Less Is More For Electrical Test Instruments By: Jeff Jowett

A 21st century trend in electrical instrumentation has leaned toward smaller, lighter and easier to manipulate testers through microcircuitry. Being portable and easy to manipulate can be beneficial enough, but there's much more to it. Size reduction is not just for ease of manufacturing or an advertising gimmick. Multiple instruments can be combined into a single handheld tester, so that an entire job can be completed with a single piece of test equipment. The user can benefit from notable cost savings and job improvement. This article will examine how many of the functions found in multiple different instruments can be included in just one handheld tester.

Less Is More

Testing electric motors for repair, maintenance and installation can take up to six different instruments. There is added expense in acquisition, the time spent on the job changing from one instrument to another with attendant hookup and the possibility of traveling to a job only to find that one of the testers has been left. These instruments may have different degrees of accuracy, creating an added challenge to coordinating all results into a coherent picture for regulatory conformance or for the client. Similarly, there is often the requirement to record test results into a data base for personal use or submit them to a third party, and this can be inordinately complicated by multiple data bases. The much easier, safer and more reliable way to do things is to simply push the same button on a single instrument every time a test result must be recorded and send it all to a single file in a single operation. The costs and delays of annual calibration is significantly reduced when it can all be accomplished in one operation.

Safety First

A handheld instrument is the paragon of convenience, but ease of operation is further enhanced by bold and robust selector switches. Multifunction membrane switches are fancy and appear futuristic, but they're for the lab, not for the jobsite. Selector switches are clearer in function, less prone to operator error and can be manipulated even with safety gloves. But there is a safety consideration with handheld units that it is imperative to understand and observe. Small overall size condenses the distances between circuits and components, posing the threat of internal arcing under the impact of voltage spikes and faults on the utility serving the site. Not to worry. All quality instruments are protected from this danger by the IEC61010 rating. The rating tells the operator in what environment and on what operating voltage the tester can be safely used, without threat of arc flash/blast. Learn to interpret this rating and always apply it correctly to the job environment. If an instrument does not prominently indicate the IEC rating, don't buy it.



Figure 1 – Insulation testing is made easy by color coding and detailed results on display

Testing Insulation

An important and fundamental electrical test is the insulation test, and many models are built around this. The test applies a selected voltage across the insulation and measures how much...or, more practically, how little...current it pulls. This is converted by Ohm's Law into resistance. The unit of measurement is the Megohm, or one million ohms. Good insulation should not measure less than a Megohm.

There may be an exception for insulation that is buried inside additional layers, such as insulating varnish on motor windings. A good tester will have a sharp voltage rise up to full selected voltage by the time it reaches 1 $M\Omega$. Poorly designed testers will show a slower voltage rise, and this is deceptive because on the critical low end of the $M\Omega$ range, where equipment may be wearing out, the insulation isn't being fully stressed and the results can be misleading. An on-board thermocouple greatly increases the accuracy and effectiveness of these tests, as the measurements can be automatically corrected to a common temperature and entered in a data base. Temperature has a profound effect on insulation readings, but the tediousness of hand correction has often led to its omission.

Common Utility Voltage

Equipment running from common utility voltage...120, 240, 480...can all be tested with a 1 kV tester. Industry standard has been 500V for maintenance tests, 1 kV for troubleshooting that can pull arcs from damaged spots or further exploit other weaknesses. Testing can be

further refined with a top-of-line tester that has almost infinite voltage selection. These models can be set up in 1V increments across the range so that, for instance, 600V equipment can be tested at 600V, not 500V. Setup should also include a pass/fail buzzer, so that testing can speed up when merely meeting a compliance requirement.

Continuity

The opposite of insulation is continuity, so the two functions commonly come together. And they should. Continuity is a simple test, where low voltage and a small test current verify that circuits are intact and without wiring errors. But even this simple test can enjoy added advantages. Sophisticated testers show color coded lead hookup on the display, so that simple connection errors are generally the result of haste and are spotted and corrected without additional error or test time. Uni- and bi-directional testing without having to switch leads, combined with a diode test, allows for quick proofing of startup circuits and the like.

There's More to Low Resistance Testing

However, there's more to low resistance testing than basic continuity. The ability to pass a milli-amp or two only establishes contact. It doesn't prove that a connection can perform its function well, such as by producing excessive heat or vibrating loose. Genuine Kelvin bridge measurements below 1Ω with a robust current and micro-ohm resolution have traditionally called for a separate tester, with two current terminals on the outside and two potential terminals on the inside, that did nothing else. Full-featured motor and electrical testers now include this feature, with test currents of 0.1



Figure 2 - Motor hookup is facilitated by on-screen guidance

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Figure 3 – Clearly marked selector switches and color coding help to eliminate operator error

A and measurement to 1 m Ω with 0.01 m Ω resolution. This enables the operator to spot joints and connections that are in process of weakening well before they become a problem. Graphic displays again show correct setup and bi-directional testing can be done from the front panel without physically switching leads.

Motor Rotation Is Important

An important but overlooked function on electric motors is motor rotation. Traditionally, this requires a separate piece of equipment; often a small, handheld item easily left behind. Now, this function can be included in a multifunction tester. Again, a sophisticated display can show the operator the lead setup and then a manual turn of the shaft will indicate if the connections are correct for that rotation (L1 L2 L3). AC/DC voltmeter and frequency measurement facilitate correct supply connections for desired shaft rotation. A built-in LCR meter measures inductance, capacitance and resistance, for more advanced troubleshooting in components such as motor and transformer windings. A sophisticated tester will further assist troubleshooting by determining the principal component of the load free of operator involvement and posting that measurement to the display.

Test Leads Are Important

Test leads are an indispensable part of electrical testing, and as often overlooked as they are important. They become worn and, without damage being noticeable to the eye, can 'leak'. Manipulating the leads should not affect the reading on the display, nor should squeezing them together. Modern testers minimize potential lead errors with color displays. A color display isn't just for looks. It can guide the operator by color coding with the leads and specific functions, cutting down or eliminating incorrect hookups that can be costly in time, accuracy and reliability.

Additional Safety Features are Necessary

With so many functions, all-in-one testers should include redundant safety features. In addition to those already mentioned there should be automatic discharge of stored charge on the test item, live voltage warning, test inhibition in the presence of extraneous voltage, and terminal lockout voltages. This latter protection permits testing to proceed in the presence of harmless low voltages, such as crosstalk in telecom, while still safely blocking test initiation at higher voltages.

A wise man once observed that time is money, and that is certainly true in electrical maintenance, installation and repair. A compact, multi-function test instrument can save test time while preventing costly errors and saving data for future comparison. Not only electric motor testing, but general maintenance, prevention

and troubleshooting of the entire electrical plant can be implemented. All operations can be performed well and accurately, without compromising the quality of results you would get from dedicated instruments.

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Jeff has 40+ years continuous employment, beginning with James G. Biddle Co., then Biddle Instruments, then AVO International, and now Megger. Last 25 years in Marketing Dept., Distribution Sales.

Jeff has written numerous trade journal articles, conducted training of distributors' sales staffs and customers, and given seminars, training sessions and talks to various electrical societies [including Nat'l Electrical Testing Ass'n (NETA) and Nat'l Joint Apprenticeship Training Committee (NJATC)], and to those open to the general industry public.

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