Operating instructions for

Motor Checker EMC-11

Operating principle

EMC-11 provides a fast and easy means to detect electrical faults – short circuits, open circuits, damaged insulation etc. – in motors and other three-phase machines.

EMC-11 is used on stationary motors. **The motor has to be isolated from its power supply before testing.** There is no need to disconnect the supply cables provided the power is switched off. Readings should be taken on or close to the motor terminals.

The basic test can be made on site, without disconnecting the phase windings. Its main purpose is to find a possible fault, not to analyse its nature. On any three-phase machine, electrical faults can be detected by:

1. measuring insulation resistance to earth
2. measuring and comparing the resistance of the stator windings
3. measuring and comparing the inductance of the stator windings and the effect of the rotor position.

Test values are not required. Resistance and inductance readings are simply compared with each other. They should be equal, or differences should be within acceptable tolerance limits. Measurements should be made in the above order. The sequence can be interrupted as soon as a fault is detected.

Motors in good condition

On a motor in good working order, insulation resistance should exceed 2 MΩ. Balanced readings for winding resistance will indicate that all the coils in the stator are complete and that their insulation is not damaged. Balanced readings for inductance, which do not change with rotor position, show that all three stator windings are similar and that the rotor is undamaged.

Tolerances

There are no internationally agreed standards for acceptable and unacceptable conditions in electric motors. Tolerances on insulation, resistance and inductance vary between manufacturers and even between individual motors of the same type and size.

Up to 5 % difference between inductance and resistance readings on individual phase windings are normally acceptable even on smaller motors below 10 kW. Differences of 10 - 15 % will normally indicate faults even on large motors above 100 kW. Insulation resistances below 1 MΩ are regarded as dangerous. The motor should not be used.

Fault conditions

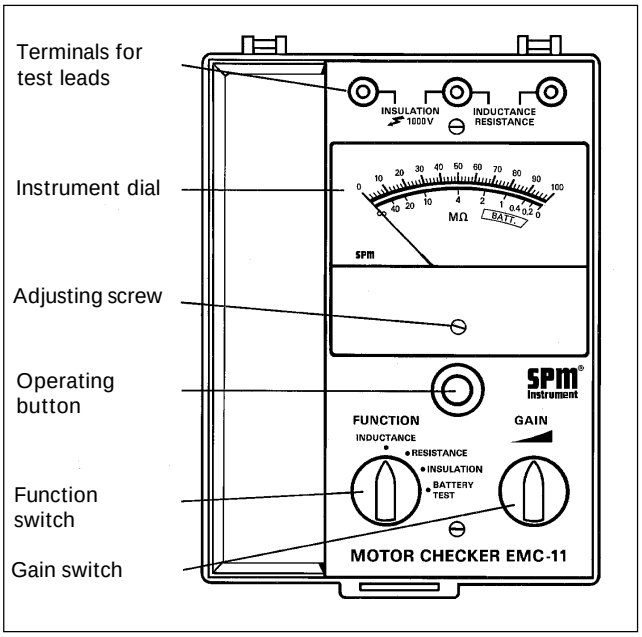
Due to the lack of standard values, fault condition is less easily defined than good condition. As a rule, if motor performance is below normal (long starting time, overload tripping, etc.), a difference of about 10 % in the resistance and/or inductance readings will indicate an electric fault in any motor. Smaller deviations, and the readings taken on motors "on the shelf" have to be judged by the user with regard to motor size, application and manufacturer's tolerances.

Note: Resistance and inductance readings on motors connected in star or delta will show approx. half the effect of a fault in a single winding. Thus, a spread of 5 % measured on a connected motor corresponds to a 10 % deviation of an individual winding.

Fault analysis

If required, the nature of a single fault can be determined by disconnecting, measuring and comparing individual phase windings.

Large differences in resistance only indicate an open circuit in one of several parallel coils which make up the stator windings, or high resistance in a contact before dismounting the motor.



Large differences in inductance only, are probably caused by an inter-turn short circuit in a stator winding. As the damage spreads, it will also affect resistance readings. A rotor fault will affect the inductance of the stator windings as the rotor position is changed.

The effect of several combined faults cannot be defined within the scope of this manual. Dismantle and examine the motor if there are large differences in resistances and inductance readings.

Using the instrument

Danger

- Switch off the power supply before testing.
- Insulation resistance is tested with 1000 V DC, max. current is 0.25 mA.

Battery test

Set the FUNCTION switch to BATTERY TEST. Press the red push button. The instrument needle should swing up and lie over the box marked BATT. If not, replace the batteries.

Test lead connection

When measuring, make sure there is good electrical contact between the clips and the motor terminals or earth point.

Test of insulation resistance

Set the FUNCTION switch to INSULATION. Connect the test leads to the terminals marked INSULATION 1000 V.

On star or delta connected motors, connect one test clip to a suitable earth point on the machine frame and the other clip to one of the supply terminals. Press the red push button. The insulation resistance to earth is displayed on the blue instrument scale.

Insulation resistance in excess of 2 MΩ are normally acceptable. Values below 1MΩ can be dangerous and the motor should not be used. In this case, further tests with EMC-11 are not necessary.

If stator windings are not interconnected, one can test the resistance to earth of each winding in turn, and also test the insulation between the windings.

NOTE: For battery test and insulation measurements the GAIN switch has no effect.

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Measuring and comparing resistance

Set the FUNCTION switch to RESISTANCE. Connect the test leads to the terminals marked RESISTANCE/INDUCTANCE.

On connected motors (star or delta): Connect the test clips to any pair of the supply terminals (U - V, V - W, U - W), as illustrated below. Press the red push button. Adjust the GAIN switch, to obtain the largest possible on-scale reading. Record the number shown on the red scale of the instrument dial.

Without altering the setting of the GAIN switch, repeat the procedure across the other two pairs of supply terminals.

Compare the difference between readings with the **lowest** of the resistance readings and check that it is within tolerances, see page 1.

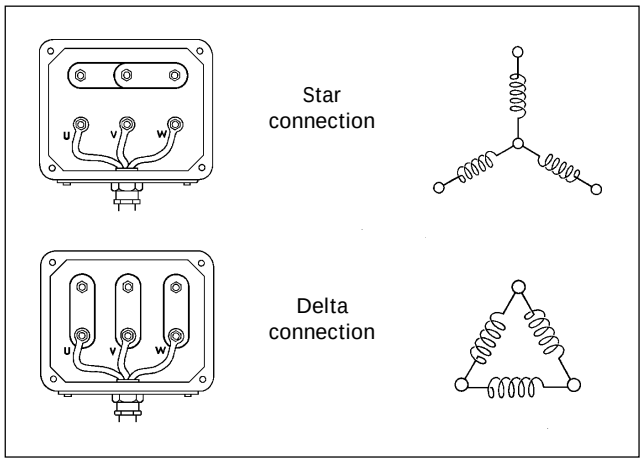
On disconnected motors: Connect the test clips to the phase winding terminals (U - U_1, etc.). Measure and compare. The difference of readings is about double of above.

Measuring and comparing inductance

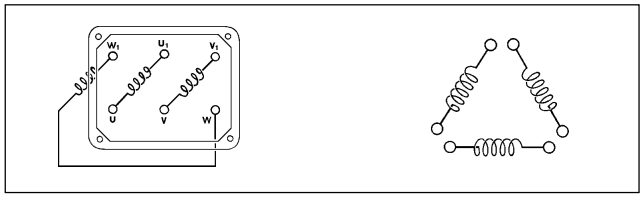
Leave the test leads connected to the terminals INDUCTANCE/ RESISTANCE. Set the FUNCTION switch to INDUCTANCE.

The rotor must be stationary while measuring inductance. The measuring procedure is the same as for resistance measurement. Adjust the GAIN switch to obtain the largest possible on-scale reading, but do not alter its setting between subsequent readings.

On connected motors /star or delta): Measure U - V, U - W, V - W. Compare the difference between readings with the **highest** of the inductance readings.



On disconnected motors: Measure U - U_1, V - V_1, W - W_1. Compare readings with the **highest** of the inductance readings and check if it is within tolerances. Equal readings, or small differences within tolerance limits, indicate that both stator and rotor are in good condition. If the motor condition is very suspect, turn the rotor approx. 90° and repeat the measurement.



Rotor test

Considerable differences between inductance readings can be due to either stator or rotor faults. A fault in one of the stator windings will show up as a difference in the reading for that winding as compared with the other two, independent of the rotor position. A rotor fault alters the inductance in any of the windings as the rotor position is changed.

Disconnect and measure across a single-phase winding (U - U1). Then turn the rotor 10 - 20° and measure again. Repeat this procedure several times, until it is certain that the readings either remain stable or considerably change with the rotor position.

A single fault in the rotor cause the needle to rise or fall **p** times per revolution, where **p** is the number of poles in the rotor. Small, regular variations in the readings are due to the position of the individual cage bars and can be disregarded.

NOTE: Do not measure while the shaft is being turned. Inductance readings should be taken only while the rotor is stationary.

Various applications

The measuring procedure as described above directly applies to squirrel cage induction motors, the most common motor type in industry. However, the measuring principle of comparing the resistance and inductance of individual windings can be applied to any three-phase machine which has a series of identical coils. This includes synchronous motors, transformers, generators, alternators, etc.

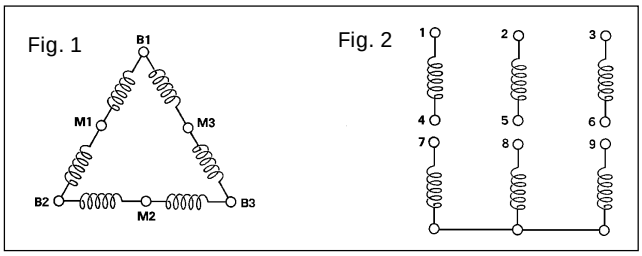
Wound rotor induction motors

Both the stator and the rotor of these motors can be tested following the standard procedures. Rotor winding resistance should be measured from the sliprings to avoid any inconsistency in the carbon brushes.

Multiple speed motors

Motors with any form of electronic speed control should be measured as the corresponding single speed motor, provided there is no shunt or series capacitance between the measuring point and the motor windings.

Motor speed can also be changed by changing the arrangement of several sets of windings. Figures 1 and 2 below show alternative means of producing different speeds. The motor in fig. 1 can be analysed as a single-speed motor in a delta connection, using terminals B1, B2, and B3. The motor in fig. 2 can be measured as a single-speed motor in star connection (terminals 7, 8, 9) plus three separate coils, measured individually across terminals 1 - 4, 2 - 5, and 3 - 6.



Power factor correction capacitors

Power factor correction devices should always be disconnected before the test. They will mask significant differences in measured inductance and therefore should not be retained in the measuring circuit.

Single phase motors

On commutator motors one can check the balance of the rotor and compare different rotor segments.

Changing batteries

The battery test is described on page 2. When the battery voltage is too low, the instrument needle fails to reach the box marked BATT.

In order to change batteries, snap open the battery cover at the bottom of the instrument. Use only 9 V alkaline cells, type IEC 6LF22. Remove batteries before storing the instrument for long periods. Leaking batteries can damage the instrument.

Technical data

Measuring range	
Inductance:	1 - 300 mH in 11 steps
Resistance:	0.2 - 60 Ω in 11 steps
Insulation:	0.2 - 40 MΩ at 1000 V DC, max 0.25 mA
Temperature range:	0° to +55° C
Batteries:	2 x 9 V, IEC 6LF22
Size:	195 x 135 x 75 mm
Weight:	1 kg

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