

Troubleshooting Procedure for Lead Tagging Problem – 12 Leads

See procedure for “Unknown Tags” if more than a few wrong tags.

Standstill Test

Use ohm meter to verify continuity of proper lead pairs. T1-T4, T2-T5, T3-T6, T7-T10, T8-T11, T9-T12. If any coil groups (lead pairs) are found with improper tagging, swap leads that appear to be incorrect. It is basically your best guess. There is no way to know for sure at this point but it does guarantee all pairs of lead numbers are together. They may still be reversed or not in the proper phase. Must spin test to verify.

Spin Test

1. Leave regulator power off by unplugging sensing leads 3 and/or 4. Only residual should be used because if a reversed coil is paralleled with a normal coil, high circulating current will flow and burn the winding in a short time.
2. Connect T4-T5-T6 together and T10-T11-T12 together. May also tie all six together, whichever is easier. Leave T1, T2, T3, T7, T8 & T9 loose.
3. Spin generator to get residual voltage. Assume you have enough residual to get significant meter resolution of at least 5V. If not, a low level excitation source will be needed.
4. Check coil voltages (line-neutral) to verify no other defects. T1-T4, T7-T10, T2-T5, T8-T11, T3-T6, T9-T12, If using two neutrals (4,5,6 & 10,11,12), be sure to use correct neutral. Also check voltage from one neutral to the other. Should be zero. If not, tie both neutrals together.
5. Check voltage between T1-T7, T2-T8 & T3-T9. They should all be zero.

If the voltage is zero, you now have the right leads paired up (barring any other defect) with the same polarity in each phase. It is still possible that one phase (both coils) is reversed with respect to the other two phases. Proceed to step 8 to verify. If one or more combinations are not zero, go to step 6.

6. If voltage between two leads is double the coil (line-neutral) voltage, one coil is reversed polarity. Swap the two leads on the coil you suspect is wrong. (e.g. Swap coil ends T1 with T4 and swap tags also) Check the voltage again between the two coils (e.g. T1-T7). You should read zero. If voltage is now zero, go to step 8 to verify entire phase polarity. If not zero, the two coils do not belong to the same phase. The voltage was likely 1.73x the coil voltage and not double. Go to step 7.
7. If voltage between two leads is supposed to be zero and you weren't able to make it zero even after reversing one coil, the coils are not from the same phase. There should be at least one other

wrong pair. The measured line-line voltage may be 1.73x the coil voltage or it may be the same. The 1.73x voltage indicates both coils have the same polarity but are from a different phase. The same voltage indicates one coil is reversed polarity and from a different phase. If you have only two sets of non-zero coils, check the voltage between the combinations of four leads. If a zero voltage pair is found, swap the coil pairs and refer back to step 5. If a double voltage pair is found, refer to step 6. If all three pairs of coils are non-zero, it becomes a guessing game. You can try various combinations until you get a zero pair or refer to the troubleshooting guide for “unknown lead tags”.

8. At this point, you may tie the corresponding “zero” pairs together or still leave apart. Each pair is one phase. Check the three sets of line-line voltages between phases. Use one or both of the leads from each phase. All should be equal and 1.73 times the line-neutral voltage. (e.g. if L-N = 120V, L-L = 208V) If one set of coils is reversed, the line-line voltage will be the same as line-neutral. (e.g. L-N = 120V, L-L = 120V) If so, check all three combinations. The pair that is HIGH, is correct. The two readings that are LOW, have the reversed phase. (e.g. T1-T2 = 120V, T2-T3 = 120V, T3-T1 = 208V. T2 is common to the low readings so it is the reversed coil. Swap T2 & T5 and T8 & T11) Recheck line-line to verify.
9. At this point, all phases should be identified with the proper polarity. Put phase sequence meter on the three phases. If correct, go to step 10. If reverse phase sequence, swap lead tags from any two phases. You must change all four tags from each phase with the corresponding number from the other phase. (e.g. T1 & T2, T4&T5, T7 & T8, T10 & T11).
10. You should now be able to test in normal fashion.

If residual voltage is insufficient for voltage resolution, a six volt battery can be used to excite the field. If no coils are connected paralleled or delta, no damage will occur even if mislabeled. Twelve volts may also be used but higher voltages will be present. This is a potential hazard with loose leads.

Troubleshooting Procedure for Unknown Lead Tags – 12 Leads

If you have no certainty in any of the lead markings or have numerous defects found, it may be best to start from scratch.

1. Disconnect all leads.
2. “Ohm” all coils and find the six pairs of leads that have continuity.
3. Arbitrarily label the coils with masking tape as “A1-A2, B1-B2, C1-C2, D1-D2 “ or whatever system you please.
4. Select one lead from each coil and connect all six together. Leave others open.
5. Spin generator with residual voltage.
6. Make matrix of loose lead combinations. (See Table 1: Line-Line Voltage Combinations)
7. Check all line-neutral voltages. All should be equal if no defects other than lead tags.
8. Check and record voltages of all possible combinations of the loose leads (line-line)

Note: Once you find a pair of leads with zero volts, you don’t need to check those against any others.

Analyzing Results

9. Any pair of line-line readings that measures “zero” are in the same phase. If you have 3 sets of zeros, all coil pairs have the same polarity. You have found all the pairs and should buy a lottery ticket if this was your first try. Each pair is one phase. (It doesn’t matter which coil you pick as T1-T4 or T7-T10. Just be consistent with the polarity.) Although proper pairs have been identified and the polarity is the same for those two coils, one pair may not be the same polarity with respect to other two. See step 11.
10. If any of the line-line readings (loose leads) are double the line-neutral reading (not 1.732 times), that is the pair of coils belonging to the same phase, but one coil is reversed. Swap one of the coils (loose end with neutral) and check for zero voltage. Separating a double voltage reading from a 1.732x reading may be difficult if residual is too low. If line-neutral voltage is 5v, double is 10V and 1.732x is 8.7V. The 1.3V is significant in this case. After this step, all pairs should be properly identified but may be reversed from other pairs. See step 11.
11. At this point, you may tie the corresponding “zero” pairs together or still leave apart. Each pair is one phase. Check the three sets of line-line voltages between phases. Use one or both of the leads from each phase. All should be equal and 1.732 times the line-neutral voltage. (e.g. if L-N =

120V, L-L = 208V) If one set of coils is reversed, the line-line voltage will be the same as line-neutral. (e.g. L-N = 120V, L-L = 120V) If so, check all three combinations. The pair that is HIGH, are correct. The two readings that are LOW, have the reversed phase. (e.g. T1-T2 = 120V, T2-T3 = 120V, T3-T1 = 208V. T2 is common to the low readings so it is the reversed coil. Swap T2 & T5 and T8 & T11) Recheck line-line to verify.

12. At this point, all phases should be identified with the proper polarity. Put phase sequence meter on the three phases in any order. If correct, label phases A_B_C according to meter. If not, swap two meter leads and verify phase sequence. Now label each lead with final appropriate number. In phase A, one of line leads is T1, the other end is T4. The other coil in phase A becomes T7-T10. This is arbitrary. Just be consistent with proper polarity. It doesn't matter if a coil is T1-T4 or T7-T10. Repeat for all phases.
13. You should now be able to test in normal fashion.

Table 1: Line-Line Voltage Combinations
(All other ends tied together)

	A1	B1	C1	D1	E1	F1
A1	X					
B1	X	X				
C1	X	X	X			
D1	X	X	X	X		
E1	X	X	X	X	X	
F1	X	X	X	X	X	X

Coil voltages (line-neutral)

A1-A2

B1-B2

C1-C2

D1-D2

E1-E2

F1-F2

Notes:

1. Any pair with zero volts belong to the same phase.
2. Any pair with double voltage of the coil voltage belong to the same phase but has a reversed coil. Swap tags on one coil. Recheck and should be zero.
3. Any pair with 1.73x coil voltage don't belong together.
4. Any pair with the voltage the same as the coil voltage don't belong together.

Sample chart with “unknown” tags. One coil is reversed polarity.

Table 1: Line-Line Voltage Combinations
(All other ends tied together)

	A1	B1	C1	D1	E1	F1
A1	X	10.4	10.4	12	10.4	10.4
B1	X	X	10.4	6	0	10.4
C1	X	X	X	6	10.4	0
D1	X	X	X	X	6	6
E1	X	X	X	X	X	10.4
F1	X	X	X	X	X	X

Coil voltages (line-neutral)

A1-A2 6 V

B1-B2 6 V

C1-C2 6 V

D1-D2 6 V

E1-E2 6 V

F1-F2 6 V

Notes:

1. 10.4 is 1.73×6
2. A1-D1 is double 6 so A1 and D1 belong together but one is reversed.
3. A1 has no 6 volt readings and D1 has two 6 volt readings. Coil D is reversed.
4. B1-E1 is 0. They belong together and have same polarity.
5. C1-F1 is 0. They belong together and have same polarity.

Sample chart with “unknown” tags. Two coils in different phases are reversed polarity.

Table 1: Line-Line Voltage Combinations
(All other ends tied together)

	A1	B1	C1	D1	E1	F1
A1	X	10.4	6	10.4	0	6
B1	X	X	12	10.4	10.4	6
C1	X	X	X	6	6	10.4
D1	X	X	X	X	10.4	12
E1	X	X	X	X	X	6
F1	X	X	X	X	X	X

Coil voltages (line-neutral)

A1-A2 6 V

B1-B2 6 V

C1-C2 6 V

D1-D2 6 V

E1-E2 6 V

F1-F2 6 V

Notes:

1. A1-E1 is zero. They belong together and have same polarity.
2. B1 – C1 is double. Coil B and C belong together but one is reversed.
3. D1 – F1 is double. Coil D and F belong together but one is reversed.
4. B1 is 1.73x coil voltage with A & E (known “good” coils). C is reversed coil.
5. D1 is 1.73x coil voltage with A & E (known “good” coils). F is reversed coil.