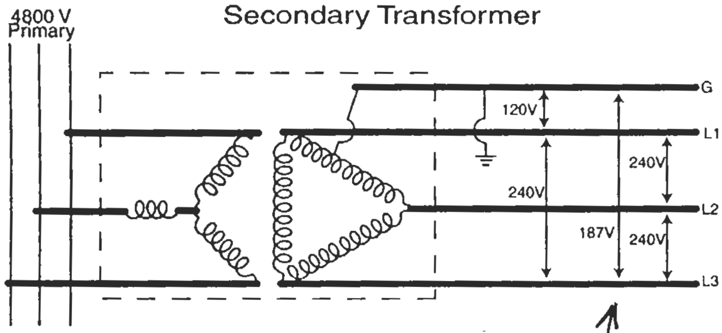
❖ Three-Phase Line Voltages

Three phase power found in commercial buildings can be in either a 240 volt or 480 volt configuration. The more common of the two electrical voltages is 240 volts. You will find 480 volt power where there are large motors being used in commercial applications. By using the higher 480 voltage, the current flow in the building's wiring is kept to a lower level.

If the supply voltage into the building is 240 volts, there are two possible electrical configurations that may be present, they are called Delta and "Y" type. This wiring diagram illustrates the Delta configuration (Fig. 1). 4800 volts is applied to the power pole's transformer primary winding. The secondary winding has four taps: ground, and three taps labeled L1 through L3. The taps are taken at different positions in the secondary and therefore have different potentials. From ground to L1 we have 120 volts available and from L2 to ground we also have 120 volts available. L3 is tapped from the other side of the delta configuration and has a potential of 187 volts to ground. This leg must never be used to power up 120 volt circuits. You will find this leg commonly called the wild leg. If you measure the voltage potential between any combination of L1, L2, and L3 legs, you will measure 240 volts. These 240 volt combinations will be used to power up our high voltage condensing unit circuits.

Fig. 1

Three Phase, 4 Wire, Delta (Δ) Secondary Transformer

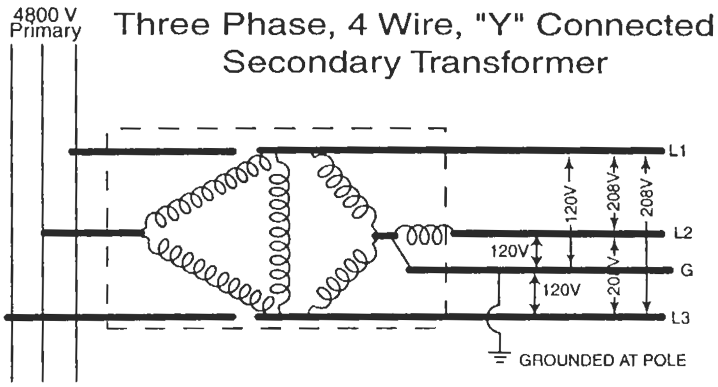


'Wild' or 'High' Leg

This electrical schematic (Fig. 2) shows the "Y" connection three phase transformer. Unlike the delta configuration, the "Y" secondary does not have a wild leg. In this configuration, any combination of L legs will have a potential of 208 volts. The potential of any L leg to ground will be 120 volts.

Fig. 2

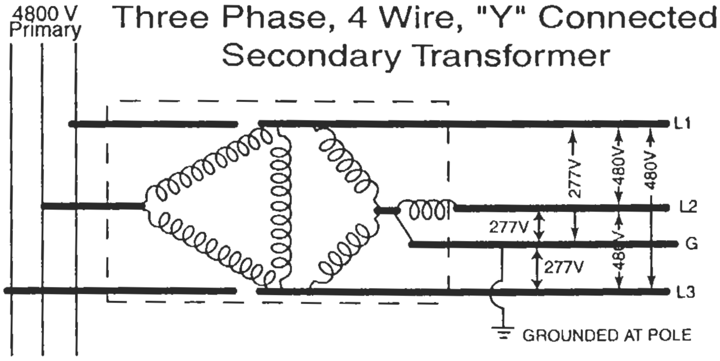
Three Phase, 4 Wire, "Y" Connected Secondary Transformer



This final diagram(Fig. 3) shows a 480 volt three phase power pole transformer. Notice that a potential of 480 volts is present between any combination of L legs. To ground, the L legs have a potential of 277 volts. If 120 volts is needed in the building, a separate step down transformer is used to provide 120 volts to the building. The 277 volts available from any L leg to neutral is typically used to power up fluorescent lighting systems.■

Fig. 3

Three Phase, 4 Wire, "Y" Connected Secondary Transformer



Three Phase Voltage Imbalance

When three phase power is supplied to a commercial building, electricians take off power from different phase legs to power up 230 volt single phase equipment. If the same leg is used for the majority of the single phase power requirements, one three phase leg may drop its voltage too far below the other legs. In practice, a maximum of a 2% voltage imbalance is all that is allowed. This is due to the fact that voltage imbalances generate excessive heat in a three phase motor stator, such as those found in expensive three phase compressors.

Calculating Voltage Imbalance

We can determine the voltage imbalance present at a jobsite by performing the following test: (Fig. 4)

1. Run the condensing unit and measure the voltage being supplied to the compressor contactor on all three legs. Make sure the compressor is running.

2. Next, add the three measured voltages and divide by three. You now have the average voltage.

3. Identify the leg with the largest difference from the average.

4. Divide the largest difference by the average voltage and multiply the result by 100.

5. The result is the percentage of difference from average. Please note that a maximum percentage of 2% is all that is allowed.

Example (Fig. 5)

L1= 235
L2= 227
L3= 229

We add them together =691 ❶ and then divide by 3 which equals an average of 230 volts ❷. Leg L1 is the farthest from the average or 5 volts too high ❸.

We then divide the difference of 5 by the average of 230 volts for a voltage imbalance of 2.17% ❹.

In this example we are higher than the allowed imbalance of 2%. In reality, this imbalance creates an increase in the temperature of the stator by 9.5% in the phase of the stator where the L1 phase is connected.

To correct the problem, try moving the lines forward on the compressor contactor lugs such as L1 goes to L2 and L2 goes to L3 and then L3 to L1, and recheck the voltages. If the problem is not corrected, move the lines forward one more position and retest. If the problem is still not corrected inform the building owner to have an electrician analyze the buildings load distribution.

Failure to correct this type of problem will create the potential for premature motor failures at the compressor and indoor blower motors.■

Fig. 4

(L1) + (L2) + (L3) = X

X ÷ 3 = Y

(L1)	(L2)	(L3)
- Y	- Y	- Y
Z1	Z2	Z3

farthest from average....

[ ] ÷ Y = Voltage Imbalance

Fig. 5

❶ (L1)235 + (L2) 227 + (L3)229 = 691

❷ 691 ÷ 3 = 230

❸

(L1)235	(L2)227	(L3)229
-230	-230	-230
5	3	1

❹ 5 ÷ 230 = 2.17%