FLUKE®

For predictive maintenance, grab a 5 kV tester

Application Note

For general insulation testing you can't beat a handheld 1 kV insulation resistance tester (IRT) also known as a megohmmeter. They're lightweight, simple and in minutes can help you determine if you've got wiring errors or damaged installation.

Checking the integrity of insulation is not only a good idea for a new install, it's a tremendous tool in ongoing maintenance, allowing you to spot problem wiring before it creates arcing, damages equipment or shuts everything down. For this type of testing however, you should take a look at the flexibility and test functions of the new 5 kV testers that are now available, like the Fluke 1550 MegOhmMeter.

Five thousand volt IRTs allow you to test the insulation in medium voltage equipment. Even if you aren't regularly testing MV gear, these megohmmeters have test features that are worth a closer look.

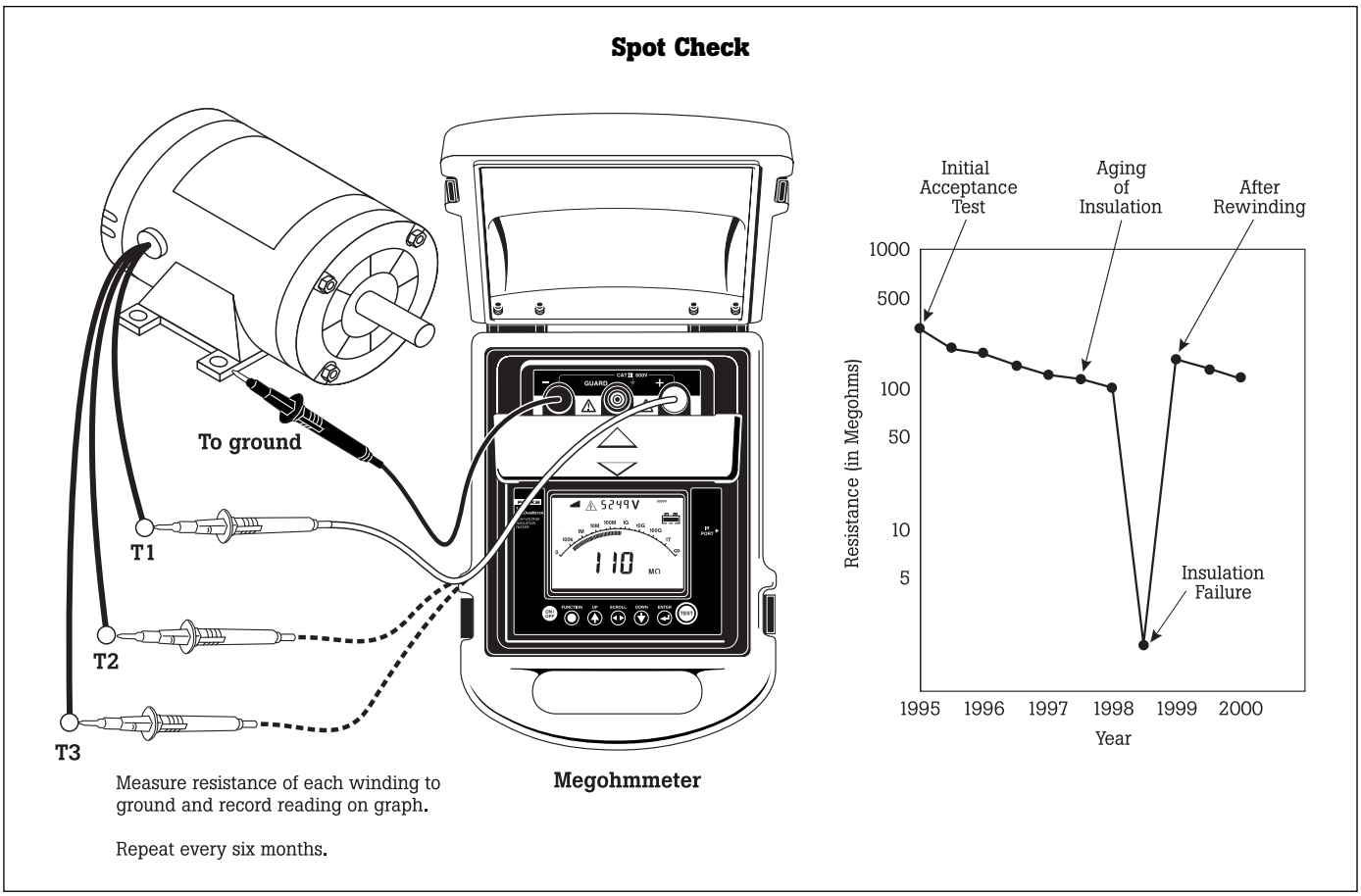
The principle of operation of IRTs is as basic as Ohm's Law: V=IR or R=V/I. The tester generates a known dc voltage (250 V, 500 V, 1k V or higher), chosen by the user, and measures the leakage current from the conductor through the insulation. The resistance is then calculated. The better the insulation, the lower the leakage current and the higher the amount of resistance present. For example, if 1000 V is applied and 1 mA measured, then R=1 MΩ. If only one-hundredth of that current, 10 uA, is measured, then R=100 MΩ.

The newest generation of IRTs are microprocessor-based and battery-powered. They are more precise than the older hand-cranked analog testers. However, many electricians still don't trust battery-powered IRTs, fearing the battery could fail at a crucial moment. To address this concern, the Fluke 1520 is equipped with four high capacity (C-cell) batteries, enough power for as many as 5000 tests. The Fluke 1550 is equipped with high capacity rechargeable batteries and has a mobile charging adapter for dc charging.

They also have battery life indicators so you know when the batteries are getting low. In addition, Fluke megohmmeters have two vital safety features not available on earlier generation insulation testers. First, since IRTs are designed to work on de-energized circuits, both the 1520 and 1550 detect live circuits. Second, they automatically discharge the residual voltage upon completion of the test.

For new installations, insulation testers are invaluable in conducting proof tests – checks for wiring errors and insulation damaged during installation. Without this test you take the risk of a hidden and potentially catastrophic phase-to-phase or phase-to-ground fault on start-up.

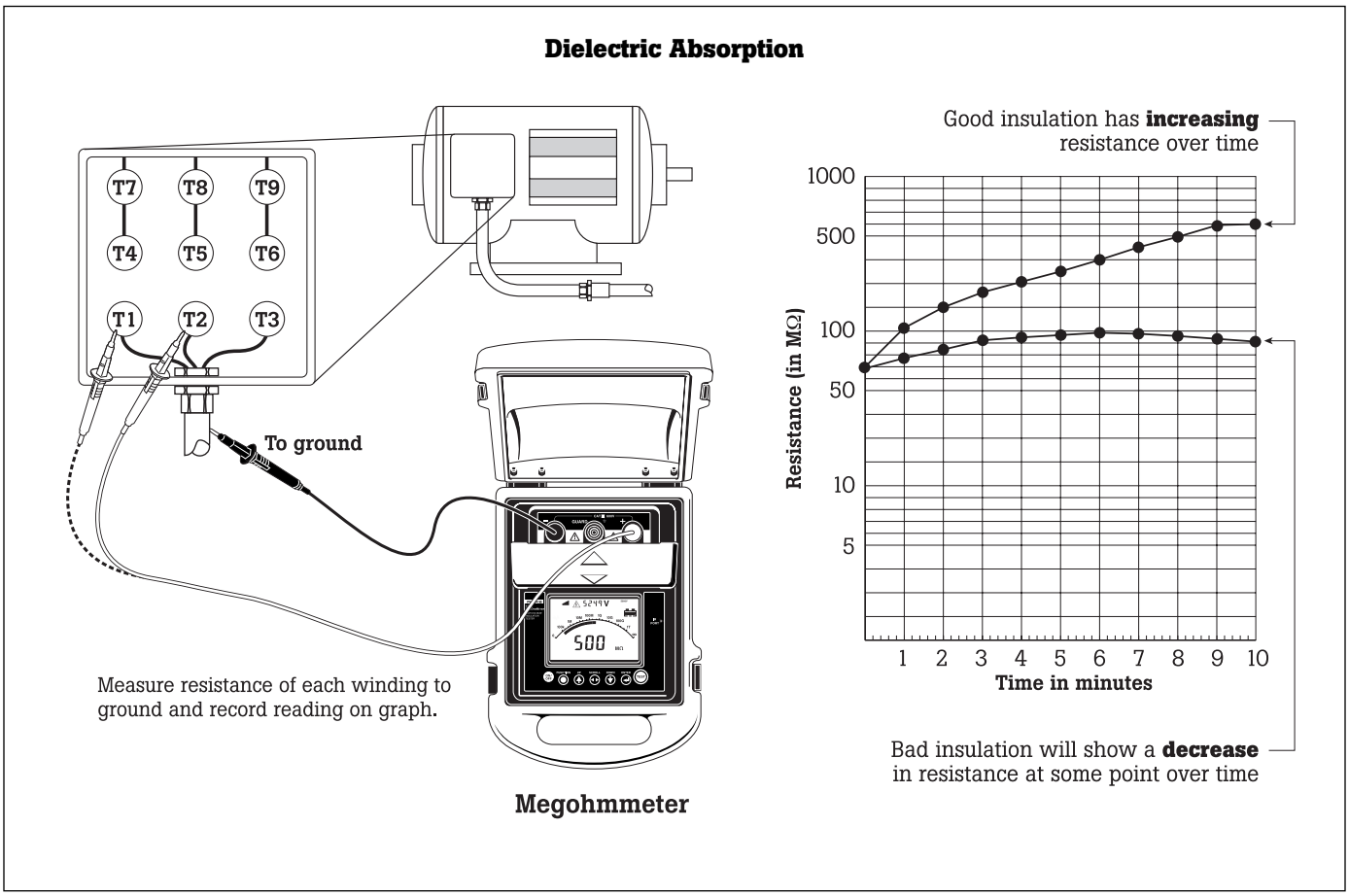
Unlike the one-time testing performed on an install, predictive maintenance requires a series of measurements that are recorded and compared at regularly timed intervals. Like many things in life, insulation goes bad over time. Stress factors like overloading and heating, vibration, excessive hot or cold temperatures, dirt, oil, chemical contaminants, and moisture conspire to rob insulation of its resistive power. Motors are especially vulnerable, since they are so often used in demanding environments.



Periodic spot check can be used for preventive maintenance, but must be adjusted for temperature and humidity.

The major challenge with taking readings at different times is that for comparisons to be valid, it is important that test conditions – temperature and humidity – be similar. Why? Because resistance decreases as temperature and humidity increase. Humidity can be recorded at the time of measurement for comparison, but the tougher task involves recording insulation temperature, which is more critical in getting an accurate reading. A quick way to determine the temperature of the insulating material is to use an infrared tester like the Fluke 61 or 65. The desired baseline temperature for measurement is 68 °F (20 °C). Double the R for every 18 °F/10 °C above this baseline and halve the R for every 18 °F/10 °C below it. For example, a 1 MΩ reading at 86 °F/30 °C will be the equivalent of 2 MΩ at 68 °F/20 °C. In the field, it's difficult to duplicate environmental effects, so derating becomes necessary, adding a further potential for error.

Newer 5 kV testers like the Fluke 1550 have an internal timer to help perform diagnostic and predictive maintenance tests that are independent of temperature and humidity effects. Timed tests make relative measurements during a single test session, when conditions remain the same, thus eliminating environmental variables. These tests are especially useful for high capacitance equipment like large motors or generators and long cable runs (low capacitance equipment includes busses, switchgear, short cable runs and small motors). The timed tests fall into two categories, time/resistance testing and ramp voltage testing.

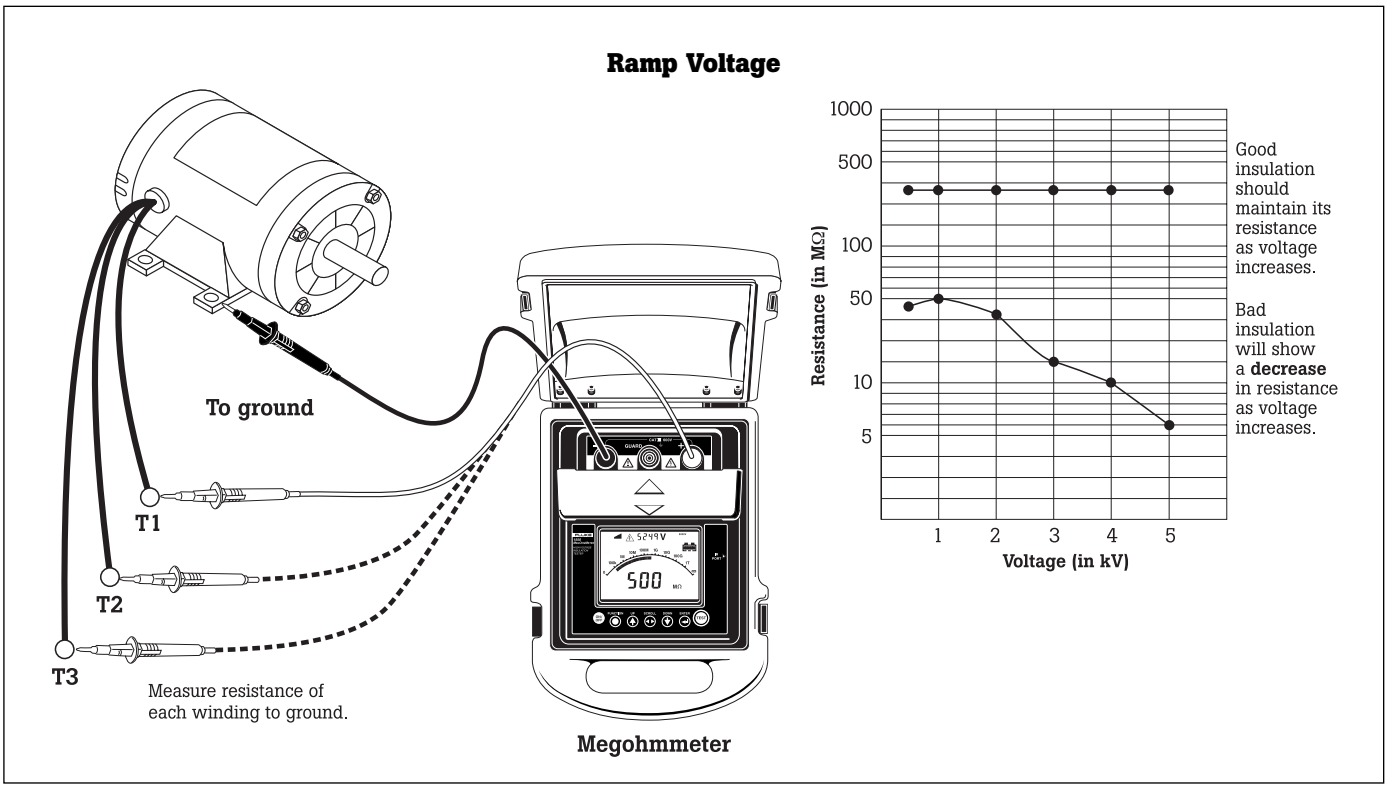


Dielectric absorption requires multiple measurements over ten minutes, but does not require adjustment for temperature and humidity.

Time-resistance tests

In time-resistance testing, it is the test voltage that stays constant, and the resistance readings that increase over time if the insulation is good. The Fluke 1550 has an internal timer that allows a constant test voltage (500 V, 1 kV, 2.5 kV or 5 kV) to be applied for a period of up to 99 minutes, though 10 minutes and less is typical.

Standard time-resistance tests include dielectric absorption and polarization index tests. Despite the fancy terms, the tests themselves are quite simple. The dielectric absorption test compares the ratio of two time-resistance readings, such as a 60-second and 30-second reading: The higher the ratio, the better the insulation. In general, a ratio above 1.4 to 1.6 indicates good insulation. The polarization index test is simply the same test taken at one minute and ten minutes. The ten minute resistance is divided by the one minute resistance. Ratios from two to four and above probably indicate good insulation. The polarization index test can be performed on new equipment to establish a baseline value and then periodically to help predict when equipment is starting to fail. If the index declines over time, it indicates deteriorating insulation. Note that the polarization index is a ratio, not an absolute measurement. By taking the ratio of two readings acquired under the same conditions, you cancel out the variables of temperature and humidity.



Step voltage or ramp voltage testing can find insulation prone to fail due to arcing.

Ramp voltage tests

While the previous tests applied a single test voltage over time, the ramp test applies an increasing voltage over time (this is typically done in five, one-minute increments). The 1550 can ramp up voltage on any of its ranges. In this case, we are not looking for the resistance to increase; good insulation should maintain its resistance reading. Bad insulation will decrease in resistance, and may even breakdown. A rule of thumb is that the resistance reading should not deviate more than 25 percent. If you use an insulation tester that does not have a voltage ramp function, a manual stop voltage test is a good alternative.

Each test has its strong points. The polarization index test is good at spotting moisture and contamination problems. These conditions allow leakage current to "track" over the surface of what should be insulators. The ramp test, on the other hand, is especially valuable for revealing physical damage problems, like pinholes or damage in brittle, aged insulation. Imperfections can result in arcing that only show up initially at higher voltages only.

Summary

The Fluke 1520 and 1550 can both perform spot tests on new and modified installations. These tests can be taken at regular intervals as part of a preventive maintenance program to trend the quality of insulation, but it is important to keep humidity and temperature of each test as constant as possible. Both are able to perform step voltage and timed tests. Newer generation 5 kV testers like the Fluke 1550, in addition to being able to test medium-voltage systems, include timers and ramp tests. Timed tests can yield important diagnostic and predictive maintenance information even under varying temperature and humidity conditions.

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