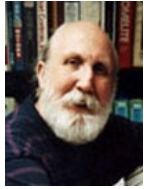




Tech Talk July 2012



Three Phase Motor Nameplate Voltage Ratings

Three phase, single speed, squirrel cage induction motors (SCIM) have their motor nameplate voltages as either

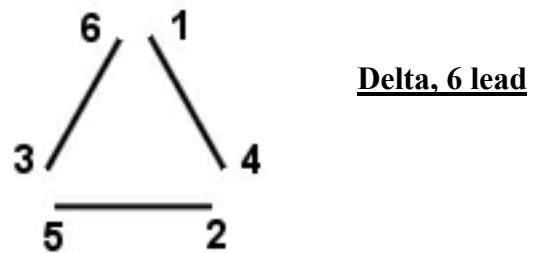
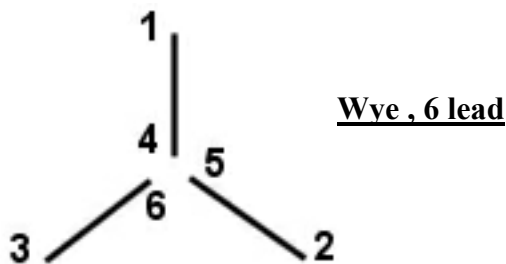
- A. Single Voltage ie 460v
- B. Dual voltage, where the ratio of the voltages is 2 to 1 ie, 230/460v
- C. Dual Voltage, where the ratio of the 2 voltages is 1.73 to 1 ie. 220/380v, 277/480v, 240/415v

Let's go back to the basics:

All 3 phase motors have 3 equal phase windings. By convention we number these windings as 1, 2 and 3. Winding 1 has a beginning of 1 and an ending of 4. Winding 2 has a beginning of 2 and an ending of 5. Winding 3 has a beginning of 3 and an ending of 6.....so we have

1 4 2 5 3 6

Now for all 3 phase SCIM, the windings can be connected in what is called a Wye or a Delta connection, as shown below.



Now when a winding is designed each phase winding is rated for a certain voltage. If you put too much voltage across the winding the winding will be too strong and will overheat. If you put too little voltage across the winding it will be too weak and not develop the torque you want.

Let us assume that each phase winding is good for a voltage of 220v.

In the Wye case above if we join 4, 5, and 6 together and put L1 to wire 1, L2 to wire 2 and L3 to wire 3 and **if the line voltage is 380v** then everything is fine because **IN A WYE CONNECTED WINDING THE PHASE WINDING VOLTAGE IS ALWAYS THE LINE VOLTAGE DIVIDED BY 1.73 (THE SQUARE ROOT OF 3)** ie $380/1.73 = 220v$

<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>JOIN</u>
1	2	3	4&5&6

If in the Delta connection we join 1 and 6 together and connect to L1, and join 2 and 4 together and connect to L2 and also join 3 and 5 together and connect to L3. **If the line voltage is 220v** each winding will have 220v across it. In this Delta case the phase winding voltage always equals the line voltage.

<u>L1</u>	<u>L2</u>	<u>L3</u>
1&6	2&4	3&5

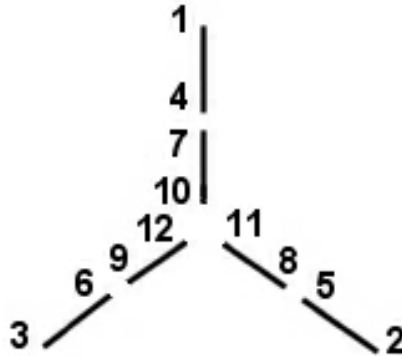
This then is an example of Case C above, dual voltage, where the nameplate ratio of the 2 voltages is **1.73 to 1**.

12 Lead Motors

We can now take the preceding information and consider what happens if the phase winding is composed of 2 equal sections. If we do, we will have a configuration similar to the next drawings.....

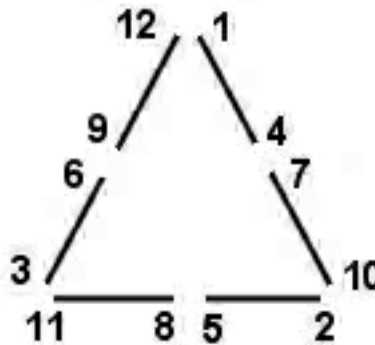
Both these drawings are examples of dual voltage motor with a voltage ratio of 2 to 1, as in **Case B** pre-

Wye, 12 lead



<u>VOLTAGE</u>	<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>JOIN</u>
High Wye	1	2	3	4&7,5&8,6&9, 10 &11&12
Low Wye	1, 7	2, 8	3, 9	4&5&6, 10&11&12

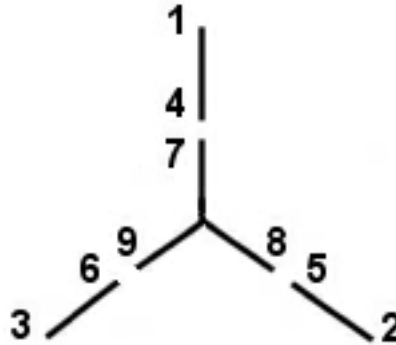
Delta, 12 lead



<u>VOLTAGE</u>	<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>JOIN</u>
High Delta	1&12	2&10	3&11	4&7,5&8,6&9,
Low Delta	1,6, 7,12	2,4, 8,10	3,5, 9,12	—

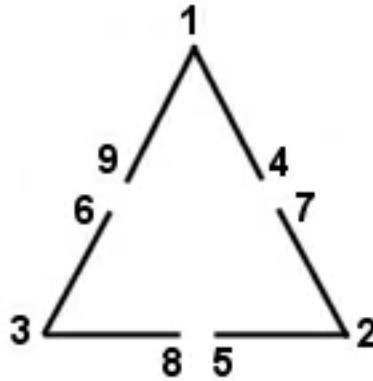
9 Lead Motors

If we take the 12 lead Wye connection and solidly join wires 10,11 and 12 together we will have a Wye Connected, Dual Voltage, 9 lead motor. In this connection the voltage ratio will be 2 to 1, as in **Case B** on the previous page



<u>VOLTAGE</u>	<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>JOIN</u>
High	1	2	3	4&7,5&8,6&9
Low	1,7	2,8	3,9	4&5&6

Similarly for the Delta motor. If we connect as below we will have a Delta Connected, 9 lead, Dual Voltage Motor, where the voltage ratio will be 2 to 1 as in **Case B**



<u>VOLTAGE</u>	<u>L1</u>	<u>L2</u>	<u>L3</u>	<u>JOIN</u>
High	1	2	3	4&7,5&8,6&9
Low	1,6,7	2,4,8	3,5,9	—

As for **Case D** where the motor is name plated 208/230/460v or 208-230/460v. Here the motor manufacturer is saying the motor can be run on any of the 3 line voltages. In other words if the motor were connected for low voltage 230v then it would also work if the supplied power was only 208v. **BE VERY CAREFUL HERE.**

The motor will run on 208v but it will not be as strong as it was on 230v and the application should be such that it could tolerate this weaker winding.

If your plant has a nominal 208v incoming line voltage ,to be safe ,buy a motor suitable only for this single voltage , especially if the load the motor will be connected to is a high torque load,like an air compressor. Also we know we have to be prepared for low incoming line voltage so a double reminder here.

Summary

1. **Six** lead,single speed, motors will always be name plated with voltages in the ratio of **1.73 to 1** and can be used as Wye Start , Delta Run motors when coupled with the correct Wye/Delta Starter.
2. **Nine** lead,single speed, motors will always be name plated with voltages in the ratio of **2 to 1**
3. **Twelve** lead, single speed, motors can be name plated with voltages in the ratio of 2 to 1 **AND ALSO** can be used as Wye Start , Delta Run motors when coupled with the correct Wye/Delta Starter.
4. **IN A WYE CONNECTED WINDING THE PHASE WINDING VOLTAGE IS ALWAYS THE LINE VOLTAGE DIVIDED BY 1.73 (THE SQUARE ROOT OF 3)**
5. Be very careful when applying any tri voltage rated motor, such as 208/230/460v, on a 208v incoming line