The Relay Testing Handbook

Generator Protection Relay Testing

Chris Werstiuk

Professional Engineer
Journeyman Power System Electrician
Electrical Engineering Technologist

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Valence Electrical Training Services

9888 W. Belleview Ave, Suite 122
Littleton, CO 80123
www.RelayTraining.com

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Author's Notes

Thanks to everyone who supported *The Relay Testing Handbook* over the years. Your support gave me the opportunity to train hundreds of relay testers on a variety of test-sets since its publication in 2012. I get new insights from students during every class that change my perspective on relay testing. This book takes everything I have learned about relay testing to provide step-by-step details to help you create dynamic tests for the most common elements in a Generator relay.

Generator relay testing isn't hard, but you need to understand the basics first. You should not read this book if you haven't read and applied *The Relay Testing Handbook: Principles and Practice*, and/or finished the *How to Test Protective Relays Online Seminar* at *RelayTraining.com*. I often refer to other books and online courses and seminars in this book. Please do not take these references as sales pitches trying to get you to buy more. I knew this book was going to be a big one that would be near publishing limits for a book, so it only includes new material. You'll see many links to other material if I've already written about a topic and have nothing new to add, and/or it's not something specific to generator relay testing.

This final version of this book contained over 1,000 pages of content. However, 800 pages is the maximum page count for print books. You can read the full book in the digital PDF version that every customer at *RelayTraining.com* receives. Some of the relay testing templates have been condensed in the physical book to meet the printers limitations for a hardcover book.

I hope I've achieved my goal to create a book that helps you understand the basic principles of generator protection in a practical manner. You should be able to test any generator relay using the step-by-step guides in this book. I've written it using dynamic testing techniques, but you can apply all of the descriptions, calculations, and principles in every chapter to test a generator relay with any technique you wish to use.

Our publishing model allows us to quickly correct errors or omissions, and implement suggestions. Please contact us at *store@relaytraining.com* to report a problem. If we implement your suggestion, we'll send you an updated copy and/or a prize. You can also go to *https://relaytraining.com/updates* to see what's changed.

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The Relay Testing Handbook: Principles and Practice:

- introduced you to relay testing,
- gave you the theory behind the most commonly used protective relay elements, and
- provided step-by-step testing instructions.

Generator relay testing can seem difficult because there are many different elements with different operating characteristics. You can confidently test any generator relay if you understand how a generator operates in the real world and are able to create these conditions with your test-set. This book explains the most important fundamentals that you can understand and apply when testing any generator relay with any test-set:

- Introduction to Generators
- Generator Control Systems
- Generator Diagrams
- Getting Ready to Test
- Element Testing Principles
- How to Perform Acceptance Tests
- How to Perform Commissioning
- How to Perform Maintenance Tests

Once you understand generator and relay testing theory, this book will show you universal, step-by-step test procedures for these elements using modern, dynamic testing techniques:

- Phase Distance (21)
- Volts/Hz (V/Hz)/Over-Excitation (24)
- Synchronizing and Synch-Check (25)
- Under-Voltage (27)
- 100% Stator Earth (27TN/64G2)
- Reverse/Under-Power (32)
- Loss of Field/Field Failure (40)
- Negative Sequence Over-Current (46)
- Breaker Failure (50BF)
- Inadvertent Energizing (50/27)
- Voltage Control/Restraint Over-Current (51V)
- Neutral Over-Voltage (59N/64G)
- Fuse Loss/Failure (60FL)
- Out of Step (78)
- Under/Over Frequency (81)
- Phase Differential (87)

Take your relay testing to the next level by learning and applying these dynamic testing principles to any relay element with a fixed time delay. You won't find another resource like this!

About the Author

Chris Werstiuk is an Electrical Engineering Technologist, a Journeyman Power System Electrician, and a state-certified Professional Engineer who has been testing relays for over two decades in environments ranging from nuclear power plants to commercial buildings. He is the author of The Relay Testing Handbook series, several articles for NETA World, and papers at both the annual InterNational Electrical Testing Association (NETA) and Hands-On Relay School conferences. Werstiuk has led training classes for testing companies, electrical utilities, and maintenance personnel at private and military installations across North America, Africa, the Middle East, and Australia. You can find out more about him at RelayTraining.com; an online resource for relay testing technicians including textbooks, online training programs, free technical content, and an online forum to exchange ideas and information.

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