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Debunking the repetitive strike test for surge protective devices

Overview

The repetitive strike test produces test results to identify the life expectancy of a surge protective device (SPD), as well as electrical durability and assembly quality. The theory is that an SPD must be capable of enduring multiple strikes and continue to function properly without degradation while providing protection to the system on which it is installed.

Debunking the test

There are some expected similarities with the repetitive strike test across the industry, however, there is no standard that dictates the parameters in which this test is to be performed. Currently there are no specifications that dictate the way the repetitive strike test is to be performed nor is there existing industry standards to designate pass/fail criteria of this test. Without a widespread accepted methodology for the repetitive strike test, customers should not have confidence in comparing the results of two manufacturers.

The results of the repetitive strike test will vary depending on several factors that could alter the results of the test. One of these factors is the setup of the test as the lead length, probe locations, and impedance on the wire lines may differ from test to test. These factors have an impact on the number of repetitive strikes the unit can endure—for example, increasing the wire impedance will affect the result by minimizing the energy shunted to ground, thus increasing the number of repetitive strikes that are reported.

Another factor that can alter the results of the repetitive strike test is the resting period between strikes induced to a unit. This is not a dictated standard and will vary the test results drastically; a longer time duration between strikes will produce better results because the metal oxide varistors (MOVs) are given time to reduce their temperature between strikes.

In most cases, the repetitive strike waveform is typically IEEE® Category C, high 20 kV (1.2 µsec/50 µsec) open circuit and 10 kA (8 x 20 µsec) short circuit, assuming a 2 ohm impedance for the generator. This waveform is applied between the line conductors and the neutral-and-ground conductors. Unless the waveform equipment is calibrated or guaranteed to run at the nominal point of the waveform, the actual waveform sent to the unit could be on the low or high side of the sine wave, ultimately impacting the number of repetitive strikes the unit can take. Additionally, there is no identification as to how the waveform will be applied to the SPD. The waveform could be induced on one mode at a time (for example A–N) or the waveform could be applied to all modes at once. This will affect the results as the same waveform would be dissipated across a different amount of MOVs.

Specifying durability

Any Nationally Recognized Testing Laboratory (NRTL) can test and list SPDs to be compliant with any standard, however, to keep it simple, this explanation will refer to the UL® NRTL. The UL Listed label ensures customers that they are selecting an SPD that has passed stringent UL safety requirements. More specifically, UL 1449 is geared toward the standards and safety for SPDs. The UL 1449 nominal discharge current rating, or I_n, offers a relative performance guide for all SPDs with the UL 1449 listing. This has a rigid set of parameters including the test requiring 6 inches of wire length from the product, and the generator must be adjusted to account for product impedance and force the peak current test level through the unit.

For type 1 applications, UL tests with either 10 kA or 20 kA current. For type 2 applications, UL can test with 3 kA, 5 kA, 10 kA, or 20 kA current. The manufacturer chooses what current they would like to use to test their product. With the test setup listed above, the SPD is subjected to 15 surges that are one minute apart at the chosen current, with the rated voltage applied between surges. The measured let-through voltage is recorded with each surge and must not deviate more than 10% from the original voltage. After 15 surges, the device must be fully functional for the nominal discharge current rating to be assigned.

The results of this test provide a measure of durability for an SPD. The higher the I_n value, the more energy the SPD is able to handle from a surge. Using the formula Energy = I^2R, we find that an SPD with I_n = 20 kA can handle four times the energy of an SPD with I_n = 10 kA. It is no wonder why the standards for installing lightning protection systems, UL 96A and NFPA® 780, require a 20 kA nominal discharge current rating; surge devices with I_n = 20 kA have the best durability.

Example: comparing results

Let's compare an integrated SPD from Manufacturer A vs. an externally mounted SPD from Manufacturer B. Both units are rated at 120 kA surge rating and 600 V delta configuration. However, the SPD from Manufacturer A has I_n = 20 kA and the SPD from Manufacturer B has I_n = 5 kA. Both units are rated for the same application but the SPD from Manufacturer A can handle 16 times the amount of energy from surges that the SPD from Manufacturer B can handle. The unit from Manufacturer A is more durable. Additionally, the voltage protection ratings from Manufacturer B will likely be higher, indicating higher let-through voltage to the system.

Conclusion

The repetitive strike test doesn't provide adequate information for a consulting engineer to specify a value to compare amongst manufacturers. The test needs to have a set of standards for comparisons to be made. Until those standards are established, the nominal discharge current rating gives the best insight to the durability of an SPD.

Contact Eaton's industrial surge department at 1-800-647-8877 to discuss our surge protection options.

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