



IEEE Guide for Fault-Locating Techniques on Shielded Power Cable Systems

IEEE Power Engineering Society

Sponsored by the
Insulated Conductors Committee

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IEEE Power Engineering Society**

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Abstract: Tests and measurements that are performed on shielded power cables to identify the location of a fault are described. Whenever possible, the limitations of a particular test and measurement to locate a fault are provided and recommendations are made regarding specialized fault-locating techniques. A fault characterization chart is included as an aid to select a fault-locating technique.

Keywords: arc reflection, cable fault locating, cable testing, grounding, safety, sectionalizing, thumping, time domain reflectometry (TDR)

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Introduction

This introduction is not part of IEEE Std 1234-2007, IEEE Guide for Fault-Locating Techniques on Shielded Power Cable Systems

Many fault-locator personnel are experienced in locating short and open circuits on shielded power cables. Proper locating of high-resistance or intermittent cable faults, which are the majority of the faults on cables with extruded dielectric insulation, is considered tedious, inconsistent, and time-consuming. Therefore, re-closing, re-fusing, burning, and thumping at unnecessarily high voltage and energy levels, in order to generate an open or short circuit, are frequently used without consideration of cable and equipment properties. The danger of activating dormant faults, generating new faults, or damaging utility and customer equipment by improper locating methods is not always recognized.

By establishing cable fault-locating guidelines and training programs that incorporate recommended cable fault-locating measurements and techniques, cable owners can realize substantial savings in manpower and cable and equipment replacement, and minimize losses from customer outages.

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IEEE Guide for Fault-Locating Techniques on Shielded Power Cable Systems

1. Overview

1.1 General

This guide has been developed as a guide for cable fault-locating techniques on shielded power cable systems. It is intended to emphasize those fault-locating techniques that maintain cable integrity, reduce customer outage time, and consider customer equipment sensitivity and safety. This guide applies to all insulated, shielded power cable systems.

1.2 Scope

The introduction of cables with extruded dielectric insulation and of modern splicing technology has imposed new conditions and restrictions on cable fault locating. The use of excessive high voltages and energies during ac, dc, and surge testing of service-aged power cable systems with extruded dielectric insulation may overstress insulation, creating defects that become faults after the cables are returned to service.

This guide is intended to be applied to medium-voltage distribution cables. Medium-voltage distribution systems generally operate at system voltages above 1 kV and up to 34.5 kV nominal.

The end user of the cable circuit should evaluate the necessity for verifying the integrity of extruded dielectric insulated cables, and, if they are in critical service, proceed to perform the high-voltage/energies testing. If not detected during dielectric tests, defects in dielectric materials may result in cable failures during the transient voltage surge episodes while in service.

1.3 Purpose

This guide is intended to provide trouble-shooting and testing personnel with information to quickly identify a faulted cable section and/or locate a cable fault with minimum risk of further damaging serviceable cables, terminations, and equipment.

2. Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 510™-1983, IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing (Reaff 1992).^{1,2,3}

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this guide, the following terms and definitions apply. *The Authoritative Dictionary of IEEE Standards*, Seventh Edition [B9]⁴, should be referenced for terms not defined in this clause.

3.1.1 aerial installation type: An assembly of insulated conductors installed on a pole or similar overhead structure; it may be self-supporting or installed on a supporting messenger cable.

3.1.2 bolted fault: A cable fault having a resistance value of less than 5 Ω .

3.1.3 branch circuits: A cable system in which independent cables branch out radially from a common source of supply. (See also: **radial feed**)

3.1.4 breakdown: A disruptive discharge through insulation.

3.1.5 cable tray installation type: A structure of ladders, troughs, channels, solid bottom, and other similar devices through which cables systems may be routed.

3.1.6 characteristic impedance: The driving impedance of the forward-traveling transverse electromagnetic wave. In cable fault locating, an incident wave on a cable (time domain reflectometer [TDR], thumper, etc.) is reflected back to the source positively, negatively, or not at all by discontinuities and inhomogenities in the cable where impedance values differ from the characteristic cable impedance, respectively.

3.1.7 concentric neutral shield (metallic shield type): Wires helically applied over the semi-conducting insulation shield to carry charging, fault, and neutral currents.

3.1.8 conduit installation type: A structure containing one or more ducts.

NOTE—Conduit may be designated as iron pipe conduit, tile conduit, etc.

3.1.9 direct buried installation type: Cable laid in a trench or pre-cast trough and covered with sand, specially prepared backfill material, and/or excavated material; or, cable plowed directly into the earth or installed into the earth with guided boring techniques.

3.1.10 direct distribution: A primary feeder or cable that supplies energy directly to a consumer.

3.1.11 drain wires shield (metallic shield type): Wires helically applied over the semi-conducting insulation shield to carry charging currents only.

3.1.12 extruded dielectrics: Insulation like polyethylene (PE), crosslinked polyethylene (XLPE), tree retardant crosslinked polyethylene (TR XLPE), ethylene propylene rubber (EPR), etc.

3.1.13 flashover: A disruptive discharge through air around or over the surface of a solid or liquid insulation, between parts at different potential, produced by the application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc.

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³ IEEE Std 510-1983 has been withdrawn; however, copies can be obtained from Global Engineering, 15 Inverness Way East, Englewood, CO 80112-5704, USA, tel. (303) 792-2181 (<http://global.ihs.com/>).

⁴ The numbers in brackets correspond to those of the bibliography in Annex A.