



VALENCE
ELECTRICAL TRAINING SERVICES

How to Test Overcurrent Relays:
An Introduction to Protective Relaying
Online Seminar



About Valence Electrical Training Services

About Our Relay Training Center

Most protective relay training falls into three categories:

- Engineering books written for design engineers, not relay testers.
- Courses hosted by relay manufacturers specific to their relays.
- Test-set manufacturer, or automated test software, training focused on how to get their solution to test the relay with minimum user input.

We believe that:

- The power system is universal, and you can apply the same principles to any relay model or manufacturer
- All modern test-sets can test any modern relay.
- A skilled relay tester will always test a relay more effectively and efficiently than a button pusher, while fixing problems the alternatives will never discover.

All of our relay training material:

- Is written specifically for relay testers in plain language.
- Is designed to be universal and can be applied to any relay or any test-set.
- Includes the theory necessary to understand what is happening inside the relay, and why.
- Has universal, step-by-step procedures so the relay tester knows how to apply the theory.
- Uses the most efficient and effective relay testing techniques used today.

The Relay Testing Handbook Series

Valence Electrical Training Services started with a paper presented at a major electrical testing conference that turned into *The Relay Testing Handbook* series, a comprehensive series of nine books, each of which covers a specific relay testing topic. Any technician who has ever been faced with a confusing or challenging situation in the field will appreciate that a relay tester, not an engineer, wrote these books. This practical resource gives you the tools you need to test almost any type of protective relay, no matter who the manufacturer is.

Some of the topics included in *The Relay Testing Handbook* series include:

- 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

Online Training

Online Protective Relay Training

Today's relay testers have to perform more work in less time and typically have very little support to help them test modern digital relays that become more complex every year. We created *The Relay Testing Handbook* series as a practical reference guide for the modern relay tester, but studies have shown that most people must apply multiple learning styles before they fully understand a topic.

We have two different styles of online training programs:

Online Training Courses:

- Watch a video that discusses the theory behind a topic. You can learn at your own pace with controls that let you pause, rewind, fast-forward, change video speed, watch close-captioning, etc.
- Use our interactive exercises that simulate the topic using the most realistic situations possible to help you learn by doing.
- Repeat the above steps for every topic in the course.
- A certificate will be issued if you pass the final quiz with a score of 80% or higher.



Online Training Seminars:

- Our online seminars are based on our in-person training classes and are focused on a specific aspect of relay testing. Unlike in-person training classes, you can use closed-captioning, fast-forward/rewind/play speed controls, and you can revisit the videos whenever you wish to help you truly absorb the material.
- Each lesson starts with a short history of the subject, an explanation of why it is important, followed by some theory to help understand the basics, and step-by-step instructions that you can follow along with in order to complete the relay testing task.
- Each lesson is broken down into bite-sized topics that usually include a short (<15 minute) video. Our goal is to always show, not tell.
- We always use real test-sets, relays, and relay settings in our examples and try to simulate real world conditions as closely as possible.
- You will receive a certificate of completion when all topics and lessons have been completed.

Our online protective relay training courses are designed to:

- Allow you to choose the topics most important to you. You can complete the training in any order.
- Be convenient. You can complete the courses at a location and time convenient for you and your schedule. You have 24/7 access and they never expire. Re-watch the videos as often as you wish.
- Focus on the skills you need to become a better relay tester. You can ask questions anytime.
- Be universally applied to any relay or test-set.

Online Training Seminars

How to Test Overcurrent Relays: An Introduction to Protective Relaying Online Seminar: 32 CEUs

This seminar covers the basics of overcurrent protection that new relay testers should know before they start testing relays. It will also fill in gaps for self-taught relay testers who had to figure it out for themselves and want to truly understand how to test all overcurrent relays from any manufacturer with any test-set.

This seminar starts at the beginning by defining the basic operating characteristics of all relays, and the current transformers that feed all overcurrent relays.

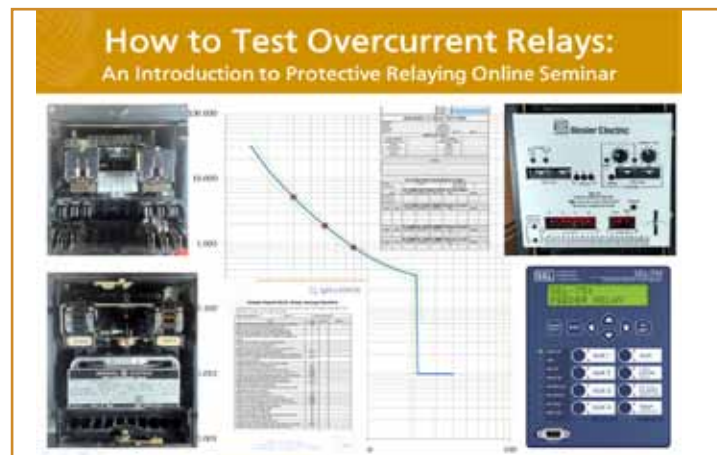
Electro-mechanical relays were the backbone of the power system for over a century and are a great teaching tool for all relay testing because every digital overcurrent relay is modeling electro-mechanical overcurrent relays. The second lesson shows you how to test electro-mechanical overcurrent relays, which sets you up with the basic skills and understanding that you can use for all relay testing.

The third lesson describes the most common kinds of power system faults so that you can troubleshoot problems after a relay operates...and test any relay with fault simulations while using the electro-mechanical relay testing techniques.

The fourth lesson will show you how to apply the skills learned in the electro-mechanical lesson to test and calibrate any digital overcurrent relay using traditional relay testing techniques.

We strongly believe that if you truly understand the theory of a topic, you will be a better relay tester because you will understand what you are testing and be able to find setting mistakes, which are the most common reasons that relays mis-operate when in-service. The fifth lesson will give you a peak behind the curtain and show you how a relay engineer uses engineering studies to create relay settings.

Modern relays should really be called intelligent electronic devices (IEDs) because, while they share some features with traditional overcurrent relays, they are much more complicated and have significantly different failure points. Traditional test techniques won't find these failure points, but you can if you take all of the knowledge and techniques learned in this seminar and apply them to IEDs with the updated overcurrent element testing plan described in this lesson.



"This is an excellent overcurrent relay training course. It can't get better than this. Thank you for the great course! I learned more in this seminar than older experienced EM relay testing trainers have tried to teach me in the past. I have now changed my perspective in my future relay testing practices."

Visnu Premchand
Student

Online Training Seminars

How to Test Overcurrent Relays: An Introduction to Protective Relaying Online Seminar: 32 CEUs (Continued)

Introduction to Protective Relays

- History of Electrical Protection
- What Are Relays For?
- Introduction to Relay Inputs
- Introduction to Current Transformer (CT) Theory
- Introduction to Current Transformer Saturation
- Current Transformer Nameplate and Specifications
- CT Nameplate Burden and Saturation Voltage
- How Relays Protect Equipment
- How Relays Ignore System Fluctuations
- How Overcurrent Relays Coordinate
- Introduction to Zones of Protection
- Relay Output Basics

How to Test Electro-Mechanical (E-M) Overcurrent Relays

- Electro-Mechanical Relay Basics
- Take a Tour of E-M Relay Components
- What to Look for in the E-M Relay's Instruction Manual
- Test-Set Current Channels – Current & VA Specifications
- Test-Set Current Channels – Voltage Requirements
- Test-Set Current Channel Capabilities
- Configuring Test-Set Current Channels for Different Relays and Taps
- How to Connect Test-Set Current Channels to the Relay
- How to Make Test-Set to Relay Sensing Connections
- How to Connect to the Relay
- How to Connect Your Test-Set to the Relay
- How Not to Perform a Pickup Test
- How to Choose the Correct Step Size
- How to Perform an E-M Relay Pickup Test
- How to Evaluate Your Pickup Test Results With % Error
- Why You Can't Always Use Percent Error Tolerances
- How to Apply Tolerances to Test-Set Software
- How to Apply Percent Tolerances to Test-Set Software When the Expected Value Is 0
- How to Perform a Manual E-M Pickup Test
- How to Perform an Automated E-M Pickup Test
- How to Adjust E-M Inverse-Overcurrent Relay Pickups
- What Are TCC Curves and Why Do They Matter?

- How to Determine Test Points and Time Delays
- How to Prepare for 51-Element Time Tests
- How to Perform Manual 51-Element Time Tests
- How to Perform Simple 51-Element Time Tests
- How to Perform 51-Element Time Tests Using Curves
- How to Perform 51-Element Time Tests Using States
- How to Adjust the Timing on an E-M Relay
- Introduction to E-M 50-Elements
- How to Perform a 50-Element Pickup Test
- How to Perform a Manual 50-Element Pickup Test
- How to Perform a 50-Element Pickup Test
- How to Adjust a 50-Element Pickup on an E-M Relay
- How to Perform a Dynamic 50-Element Pickup Test
- Introduction to Electro-Mechanical Targets
- How to Test Electro-Mechanical Relay Targets
- How to Use a Test-Set to Test E-M Targets
- How to Manually Test E-M Targets With Your Test-Set
- How to Test E-M Targets With Your Test-Set
- How to Test E-M Relays Using Pre-Built Test Plans
- How to Inspect the Cover and Case
- How to Perform a Mechanical Inspection of the Relay
- How to Inspect the Relay's Contacts
- How to Perform a Creep Test
- How to Perform a Mechanical Zero Test
- How to Perform an Insulation Resistance Test
- How to Verify the Relay's Trip Circuit (NERC)
- How to Safely Put the Relay Back Into Service
- How to Verify the In-Service Relay Inputs (NERC)
- Are Electro-Mechanical Relay Testing Myths True?
- Putting It All Together – How to Test an Electro-Mechanical Overcurrent Relay From Start to Finish
- All the Extras – Downloads and More Training Options

Understanding Power System Faults

- Overcurrent Relays Under Normal Conditions
- What Happens During a Fault
- Fault Voltage and Fault Current During 3-Phase Faults
- How E-M Overcurrent Relays Respond to 3-Phase Faults
- Fault Current Magnitude and Direction in P-P Faults
- Fault Current vs. Phase Current in P-P Faults
- Fault Voltages in Phase-to-Phase Faults

Online Training Courses

How to Test Overcurrent Relays: An Introduction to Protective Relaying Online Seminar: 32 CEUs (Continued)

- What Phase Voltages Look Like During P-P Faults
- Fault Voltages and Fault Current in Phase-Phase Faults
- How E-M OC Relays Respond to P-P Faults
- Fault Voltage and Fault Current in P-N Faults
- How E-M OC Relays Respond to P-N Faults
- Benefits of E-M OC Relays
- What Faults Really Look Like
- Applying Realistic Faults When Testing Relays

How to Test Simple Digital Overcurrent (SDO) Relays

- Introduction to Simple Digital Overcurrent Relays
- How to Prepare to Test a Simple Digital Overcurrent Relay
- How to Prepare to Test an SDO Relay With Your Test-Set
- How to Connect to a Simple Digital Overcurrent Relay
- How to Connect an SDO Relay to Your Test-Set
- How to Configure Inputs When Testing Digital Relays
- How to Create a 51-Pickup Test Plan for an SDO Relay
- How to Perform Manual Pickup Tests on an SDO Relay
- How to Adjust the 51-Pickup on an SDO Relay
- How to Perform a Ramping 51-Pickup Test on a Simple Digital Overcurrent Relay With Your Test-Set
- How to Create a 51-Timing Test Plan for an SDO Relay
- How to Perform 51-Timing Tests on an SDO Relay
- How to Perform 51-Timing Tests on a Simple Digital Overcurrent Relay With Your Test-Set
- How to Create a 50-Pickup Test Plan for an SDO Relay
- How to Adjust the 50-Pickup on an SDO Relay
- How to Perform a 50-Pickup Test on a Simple Digital Overcurrent Relay With Your Test-Set
- How to Verify the Outputs on an SDO Relay
- How to Verify the Targets on an SDO Relay
- How to Put the SDO Relay Back Into Service
- How to Verify the Trip Circuit Connected to an SDO Relay
- How to Verify the In-Service Relay Inputs Connected to a Simple Digital Overcurrent Relay
- Putting It All Together
- Putting It All Together With Your Test-Set
- All the Extras – Downloads and Additional Training

Introduction to the Power System Studies Used to Create Relay Settings

- Introduction to Power System Study Single Line Drawings
- Introduction to Load Flow Studies
- How to Calculate the Maximum Fault Current Using An Infinite Buss
- How Does the System MVA Affect the Fault Voltage and Current in a System
- How Does an Impedance Affect the Fault Voltage and Current in a System
- How Does a Connected Motor Affect the Fault Voltage and Current in a System
- Introduction to Short Circuit Studies
- Introduction to Time Coordination Curves for Relays
- Introduction to Time Coordination Curves for Cables
- Introduction to Time Coordination Curves for Transformers
- Introduction to Time Coordination Curves (TCCs) Through Transformers
- Introduction to Time Coordination Curves for Motors
- How Motors Affect Non-Motor Relay Coordination
- Introduction to Arc Flash
- How Relay Settings Affect Arc Flash
- How to Get Time Test Values From a TCC Chart
- How to Get Time Test Values From a Coordination Study
- All the Extras – Downloads and Additional Training

How to Test Overcurrent (50/51) Elements in IEDs

- What You Need to Test 50/51 Elements Inside an IED
- How You Should Test the 50/51 Elements Inside an IED
- How to Prepare to Test the 50/51 Elements Inside an IED
- How to Test the Phase 50/51 Elements Inside an IED
- How to Test the Ground 50/51 Elements Inside an IED
- How to Test the Electro-Mechanical Reset Overcurrent Elements Inside an IED
- How to Review and Report Your 50/51 Element IED Tests
- How to Test the 50/51 Elements Inside an IED
- All the Extras – Downloads and Training Options



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