MODERN SURGE TESTING WITH COMBINATION V/I WAVES

Introduction

The conventional practice of applying separate procedures to test for equipment (EUT) failure caused by spike surges does not account for all possible cases of surge-generated failures. EUT impedance levels had been determined, heretofore, as a preliminary to testing, to allow operator selection of a voltage or a current surge (e.g., high for insulation, low for arresters). EUT systems with an ac connection produce both high *and* low impedances during the same surge (resulting from flashover or arrester performance), a phenomenon which sequential test procedures are unable to deal with.

New single-output surge generators have been developed which respond immediately to the input impedance of the circuit or system under test. This article discusses such generators.

Surge testing evolved in the high-voltage laboratory as a method of testing either insulation or surge arresters.

For insulation, a 1.2 x 50 μs high voltage wave (Figure 1) was applied to the test piece.[1] Only milliamperes were available from the surge generator, but that was sufficient: either the insulation flashed over or it didn't.

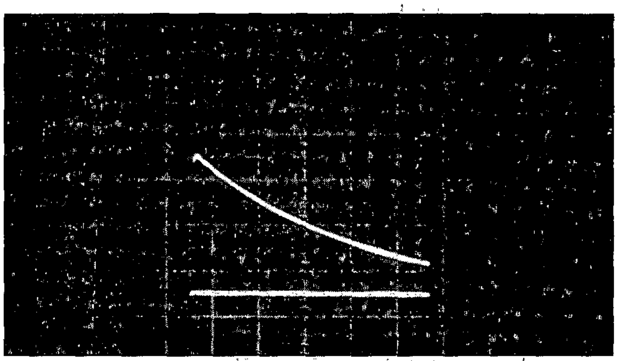

Figure 1. Typical 1.2 x 50 μs Open-Circuit Voltage Surge Waveform (1 kV/small div, 10 μs/small div).

On the other hand, for a power transmission or distribution arrester, tests were designed in such a way as to force a 8 x 20 μs current wave (Figure 2) through the device under test, using thousands, or even tens of thousands of amperes.[1] The resulting voltage developed across the device was then measured.*

With modern electronic circuits and systems, however, these traditional surge test impedance concepts can be misapplied. To understand this, it is necessary to review the power-line surge environment, as well as surge input characteristics of typical electronic systems.

*This is the origin of the 1.2 x 50 μs surge waveshape. When the thyrite material used for arresters was driven from an 8 x 20 μs current source, it developed a voltage in the form of the 1.2 x 50 μs wave.

This paper is an adapted version of "Single Output, Voltage and Current Surge Generation for Testing Electrical Systems" *by P. Richman which appears in the IEEE 1983 INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY, Arlington, VA, August 23-25, 1983, pp. 47-51.*

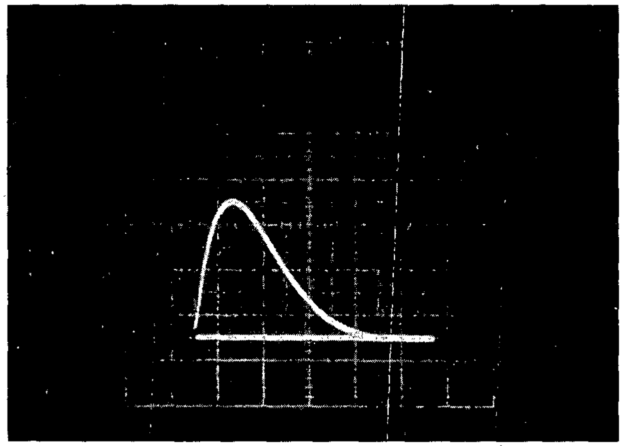

Figure 2. Typical 8 x 20 μs Short-Circuit Current Surge Waveform (500 A/small div, 5 μs/small div).

Power-Line Surge Environment

IEEE Std 587-1980 characterizes the surge environment at various locations on the ac power line.[2] Two primary locations are identified. Category A represents long-branch circuits, i.e. the typical wall socket. Category B is the designation for short-branch circuits, i.e., for higher-power systems, either located at short wiring distances from the breaker box or distribution panel, or driven directly from them via heavy runs. Examples include large computers and industrial lighting systems.

For each category, open-circuit voltage and short-circuit current waves are specified in IEEE 587. Both categories A and B require the open-circuit "ring" wave of Figure 3, a 100 kHz cosine, with 0.5μs rise time and Q of approximately 3. The maximum peak voltage required for worst-case locations is 6kV. Category A calls for a corresponding worst-case short-circuit current of 200 A, while category B specifies 500 A.

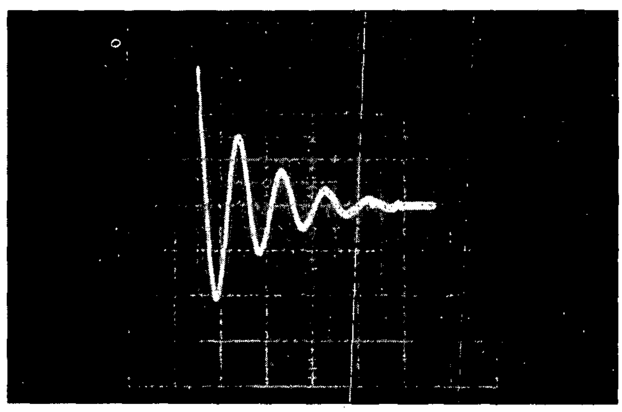

Figure 3. Typical 100 kHz Cosine "Ring" Wave (1kV/small div, 5 μs/small div).