Hands On Relay School
Relay Test Equipment Basics

Outline

• Introduction
• The Modern Test Set
• Amplifiers
• Binary Inputs
• Binary Outputs
• Communication
• Testing Philosophies and Methods

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Relay test equipment provides a test stimulus and measures the relay’s response.
Early relay testing was done with generic equipment or “homemade” devices.
Later, purpose built equipment appeared.

Wilmar three phase set with variacs, phase shifter, load box, and timer.

Megger SR51
In the 1980’s, specialized microprocessor controlled test sets were developed.
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Introduction

This led to software control
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Introduction

Current test set models are lighter, more powerful, and incorporate sophisticated self protection and control software.
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Modern test sets typically incorporate the following features:

- Switch mode or Linear amplifiers with feedback
- Protection for shorted voltage channels, open current channels, over temperature, supply circuit protection, and internal fault conditions.
- Intelligent control which realistically simulates the power system without burdening users with complex mathematics.
For better performance and to avoid damage, observe the following:
1. Properly store and transport your test set.
2. Be aware of condensation conditions.
3. Do not try and push 1800 watts through a 100’ 14awg extension cord, a drug store power strip, or undersize bench wiring.
4. To not obstruct ventilation openings or allow foreign material to enter the test set.
5. Do not connect a current amplifier to a station battery or any other external voltage source.
6. Do not try to roll a lockout, trip a breaker, or power any significant load with the contact output.
Avoiding Damage

Be aware that some test sets can damage protective relays. Carefully observe hardware limitations.
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- **Amplifiers**
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Current Amplifiers

• Power switch: Applies power to the test set.
• Current amplifier power supply: Converts AC line input to positive and negative DC.
• Current Amplifier: Converts DC rail voltage to desired output by rapidly switching the gate signal to positive and negative output transistors. This switching is controlled by the CPU through a gate drive circuit.
• Output signals are then smoothed using filters before being sent to the test set outputs.
Current Amplifier Specifications:
• Compliance voltage: This is also the rail voltage. The higher the rail voltage, the higher the load impedance can be.
• Maximum current: Usually the maximum current capability of a current amplifier.
• Current Amplifier VA: This theoretical maximum power only occurs at one load and therefore has very little importance.
• Accuracy, resolution, noise and distortion figures are usually given as well.
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Amplifiers

Typical Current Amplifier Connections (three phase):

![Diagram of current amplifier connections](image-url)
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Amplifiers

Current Amplifier Connections (three phase with residual):

![Current Amplifier Connections Diagram](image-url)
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**Amplifiers**

Current Amplifier Connections (Paralleled for high current):
Current Amplifier Connections (series-connected for High Compliance):
Voltage Amplifiers

• Power switch: Applies power to the test set.
• Voltage amplifier power supply: Converts AC line input to positive and negative DC Voltage Rails. Typically a switch mode power supply engineered for higher output voltage and therefore lower output current.
• Voltage Amplifier: Converts DC rail voltage to desired output by rapidly controlling gate voltage and switching output transistors. This switching is controlled by the CPU through a gate drive circuit.
Voltage Amplifier Specifications:

- **Maximum Voltage**: This is also the rail voltage.
- **Maximum Amplifier VA**: VA/voltage determines how much current the amplifier will source at maximum output voltage.
- **Accuracy, resolution, noise and distortion**: are given as well.
Amplifiers

Amplifier Connections (Typical digital relay):

Voltage Amplifier Output:

Current Amplifier 1 Output:

Battery Simulator:

N321 Current Amplifier 1 Output

N321 Voltage Amplifier Output

IA
VB
VC
VA

IB
VC

IC
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Binary inputs provide the means to measure relay response. They are designed to have a high internal impedance to prevent relay misoperations.

Two operating modes:

- Internally wetted: Test set supplies a wetting voltage to determine the status of a contact
- Externally wetted: Test set relies on external voltage source to determine the status of a contact

**Caution:** Before connecting multiple inputs, carefully observe input polarity and verify input isolation to prevent “sneak circuits”.
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**Binary Outputs**

Usually light duty electromechanical contacts to simulate breaker position, permissive, or blocking signals to the relay under test.

It is important not to overload these contacts.
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Binary I/O Connections
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Modern test sets incorporate serial, TCP/IP, or proprietary communication ports to facilitate communication with control software, another test set, or relay network. Relay networks can be accessed through IEC61850 by reading ICD files, discovering available “geese”, and incorporating goose messaging in test set I/O.
• IRIG and/or GPS is also provided to facilitate end to end testing.
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Modern test sets allow the user to employ different test methods to match the technology of the device to be tested.

- Electro-mechanical relays require specific pickup point and operate time tests to verify proper adjustment and function of internal hardware. These relays frequently require high output power.
- Digital relays require increasingly sophisticated test methods to verify proper wiring, configuration and logic settings. In addition, these relays sometimes require high output current.
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Have a great week!

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