Identifying Unmarked Leads Of 6-Lead Motors With 1 Or 2 Windings

Procedures Also Help Identify Type Of Connection When There Is No Nameplate

By Chuck Yung
EASA Technical Support Specialist

One frequent request of EASA's technical support staff is for help in identifying unmarked motor leads. This article introduces a set of procedures for identifying unmarked leads of 6-lead motors with 1 or 2 windings. For most connections, the only tools required for these procedures are an **ohmmeter** and **surge tester**.

An additional benefit is that these procedures can be used to identify the type of connection (**Table 1**); for example, when a motor is received without a nameplate. With 6 leads, the motor connection could be part-winding start, wye-delta, or a 2-speed design.

Information about the application can save several steps in the identification process. For instance, a vertical motor from a municipal water plant is likely to be connected for part-winding starting. If the application is a centrifuge or other high-inertia load, it is likely to use a wye-delta connection. A fan application or mixer is more likely to have a 2-speed winding.

Determining Continuity

When a motor has no nameplate, the first step in identifying the type of connection is to use an **ohmmeter** to determine which leads have continuity. The meter must be capable of accurately measuring the resistance. If the resistance is less than 5 ohms, use a **milli-ohm meter** or **bridge device**.

2 Circuits, 3 Leads Each

If the motor has 2 independent circuits of 3 leads each, it is either a part-winding start or a 2-winding motor. Surge test each set of 3 leads separately.

If the surge test pattern for each 3-lead circuit has two "good" patterns and 1 "bad" pattern, the motor has an adjacent-pole part-winding start. For each set of 3 leads, the good pattern occurs when comparing leads 1 to 3, or 7 to 9. The "bad" surge pattern occurs when comparing lead 2 to either 1 or 3, and when comparing lead 8 to lead 7 or 9. So the leads common to the "bad" surge patterns are #2 and #8. Connect 2 & 8 together, then pair the other 4 leads (1 from each circuit together), and surge test in the run configuration. If the surge pattern is good, the pairs are correct: 1 & 7, 2 & 8, 3 & 9. If not, swap the pairs and repeat.

If both sets of 3 leads have good surge test patterns, the motor is either a 2-speed 2-winding motor, or a skip-pole part-winding start.

Test run the assembled motor with each set of 3 leads, and use a tachometer to determine the rpm. If both operate at the same speed, the connection must be a skip-pole part-winding start. Label one set as 1-2-3 and the other as 7-8-9. Test run each set to establish the correct phase sequence; the direction of rotation should be the same for 1-2-3 as for 7-8-9.

If the motor runs at two different speeds, label the low speed leads 1-2-3, and the leads for the high speed winding as 11-12-13. Be sure to label the leads for the same direction of rotation / phase sequence. To facilitate this, the phase sequence of your test panel leads should be clearly labeled.

Do not attempt to run an adjacent-pole part-winding start motor in the start mode. Surge compare the winding in the run configuration (pairing leads 1 & 7, 2 & 8, and 3 & 9); then test run the motor in the same run configuration. **Caution:** You must surge test the winding in the run configuration to be sure that leads 1, 3,

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Table 1. Test tips for identifying the type of winding.

Circuit combinations	Connection	Test tip
3 circuits of 2 leads each	Wye-delta	Wye first, then delta
2 circuits of 3 leads each	Two-winding motor	Each set of 3 has a good surge test pattern
	Or: Part-winding start (adjacent-pole)	Each set of 3 has 1 good surge test pattern & 2 bad patterns
All 6 leads have continuity	Double-delta/extended delta	Verify the application
	Or: Dahlander (2-speed) CT-constant torque CH-constant horsepower VT-variable torque	CT or CH- must run motor assembled to check speed

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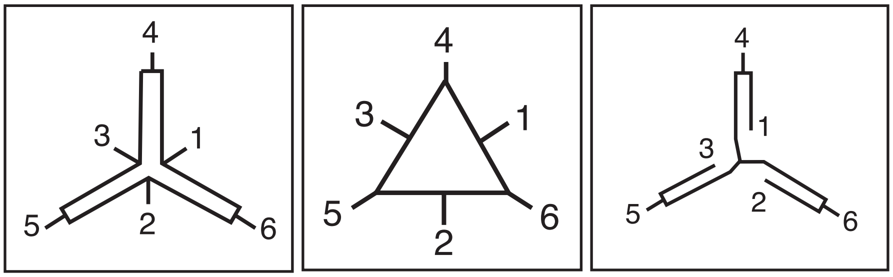

Figure 1. From left to right, constant torque, constant horsepower and variable torque connections.

7 and 9 are correctly identified. **The consequence of swapping 1-2-3 with 7-8-9: None.**

3 Circuits, 2 Leads Each

If the continuity check reveals that the 6 leads are divided into 3 sets of 2 leads, the motor has a wye-delta connection. It could be a wye-start delta-run, or a dual-voltage connection with the voltage ratio of 1 to 1.732 (e.g., a 230/400v IEC motor). The pairs are 1-4, 2-5 and 3-6. To correctly identify the leads, arbitrarily label the 3 pairs as 1-4, 2-5, 3-6. Connect leads 4, 5 and 6 together (wye), and surge test leads 1-2-3. If the surge pattern is bad in two comparisons, select the lead that is common to both bad patterns. Reverse the numbers on that lead with the lead in circuit with it (i.e., if lead #3 is the common lead in the two bad surge patterns, exchange leads #3 and #6) and surge test it again.

When the surge comparison results in a "good" patterns with the wye configuration, reconnect the leads delta (1 & 6, 2 & 4, 3 & 5) and surge test them as final verification that all the leads are correctly identified. **The consequence of reversing all 3 pairs (1-4, 2-5, and 3-6): None.**

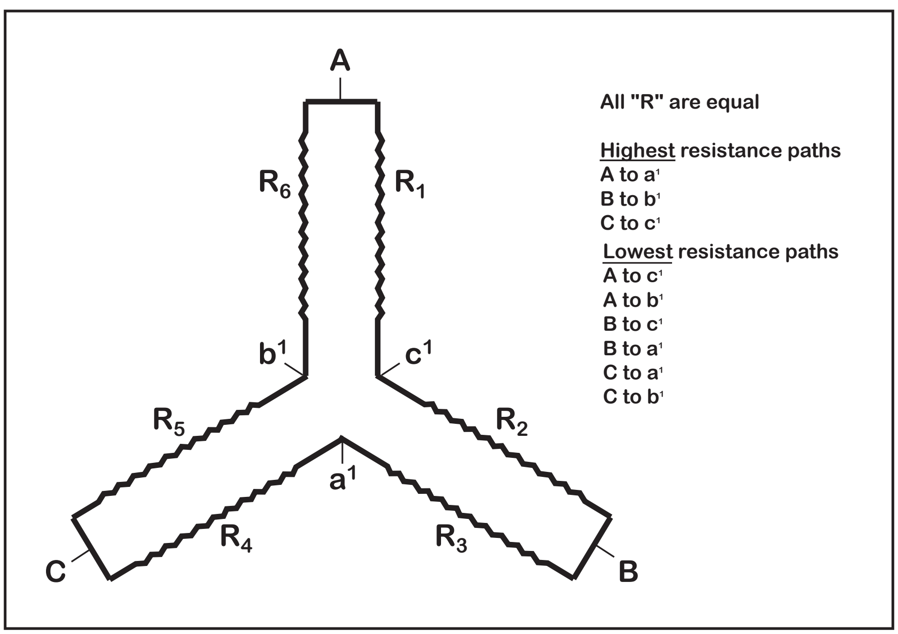

Figure 2. Treat each pair of leads as a series-parrallel resistor circuit and use the ratios in Table 2 to identify the leads.

All 6 Leads Have Continuity

If all 6 leads are in circuit, the connection is either an extended delta / double delta PWS, or a 2-speed 1-winding. Of the various possibilities of "6 unmarked leads", the 2-speed 1-winding is the most challenging to identify.

2-speed 1-winding

The 2-speed winding (with a 2:1 speed ratio) is called a "Dahlander" connection. This special connection allows the coil groups to be energized salient-pole for one speed, or consequent-pole to form twice the poles and thereby operate at half the rpm of the high speed. While the most common Dahlander connection is the constant-torque 2-wye/1-delta, other connections are also used. This procedure works regardless of the number of circuits. For visual reference, **Figure 1** illustrates schematics of the constant-torque, constant hp and variable torque (CT, CH and VT, respectively) connections.

There is continuity among all 6 leads of a 2-speed winding, so we can apply basic principles of paralleled resistors to determine the lead markings. The ratio of resistances for the variable torque connection is intuitive, so we will first cover the more complicated CT / CH procedure.

Constant Torque Or Hp

From **Figure 1** we can see that the **constant torque** and **constant horsepower** Dahlander connections are symmetrical, so there is a 50-50 chance of correctly labeling 1-2-3 and 4-5-6 by the resistance alone. It will be necessary to test-run the motor, as the final step to confirm the lead markings.

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Table 2. Lead-to-lead resistance ratios for CT or CH Dahlander connection.

	4	6	5	2	3
4	-				
6	.89	-			
5	.89	.89	-		
2	1.0	.56	.56	-	
3	.56	1.0	.56	.89	-
1	.56	.56	1.0	.89	.89

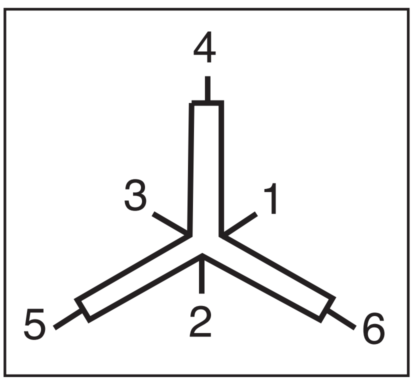

Figure 3. Constant torque schematic.

The path between any 2 leads can be traced in either a clockwise or counter-clockwise direction (**Figure 2**). Therefore, the resistance between any 2 leads may be treated as 2 sets of paralleled resistors. The ratio of the resistance of the 2 parallel paths (CW and CCW) can be discerned from **Figure 2**. The resistance of paralleled resistors (R1 and R2 in the formula below) can be calculated by:

Resistance of circuit
= (R1 x R2)/(R1 + R2)

Since the winding is comprised of identical coil groups, the ratio of the resistances can be used to determine which leads are which. ***Regardless of the winding resistance or number of circuits, the ratio of the resistances is constant.***

Start by using letters to temporarily identify the leads. Use an accurate ohmmeter to measure the resistance from each lead to the other 5 leads. If the resistance of the winding is at least 5 ohms (winding resistance is inversely proportional to the hp/kW rating) a normal volt-ohmmeter is sufficient. For larger hp ratings, the winding resistance is usually so low that a DLRO, **milli-ohm meter** or bridge is required to obtain useful values. The meter should be capable of measuring to at least 3 significant digits. Use the ratios from the **Table 2** to interpret your results.

There will be 3 lead-pairs with resistances higher than the others. It should be evident from **Figure 3** that those combinations are 1-5, 2-4, and 3-6. We will not know for certain whether the two sets of numbers are correctly identified (i.e., 1-2-3 might actually be 5-4-6, and vice versa) until the motor is test run, so affix temporary labels. **Caution:** Whether we have the 3 pairs reversed or not, at this point the winding surge test will yield good results.

The resistance between 1, 2 and 3 will be approximately 89% of the resistance between 1-5, 2-4 and 3-6. (The resistance between 4-5-6 is also 89% of the maximum values.)

The lowest resistance pairs will be: 1-6, 2-6, 2-5, 3-5, 4-3, and 1-4. The lead with the lowest resistance to both 5 and 6 is therefore lead #2. Likewise, lead #1 will have the lowest resistance to leads #4 and #6; and lead #3 to leads #4 and #5.

Next, surge test the windings using both the low and high-speed connections. The surge test pattern should appear normal, even if leads 1-2-3 were exchanged with 5-4-6.

Assemble the motor, and test-run it using both high and low speed connections. If it runs correctly on both speeds, the leads are correctly identified. If leads 1-2-3 and 5-4-6 are swapped, the motor will probably run on the high speed connection, but it will be noisy and the speed will be

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Table 3. Resistance ratio of Variable Torque leads.

Lead #	1	2	3	4	5
1					
2	1.0				
3	1.0	1.0			
4	.25	.75	.75		
5	.75	.75	.25	.5	
6	.75	.25	.75	.5	.5

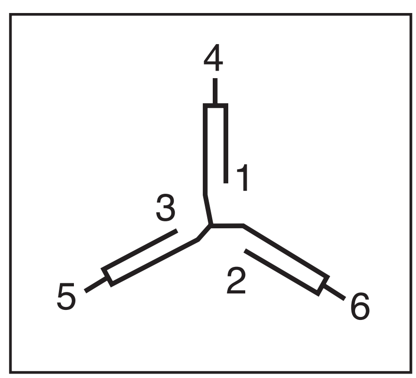

Figure 4. Variable torque schematic.

Identifying 9 unmarked leads of three-phase motors

If some are marked, the process is the same, but may require fewer steps

By Tom Bishop, P.E.
EASA Senior Technical Support Specialist

The markings on the external leads of a motor sometimes become defaced or are removed, which makes it necessary to identify and mark them before the motor can be properly connected to the line. This article will address lead identification of three-phase motors with 9 leads, based on the premise that none of the leads are marked. If some of the leads are marked, the process is the same, but may require fewer steps. **Note:** See the May 2008 issue of *Currents* for the article "Identifying Unmarked Leads Of 6-Lead Motors With 1 Or 2 Windings."

Safety first

Make certain to follow all applicable electrical safe work practices during the tests described in this article. ***For each step of the test process, make certain that the motor is de-energized before making any connections.*** The motor will need to be started and stopped many times during this procedure, which may seem cumbersome. However, keep safety first and make certain that the power is off and the motor shaft has stopped rotating before making any connections.

The first step is to use an ohmmeter to identify whether the winding is wye or delta connected. If wye connected, there will be 3 circuits of 2 leads and 1 circuit of 3 leads. If delta connected, there will be 3 separate 3-lead circuits.

Wye connected motor

We will first address the case of a three-phase 230/460 volt wye connected 9-lead motor with no-lead markings. Testing for continuity with an ohmmeter or test light will indicate 4 independent circuits. There will be 3 circuits with 2 leads each and 1 circuit with 3 leads. To make it easier to identify each individual circuit, tie the leads of each of the 4 circuits together with a string or tie-wrap, about 3 inches (75 mm) from the end of each lead. **Figure 1** illustrates the winding connections and test voltages related to this procedure.

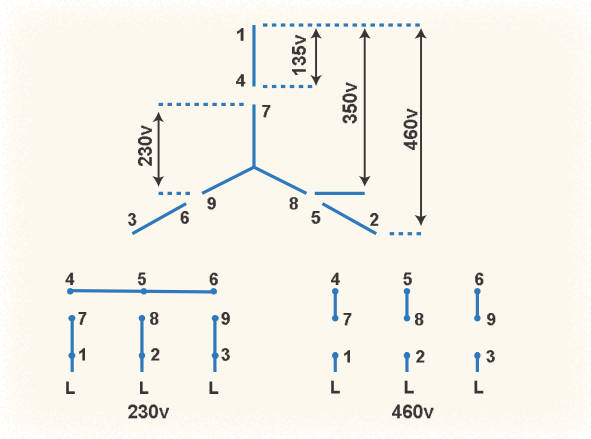

Figure 1: Winding connection and test voltages for 9-lead wye motor.

Take the 3-lead circuit and randomly mark the leads T7, T8 and T9. Separate and tape off (electrically insulate) the other leads and connect T7, T8 and T9 to a de-energized 230 volt three-phase test supply. Start the motor and run it at no load. The motor should not make any unusual sounds and the currents should be balanced. De-energize the motor to make connections, and re-energize after safely reconnecting motor and voltmeter leads.

The next step is to identify the 2-lead circuits (1-4, 2-5, 3-6). To do this, connect 1 lead of any 2-wire circuit to T7 and the other lead to 1 side of an AC voltmeter which has at least a 500 volt scale. Connect the other voltmeter lead first to T8 and then to T9. (**Tip:** If two voltmeters are available they can be used to simultaneously perform these 2 tests.) There is a 1-in-3 chance of picking the right circuit the first time, so don't be discouraged. If you pick a wrong 2-wire circuit, the readings will be unequal and you must try another 2-wire circuit. If the voltages to T8 and T9 are equal and about 350 volts, the 2-wire circuit and connection are correct. If the readings are equal and about 135 volts, reverse the leads of the 2-wire circuit, and the result should be about 350 volts to each lead. Following this, take the lead that is connected to T7 and mark it T4; and mark the lead on the voltmeter T1.

> ***For each step of the test process, make certain that the motor is de-energized before making any connections.***

After completing the steps above, take another 2-wire circuit and connect one lead to T8 and the other lead to the voltmeter. As with the first circuit, when the correct lead connection is found there will be about 350 volts when connected to T9 or T7. Take the lead connected to T8 and mark it T5; and mark the other lead T2.

The third 2-lead circuit is tested in the same manner by connecting 1 lead of it to T9 and again testing for 350 volts when you connect to T7 or

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Identifying 9 unmarked leads of three-phase motors

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T8. Take the lead connected to T9 and mark it T6, and mark the other lead T3.

The next test is to confirm that the connection is correct for 460 volts. Connect T4 to T7, T5 to T8, and T6 to T9; then connect each of the other leads, T1, T2 and T3 to the supply lines. Run test the motor with no load at 460 volts. If the motor does not make any unusual sounds and the currents are balanced and at a level expected for no load, the markings are correct. See the February 2005 *Currents* article, "No-load Current Basics: Practical Guidelines For Assessment."

The final test is to confirm that the connection is also correct for 230 volts. Connect T4, T5 and T6 together; then connect leads T1 and T7 together for one lead, T2 and T8 for the second lead, and T3 and T9 for the third lead. Run test the motor with no load at 230 volts. If the motor does not make any unusual sounds and the currents are balanced and at a level expected for no load, the markings are correct.

Delta connected motor

We will now consider a three-phase 230/460 volt delta connected 9-lead motor with unmarked leads. Begin by testing the leads for continuity with an ohmmeter or test light. With a delta connection there will be three circuits of three leads each. To make it easier to identify each individual circuit, tie the leads of each of the three circuits together with a string or tie-wrap, about 3 inches (75 mm) from the end of each lead. Next, label one circuit "A," the next circuit "B" and the last circuit "C." **Figure 2** illustrates the winding connections and test voltages related to this procedure.

Connect each lead of circuit A to a de-energized 230 volt, three-phase test supply. Separate and tape off (electrically insulate) the other leads. Start the motor and run it at no load. The motor should not make any unusual sounds and the currents should be balanced. De-energize the motor to make connections, and re-energize after safely reconnecting motor and voltmeter leads.

Next, connect one lead of circuit A to one lead of circuit B. Then put the voltmeter from one of the other leads of circuit B to first one and then the other lead of circuit A. (**Tip:** If two voltmeters are available they can be used to simultaneously perform these two tests.) What is being sought are 2 leads that will result in a meter reading of approximately 460 volts. If the value is not 460 volts, repeat the test with the other lead of circuit A.

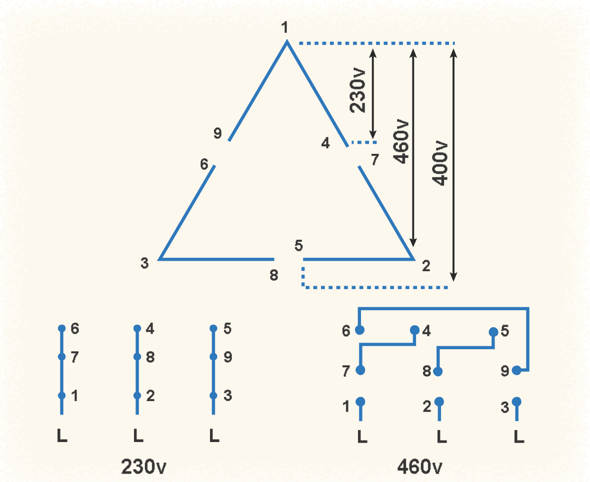

Figure 2: Winding connection and test voltages for 9-lead delta motor.

If the 460-volt reading is still not obtained, disconnect the two groups and connect groups A and B together with two different leads and repeat the test. This may take a lot of connecting and reconnecting; but between the two groups there will be a pair of wires, one from each group, that will result in a voltmeter reading of 460 volts. When these are found, mark the lead from circuit A T1 and the lead from circuit B T2. Next, mark the lead from circuit A that is connected to circuit B T4, and the lead that is connected to T4 mark as T7; then mark the third lead of circuit A T9, and the other lead of circuit B T5.

Disconnect circuit A from circuit B and connect 1 lead from circuit C to T9 of circuit A. Place one lead of the voltmeter on T1 and read the voltage between T1 and the other 2 leads of circuit C. The purpose is to find the 460 volt lead in circuit C. When this lead is found, mark it T3. Take the lead connected to T9 and mark it T6. Take the other lead of circuit C and mark it T8.

The next test is to confirm that the connection is correct for 460 volts. Connect T4 to T7, T5 to T8, and T6 to T9; then connect each of the other leads, T1, T2 and T3 to the supply lines. Run test the motor with no load at 460 volts. If the motor does not make any unusual sounds and the currents are balanced and at a level expected for no load, the markings are correct. See the February 2005 *Currents* article, "No-load Current Basics: Practical Guidelines For Assessment."

The final test is to confirm that the connection is also correct for 230 volts. Connect T1, T6 and T7 together and use them as one lead. Use T2, T4 and T8 together as the second lead, and T3, T5 and T9 together as the third lead. Run test the motor with no load at 230 volts. If the motor does not make any unusual sounds and the currents are balanced and at a level expected for no load, the markings are correct.

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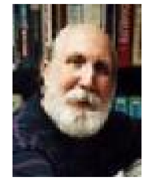


TECH TALK

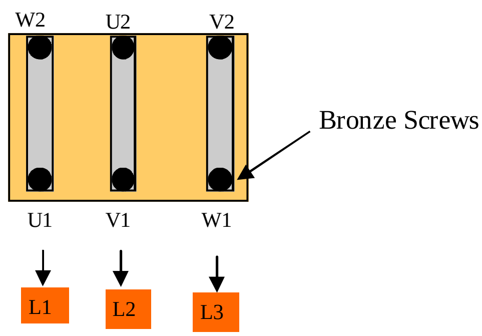
Volume 2 Issue No. 2 May, 2003

EUROPEAN MOTOR CONNECTIONS

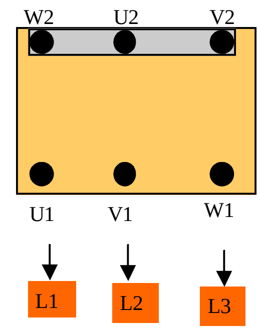
Shown below are representations of the wiring connections made to European Motor terminal blocks

DUAL VOLTAGE-SINGLE SPEED -6 MOTOR LEADS—6 TERMINALS

A. LOW VOLTAGE
1 DELTA

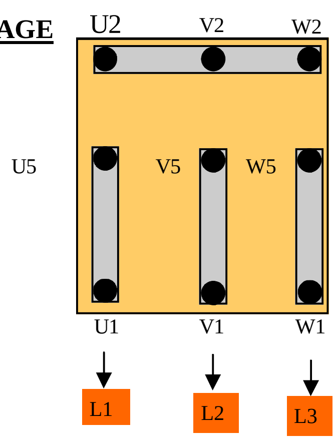


B. HIGH VOLTAGE
1 WYE

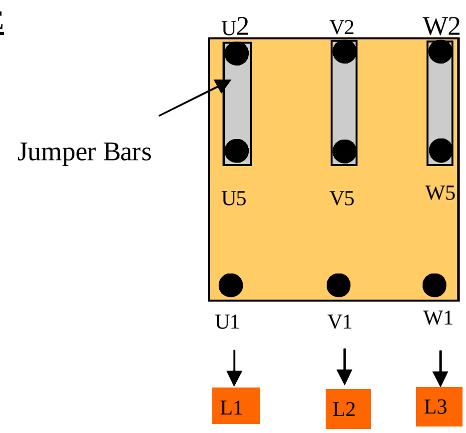


DUAL VOLTAGE-SINGLE SPEED -9 MOTOR LEADS –9 TERMINALS

A. LOW VOLTAGE
2 WYE

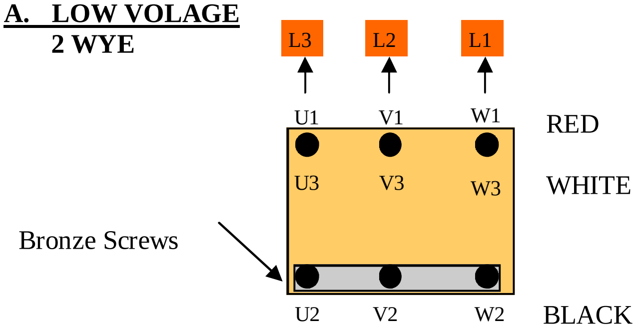


B. HIGH VOLTAGE
1 WYE

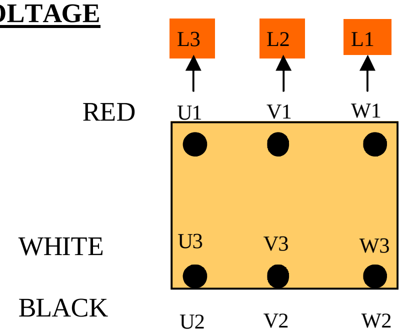


DUAL VOLTAGE-SINGLE SPEED -9 MOTOR LEADS –6 TERMINALS (LAFERT HE/ST Motors)

A. LOW VOLAGE
2 WYE



B. HIGH VOLTAGE
1 WYE



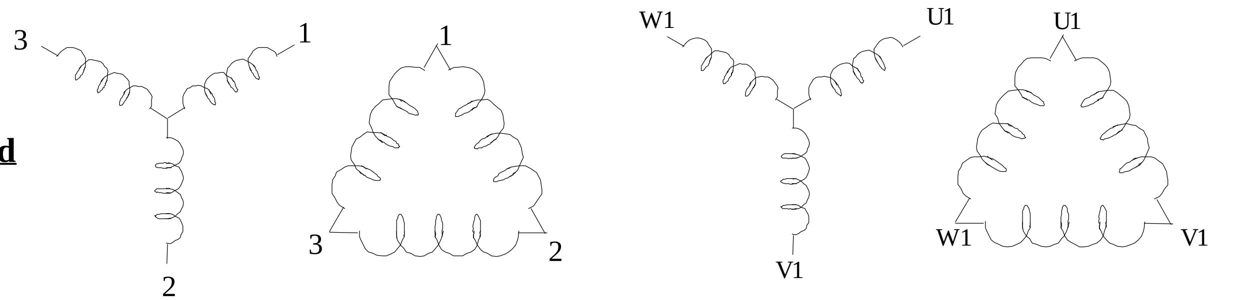
Note: U1 = 1, V1 = 2, W1 = 3, U2 = 4, V2 = 5, W2 = 6, U5 = 7, V5 = 8, W5 = 9 (If numbers are used)

Holland Industrial,518 West Montgomery Street,Henderson,NC.,27536

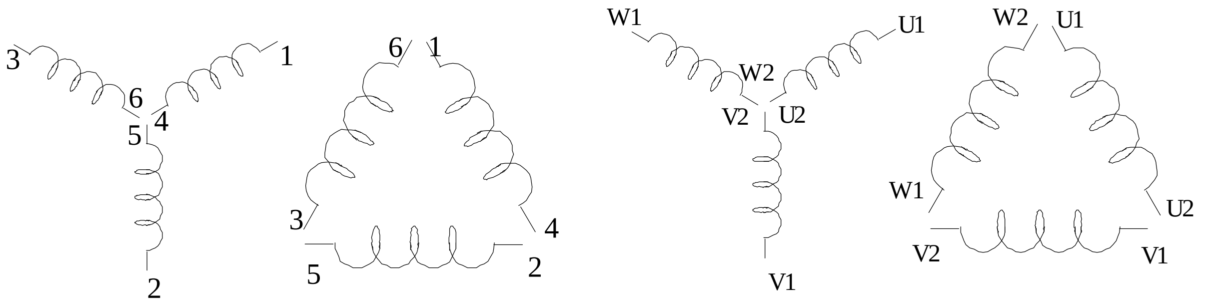
Tel. 1-800-232-7541, Fax 1-252-492-2444 , E-Mail: sales @ holland-

NEMA	New IEC

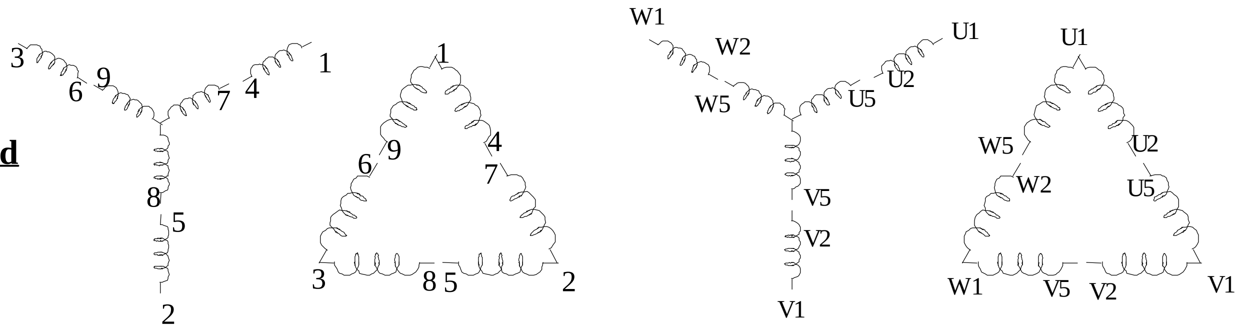
3 Lead



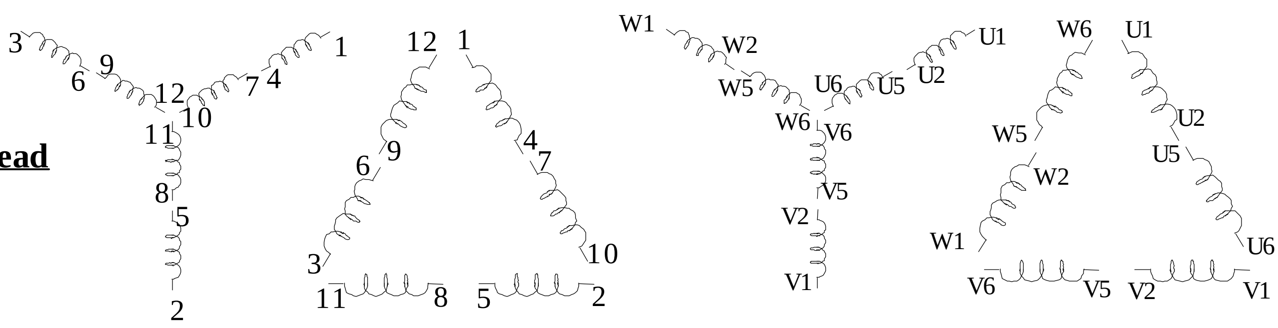
6 lead



9 Lead



12 Lead



Title:	
Wye & Delta Numbering,3 Phase Motors	
Author: NG	
Date: 10/21/05	Sheet:
Revision:	

Single Speed Motors, 3 Phase, 3, 6 and 9 Leads

Leads Out of Motor	Lead Markings NEMA	Possibilities	Lead Markings IEC Old	Lead Markings IEC New
3	1,2,3,	Across The Line Start	U,V,W,	U1,V1,W1,
6	1,2,3,4,5,6,	(a)Can be a single voltage Wye or (b)Single Voltage Delta, or (c)A Two Voltage motor(where higher voltage) Star, is 1.73 x Lower Voltage,Delta. or it could be configured (d)as a Soft Start, Wye Start Delta Run	U,V,W,X,Y,Z,	U1,V1,W1,U2,V2,W2,
		(a)If single(higher) voltage Wye then L1,L2 and L3 goes to 1,2,&3 and 4,5,&6 are joined together	If single voltage Wye then L1,L2 and L3 goes to U,V,& W and X,Y,and Z are joined together	If single voltage Wye then L1,L2 and L3 goes to U1,V1,&W1 and U2,V2,&W2 are joined together
		(b)If single(lower) voltage Delta then 1&6 are connected to L1, 2&4 are connected to L2 and 3&5 are connected to L3	If single voltage Delta then U&Z are connected to L1, V&X are connected to L2 and W & Y are connected to L3	If single voltage Delta then U1&W2 are connected to L1, V1&U2 are connected to L2 and W1&V2 are connected to L3
		(c) If two voltage motor then for low voltage(Delta) hook up as (b) above and for high voltage(Wye) hook up as (a) above		
		If Wye Start Delta Run then for **Wye Start** L1,L2 & L3 connect to 1,2,& 3 and 4,5&6 are joined together and for **Delta Run** 1&6 are connected to L1, 2&4 are connected to L2 and 3&5 are connected to L3. The above sequence is carried out by a Wye Delta Starter,consisting of 3 contactors and 1 timer	If Wye Start Delta Run then for **Wye Start** L1,L2 & L3 connect to U,V,& W and X,Y,and Z are joined together and for **Delta Run** U&Z are connected to L1, V&X are connected to L2 and W & Y are connected to L3	If Wye Start Delta Run then for **Wye Start** L1,L2 & L3 connect to U1,V1,&W1 and U2,V2,&W2 are joined together and for **Delta Run** U1&W2 are connected to L1, V1&U2 are connected to L2 and W1&V2 are connected to L3
6	1,2,3,7,8,9,	**Part Winding Start.** On first step T1,T2 & T3 connect to motor leads 1,2 &3 through 1M contactor. On second step M stays energised and 2M contactor pulls in and connectrs T7,T8 & T9 to motor leads 7,8,& 9 The sequence is carried out by a Part Winding Starter consisting of 2 contactors and 1 timer		
9	1,2,3,4,5,6,7,8,9,	(a)Dual voltage Wye connected (b)Dual voltage Delta connected		
		If (a) dual voltage wye connected For **high** voltage connection L1 goes to lead 1, L2 goes to 2 and L3 goes to 3, also 4&7 are joined together,5&8 are joined together and 6&9 are joined together. For **low** voltage connectioon leads 1&7 are joined together and connected to L1,leads 2&8 are joined together and connected to L2 and 3&9 are joined together and connected to L3		**If (a) dual voltage wye connected** For **high** voltage connection L1 goes to lead U1, L2 goes to V 1 and L3 goes to W 3, also U2&U3 are joined together, V 2 & V3 are joined together and W 2 & W 3 are joined together.(1 Y conn) For **low** voltage connectioon leads U1 & U3 are joined together and connected to L1,leads V 1& V 3 are joined together and connected to L2 and W1& W 3 are joined together and connected to L3 (2 Y conn)
		If (b) dual voltage delta connected For **high** voltage connection L1 goes to lead 1,L2 goes to lead 2 and L3 goes to lead 3,also 4&7 are joined together and taped aslo 5&8 are joined and taped and 6&9 are joined and taped For **low** voltage connection leads 1,6,7 are joined L1,leads 2,4,8 are joined to L2 and leads 3,5,9 are joined to L3		

Nema	1	2	3	4	5	6	7	8	9	10	11	12
New IEC	U1	V1	W1	U2	V2	W2	U5	V5	W5	U6	V6	W6
Old IEC	U1	V1	W1	X1	Y1	Z1	U2	V2	W2	X2	Y2	Z2
Also	U	V	W	X	Y	Z						

Title: Single Speed,Three Phase, Motor Connections 3 , 6 and 9 Leads	
Author: NG	
Date: 10/17/05	Sheet: 1
Revision:	Holland Industrial

Single Speed Motors, 3 Phase, 12 Leads

Leads Coming Out of Motor	Lead Markings NEMA	Possibilities	Lead Markings IEC Old	Lead Markings IEC New
12	1,2,3,4,5,6,7,8,9,10,11,12,	(a) Single voltage Wye connection (b) Single Voltage Delta Connection (c) Dual voltage Wye connection (d) Dual voltage Delta connection (e) Wye start delta run		U1,U2,V1,V2,W1,W2,U5,U6,V5,V6, W5,W6
		(a) **If single voltage Wye** connection then L1,L2 and L3 connect to 1,2,and 3. Also 10,11&12 are joined together and 4&7 are joined,5&8 are joined and 6&9 are joined.		(a) **If single voltage Wye** connection then L1,L2 and L3 connect to U1,V1,and W1. Also U6,V6 and W6 are joined together and U2&U5 are joined,V2&V5are joined and W2&W5 are joined.
		(b)**If single voltage Delta** connection then 1&12 are joined and connected to L1,2&10 are joined and connected to L2,and 3&11 are joined and connected to L3. Also 4&7 are joined together,5&8 are joined together and 6&9 are joined together.		(b)**If single voltage Delta** connection then U1&W6 are joined and connected to L1, V1& U6 are joined and connected to L2,and W1& V6 are joined and connected to L3. Also U2 & U5 are joined together,V2 & V5 are joined together and W2 & W5 are joined together.
		(c)**If dual voltage Wye** conection For **high** voltage connection is as (a) above For **low** voltage connection 1&7 are joined and connected to L1,2&8 are joined and connected to L2 and 3&9 are joined and connected to L3 Also 4&5&6 are joined together and 10&11&12 are joined together.		(c)**If dual voltage Wye** conection For **high** voltage connection is as (a) above For **low** voltage connection U1 & U5 are joined and connected to L1,V1 & V5 are joined and connected to L2 and W1 & W5 are joined and connected to L3 Also U2 &V2 & W2 are joined together and U6 &V6 &W6 are joined together.
		(d) **If dual voltage delta** connection For **high voltage** hook up as (d) above. For **low voltage** join 1&6&7&12 together and connect to L1, join 2&4&8&10 together and connect to L2, join 3&5&9&11 together and connect to L3		(d) **If dual voltage delta** connection For **high voltage** hook up as (d) above. For **low voltage** join U1 & W2 &U5 & W6 together and connect to L1, join V1 & U2 & V5 &U6 together and connect to L2, join W1& V2 & W5 & V6 together and connect to L3
		(e)**If wye start delta run** then for wye start hook up as (a) above and for delta run hook up as (b) above. The above sequence is carried out by a Wye Delta starter consisting of 3 contactors and 1 timer. Motor always runs as a delta after wye connection soft start.		(e)**If wye start delta run** then for wye start hook up as (a) above and for delta run hook up as (b) above. The above sequence is carried out by a Wye Delta starter consisting of 3 contactors and 1 timer. Motor always runs as a delta after wye connection soft start.

Emma	1	2	3	4	5	6	7	8	9	10	11	12
New IEC	U1	V1	W1	U2	V2	W2	U5	V5	W5	U6	V6	W6
Old IEC	U1	V1	W1	X1	Y1	Z1	U2	V2	W2	X2	Y2	Z2

Title:	Single Speed,Three Phase, Motor Connections 12 Leads	
Author:	NG	
Date:	10/17/05	Sheet: 2
Revision:		Holland Industrial

Two Speed Motors, 3 Phase

Leads Coming Out of Motor	Lead Markings NEMA	Description	Lead Markings& Notes IEC Old	Lead Markings IEC New
6	T1,T2,T3, T11,T12,T13	**2 Speed - 2 Winding - Single Voltage** T1,T2,T3 Low Speed T11,T12,T13 High Speed **To reverse rotation,interchange any 2 line leads To reverse rotation of Low or High Speed only,interchange any 2 motor leads of the respective speed e.g. interchange T1 and T2, or T12 and T13	Ua , Va , Wa, Xa , Ya , Za , **2 electrically separate windings** ie no ohmic connection between them	1U, 1V, I W Low Speed 2U, 2V, 2 W High Speed
6	T1,T2,T3 T4,T5,T6	**2 Speed - 1 Winding - Single Voltage** **Variable Torque or Constant Torque** For **Low** Speed T1,T2 and T3 are connected to L1,L2,and L3 and T4,T5 and T6 are open For **High** Speed T6 goes to L1, T4 goes to L2 and T5 goes to L3, leads T1, T2 and T3 are joined together **To reverse rotation,interchange any 2 line leads **Speeds always in ratio of 1:2**	**Pole Changeable Winding (Dahlander)** Windings are **not** electrically separate For **Constant Torque** the typical **internal** motor connection of the motor is : 1 Delta for Low Speed and 2 Wye(Star) for the High Speed **Also Low Speed HP is half of High Speed HP** For **Variable Torque** the typical internal motor connection is : 1 Wye for Low Speed and 2 Wye for High Speed **Also Low Speed HP is a quarter of High Speed HP**	1U, 1V, I W Low Speed 2U,2V,2W High Speed
6	T1,T2,T3 T4,T5,T6	**2 Speed - 1 Winding - Single Voltage** **Constant Horsepower** For **Low** Speed T1,T2 and T3 connect to L1,L2 and L3 and T4,T5 and T6 are joined together For **High** Speed T6 goes to L1,T4 goes to L2 and T5 goes to L3 Leads T1 ,T2 and T3 are open **To reverse rotation,interchange any 2 line leads **Speeds always in ratio of 1:2**	**Pole Changeable Winding (Dahlander)** Windings are **not** electrically separate For **Constant Horsepower** the typical internal motor connection is : 2 Wye for Low Speed and 1 Delta for High speed **Horsepower is the same at both speeds,however this may not apply to some European Motors**	1U, 1V, I W Low Speed 2U,2V,2W High Speed

For Pole Changeable Windings

Nema	T1	T2	T3	T4	T5	T6
New IEC	1U	1V	1W	2U	2V	2W
Old IEC	Ua	Va	Wa	Ub	Vb	Wb

Additional Notes

3 Speed Motors	Usually accomplished using one Pole Change Winding(1:2) and one separate winding
4 Speed Motors	Usually accomplished using two Pole Change Windings(1:2)

Title: Two Speed,Three Phase, Motor Connections	
Author: NG	
Date: 10/23/05	Sheet3
Revision:	Holland Industrial

European Motor Lead & Terminal Block Identifications

		Old			New		
1.	Line Connection	R	S	T	L1	L2	L3
		MP			N		
2.	Single Speed Motors	U	V	W	U1	V1	W1
		X	Y	Z	U2	V2	W2
	Rotor Connection	u	v	w	K	L	M
	Multi Voltage Motors	Ua	Va	Wa	U1	V1	W1
		Xa	Ya	Za	U2	V2	W2
		Ub	Vb	Wb	U5	V5	W5
		Xb	Yb	Zb	U6	V6	W6
3.	Multi Speed Motors	Ua	Va	Wa	1U	1V	1W
		Ub	Vb	Wb	2U	2V	2W
		Uc	Vc	Wc	3U	3V	3W
		Ud	Vd	Wd	4U	4V	4W
	Multi Speed w/separate	Ua	Va	Wa	1U1	1V1	1W1
	winding or Y-Delta start	Xa	Ya	Za	1U2	1V2	1W2
		Ub	Vb	Wb	2U1	2V1	2W1
		Xb	Yb	Zb	2U2	2V2	2W2
4.	Single Phase Motors	U	V		U1	U2	
		W	Z		Z1	Z2	
5.	Aux. Components						
	Thermistor	P1	P2		10	11	
	Bimetal - NC	O1	O2		20	21	
	Bimetal - NO	S1	S2		30	31	
	Magnetic Brake	M1	M2		60	61	
	Heater Element	H1	H2		70	71	

Title: European Motor Lead & Term Block Identification	
Author:	
Date:	Sheet:
Revision:	