SIEMENS

TechTopics No. 108

Lightning-impulse (BIL) ratings for medium-voltage controllers

The standard for medium-voltage controllers, UL 347, specifies the required dielectric-withstand voltage values for the controllers. For controllers rated over 3.6 kV up to 7.2 kV, UL 347 specifies that the lightning-impulse withstand voltage should be either 45 kV or 60 kV. For controllers rated 1,500 V to 3,600 V, UL 347 specifies values of 30 kV or 45 kV.

The SIMOVAC™ medium-voltage controllers have a rated lightning-impulse (BIL) voltage of 60 kV for equipment up to 7.2 kV.

Users have asked Siemens to explain why the dielectric-withstand voltage values for medium-voltage controllers do not match those of metal-clad switchgear. For metal-clad switchgear up to 4.76 kV, the impulse rating is 60 kV, while for switchgear over 4.76 kV up to 15.0 kV, the impulse rating is 95 kV.

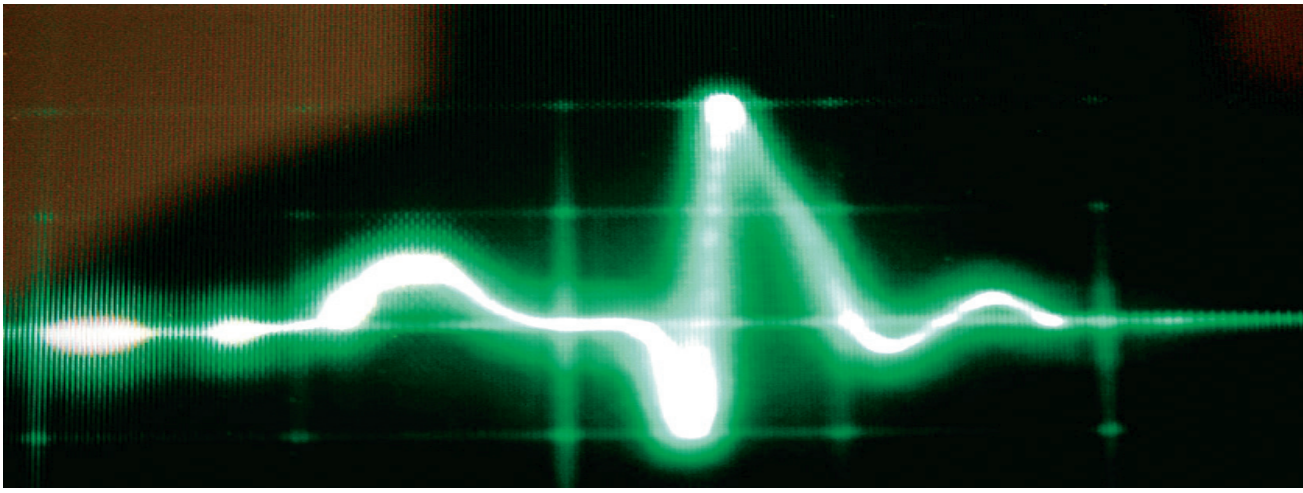
The simplistic answer is that the standards for switchgear are created in the IEEE Power & Energy Society's Switchgear Committee, while those for medium-voltage controllers are made in working groups operating under the procedures of UL. While this is valid, the real reason that the values differ is that the two types of equipment are intended for different applications.

To examine this, first consider the requirements for the medium-voltage controllers. The standard for controllers is UL 347, which is also an ANSI standard. For both medium-voltage controllers and for medium-voltage, metal-clad switchgear, if the equipment is subject to exposure to lightning or transient voltages that exceed the capabilities of the equipment, surge arresters (lightning arresters) should be applied either in the equipment, or externally where the exposure to lightning strikes is most significant.

Now consider the application. Medium-voltage controllers are most often used to control rotating machines (motors). Motors do not have an impulse rating since their windings are embedded directly in the core steel. However, an approximation can be made of what the impulse capability of a motor might be by referencing some historic papers and guides.

An IEEE working group of the insulation subcommittee of the rotating machinery committee suggested that the approximate impulse capability of motors is 125 percent of the crest value of the motor's power frequency (60 Hz) one-minute, high-potential test voltage. For a 4.0 kV motor, the crest value of the test voltage is 12.73 kV, while for a 6.0 kV machine, it is 20.1 kV. Using the estimated factor of 125 percent shown in IEEE 141, the equivalent calculated impulse capabilities would be 15.9 kV for the 4.0 kV machine, and 25.1 kV for the 6.0 kV machine. These values were not proposed as requirements for motors, but rather, as a comparative value for use in insulation coordination studies and the application of surge arresters for motor protection.

The values computed by the rotating machines working group are not requirements for motors and are merely calculated values suggested for use in insulation coordination studies. So the values of 15.9 kV for the 4.0 kV motor, or 25.1 kV for the 6.0 kV motor may not be the correct values for impulse capability of a machine. However, one suspects that the real capabilities of the machines would not be significantly different from those suggested by the working group.



If these values are compared to the 60 kV impulse rating of SIMOVAC controllers, the values for the controllers are far in excess of the dielectric capabilities of the machines they protect. Thus, the conclusion follows that the impulse-withstand capabilities of medium-voltage controllers are tailored to the application to motor starting and clearly appropriate for the equipment.

Reference:

- IEEE Transactions on Power Apparatus and Systems, Vol. PAS-100, No. 8, August 1981, “Impulse Voltage Strength of AC Rotating Machines”.

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