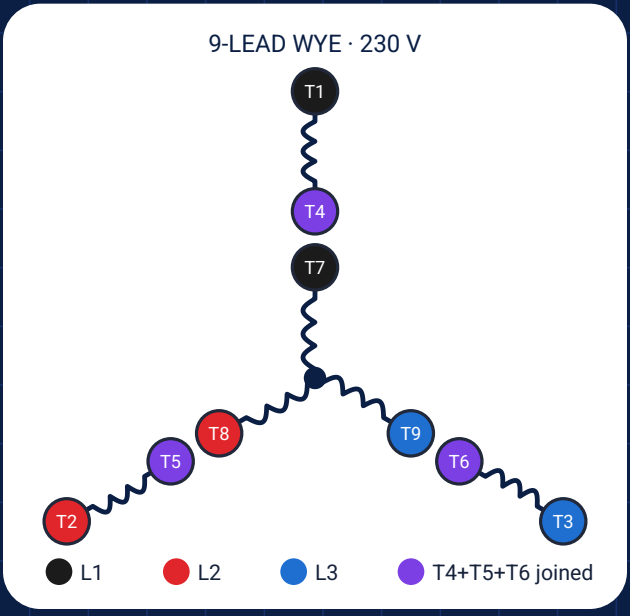
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FREE PRINTABLE GUIDE · US MOTOR WIRING

NEMA T1 TO T12 LEAD MARKINGS MOTOR WIRING GUIDE 3-PHASE & SINGLE-PHASE

9-lead and 12-lead motors, wye and delta, 230 V and 460 V, with clear diagrams.

- How to read the nameplate
- 9-lead wye and delta at 230 V and 460 V
- 12-lead motors and wye-delta starting
- Single-phase: capacitor start, PSC, 115/230 V
- Testing, NEC 430 protection, troubleshooting



WHAT'S INSIDE

Keep it on your phone or print the pages you use most.

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SAFETY FIRST
Lock out, test before touching

NEMA MG-1
T1 to T12 lead markings

NEC 430
Motor circuits

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Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

BEFORE YOU TOUCH A MOTOR

Motors mix high voltage with parts that move. Read this page first.

1 SHUT IT DOWN

Stop the motor, then open the disconnect or breaker. A drive (VFD) or a capacitor can stay charged: wait the time on its label.

2 LOCKOUT / TAGOUT

Put your own lock and tag on the disconnect, following your company's LOTO procedure (OSHA 1910.147). One worker, one lock.

3 TEST FOR ABSENCE

Check your meter on a known live source, test every phase to phase and to ground, then check the meter again.

4 GROUND THE MOTOR

The equipment grounding conductor goes to the ground lug in the terminal box or on the frame. Never skip it.

TOOLS YOU NEED

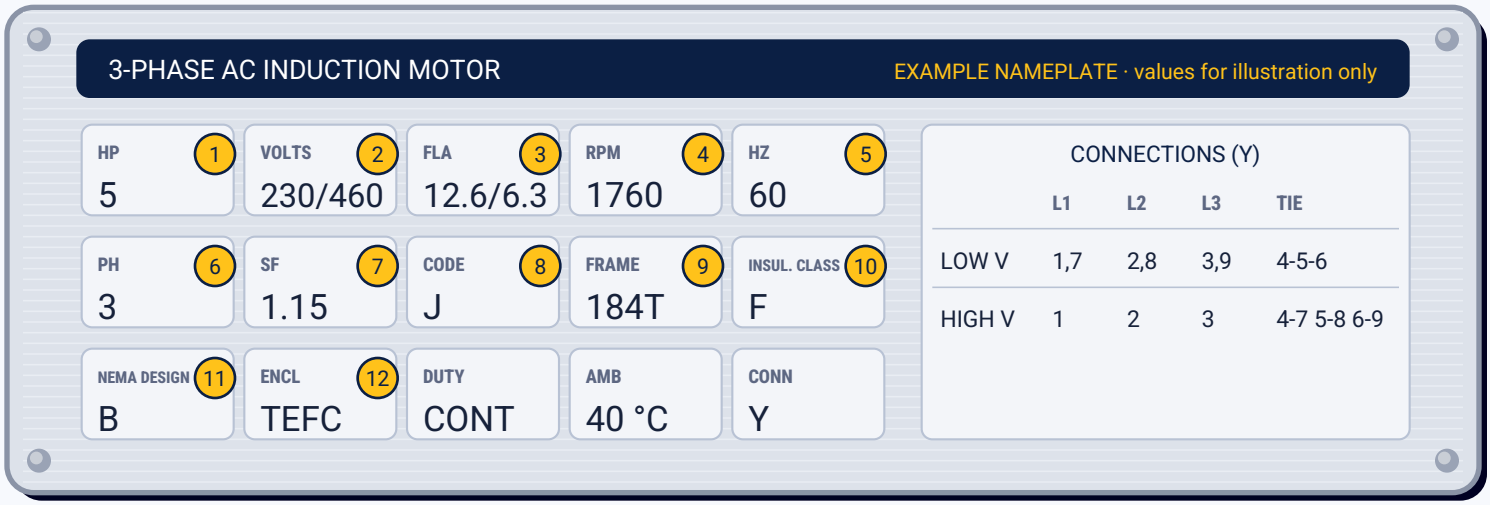
- Lockout kit: locks, tags, hasp
- Clamp meter (amps)
- Phase rotation meter
- Multimeter (CAT III or higher)
- Insulation tester (megohmmeter)
- Insulated tools, lugs, connectors, tape

Moving parts: keep guards in place and uncouple the load before the first test run whenever you can. A motor that starts the wrong way can damage pumps and compressors.

Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

HOW TO READ THE NAMEPLATE

Everything you need to wire and protect the motor is on this metal plate.



1 **HP**
Mechanical power at the shaft, not the power the motor draws.

2 **VOLTS**
Two numbers = dual-voltage motor. 230 V uses the low-voltage connection, 460 V the high-voltage one.

3 **FLA**
Full-load amps at each voltage. Use it to set the overload relay.

4 **RPM**
Speed at full load. About 1,750 = 4-pole, about 3,500 = 2-pole (60 Hz).

5 **HZ**
Line frequency. In the US it is 60 Hz.

6 **PH**
3 = three-phase, 1 = single-phase.

7 **SF**
Service factor. 1.15 = can carry 15% extra load at rated voltage, running hotter. Do not plan on it.

8 **CODE**
Code letter: how much current the motor pulls to start (locked rotor). Used in NEC calculations.

9 **FRAME**
NEMA frame = mounting size. First two digits divided by 4 = shaft height in inches (184T = 4.5 in).

10 **INSUL. CLASS**
Max winding temperature: B 130 °C, F 155 °C, H 180 °C.

11 **NEMA DESIGN**
Torque and starting-current curve. Design B is the most common.

12 **ENCL**
Enclosure. ODP = open drip-proof, TEFC = totally enclosed fan-cooled.

! The connection diagram is on the nameplate or inside the terminal box cover. If it is different from this guide, the motor's own diagram wins.

SAFETY FIRST — Lock out, test before touching

NEMA MG-1 — T1 to T12 lead markings

NEC 430 — Motor circuits

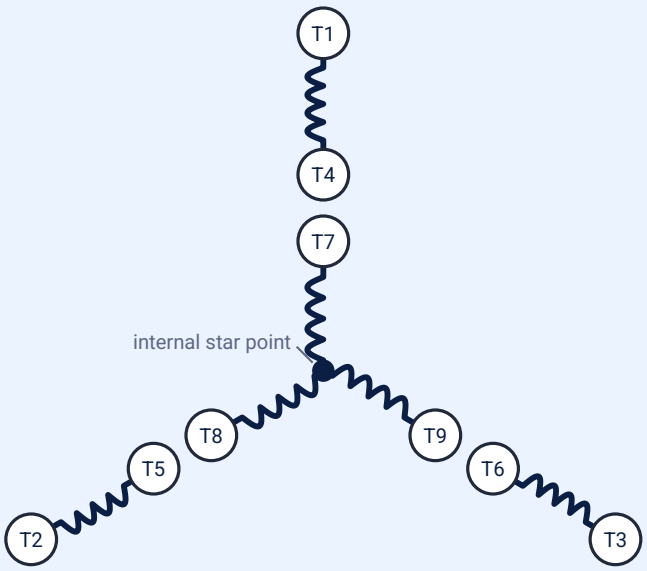
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Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

9 LEADS: WYE OR DELTA?

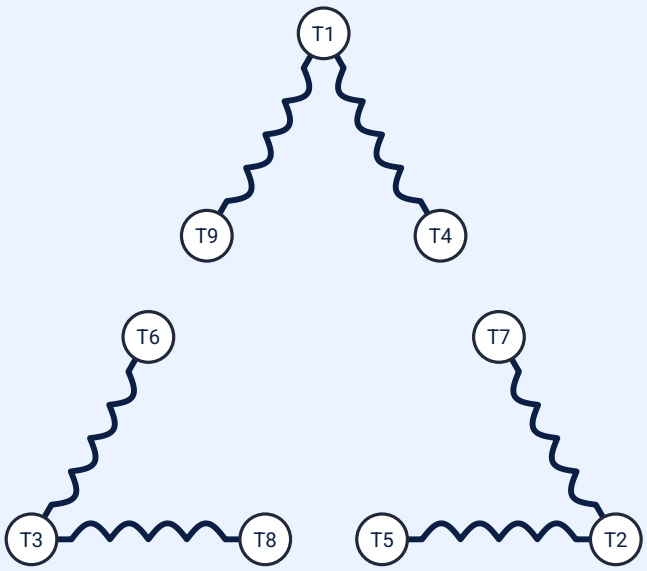
Same T1 to T9 numbers, two different insides. The nameplate says Y or Δ.

WYE (Y) MOTOR



Ohmmeter: 3 pairs (T1-T4, T2-T5, T3-T6) + 1 group of 3 (T7-T8-T9).

DELTA (Δ) MOTOR



Ohmmeter: 3 groups of 3 (T1-T4-T9, T2-T5-T7, T3-T6-T8).

LOW VOLTAGE = PARALLEL

At 230 V the two coils of each phase are connected side by side. Each line feeds two (wye) or three (delta) leads.

HIGH VOLTAGE = SERIES

At 460 V the two coils of each phase are connected end to end. Same horsepower, half the current.

TAGS LOST?

The ohmmeter tells wye from delta, but finding each T-number and its polarity takes a motor-shop procedure. Do not guess.

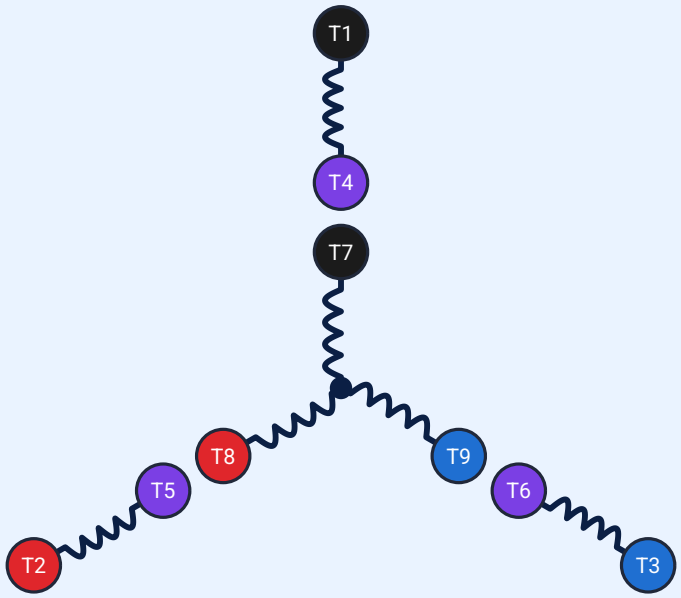
! At 460 V both motors take the same connection (L1-T1, L2-T2, L3-T3, T4-T7, T5-T8, T6-T9). At 230 V they are different, so confirm Y or Δ before wiring for low voltage.

9 LEADS · WYE (Y) · LOW VOLTAGE

WYE - LOW VOLTAGE 230 V

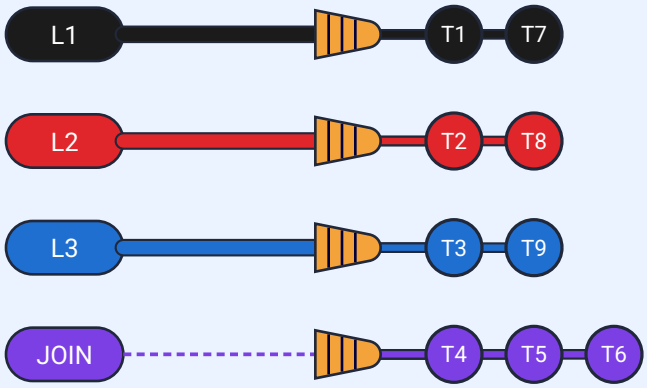
The two coils of each phase work in PARALLEL. Each line feeds two leads, and T4, T5 and T6 are joined to make a second star point.

INSIDE THE MOTOR



IN THE TERMINAL BOX

Common US line colors (check the site's color code)



L1 BLACK · L2 RED · L3 BLUE · Joined leads (insulate)

CONNECTION

- L1 = T1 + T7
- L2 = T2 + T8
- L3 = T3 + T9
- TIE T4 + T5 + T6

STEP BY STEP

1. Lock out and test for absence of voltage.
2. L1 to T1 + T7, L2 to T2 + T8, L3 to T3 + T9.
3. Join T4 + T5 + T6 together and insulate. They do not go to any line.
4. Ground lug to the equipment ground. Close the box and check rotation.

WATCH OUT

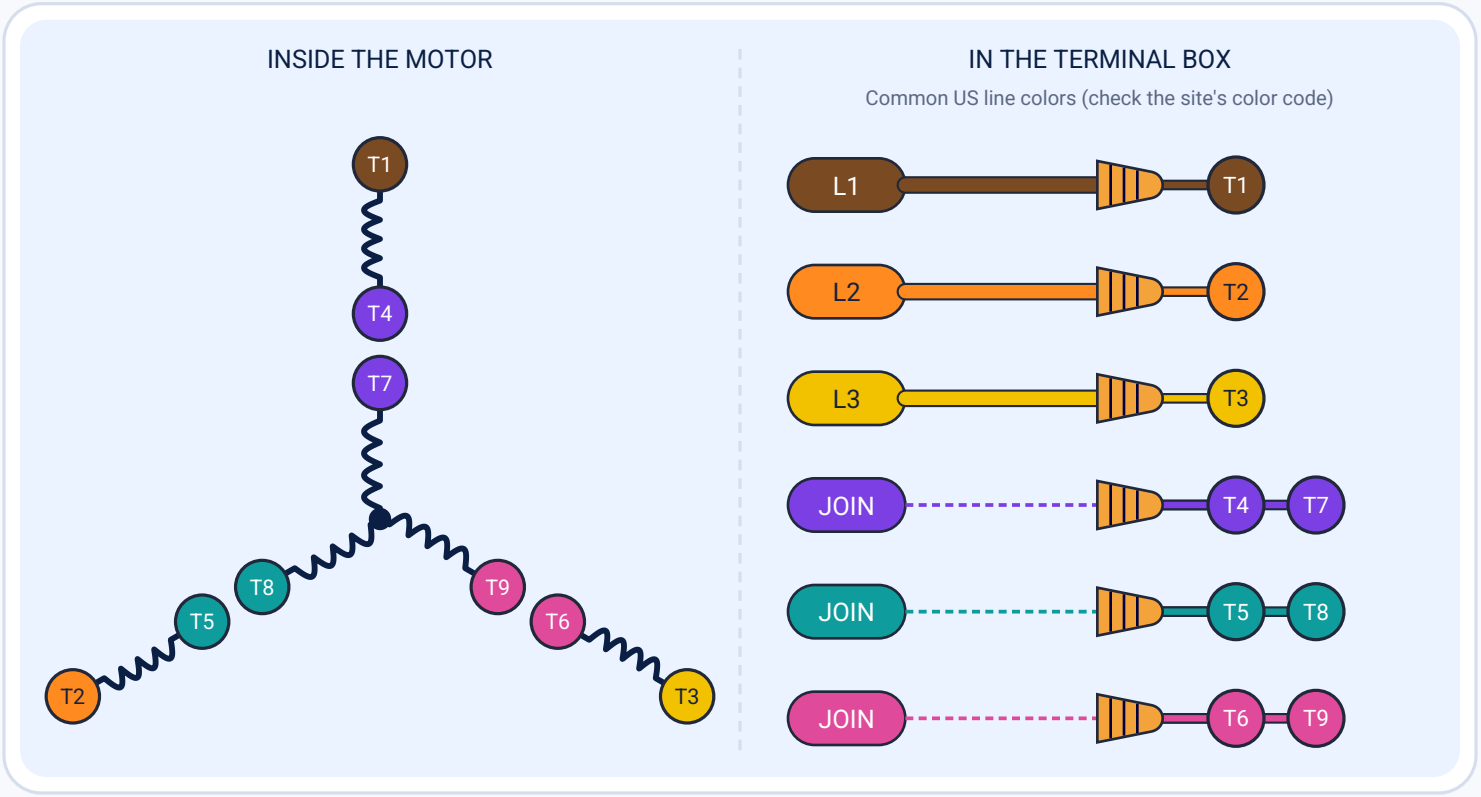
Putting 460 V on this low-voltage connection burns the motor fast. Measure the line voltage before you wire.

Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

9 LEADS · WYE (Y) · HIGH VOLTAGE

WYE - HIGH VOLTAGE 460 V

The two coils of each phase are in SERIES. Only T1, T2 and T3 get the lines; the other six leads are joined in pairs.



L1 BROWN · L2 ORANGE · L3 YELLOW · Joined leads (insulate)

CONNECTION

- L1 = T1
- L2 = T2
- L3 = T3
- TIE T4 + T7
- TIE T5 + T8
- TIE T6 + T9

STEP BY STEP

1. Lock out and test for absence of voltage.
2. L1 to T1, L2 to T2, L3 to T3.
3. Join in pairs and insulate: T4-T7, T5-T8, T6-T9.
4. Ground the frame. Make sure no bare lead touches the box before closing it.

WATCH OUT

On a 230 V supply this connection runs weak: the motor lacks torque and overheats under load. Match the connection to the voltage you measured.

SAFETY FIRST
Lock out, test before touching

NEMA MG-1
T1 to T12 lead markings

NEC 430
Motor circuits

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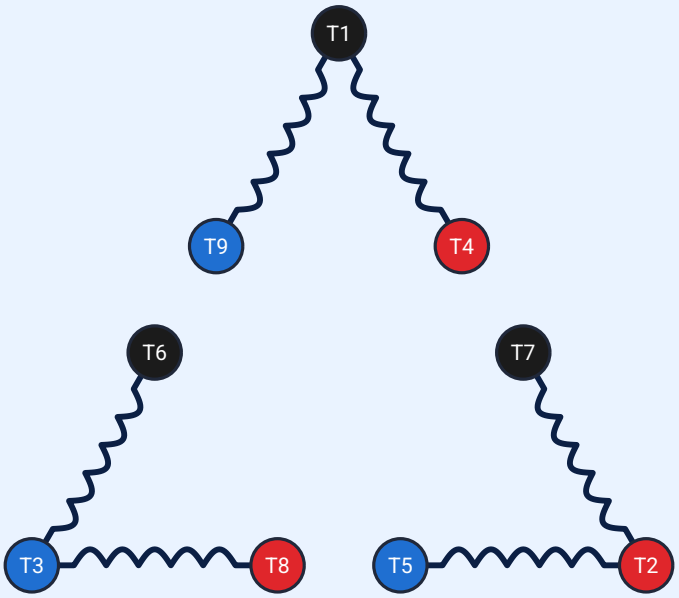
Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

9 LEADS · DELTA (Δ) · LOW VOLTAGE

DELTA · LOW VOLTAGE 230 V

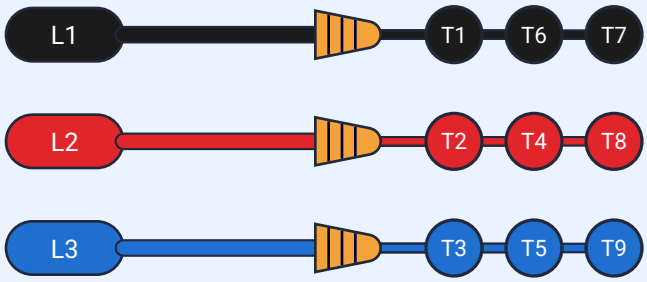
Two coils in PARALLEL on each side of the triangle. Each line gets three leads in the same connector.

INSIDE THE MOTOR



IN THE TERMINAL BOX

Common US line colors (check the site's color code)



L1 BLACK · L2 RED · L3 BLUE

CONNECTION

- L1 = T1 + T6 + T7
- L2 = T2 + T4 + T8
- L3 = T3 + T5 + T9

STEP BY STEP

1. Lock out and test for absence of voltage.
2. L1 to T1 + T6 + T7.
3. L2 to T2 + T4 + T8, L3 to T3 + T5 + T9.
4. All nine leads are used, none is left alone. Ground the frame.

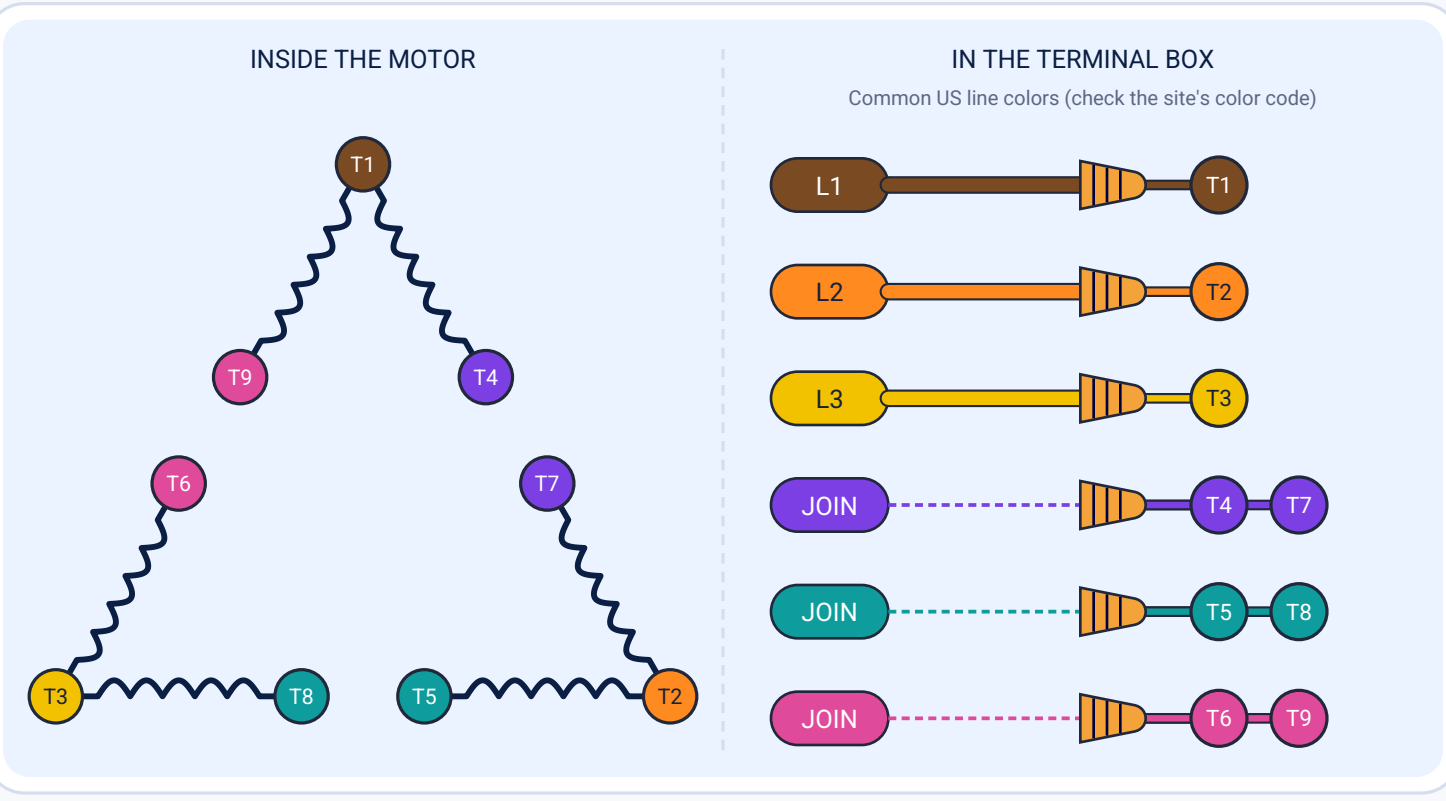
WATCH OUT

Three leads plus the line wire in one connector: use a connector or lug listed for that number and size of wires.

9 LEADS · DELTA (Δ) · HIGH VOLTAGE

DELTA · HIGH VOLTAGE 460 V

Two coils in SERIES on each side of the triangle. The pattern is the same as the wye high-voltage connection.



L1 BROWN · L2 ORANGE · L3 YELLOW · Joined leads (insulate)

CONNECTION

- L1 = T1
- L2 = T2
- L3 = T3
- TIE T4 + T7
- TIE T5 + T8
- TIE T6 + T9

STEP BY STEP

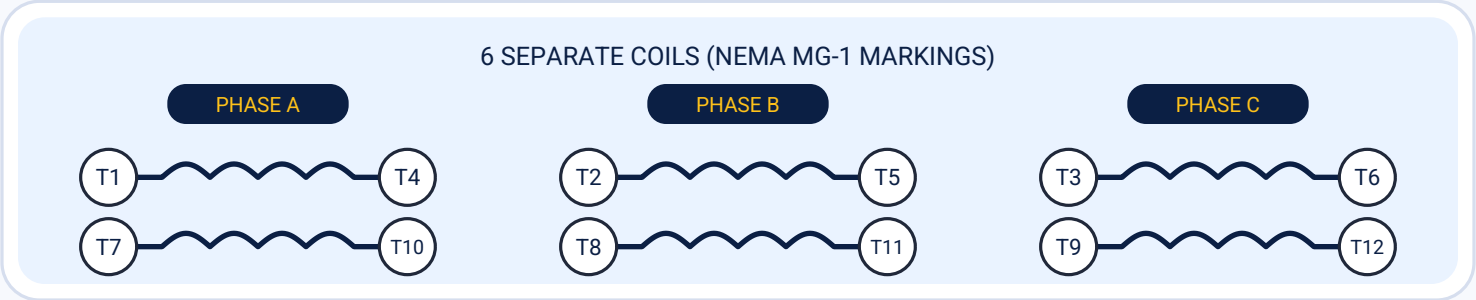
1. Lock out and test for absence of voltage.
2. L1 to T1, L2 to T2, L3 to T3.
3. Join in pairs and insulate: T4-T7, T5-T8, T6-T9.
4. Ground the frame and check rotation with the load uncoupled if possible.

WATCH OUT

High voltage looks the same on wye and delta 9-lead motors, low voltage does not. Check Y or Δ on the plate before wiring for 230 V.

12-LEAD MOTORS (T1 TO T12)

Every coil end comes out of the motor: 6 coils, 2 per phase. That allows wye or delta, at low or high voltage.



Connection	L1	L2	L3	Join and insulate
Wye · low voltage (parallel)	T1 + T7	T2 + T8	T3 + T9	T4-T5-T6 · T10-T11-T12
Wye · high voltage (series)	T1	T2	T3	T4-T7 · T5-T8 · T6-T9 · T10-T11-T12
Delta · low voltage (parallel)	T1 + T6 + T7 + T12	T2 + T4 + T8 + T10	T3 + T5 + T9 + T11	nothing (all leads on lines)
Delta · high voltage (series)	T1 + T12	T2 + T10	T3 + T11	T4-T7 · T5-T8 · T6-T9

WYE-DELTA START WITH A 12-LEAD MOTOR

230 V	start: wye low voltage	→ run: delta low voltage
460 V	start: wye high voltage	→ run: delta high voltage

WHY 12 LEADS

With all ends outside, the same motor can be wired wye or delta at two voltages. That is what a wye-delta starter needs.

WHICH ONE RUNS?

The nameplate tells the running connection. On a typical 230/460 V motor built to run in delta, the wye connections are used only to start it.

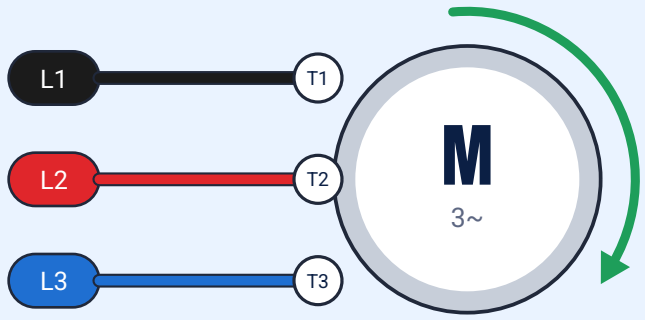
CHECK THE PLATE

This table follows the NEMA MG-1 lead markings. Some makers differ: the diagram on the motor always wins.

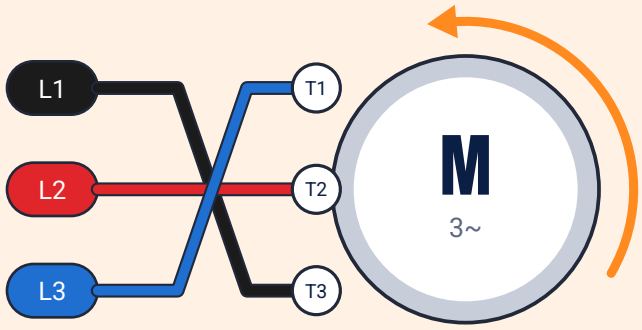
REVERSING A 3-PHASE MOTOR

Swap any two of the three lines. That is all it takes.

FORWARD



REVERSE



L1 and L3 swapped

SWAP LINES, NOT LEADS

On 9- and 12-lead motors, swap two incoming LINE wires (for example L1 and L3), each with its whole bundle. Never pull a single T-lead out of a bundle.

CHECK BEFORE COUPLING

Use a phase rotation meter, or bump the motor with the load uncoupled. Pumps, compressors and fans can be damaged running backwards.

FORWARD / REVERSE STARTER

For frequent reversing, use a reversing starter: two contactors with mechanical and electrical interlock, so they can never close together.

Rolling all three lines (L1 to L2, L2 to L3, L3 to L1) does NOT reverse the motor: the phase sequence stays the same. Swap only two.

SAFETY FIRST
Lock out, test before touching

NEMA MG-1
T1 to T12 lead markings

NEC 430
Motor circuits

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Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

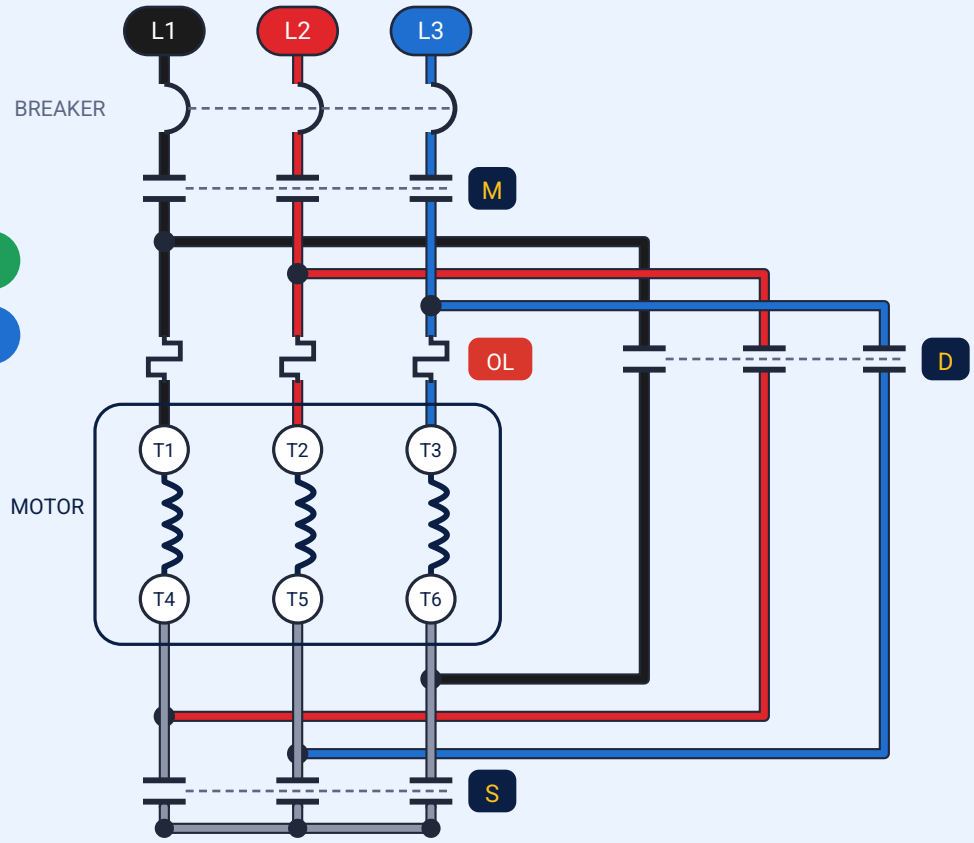
WYE-DELTA STARTING

Start in wye with less current, then run in delta with full power. Simplified power diagram (6-lead motor).

M = MAIN
S = STAR (WYE)
D = DELTA
OL = OVERLOAD

START: M + S = Y

RUN: M + D = Δ



SEQUENCE

1. START: M and S close. The motor runs in wye: each winding sees line voltage divided by 1.73, so starting current and torque drop to about 1/3.
2. The timer (TR) counts while the motor speeds up. Set it per the starter manual so the change happens near full speed.
3. S opens, then D closes: the windings are now in delta at full voltage.
4. S and D must never be closed together: use mechanical and electrical interlock.

WATCH OUT

The motor must be rated to RUN in delta at your line voltage (6 or 12 leads, wye-delta start on the plate). Best for loads that start light: fans, pumps, unloaded compressors.

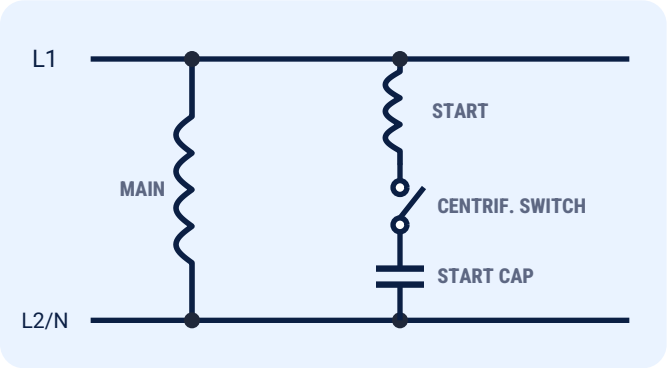
OVERLOAD

Drawn in the winding leads, the overload sees winding current, not line current. Set it as the starter maker says (about FLA divided by 1.73).

Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

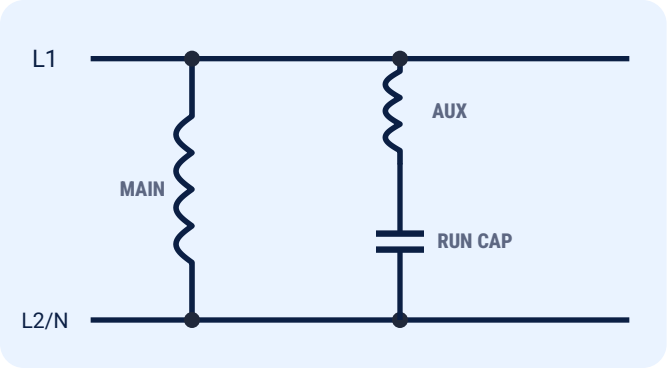
SINGLE-PHASE MOTORS

One phase alone cannot make the motor turn. A second winding (start or auxiliary) gives the push.



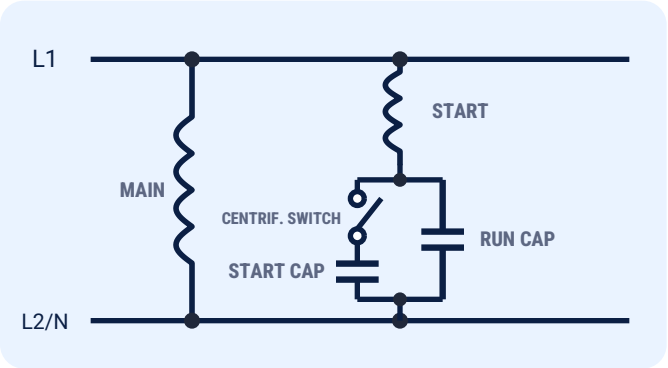
CAPACITOR START

- Start winding, start capacitor and centrifugal switch in series.
- The switch opens as the motor nears running speed and drops the start winding.
- High starting torque: compressors, pumps, shop tools.



PSC (PERMANENT SPLIT CAPACITOR)

- The run capacitor stays in the circuit all the time.
- No centrifugal switch to wear out.
- Low starting torque, quiet: fans, blowers, HVAC.



CAP START / CAP RUN

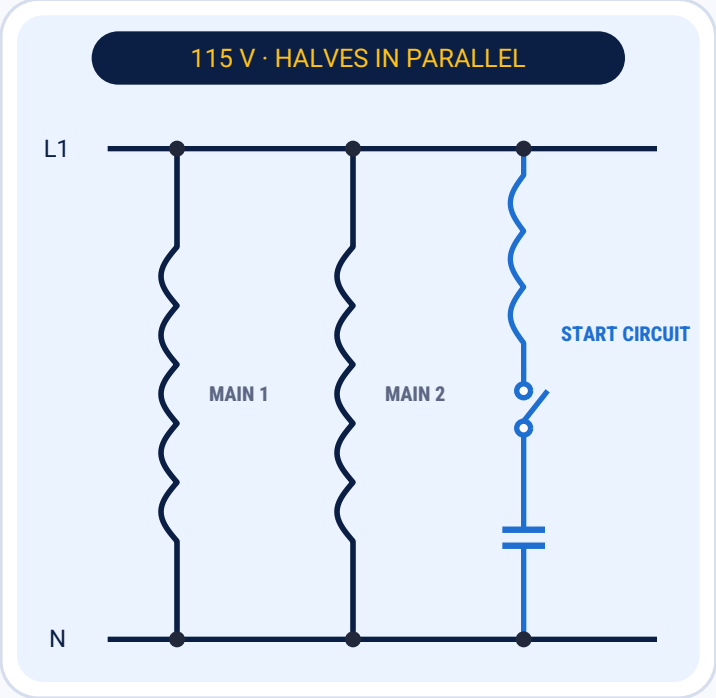
- Start capacitor and switch for starting, run capacitor for running.
- High starting torque and better efficiency.
- Larger motors, air compressors, well pumps.

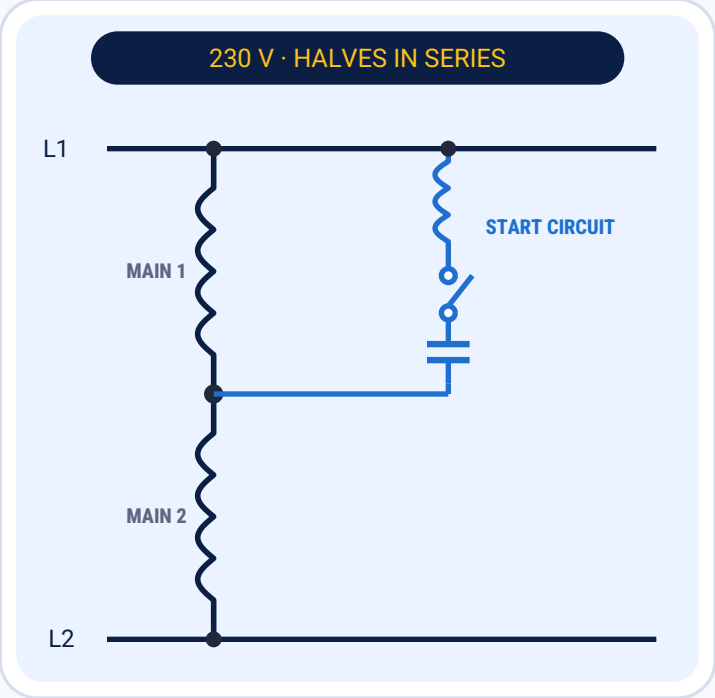
CAPACITOR SAFETY

A capacitor can hold a charge after power is off: discharge it the way the maker says before touching. Replace it with the same µF and an equal or higher voltage rating.

115/230 V AND REVERSING

Dual-voltage single-phase motors: the main winding comes in two halves.



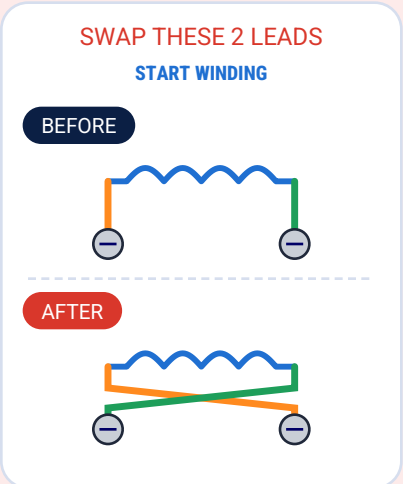


Typical layout: the start circuit always sees about 115 V. Lead numbers and colors change from maker to maker.

REVERSING: FOLLOW THE NAMEPLATE DIAGRAM

To reverse a single-phase motor, swap the two leads of the START (auxiliary) winding, with the motor stopped. Lead numbers and colors are NOT the same on every motor: use the diagram on the nameplate or inside the terminal cover. No diagram? Do not guess.

- Wait until the motor stops completely before reversing.
- On dual voltage, swap the start winding leads only, never one half of the main winding.
- Shaded-pole and many PSC fan motors cannot be reversed by moving leads.
- Some PSC motors reverse by moving the capacitor to the other winding, only if the diagram shows it.



SAFETY FIRST
Lock out, test before touching

NEMA MG-1
T1 to T12 lead markings

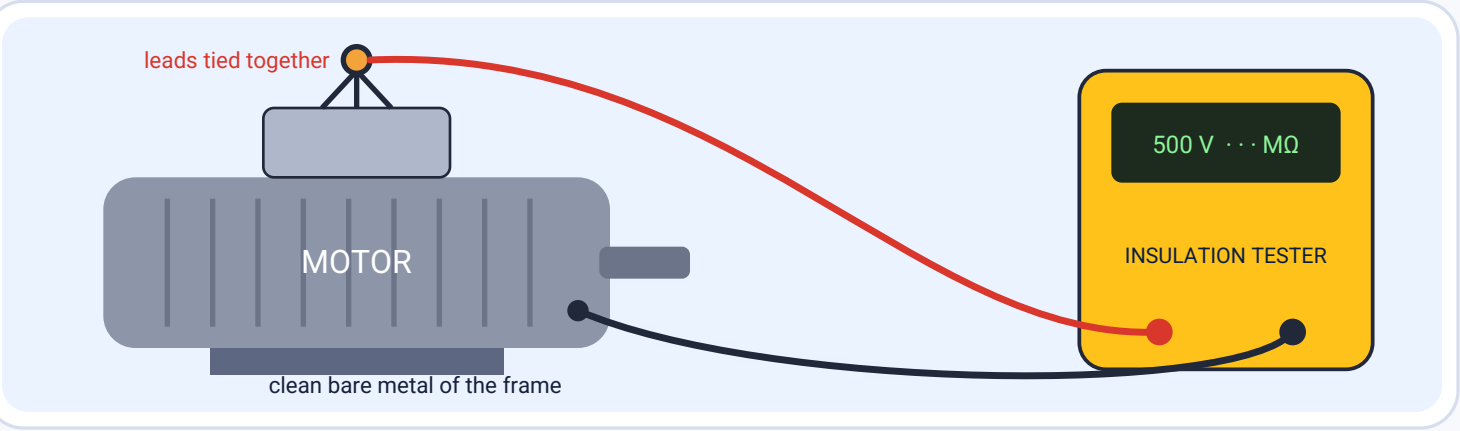
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TESTING: MULTIMETER AND MEGGER

Two quick tests before you energize a motor that sat, got wet or tripped.



MULTIMETER (OHMS) · COILS

1. Lock out and disconnect the motor leads from the supply.
2. Every coil must show continuity (low ohms). Open = broken coil.
3. Compare the phases: readings should be almost equal. One low or very different reading points to shorted turns.
4. The lead groups also tell wye from delta (see the 'wye or delta' page).

MEGGER · COILS TO FRAME

1. Disconnect drives, capacitors and electronics first: the test voltage can destroy them.
2. One probe on the motor leads tied together, the other on the frame.
3. Motors under 1,000 V are usually tested at 500 V DC (IEEE 43). Use the minimum value from the maker or your company.
4. Low or falling readings = moisture, dirt or damaged insulation. Discharge the windings after the test.

CLAMP METER · AFTER START-UP

1. Measure the current on all three lines with the motor loaded.
2. Current at or below the nameplate FLA, and close on all lines.
3. Check the voltage between lines too: a small voltage unbalance causes a much bigger current unbalance and heat.

Write down every reading with the date and motor temperature. The trend over time tells more than a single number.

Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

BREAKER AND OVERLOAD (NEC 430)

Motors have their own NEC article. Nameplate FLA for the overload, NEC table current for the rest.

NAMEPLATE FLA	NEC TABLE CURRENT
Overload relay	Conductors, breaker or fuses, disconnect

1

OVERLOAD RELAY

Size it from the NAMEPLATE FLA (NEC 430.6(A)(2) and 430.32): up to 125% of FLA for SF 1.15 or higher, 115% for other motors. Many relays are simply set to the FLA: follow the relay instructions.

2

CONDUCTORS

Use the NEC table current, not the nameplate (Table 430.248 single-phase, 430.250 three-phase). For one motor: at least 125% of that value (430.22).

3

BREAKER OR FUSES

Short-circuit and ground-fault protection per 430.52 and Table 430.52. The maximum percentage depends on the device (inverse-time breaker or fuse type) and the motor.

4

DISCONNECT

A disconnecting means in sight of the motor and its controller (430.102). Check the exceptions that apply.

5

GROUNDING

Equipment grounding conductor to the motor frame and terminal box (NEC 430 Part XIII and Article 250).

⚠ This page is a road map, not a sizing table. Use the NEC edition adopted in your area and the local inspector's rules.

TROUBLESHOOTING

The 6 problems that show up most, and where to look first.

Hums but will not start

3-phase: one line missing (blown fuse, bad contact). 1-phase: bad start capacitor or centrifugal switch stuck open. Also look for a jammed load.

Runs hot

Wrong connection for the voltage, overload, low or unbalanced voltage, or a dirty or blocked cooling fan.

Turns the wrong way

3-phase: swap any two lines. 1-phase: swap the start winding leads following the nameplate diagram.

Breaker trips right away

Short or ground fault: megger the motor and the cable. Also check the connection against the nameplate.

Overload trips after a while

Real overload, wrong overload setting, a missing phase or unbalance. Clamp all three lines and compare with FLA.

Noisy or vibrating

Bearings, misalignment, loose mounting or a missing phase. A loud hum right at start can mean the wrong connection.

Study guide. The motor's own nameplate diagram, the NEC and local codes always come first. Motor work may require a licensed electrician.

FINAL CHECKLIST

- [ ] Supply voltage measured and matching the plate.
- [ ] Wye or delta confirmed on the nameplate.
- [ ] Each lead in the right connector, none left loose.
- [ ] Joined leads insulated, connectors rated for the wires.
- [ ] Ground connected to the frame or terminal box.
- [ ] Overload set from the nameplate FLA.
- [ ] Rotation checked, load uncoupled if possible.
- [ ] Running current on all lines at or below FLA.

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