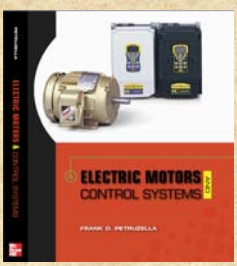


Chapter 5

Electric Motors

PART 8 Motor Maintenance and Troubleshooting

MOTOR MAINTENANCE

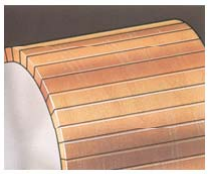
Schedule periodic inspections. **The key to minimizing motor problems is scheduled routine inspection and service.**

Keep records of all maintenance schedules and procedures performed. The frequency and procedures of routine service varies widely between applications. Motor should be inspected periodically for things such as shaft alignment, motor base tightness, and belt condition and tension.

Brush and commutator care. **For DC motors remove the covers and perform checks on brush wear, spring tension, commutator wear or scoring.**

- **Replace worn brushes.**

- **The commutator should be clean, smooth and has a polished brown surface where the brushes ride.**



- **The brushes must ride on the commutator smoothly with little or no sparking and no brush chatter.**

Testing motor winding insulation. **Twice yearly, test winding and winding-to-ground resistance to identify insulation problems.**

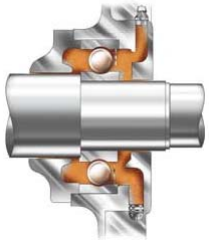
Rated Motor Voltage	Minimum Insulation Resistance
600 Volts and Below	1.5 Megohm
2300 Volts	3.5 Megohm
4000 Volts	5.0 Megohm

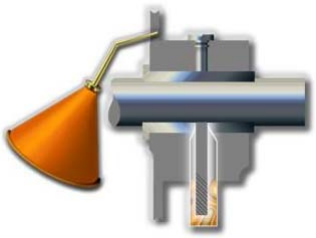
MegOhmMeter (Megger) Insulation Tester

Keep motors clean. **Wipe, brush, vacuum or blow accumulated dirt from the frame and air passages of the motor. Dirty motors run hot when thick dirt insulates the frame and clogged passages reduce cooling airflow.**

Keep motors dry. **Motors that are used continuously are not prone to moisture problems. It is the intermittent use or standby motor that may have difficulties. Try to run the motor for at least a few hours each week to drive off moisture.**

Lubricate motors **according to manufacturer specifications. Apply high-quality greases or oils carefully to prevent contamination by dirt or water.**





Check for excessive heat, noise and vibration. **Feel the motor frame and bearings for excessive heat or vibration. Listen for abnormal noise. All indicate a possible system failure. Promptly identify and eliminate the source of the heat, noise or vibration.**

Excessive starting is a prime case of motor failures. **The high current flow during start-up contributes a great amount of heat to the motor. For motors 200 HP and below, the maximum acceleration time a motor connected to a high inertia load can tolerate is about 20 seconds. The motor should not exceed more than about 150 start-seconds per day.**

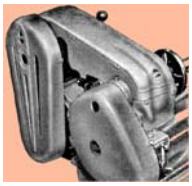
TROUBLESHOOTING MOTORS

Any type of electrical testing involves risk and complacency can lead to injury!

Disconnect power to the motor and complete lock-out and tag-out procedures before performing service or maintenance.

Discharge all capacitors before servicing the motor.

Always keep hands and clothing away from moving parts.



Be sure required safety guards are in place before starting equipment.

Electrical contact accounts for one fifth of all construction deaths. *Never work on energized equipment unless this is absolutely necessary for examination, adjustment, servicing, or maintenance.*

Always wear the appropriate personal protective equipment and have a partner working with you, in case of emergency.

Typical instruments **used for troubleshooting motor operation problems include a multimeter, clamp-on ammeter, meg-ohmmeter and infrared thermometers.**

Test leads should be rated at the same or greater that that of the meter.

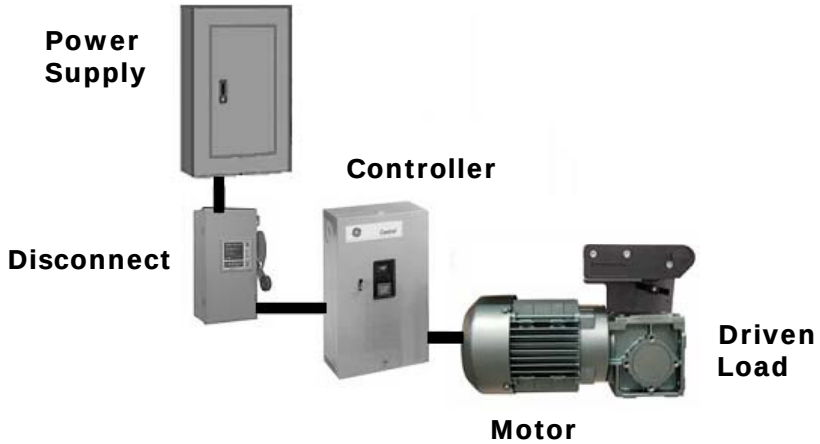
Multimeter

Ammeter

Megohmmeter

Thermometer

The basic motor system consists of the power supply, controller, motor and driven load. When a motor problem occurs, it is first necessary to find ***which of the parts of the system is at fault.***

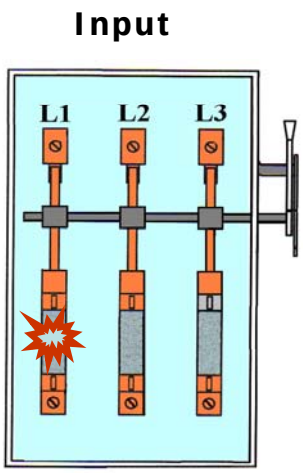


TROUBLESHOOTING GUIDES

SYMPTOM: The motor fails to start.

POSSIBLE CAUSE:

Blown fuse or open circuit breaker. **Check the voltage at the input and output of the overcurrent protection device. If voltage is measured at the input but not at the output the fuse is blown or the circuit breaker is open. Check the rating of the fuse or circuit breaker. It should be at least 125% of the motors full load current.**



SYMPTOM: The motor fails to start.

POSSIBLE CAUSE:

Motor overload relay on starter tripped. **Allow overload relay to cool and reset overload. If the motor causes the overload to open after a short period, check for motor shorts and grounds. Check the full-load current of the motor and compare it to the setting of the overload relay.**

SYMPTOM: The motor fails to start.

Low voltage or no voltage applied to the motor. **Check the voltage at the motor terminals. The voltage must be within 10% of the motor nameplate voltage. Determine the cause of the low voltage. Loose fuse clips and connections at the terminals the disconnect switch or circuit breaker can result in low voltage at the motor.**

POSSIBLE CAUSE:

SYMPTOM: The motor fails to start.

POSSIBLE CAUSE:

Mechanical overload. **Rotate the motor shaft to see if a binding load is the problem. Check for frozen bearings. Check the air gap between the stator and rotor. Reduce the load or try operating the motor with no load applied.**

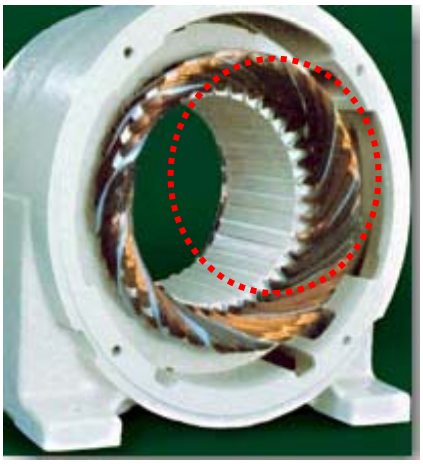
SYMPTOM: The motor fails to start.

POSSIBLE CAUSE:

Defective motor windings. **Make resistance checks of the motor windings for opens and shorts in coil windings and coils shorted to ground faults. An ohmmeter reading of infinity across a set of coil windings means that there is break somewhere. One way to test for a shorted coil winding is to compare its resistance reading with that of a known good identical coil. A short in only a few turns of a coil while difficult to detect will still result in a motor overheating.**

SYMPTOM: The motor fails to start.

POSSIBLE CAUSE:



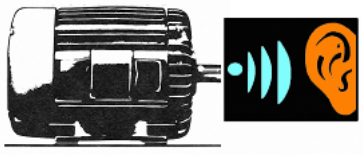
Burnt out motor. **If one or more of the motor windings looks blackened and smells burnt, its most likely burnt out and needs to be replaced.**

SYMPTOM: The motor overheats.

POSSIBLE CAUSES:

- ***Load.*** **A basic rule is that your motor should not get too hot to touch. Check ammeter reading against full-load current rating of motor. For a higher than normal current reading reduce the load or replace motor with a larger sized one.**
- ***Insufficient cooling.*** **Remove any build up of debris in or around the motor.**
- ***Bearings and alignment.*** **Bad bearings or poor coupling alignment can increase friction and heat.**
- ***Source voltage.*** **If the operating voltage is too high or too low, the motor will operate at a higher temperature. Correct voltage to within 10% of the motor's rating.**

SYMPTOM: Excessive motor noise and vibration.



POSSIBLE CAUSES:

- ***Bearings.*** **With the motor stopped, try gently moving the shaft up and down to detect bearing wear. When the handle of a screwdriver is placed to the ear and the blade to the bearing housing, the screwdriver will amplify the noise, similar to the action of a stethoscope. Replace worn or loose bearings. Replace dirty or worn-out oil or grease.**

- ***Coupling mechanism.*** **Check for bent shaft on motor or load. Straighten if necessary. Measure the alignment of the couplings. Realign if necessary.**

- ***Loose hardware.*** **Tighten all loose components on the motor and load.**

SYMPTOM: Motor produces an electric shock when touched.

POSSIBLE CAUSE:

- ***Grounding*****. Broken or disconnected equipment grounding conductor.**
- **Motor winding shorted to frame.**
- **Check motor junction box for poor connections, damaged insulation, or leads making electrical connection with the frame.**

SYMPTOM: Motor overload protector continually trips.

POSSIBLE CAUSES:

- ***Ambient temperature too high.*** **Verify that the motor is getting air for proper cooling.**
- ***Load.*** **Load too high. Verify that the load is not jammed. Remove the load from the motor and measure the no-load current. It should be less than the full load rating stamped on the nameplate.**
- ***Overload protector may be defective*****. Replace the motor's protector with one of the correct rating.**
- ***Winding shorted or grounded.*** **Inspect windings for defects, loose or cut wires that may cause a path to ground.**

TROUBLESHOOTING SINGLE-PHASE MOTORS

Problem: Split-phase motor hums and it will run normally if started by hand.

- Possible Cause: Centrifugal switch is not operating properly.

Disassemble the mechanism. Clean the contacts. Adjust spring tension. Replace switch.

Problem: Capacitor start motor hums and it will run normally if started by hand.

- Possible Cause: Centrifugal switch (same as for a split-phase motor)
- Defective capacitor. Test capacitor. If defective replace.

Problem: Start capacitors continually fail.

- Possible Causes: The motor is not coming up to speed quickly enough as a result of not being sized properly.
- The motor is being cycled too frequently. Capacitor manufacturers recommend no more than 20, 3-second starts per hour.
- Starting switch may be defective, preventing the motor from opening the start winding circuit.

Problem: Run capacitor fails.

- Possible Causes: Ambient temperature too high.
- Possible power surge to motor caused by high transient voltage. If a common problem install a surge protector.

Problem: Universal motor sparks.

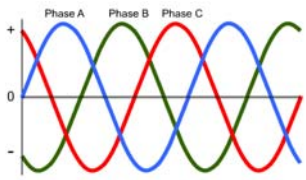
- **Possible Causes: New brushes not properly seated. Seat brushes with fine sandpaper to fit contour of commutator.**
- **Worn or sticky brushes. Replace brushes or clean brush holder.**
- **Open or shorted armature coils. Replace armature.**

TROUBLESHOOTING THREE-PHASE MOTORS

Problem: Single phasing – one phase of the 3-phase system is lost. Squirrel cage motor will not start but if in operation may continue to operate at increased current and diminished capacity. Unique high pitched sound from motor.

- **Possible Causes: A fuse is blown or one leg of a circuit breaker is open.**
- **Check each of the 3-phase power lines for correct voltage.**

Problem: the voltages of all three phases are not equal. Motor operates at a higher than temperature and reduced efficiency.

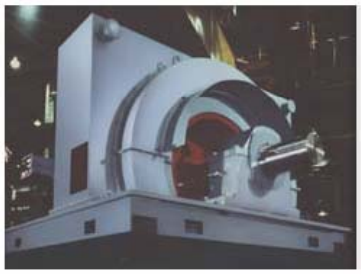


- **Possible Causes: Blown fuse on power factor correction capacitor bank – find and replace fuse.**
- **Uneven single-phase loading – distribute single-phase loads more evenly on the 3-phase circuit.**
- **Utility unbalanced voltages – if the incoming voltages are substantially unbalanced contact the utility and ask them to correct the problem.**
- **Harmonic distortion – The presence of harmonic distortion in the applied voltage to a motor will increase motor temperature, which could result in insulation damage and possible failure.**
- **Locate the sources of the harmonics and use harmonic filters to control or reduce harmonics.**

Problem: Wound rotor (slip ring) induction motor fails to start or starts and runs erratically.

- **Possible cause: External rotor resistors – failed components in the resistor bank.**
- **Clean slip rings and check brushes for wear and proper pressure.**

Problem: Synchronous motor experiences increased start-up time or erratic acceleration.



- **Possible Cause: Damaged or defective amortisseur (squirrel cage) windings. – Historical in-rush testing that records the stator's current during start-up can greatly assist in determining if these windings have degraded over the life of the motor.**

TROUBLESHOOTING DIRECT CURRENT MOTORS

Problem:
Excessive arching at brushes.

- **Possible Causes: Worn or sticky brushes. Replace brushes or clean brush holder.**
- **Incorrect brush position with respect to neutral plane. Rotate brush rigging to the correct position to aid in commutation.**
- **Overload. Measure current to the motor and compare to full load current rating. If necessary, reduce motor load.**
- **Dirty commutator. The commutator surface should be clean and bright, slight scratches and discoloring can be removed with emery paper. Deep scratches/ridges require the commutator to be machined and mica undercut.**
- **Armature faults. Test for open and shorted windings in the armature and correct or replace motor.**
- **Field windings faults. Test for shorts, opens, and ground faults and correct or replace motor.**

Problem: Rapid brush wear.

- **Possible Causes: Wrong brush material, type, or grade. Replace with brushes recommended by manufacturer.**
- **Incorrect brush tension. Adjust brush tension so that the brush rides freely on the commutator. Replace brush springs if tension measured by a scale is insufficient.**

TROUBLESHOOTING LADDER

A *troubleshooting ladder or tree* may be used to guide you through the steps of the troubleshooting process. Sequential in nature, its simplicity can often save time in arriving at the source of a motor problem. The following a typical example of a troubleshooting ladder used to determine the cause of *overheating of a 3-phase squirrel cage induction motor.*