

## Single-phase motors

### Application Note

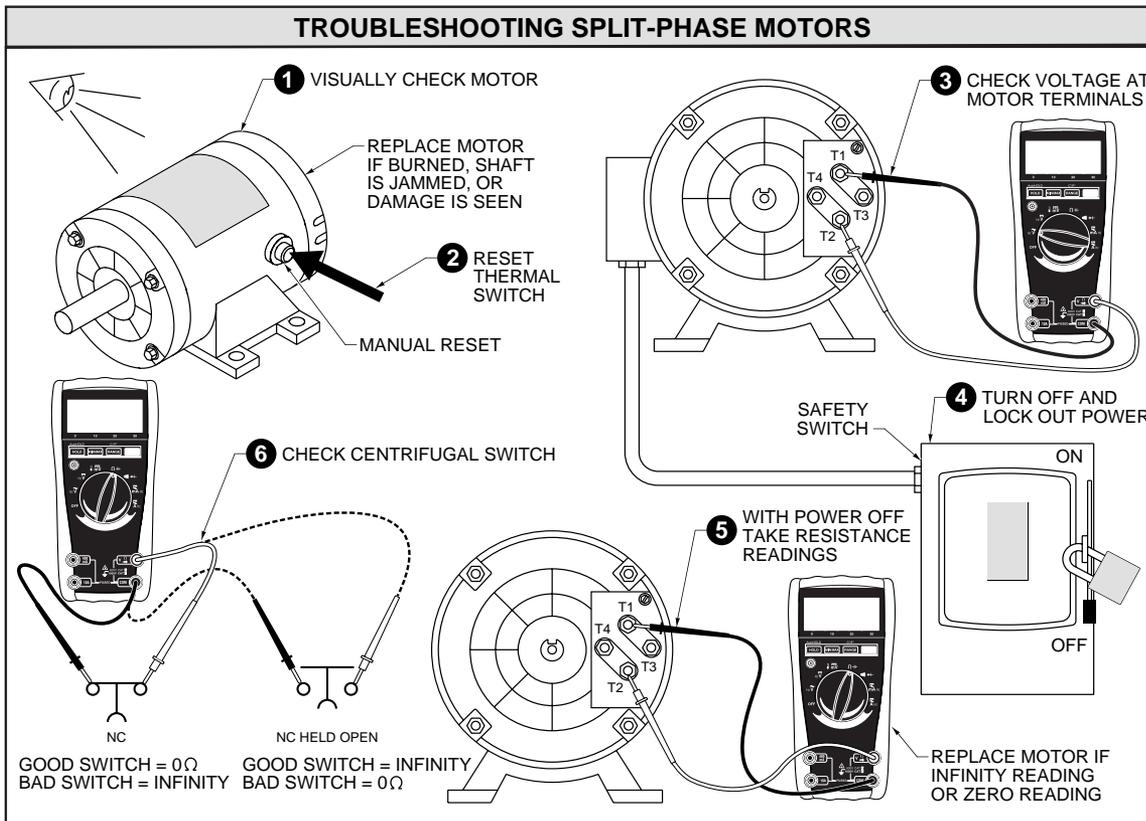


Figure 1. Troubleshoot split-phase motors with an ohmmeter.

Most problems with 1 $\phi$  motors involve the centrifugal switch, thermal switch, or capacitor(s). If the problem is in the centrifugal switch, thermal switch, or capacitor, the motor is usually serviced and repaired. However, if the motor is more than 10 years old and less than 1 HP, the motor is usually replaced. If the motor is less than 1/8 HP, it is almost always replaced.

### Troubleshooting split-phase motors

The split-phase motor has a starting and running winding. The starting winding is automatically removed by a centrifugal switch as the motor accelerates. Some split-phase motors also

include a thermal switch that automatically turns the motor OFF when it overheats. Thermal switches may have a manual reset or automatic reset. Caution should be taken with any motor that has an automatic reset, as the motor can automatically restart at any time. See Figure 1. To troubleshoot a split-phase motor, apply the following procedure:

1. Turn power to motor OFF. Visually inspect the motor. Replace the motor if it is burned, the shaft is jammed, or if there is any sign of damage.
2. Check to determine if the motor is controlled by a thermal switch. If the thermal

switch is manual, reset the thermal switch and turn motor ON.

3. If the motor does not start, use a voltmeter to check for voltage at the motor terminals. The voltage should be within 10 % of the motor's listed voltage. If the voltage is not correct, troubleshoot the circuit leading to the motor. If the voltage is correct, turn power to motor OFF so the motor can be tested.
4. Turn the handle of the safety switch or combination starter OFF. Lock out and tag the starting mechanism per company policy.

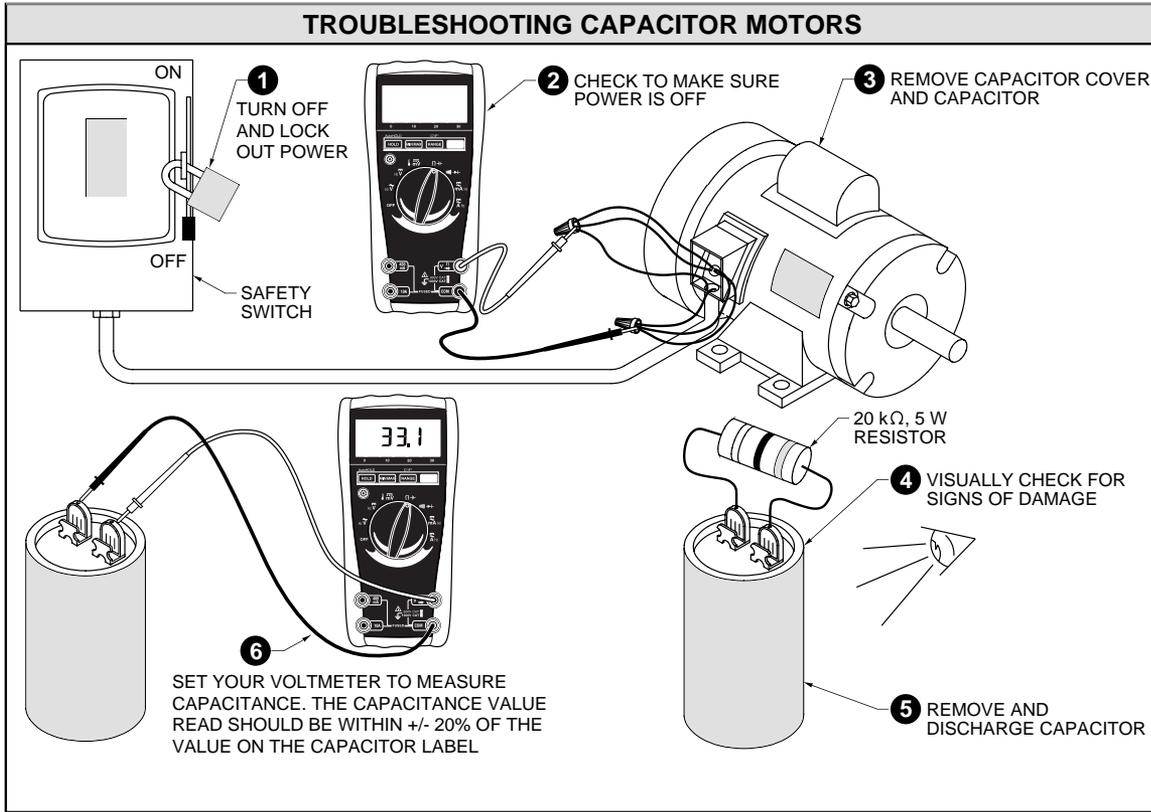


Figure 2. Troubleshoot capacitors with an ohmmeter and a resistor.

5. With power OFF, connect the ohmmeter to the same motor terminals the incoming power leads were disconnected from. The ohmmeter will read the resistance of the starting and running windings. Since the windings are in parallel, their combined resistance is less than the resistance of either winding alone. If the meter reads zero, a short is present. If the meter reads infinity, an open circuit is present. In either case the motor should be replaced.
6. Visually inspect the centrifugal switch for signs of burning or broken springs. If any obvious signs of problems are present, service or replace the switch. If not, check the switch using an ohmmeter.

Manually operate the centrifugal switch. (The endbell on the switch side may have to be removed.) If the motor is good, the resistance on the ohmmeter will decrease. If the resistance does not change, a problem exists. Continue checking to determine the problem.

### Troubleshooting capacitor motors

A capacitor motor is a split-phase motor with the addition of one or two capacitors. Capacitors give the motor more starting and/or running torque. Troubleshooting capacitor motors is similar to troubleshooting split-phase motors. The only additional device to be considered is the capacitor.

Capacitors have a limited life and are often the problem in capacitor motors. Capacitors may have a short circuit, an open circuit, or may deteriorate to the point that they must be replaced. Deterioration can also change the value of a capacitor, which can cause additional problems. When a capacitor short-circuits, the winding in the motor may burn out. When a capacitor deteriorates or opens, the motor has poor starting torque. Poor starting torque may prevent the motor from starting, which will usually trip the overloads.

All capacitors are made with two conducting surfaces separated by dielectric material.

Dielectric material is a medium in which an electric field is maintained with little or no outside energy supply. It is the type of material used to insulate conducting surfaces of a capacitor. Capacitors are either oil or electrolytic. Oil capacitors are filled with oil and sealed in a metal container. The oil serves as the dielectric material.

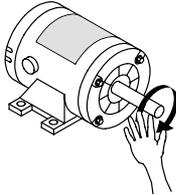
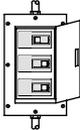
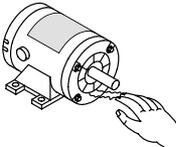
More motors use electrolytic capacitors than oil capacitors. Electrolytic capacitors are formed by winding two sheets of aluminum foil separated by pieces of thin paper impregnated with an electrolyte. An electrolyte is a conducting medium in which the current flow occurs by ion migration. The electrolyte is used as the dielectric material. The aluminum foil and electrolyte are encased in a cardboard or aluminum cover. A vent hole is provided to prevent a possible explosion in the event the capacitor is shorted or overheated.

AC capacitors are used with capacitor motors. Capacitors that are designed to be connected to AC have no polarity. See Figure 2.

To troubleshoot a capacitor motor, apply the following procedure:

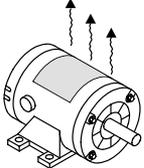
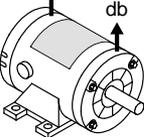
1. Turn the handle of the safety switch or combination starter OFF. Lock out and tag the starting mechanism per company policy.
2. Using a voltmeter, measure the voltage at the motor terminals to make sure the power is OFF.
3. Capacitors are located on the outside frame of the motor. Remove the cover of the capacitor. Caution: A good capacitor will hold a charge, even when power is removed.
4. Visually check the capacitor for leakage, cracks, or bulges. Replace the capacitor if present.
5. Remove the capacitor from the circuit and discharge it. To safely discharge a capacitor, place a 20,000 Ω, 2 W resistor across the terminals for five seconds.
6. After the capacitor is discharged, connect the ohmmeter leads to the capacitor terminals. The ohmmeter will indicate the general condition of the capacitor. A capacitor is either good, shorted, or open. Set your voltmeter to measure capacitance. The capacitance value read should be within ± 20 % of the value on the capacitor label.

### Troubleshooting Guide for Single-Phase Motors

Problem	Possible Cause	Suggested Test Tool	Corrective Action
 <p>Motor will not start</p>	Thermal cutout switch is open		Reset the thermal switch. Caution: Resetting the thermal switch may automatically start the motor.
	Blown fuse or open CB	Basic electrical tester, DMM , clamp meter, or Megohmmeter	Test the OCPD. If voltage is present at the input, but not the output of the OCPD, the fuse is blown or the CB is open. Check the rating of the OCPD. It should be at least 125 % of the motor's FLC.
	Motor overload on starter tripped		Allow overloads to cool. Reset overloads. If reset overloads do not start the motor, test the starter.
	Low or no voltage applied to motor	Basic electrical tester, DMM or clamp meter	Check the voltage at the motor terminals. The voltage must be present and within 10 % of the motor nameplate voltage. If voltage is present at the motor but the motor is not operating, remove the motor from the load the motor is driving. Reapply power to the motor. If the motor runs, the problem is with the load. If the motor does not run, the problem is with the motor. Replace or service the motor.
	Open control circuit between incoming power and motor	Basic electrical tester, DMM or clamp meter	Check for cleanliness, tightness, and breaks. Test the circuit starting with the incoming power and moving to the motor terminals. Voltage generally stops at the problem area.
	Starting winding not receiving power	Basic electrical tester, DMM or clamp meter	Check the centrifugal switch to make sure it connects the starting winding when the motor is OFF.
 <p>Fuse, CB, or overloads retrip after service</p>	Blown fuse or open CB	Basic electrical tester, DMM , clamp meter, or Megohmmeter	Test the OCPD. If voltage is present at the input, but not the output of the OCPD, the fuse is blown or the CB is open. Check the rating of the OCPD. It should be at least 125 % of the motor's FLC.
	Motor overload on starter tripped		Allow overloads to cool. Reset overloads. If reset overloads do not start the motor, test the starter.
	Low or no voltage applied to motor	Basic electrical tester, DMM or clamp meter	Check the voltage at the motor terminals. The voltage must be present and within 10 % of the motor nameplate voltage. If voltage is present at the motor but the motor is not operating, remove the motor from the load the motor is driving. Reapply power to the motor. If the motor runs, the problem is with the load. If the motor does not run, the problem is with the motor. Replace or service the motor.
	Open control circuit between incoming power and motor	Basic electrical tester, DMM or clamp meter	Check for cleanliness, tightness, and breaks. Test the circuit starting with the incoming power and moving to the motor terminals. Voltage generally stops at the problem area.
	Motor shaft does not turn		Disconnect the motor from the load. If the motor shaft still does not turn, the bearings are frozen. Replace or service the motor.
 <p>Motor produces electric shock</p>	Broken or disconnected ground strap		Connect or replace ground strap. Test for proper ground.
	Hot power lead at motor connecting terminals is touching motor frame		Disconnect the motor. Open the motor terminal box and check for poor connections, damaged insulation, or leads touching the frame. Service and test motor for ground.
	Motor winding shorted to frame		Remove, service, and test motor.

Troubleshooting Guide continued on next page

**Troubleshooting Guide for Single-Phase Motors** continued

Problem	Possible Cause	Suggested Test Tool	Corrective Action
 <p>Motor overheats</p>	Starting windings are not being removed from circuit as motor accelerates		When the motor is turned OFF, a distinct click should be heard as the centrifugal switch closes as the motor slows down.
	Improper ventilation	Infrared thermometer	Clean all ventilation openings. Vacuum or blow dirt out of motor with low-pressure, dry, compressed air.
	Motor is overloaded	Basic electrical tester, clamp meter or DMM with clamp accessory	Check the load for binding. Check shaft straightness. Measure motor current under operating conditions. If the current is above the listed current rating, remove the motor. Remeasure the current under no-load conditions. If the current is excessive under load but not when unloaded, check the load. If the motor draws excessive current when disconnected, replace or service the motor.
	Dry or worn bearings		Dry or worn bearings cause noise. The bearings may be dry due to dirty oil, oil not reaching the shaft, or motor overheating. Oil the bearings as recommended. If noise remains, replace the bearings or the motor.
	Dirty bearings		Clean or replace bearings.
 <p>Excessive Noise</p>	Excessive end play		Check end play by trying to move the motor shaft in and out. Add end-play washers as required.
	Unbalanced motor or load		An unbalanced motor or load causes vibration, which causes noise. Realign the motor and load. Check for excessive end play or loose parts. If the shaft is bent, replace the rotor or motor.
	Dry or worn bearings		Dry or worn bearings cause noise. The bearings may be dry due to dirty oil, oil not reaching the shaft, or motor overheating. Oil the bearings as recommended. If noise remains, replace the bearings or the motor.
	Excessive grease		Ball bearings that have excessive grease may cause the bearings to overheat. Overheated bearings cause noise. Remove any excess grease.



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**Fluke Corporation**  
 PO Box 9090, Everett, WA USA 98206  
 Fluke Europe B.V.  
 PO Box 1186, 5602 BD  
 Eindhoven, The Netherlands  
 For more information call:  
 In the U.S.A. (800) 443-5853 or  
 Fax (425) 446-5116  
 In Europe/M-East/Africa (31 40) 2 675 200 or  
 Fax (31 40) 2 675 222  
 In Canada (800) 36-FLUKE or  
 Fax (905) 890-6866  
 From other countries +1 (425) 446-5500 or  
 Fax +1 (425) 446-5116  
 Web access: <http://www.fluke.com>

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