



Figure 1.14a - Measuring contactor coil resistance

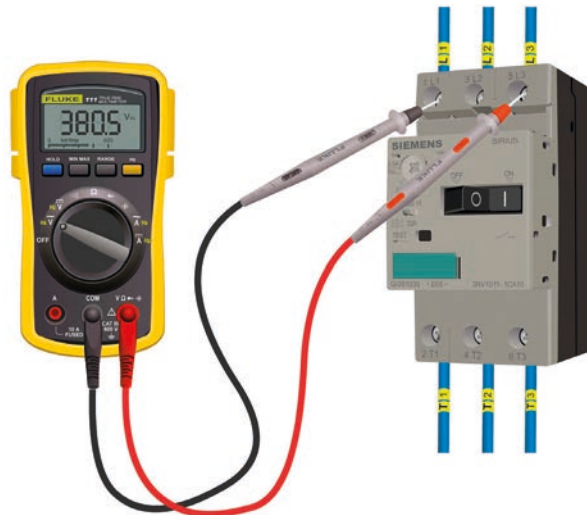


Figure 1.14b - Measuring voltage supplied to a circuit breaker

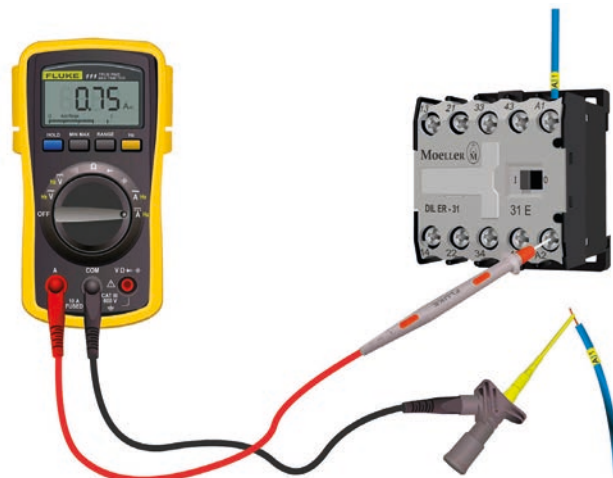


Figure 1.14c - Measuring a relay coil's current

To measure current

Most multimeters can only measure current up to 10 A maximum. The current measuring facility is intended only for small current components and, in particular, for electronic circuits. The instrument will almost certainly be damaged if it is used to measure the current to motors and other power circuits.

The basic current range can be extended by using external shunts (DC) and current transformers (AC). These accessories are generally purchased separately from the instrument manufacturers.

The procedure to be used to measure current in a small current circuit is:

- ✓ Prove the correct instrument operation.
- ✓ Adjust the test leads as designated for current measurement.
- ✓ Switch the instrument to the highest current range (either acA or dcA as appropriate).
- ✓ Turn off the power to the circuit to be tested and discharge all capacitors.
- ✓ Open the circuit in which current is to be measured – removing a fuse-link often gives a convenient point for current measurement.

Securely connect the probes in series with the load in which current is to be measured.

Turn ON the power to the circuit being tested. Note the current value on the meter display.

Turn OFF the power to the circuit being tested and discharge all capacitors.

DISCONNECT the test probes and switch the instrument to OFF. Reconnect the circuit that was being tested.

On a larger consumer, over 10 A, the most convenient way to measure current is to use a clampmeter, which is simply clamped around an insulated conductor. Similarly, mini-clampmeters are available which can be used on electronic circuits.

1.10 Diode Tests

Electronic diodes, and other semiconductor devices with p-n junctions, (eg the base-emitter of a transistor) can be tested using the following procedure:

- ✓ Prove the correct instrument operation.
- ✓ Switch the instrument to diode test.

If the diode is still in circuit, turn off the power to the circuit, discharge all capacitors and remove fuses.

In this test the instrument drives a small DC current (a few mA) through the diode/p-n junction while it also acts as a voltmeter to measure the volt drop across it.

- ✓ Connect the two probes across the diode.
- ✓ Read the forward volt drop across the diode. This should be between 500 mV and 900 mV (0.5–0.8 V) for a healthy silicon diode or p-n junction.
- ✓ Reverse the probe connections and the display should indicate over range.

If the display indicates over range in both directions, the diode is open-circuit faulted. If the display indicates less than 1 V in both directions, the diode may be short-circuit faulted.

The associated diode circuitry may be giving false readings, so the diode must be disconnected from the circuit and retested.

Diodes can also be tested with a multimeter to determine the resistance of a PN junction.

A diode has a relatively low resistance in the forward bias direction when positive polarity is applied to the anode, and a considerably greater resistance in the reverse bias direction when negative polarity is applied to the anode.

As illustrated in Figures 1.15a and 1.15b, a multimeter shows 524 Ω being connected in forward bias and 0L (over limit) in reverse bias, proving that the diode is 'good'.



Figure 1.15a - Measuring PN junction resistance in forward bias (positive lead is connected to anode)



Figure 1.15b - Measuring PN junction resistance in reverse bias (positive lead is connected to cathode)

1.11 Current Clampmeters

Power currents (AC) can be measured simply by using a clampmeter that acts as a current transformer. The instrument's tongs are clipped round a single insulated conductor and the circuit is not interrupted.

The value of current is obtained from the magnetic flux strength around the conductor and is displayed on a digital display.

Direct current (DC) measurement is also available with clampmeters that have a flux-voltage transducer, known as a 'Hall-effect' device.

Many modern clampmeters are virtually multimeters, with the addition of facilities to measure voltage and resistance and currents up to 1,000 A.



Figure 1.16 - Current clampmeter

Precautions must be taken when measuring the current in uninsulated conductors.

More advanced clamp type meters can indicate power and power factor in single and three-phase AC circuits by using additional connections to measure voltage.

QUESTION

What would a clampmeter indicate if clipped around a 3 core cable that is known to be carrying 100 A AC to a motor?

ANSWER

Zero.

This is because the clampmeter monitors the magnetic flux around the cable, which is produced by the current. In a balanced 3-core (or 2-core) cable, the net flux is zero – therefore, there is no indication. This is why the clampmeter is only connected around a single conductor.

1.12 Live-Line Testers

When equipment is to be inspected for maintenance, it is important that supplies are switched 'off' and locked 'out'. The equipment must then be 'proved' to be dead to eliminate the danger of electric shock. A live-line (or voltage) tester is a simple device that checks only whether or not a voltage exists at terminals.

Live-line testers, up to 500 V, are of various types. Some light up (eg screwdriver type with a neon indicator), some make a noise, others (as shown in Figure 1.14) operate LEDs to indicate the approximate value of voltage.

It is important that voltage testers themselves are 'proved' to operate correctly before use. This can be conveniently carried out at the electrical workshop test panel.

Homemade test lamps should not be used.

Testers with either damaged casing or insulation on the test leads should never be used as they can be dangerous to personnel.

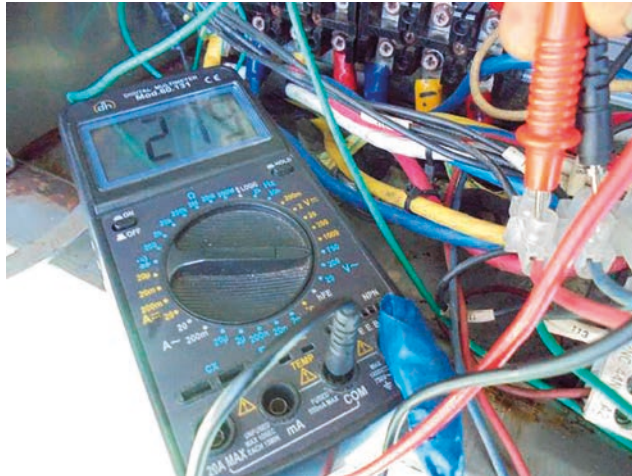


Figure 1.17 - Damaged DMM leads

Particular care is required with high voltage circuits, where a special HV test probe must be used (see Chapter 8).

1.13 General Electrical Maintenance

All equipment is subject to wear and tear and will eventually need to be replaced. As equipment nears the end of its safe working life, its condition may deteriorate to a dangerous extent.

The purpose of maintenance, therefore, is to extend the useful life by repair and/or replacement of defective parts and to maintain it in a safe and serviceable condition.

The marine environment is particularly difficult for electrical equipment due to the damp, salt-laden atmosphere, extremes of temperature and constant vibration. Shipboard equipment has a particular need for correct maintenance.



Figure 1.18 - Live-line tester

An efficient electrical engineer (or chief engineer if there is no electrical engineer on board) must know the ship's power system and its equipment. The ship's technical library must be kept in order and be updated to the actual condition of onboard applications. Electrical services and equipment must be kept under continuous observation so that normal healthy operating conditions become known and abnormal operation becomes quickly apparent. Faults should be pinpointed and corrected before a breakdown occurs.

Maintenance can be classified as:

- Condition monitoring
- planned maintenance
- breakdown maintenance.

Condition monitoring (preventive maintenance)

This is when equipment is regularly monitored and tested. When monitoring indicates that a breakdown is imminent, the equipment is repaired or replaced and any other specified maintenance procedures are carried out. Regular insulation testing and vibration testing are two forms of condition monitoring.

Condition monitoring is also carried out at fixed regular intervals. The aim is to forestall breakdown by predicting probable failure from the trend shown by the monitoring results.

The advantage of this type of maintenance is that equipment is not subjected to unnecessary maintenance.

Equipment is regularly condition monitored according to a monitoring schedule. Measurements are taken of insulation resistance, temperature and vibration (of motors). Contacts and other parts subject to deterioration are inspected.

All findings are recorded in an historical record file. No maintenance is carried out until the trend of test results indicates that it has become necessary. The equipment is then either replaced, repaired or subjected to a major overhaul.

A maintenance records system is required. The recorded measurements of insulation resistance may show a falling trend, indicating a progressive degradation of insulation. The equipment should be inspected and repaired before the insulation resistance falls to a dangerously low value.

Hot spot temperatures emitted from live electrical equipment can be monitored from a safe distance using an infrared detector or camera.

The recorded measurements of the vibration of a motor may follow a rising trend, indicating progressive bearing deterioration. Bearings must be replaced before failure occurs.

Planned maintenance (preventive maintenance)

This is when equipment is regularly inspected and maintained according to a manufacturer's timetable and procedures that specify the actual work to be done to prevent equipment failure.