



Review of IEEE C57.159

Guide of Transformers for Application in

Distributed Photovoltaic (DPV) Power Generation Systems

— Technical Presentation —
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1. Abstract

This Guide provides general and specific recommendations on application of step-up and step-down liquid-immersed and dry-type transformers in DPV power generation systems for commercial, industrial and utility applications.

The guide focuses mainly on the inverter transformers of the DPV systems which are connected to inverters supplying AC voltage and current to the primary (LV) winding of the transformer. Some specifics attributed to the auxiliary power transformers in these systems are also discussed.

Transformers covered with this guide comply with the relevant requirements defined in IEEE Standards C57.12.00 for liquid-immersed transformers, and C57.12.01 for dry-type transformers.

The tutorial will cover the following topics:

- History and Application of DPV Grid Transformers
- Overview
- Normative References and Definitions
- Specifics of DPV Power Generation Systems in Relation to a Transformer Application
- Transformer Specification
- Transformer Parameters Selection and Transformer Design
- Transformer General Requirements, Construction and Protection
- Transformer Tests, Installation and Commissioning
- Transformer Maintenance, Diagnostics and Monitoring
- Bibliography

Dr. Shertukde will first present a review of the history of DPV transformers and the work done by the task force to develop a position paper after it was formed in 2008. Mr. Kennedy of Niagara Transformer and Mr. Gaytan of GE-Prolec will cover the other salient aspects of DPV transformers.

Specifically, Mr. Sheldon Kennedy will cover issues applicable to specification of DPV transformers, tests, and additional issues which apply to installation, commissioning, and maintenance, and also diagnostics and monitoring. Mr. Carlos Gaytan will review design considerations for liquid-immersed transformers connected to DPV systems, such as solar duty cycle size optimization based on load profiles, winding configurations, use of electrostatic shields, as well as other relevant design features.

2. Learning Objectives

This presentation will help engineers understand the purpose and application of distributed photovoltaic (DPV) grid transformers in the ever-growing alternate energy source: solar power.

3. Learning Outcomes

As a result of attending this session, attendees will gain an understanding of technology and application of DPV grid Transformers.

4. Presenters' Biographies

Carlos Gaytan received his BS degree in Electronic and Communications Engineering from Nuevo Leon State University, and a Master's Degree in Electrical Engineering, with a major in Power Systems from Monterrey ITESM. In 1988, he joined Prolec GE, where he has held several leadership positions in Product Engineering, Quality Assurance, Product Development and Technology, covering all distribution transformer product lines. He is member of IEEE Transformers Committee, with an active participation as member of the Distribution Transformers Subcommittee, currently acting as chair of WG C57.12.39 Standard Requirements for Distribution Transformer Tank Pressure Coordination, and vice chair of WG C57.12.36 Standard Requirements for Liquid-Immersed Distribution Substation Transformers. He has participated with the US Department of Energy Committee for development of energy efficiency standards for distribution transformers.

Sheldon P. Kennedy, P.E. has 43 years of electrical engineering experience. Since 1985 he has been with Niagara Transformer, presently as Vice President Engineering, and previously Engineering Manager. Prior to that, he was at R.E. Uptegraff Manufacturing. He also worked in the following companies earlier in his career: Allegheny Power, West Penn Power Company, and US Steel Corporation. Sheldon is a Fellow Member of IEEE, a member of the IEEE/PES Transformers Committee, serving on many subcommittees, working groups, task forces. He was chair of the NEMA Transformer Section and Chairman of the C57 Accredited Standards Committee. Also, as a member of the IEEE Industry Applications Society (IAS), Petroleum and Chemical Industry Conference (PCIC), Sheldon has served as Chairman of the Electrochemical Subcommittee. He is also the Converter Transformer Expert for the ANSI US National Committee, TC 14 to IEC. He has authored several IEEE papers, a Doble conference paper, and the chapter on rectifier transformers in the CRC Press book, Electric Power Transformer Engineering. He received a BSEE from Pennsylvania State University and is a registered Professional Engineer.

Dr. Hemchandra M. Shertukde, Ph.D., P.E. is Professor of Electrical Engineering at the University of Hartford, CT and President of Diagnostic Devices, Inc. He is a senior member of IEEE and a member of the IEEE/PES Transformers Committee. He is presently the chair of working group for IEEE C57.159, which created the Guide for Application of DPV Grid Transformers. The guide is currently in its last stages of balloting. The work of the previously associated task force resulted in a position paper which was accepted to be presented at the IEEE-ICEEOT Conference in Chennai, in March 2016. He has written four solo books: one in 2010 on Transformer Design, Theory and Practice published by Verlag-Dr. Mueller; and a second one in 2014 on DPV Grid Transformers by CRC Press. Dr. Shertukde has published several transaction papers in the IEEE Transactions of Controls and Signal Processing, and proceeding papers in several international conferences.