

An American National Standard

IEEE Guide for the Protection of Shunt Reactors

Sponsor
**IEEE Power Systems Relaying Committee
of the
IEEE Power Engineering Society**

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Abstract: ANSI/IEEE C37.109-1988 *IEEE Guide for the Protection of Shunt Reactors*, discusses the protection of shunt reactors used typically to compensate for capacitive shunt reactance of transmission lines. The more common circuit arrangements and protective relaying schemes presently in use are discussed and illustrated.

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Foreword

(This Foreword is not a part of ANSI/IEEE C37.109-1988, IEEE Standard Guide for the Protection of Shunt Reactors.)

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IEEE Guide for the Protection of Shunt Reactors

1. Introduction

This guide covers protection of shunt reactors used typically to compensate for capacitive shunt reactance of transmission lines. A survey of shunt reactor protection, conducted in 1979 by the Shunt Reactor Protection Working Group of the IEEE Power System Relaying Committee, was used as a reference to determine the more common circuit arrangements and protective relaying schemes presently in use.

Other arrangements or special applications of reactors such as harmonic filter banks, static var compensation (SVC), high voltage direct current (HVDC), or current-limiting reactors are not specifically addressed; however, the protective methods described in this guide are usually applicable to this equipment.

2. References

This guide shall be used in conjunction with the following publications:

- [1] ANSI/IEEE C57.21-1981, Requirements, Terminology, and Test Code for Shunt Reactors Rated Over 500 kVA.¹
- [2] ANSI/IEEE C62.2-1987, IEEE Guide for Application of Gapped Silicone Carbide Valve-Type Surge Arresters for Alternating-Current Systems.
- [3] ANSI/IEEE C62.11-1987, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits.
- [4] ASEA Electric *Recommendations for Protective Relays*, Pamphlet ZF27-004E Reg. 4771. ASEA Brown Boveri, Protective Relay Division, Allentown, PA, 1985.

¹ANSI/IEEE publications are available from the Institute of Electrical and Electronics Engineers, Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, or the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10018.

- [5] EDWARDS, L., CHADWICK, J. W., JR., RIESCH, H. A. and SMITH, L. E., Single-Pole Switching on TVA's Paradise-Davidson 500-kV Line Design Concepts and Staged Fault Test Results, *IEEE Transactions on Power Apparatus and Systems*, Vol PAS-90, Nov./Dec. 1971, pp. 2436–2450.
- [6] ENGELHARDT, K. H., EHV Line-Connected Shunt Reactor Protection Application and Experience, *International Conference on Large High-Voltage Electric Systems, C.I.G.R.E.*, Paris, France, paper No. 34-09, 1984.
- [7] KIMBARK, E. W., Suppression of Ground-Fault Arcs on Single-Pole Switched EHV Lines by Shunt Reactors, *IEEE Transactions on Power Apparatus and Systems*, Vol. 83/No. 3, Mar. 1964, pp 285–290.
- [8] PICKETT, M.J., et al, Near Resonance Coupling on EHV Circuits, *IEEE Transactions on Power Apparatus and Systems*, Vol PAS-87, Aug. 1967, pp 322–325.
- [9] Power System Relaying Committee Report. Shunt Reactor Protection Practices. *IEEE Transactions on Power Apparatus and Systems*, Vol PAS-103, Aug. 1984, pp. 1970–1976.
- [10] S&C Electric Company, Chicago, IL. *RD-3221 Operating Description*, Aug. 1985.
- [11] Trench Electric, Toronto Ontario, Canada. *Shunt Reactor Bulletin T100-35-02I*, May 1984.

3. Use of Reactors

Shunt reactors are used to provide inductive reactance to compensate for the effects of high charging current of long transmission lines and pipe-type cables. For light load conditions, this charging current can produce more leading reactive kVA than the system can absorb without risk of instability or excessively high voltages at the line terminals.

4. Typical Reactor Protection

Two basic shunt-reactor configurations are considered:

- 1) Dry-type, connected ungrounded wye which are connected to the impedance-grounded tertiary of a power transformer.
- 2) Oil-immersed, wye-connected, with a solidly grounded or impedance-grounded neutral, connected to the transmission system.

Major fault protection for dry-type reactors is achieved through over-current, differential, or negative-sequence relaying schemes, or by a combination of these relaying schemes. Protection for low-level turn-to-turn faults is provided by a voltage-unbalance relay scheme with compensation for inherent unbalance.

Major fault protection for oil-immersed reactors is achieved through over-current relaying, differential relaying, or a combination of both. Protection for low-level turn-to-turn faults is provided by impedance, thermal, gas-accumulator, or sudden-pressure relays, or by a combination of these relays.

5. Reactor Construction and Characteristics

The two general types of construction used for shunt reactors are dry-type and oil-immersed. The construction features of each type, along with variations in design, are discussed under the headings which follow.