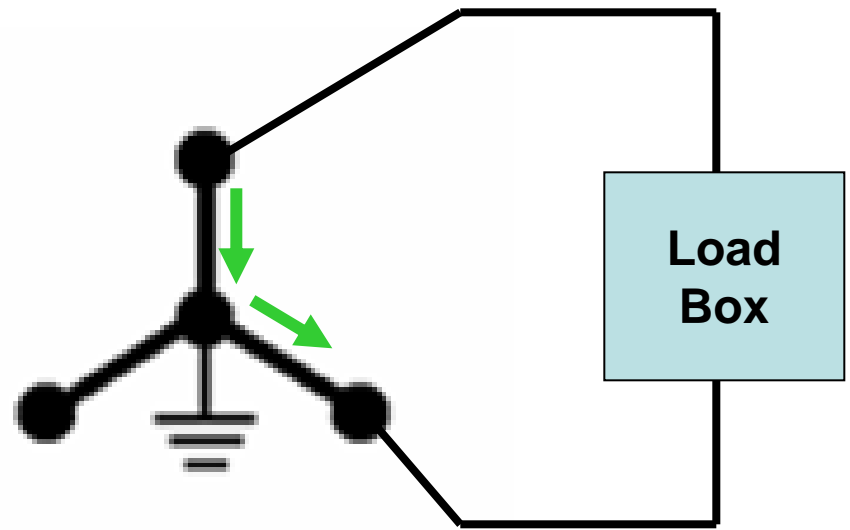
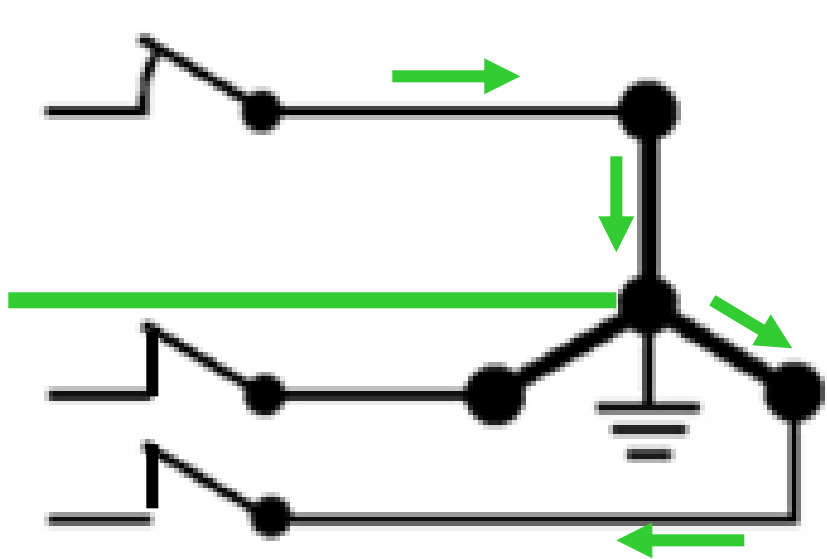


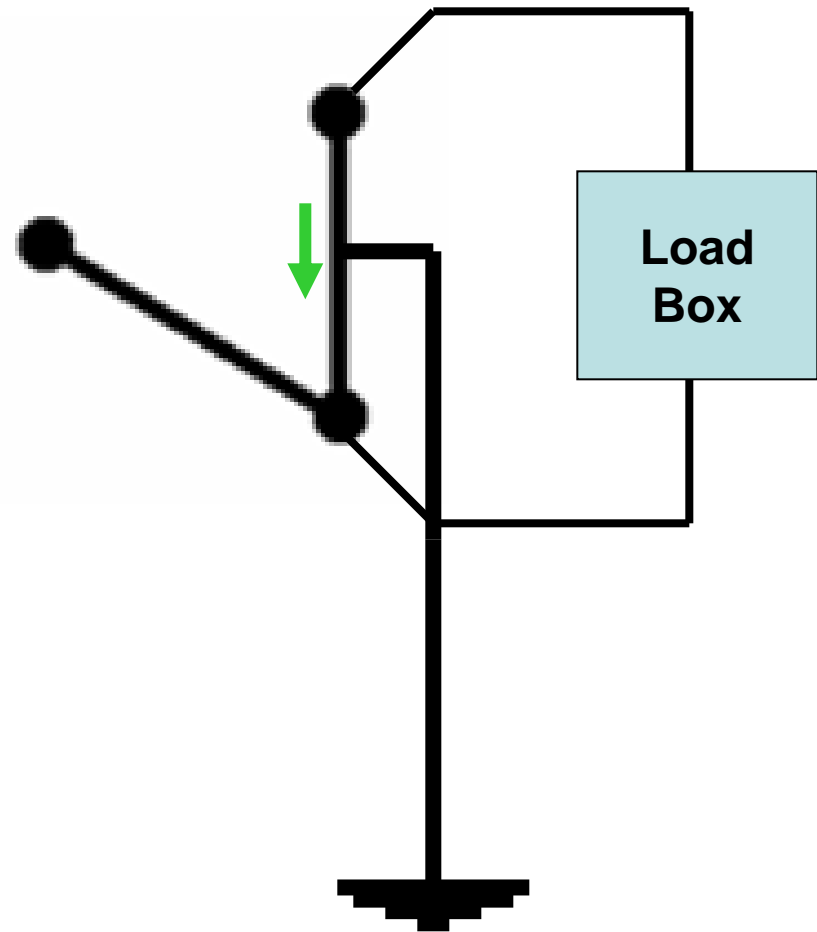
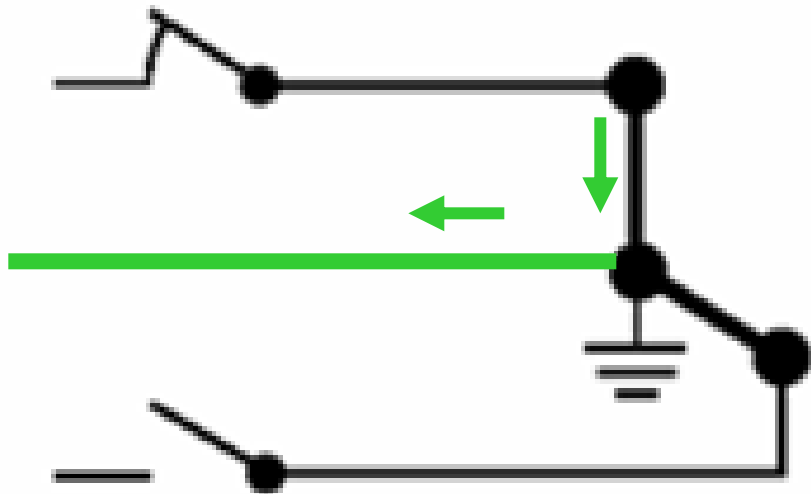














# Important Considerations are:

- A balanced three phase load on any system using three transformers will NOT cause any neutral current in the primary
- If the transformer bank has no primary winding connection to the primary neutral, the load (at the farm) CAN NOT cause a primary neutral current.
- On most systems, a balanced three phase load box will do nothing to load up the primary neutral.