

The Relay Testing Handbook

End-to-End Testing



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Get More Relay Testing Handbooks at RelayTraining.com

The Relay Testing Handbook: Principles and Practice includes:

- Basic electrical fundamentals
- Basic relay testing fundamentals
- Relay testing equipment options and how to use them
- Information about the most common protective elements (50/51/67/59/27/81/87/21 protection) including:
 - Theory behind the element
 - How and when the element is applied
 - Step-by-step test procedures
 - Tips and tricks to overcome common problems
- Relay testing approaches and how to select the best ones
- Test plans with real-world applications
- Examples from multiple manufacturers and test-set models



The Relay Testing Handbook: Simplified Motor Testing includes:

This book will show you how to test any motor relay with any test-set through these motor topics:

- Introduction to motors
- Understanding motor connections and controls
- How to connect your test-set
- General motor testing principles



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

- | | |
|---------------------------------------|--|
| • Restart Block/Backspin | • Short Circuit/Phase Overcurrent (50P) |
| • Time Between Starts/Starts per Hour | • Undercurrent/Load Loss/Underpower (37) |
| • Thermal Overload Alarm/Trip (49) | • Undervoltage/Overvoltage (27/59) |
| • Thermal Capacity Alarm (TCU) | • Under/Over Frequency (81) |
| • Mechanical Jam | • Power Factor (55)/Reactive Power (VAR) |
| • Acceleration Trip | • Ground Fault Trip (50N) |
| • Current Unbalance Trip/Alarm (47) | • Phase Differential (87M) |
| • Single-Phase Trip | • RTD Testing |

Get Online Relay Training at RelayTraining.com

How to Test Protective Relays, 16 CEUs

This online protective relay testing seminar follows Chris Werstiuk (author of *The Relay Testing Handbook*) as he tests a relay from start to finish. You'll learn the basic skills needed to test any digital relay with any modern test-set, how to perform each testing step, and why each step is important.

You'll see how to make smarter test plans that are quicker and more effective than traditional methods (including tips and tricks you won't find in any manual or YouTube video).

Watch this series of videos on any device with speakers or headphones, and a high-speed internet connection. The videos are broken down into logical chunks that you can watch at any time, and in any order, to fit this series into your busy schedule.

What do I get?

- A simple flowchart to follow while testing digital protective relays with any test-set
- Unlimited access to 17+ hours of videos where Chris Werstiuk tests various relays using different test-sets, and explains how he performs the test, and why
- Content to download and follow along
- Comment sections to ask Chris questions, and interact with other students



"This is a fantastic course in how to test relays and covers aspects that are not found anywhere else - set up, print and documentation review, testing philosophy, the testing process and reporting results. The quality of the material in these videos and Chris's engaging delivery have led me to be infinitely more prepared to take on the task of relay testing than ever before."

Benjamin

How to Test Protective Relays Seminar

"Chris is extremely knowledgeable and experienced. He has seen almost every mistake that can be made in the protection and control game. This course will provide you with a great step-by-step guide to testing. Not only will you have a good guide, but you will understand WHY you are doing that step."

Student

How to Test Protective Relays Seminar

Get Online Training Courses at RelayTraining.com

Course 1-1: The Three-Phase Electric Power System, 4 CEUs

Protective relays constantly look at the three-phase electric power system and try to decide whether the system is normal or under fault conditions. A relay tester who understands the three-phase electrical system can build highly efficient test plans to test the entire relay (not just the individual pieces of it) to make sure it actually operates when it's supposed to.

We will cover the following topics in this lesson to give you a foundation in three-phase electrical theory to help you become a craftsman instead of a button pusher:

Introduction to Electrical Fundamentals and Frequency

- How electricity is created
- What is a cycle
- How to count cycles
- Understand how frequency and cycles are related
- Converting cycles to seconds
- Converting seconds to cycles
- Converting cycles to cycles



Three-Phase Electric Power Systems

- How three-phase electric power systems are created
- How to determine which kind of three-phase electric power system is being generated
- How to change one kind of three-phase electric power into another

"I learned a lot from this course. Having no relay testing experience, I was grateful the real world examples were shown. I will definitely continue with this program, as they become available."

Joe

The Three-Phase Electric Power System

"Excellent refresher for someone in the field who doesn't deal with phasors and/or frequency/time/cycle conversions very often."

Student

The Three-Phase Electric Power System

Get Online Training Courses at RelayTraining.com

Course 1-2: Phasor Drawings for Relay Testers, 4 CEUs

Phasor diagrams are used to understand the electrical system at a glance. Unfortunately, your test-set probably has a different phase angle system than your meter or relay, which can make relay testing a nightmare. How are you supposed to translate phase angles between devices that use different references?

This course introduces you to phasors in seven detailed video lessons and quizzes, which cover:

- Understanding Phasors
- Drawing Phasor Drawings
- Drawing Phasors with Lagging Angles for GE SR Relays, Megger Equipment, and RTS Software
- Drawing Phasors with Different Scales

In a perfect world, these four lessons would be all you needed to become a phasor drawing master. Unfortunately, it seems every manufacturer has a different system for the angles in phasor drawings. The remaining lessons in this course help you understand all of the different angle systems used by all the major equipment vendors:

- Drawing Phasors with Positive Angles for Manta and Doble Test-Sets
- Drawing Phasors with Negative Angles for GE UR Relays
- Drawing Phasors with Positive and Negative Angles for SEL, SIEMENS, ABB, and Alstom Relays (And Most Equipment Not Listed)



"For people who feel they may know some details about relay testing but get confused by the different phase angles and phase rotation. It clears up the differences and opens your eyes to the need to be careful when trying to figure out phase rotation."

Customer Review

Phasor Drawings for Relay Testers

"If you want to take your relay testing knowledge to the next level, this course is a must!"

Student Evaluation

Phasor Drawings for Relay Testers

Get Hands-On Protective Relay Testing Training

Effective, Hands-On Training for Relay Testers

Valence Electrical Training Services has shown its commitment to the high-voltage electrical testing industry with *The Relay Testing Handbook* series and our online training series. Many people we have met over the years have requested a complete training program so that their test technicians will be able to answer all of these questions:

- What is a protective relay?
- Where are protective relays used?
- Why do protective relays need to be tested?
- What are the most common protective relay functions?
- How do I test any protective relay or element?
- What are the most effective test techniques available?



Most protective relay training classes are equipment-specific, include over four days of training, and are based on decades-old material. This means that the student only learns one way to test the relay, can become overloaded with too much or dated information, and requires overtime travelling to and from the training site.

We have combined all of our training experience to create a modern curriculum for today's relays and test equipment. Our class sizes, topics, and durations have been carefully planned to make sure our trainees actually retain the information they obtain in the class through a combination of theory and hands-on training. We use modern relays and techniques that can be applied to any modern test-set from any manufacturer.

We offer the following hands-on relay testing training classes at your location:

- Introduction to Modern Relay Testing (3 days, 24 CEUs)
- Protective Relay Testing Fundamentals (3 days, 24 CEUs)
- Line Distance Protective Relay Testing (3 days, 24 CEUs)
- End-To-End Communication Testing (2 days, 16 CEUs)
- Differential Protective Relay Testing (2 days, 16 CEUs)
- Generator Protective Relay Testing (3 days, 24 CEUs)
- Digital Relay Logic Testing (2 days, 16 CEUs)
- Motor Protective Relay Testing (2 days, 16 CEUs)
- Custom Classes for your specific requirements

The Relay Testing Handbook series is an indispensable resource that every relay tester should keep at their fingertips. All books in the series are written for relay testers, rather than for design engineers, so you don't have to decipher engineering textbooks when performing relay tests.

The Relay Testing Handbook: End-to-End Testing provides a basic introduction to this important testing technique and a step-by-step procedure for performing a successful end-to-end test. This volume also includes an overview of the most common communication-assisted protection schemes to help the reader understand how these schemes operate.

This volume is designed to help you understand:

- The basic principles behind end-to-end testing
- The reasons end-to-end testing is performed
- How end-to-end testing works
- When and where this type of test should be performed

The following topics are described with realistic, practical examples and detailed instructions:

- Introduction to end-to-end testing
- Detailed end-to-end testing procedures
- Descriptions of the most common protection schemes including:
 - Direct Under-Reaching Transfer Trip (DUTT)
 - Permissive Over-Reaching Transfer Trip (POTT)
 - Directional Comparison Unblocking (DCUB)
 - Permissive Under-Reaching Transfer Trip (PUTT)
 - Directional Comparison Blocking (DCB)
 - Line Differential (Pilot Wire, Charge Comparison, Traditional Differential, Alpha Plane)

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](https://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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