

American National Standard

guide for
surge withstand capability
(SWC) tests

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IEEE Guide for Surge Withstand Capability (SWC) Tests

1. Introduction

1.1 General. The insulation characteristics of protective relays and their associated auxiliaries have been the concern of relay engineers since the early 1920's. Until about 1954, relays utilized principally electromechanical construction. Some investigations were made during this period on the effects of surges on these relays. This has been reported in the literature.

The development of the transistor resulted in semiconductor components being used in both relay and communication equipment. Field experience indicated that these components are sensitive to certain electrical surges. Since about 1960, considerable amount of investigation has been done relating to the nature of these surges and methods for their control in relation to static relaying. The results of some of these studies are given in Refs [4] through [17]. These investigations and others were used as a basis by the IEEE Relay Committee's Working Group on Static Relay Surge Protection to develop the surge withstand capability (SWC) test for relays.

1.2 Surge Withstand Capability (SWC). The surges and how they relate to protective relay schemes can logically be divided into two general categories; first, the control of the surges presented to the relay systems, and second, the ability of the relay systems to withstand the surges. The surges presented to the relay systems can be generated either within the circuits to the system or induced into the circuits. Certain construction practices can be followed which will minimize the surges impressed upon the relay.

Further discussion here is based on the premise that steps have been taken in the de-

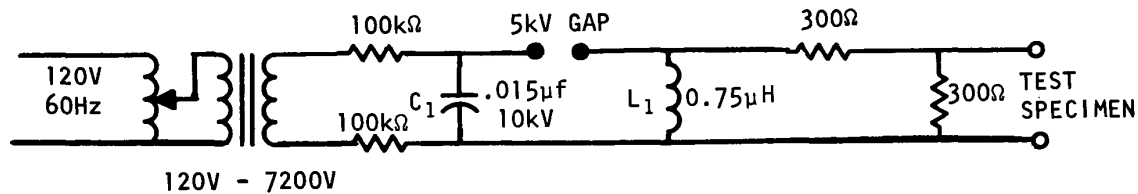
sign of the circuits to minimize surges. In brief, both the user of static relay equipment and the manufacturers each have a given area of responsibility relating to surge protection of relay schemes. The literature presently contains many discussions of the methods of limiting the surges to which the relay systems are exposed (see Refs [4] – [6] and [12]). Based on the data presented in the above references and in other unpublished data, the working group of the IEEE Power System Relaying Committee has proposed a definition of an SWC test for relay systems which is as follows.

2. Definition of SWC Wave Shape and Characteristics

The SWC test wave is an oscillatory wave, frequency range of 1.0 MHz to 1.5 MHz, voltage range of 2.5 kV to 3.0 kV crest value of the first half cycle peak, envelope decaying to 50 percent of the crest value of the first peak in not less than 6 μ s from the start of the wave. The source impedance of the surge generator used to produce the test wave shall be 150 Ω . The test wave to be applied to a test specimen at a repetitive rate of not less than 50 tests per second for a period of not less than 2.0 seconds.

NOTE: (1) All voltage and time values refer to the open circuit condition of the surge generator. (2) Time period and repetition rate have been chosen to cover equipment which is used on 50 Hz as well as 60 Hz systems.

The test is a design test for relay systems, in particular, static relay systems. A schematic diagram of a typical surge generator is shown in Fig 1.



$T \cong 6-10\mu s$ to 1/2 value
 C_1 = Mica type
 $L_1 \cong 3$ turns no 9 wire on 2½ in diameter form

Fig 1
Typical SWC Test Circuit

3. Equipment to Be Tested

Equipment to be subjected to the SWC test is described below in general terms and is shown in Figs 2 and 3. Because of changes in relay engineering nomenclature, equipment definitions in this section illustrate by example the intent of this guide.

3.1 General. Transient voltages usually are capacitively or magnetically coupled from a high voltage source of electrical noise into secondary circuits or control wiring. Since these voltages may appear unsuppressed across connection points of components associated with the protective relay system, it must be determined that they will not cause a failure or a misoperation of the system.

3.2 Nomenclature and Definitions

3.2.1 input current circuits. An input circuit, to which is applied either a voltage or current which is a measure of primary current.

3.2.2 input voltage circuit. An input circuit to which is applied either a voltage or a current which is a measure of primary voltage.

3.2.3 measuring units and relay logic. Analog or digital devices which analyze the input currents and voltages to determine the immediate status of that part of the power system that they were installed to protect and to provide the control signal to trip circuit breakers.

3.2.4 communications interface equipment. A portion of a relay system (shown in Fig 2) which transmits information from the relay

logic to a communications link, or conversely to logic, for example, audio tone equipment, a carrier transmitter-receiver when an integral part of the relay system.

3.2.5 communications link. Any of the communications media, for example, microwave, power line carrier, wire line.

3.2.6 computer interface equipment. A device which interconnects a protective relay system to an independent computer, for example, an analog to digital converter, a scanner, a buffer amplifier.

3.2.7 relay system. An assembly usually consisting of measuring units, relay logic, communications interfaces, and necessary power supplies (as shown in Fig 2 or 3). The communications link is not considered as a part of a relay system.

3.2.8 signal circuit. Any circuit other than input voltage circuits, input current circuits, power supply circuits, or those circuits which directly or indirectly control power circuit breaker operation.

3.2.9 output circuit. An output from a relay system which exercises direct or indirect control of a power circuit breaker, such as trip or close.

3.2.10 power supply circuit. An input circuit to a relay system which supplies auxiliary power for the proper functioning of the relay system.

3.2.11 common mode voltage. The voltage common to all conductors of a group as measured between that group at a given location and an arbitrary reference (usually earth).