

# Hands On Relay School

## Test Set Selection



# Hands On Relay School

## Relay Test Equipment Basics

### Outline

- Introduction
- The Modern Test Set
- Amplifiers
- Binary Inputs
- Binary Outputs
- Communication

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# Hands On Relay School

## Relay Test Equipment Basics

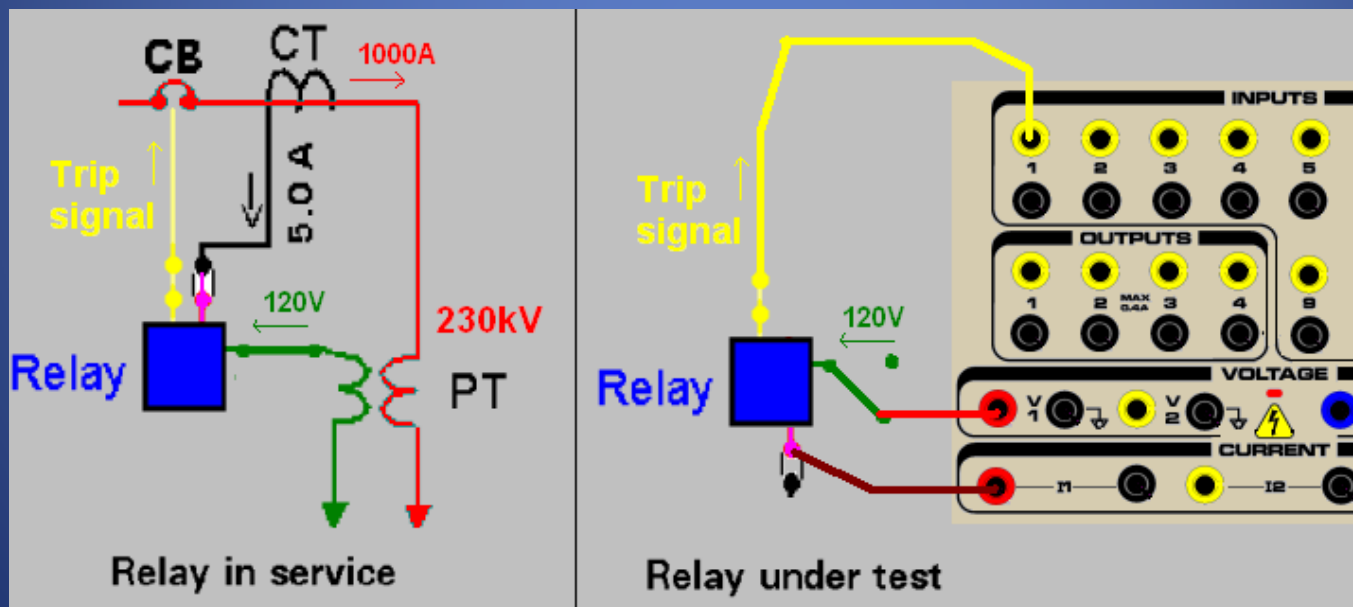
### Outline

- **Introduction**
- The Modern Test Set
- Amplifiers
- Binary Inputs
- Binary Outputs
- Communication
- Avoiding Damage

# Hands On Relay School-Relay Test Equipment Basics

## Introduction

Relay test equipment provides a stimulus and measures the relay's response.



# Hands On Relay School-Relay Test Equipment Basics

## Introduction

Early test equipment was off the shelf or frequently homemade and left a lot to be desired.



# Hands On Relay School-Relay Test Equipment Basics

## Introduction

Later, purpose built test sets appeared.



*Early Megger SR51*



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

# Hands On Relay School-Relay Test Equipment Basics

## Introduction

Eventually, microprocessor based test sets were developed.



# Hands On Relay School-Relay Test Equipment Basics

## Introduction

Current models are lighter, more powerful, and incorporate sophisticated self protection and control software.



# Hands On Relay School

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# Hands On Relay School-Relay Test Equipment Basics

## The Modern Test Set

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, and internal fault conditions.
- Intelligent control which realistically simulates the power system.

# Hands On Relay School

## Relay Test Equipment Basics

### Outline

- Introduction
- Testing Philosophies and Methods
- **Amplifiers**
- Binary Inputs
- Binary Outputs
- Avoiding Damage

# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

### Current Amplifiers

- Power switch: Applies power to the test set.
- Current amplifier power supply: Converts AC line input to positive and negative DC Rails. Typically a switch mode power supply configured for higher output current and therefore lower output voltage. The required rail Voltage is selected manually or automatically.
- 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.

# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

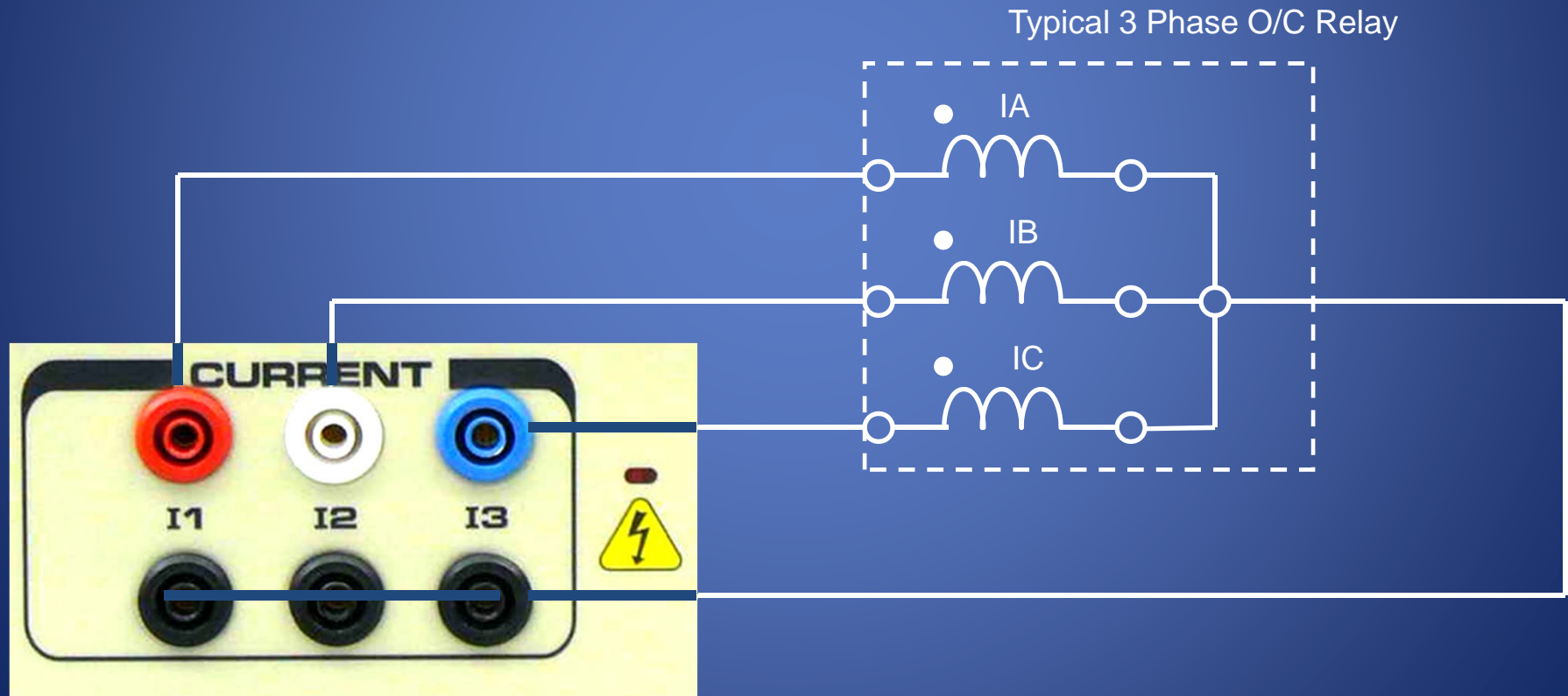
### Current Amplifier Specifications:

- Compliance voltage: This is also the rail voltage. The higher the rail voltage, the higher the impedance the amplifier can drive.
- 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.

# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

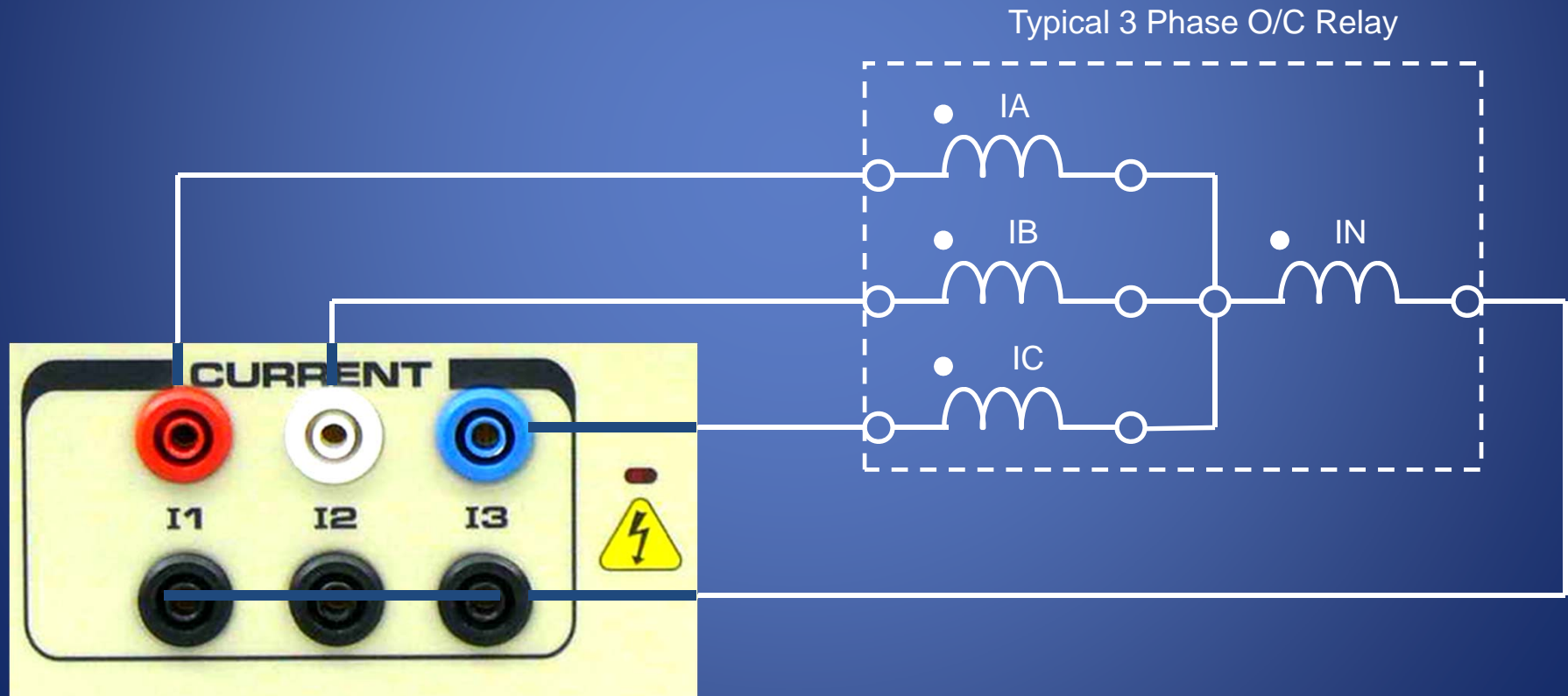
Current Amplifier Connections (three phase):



# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

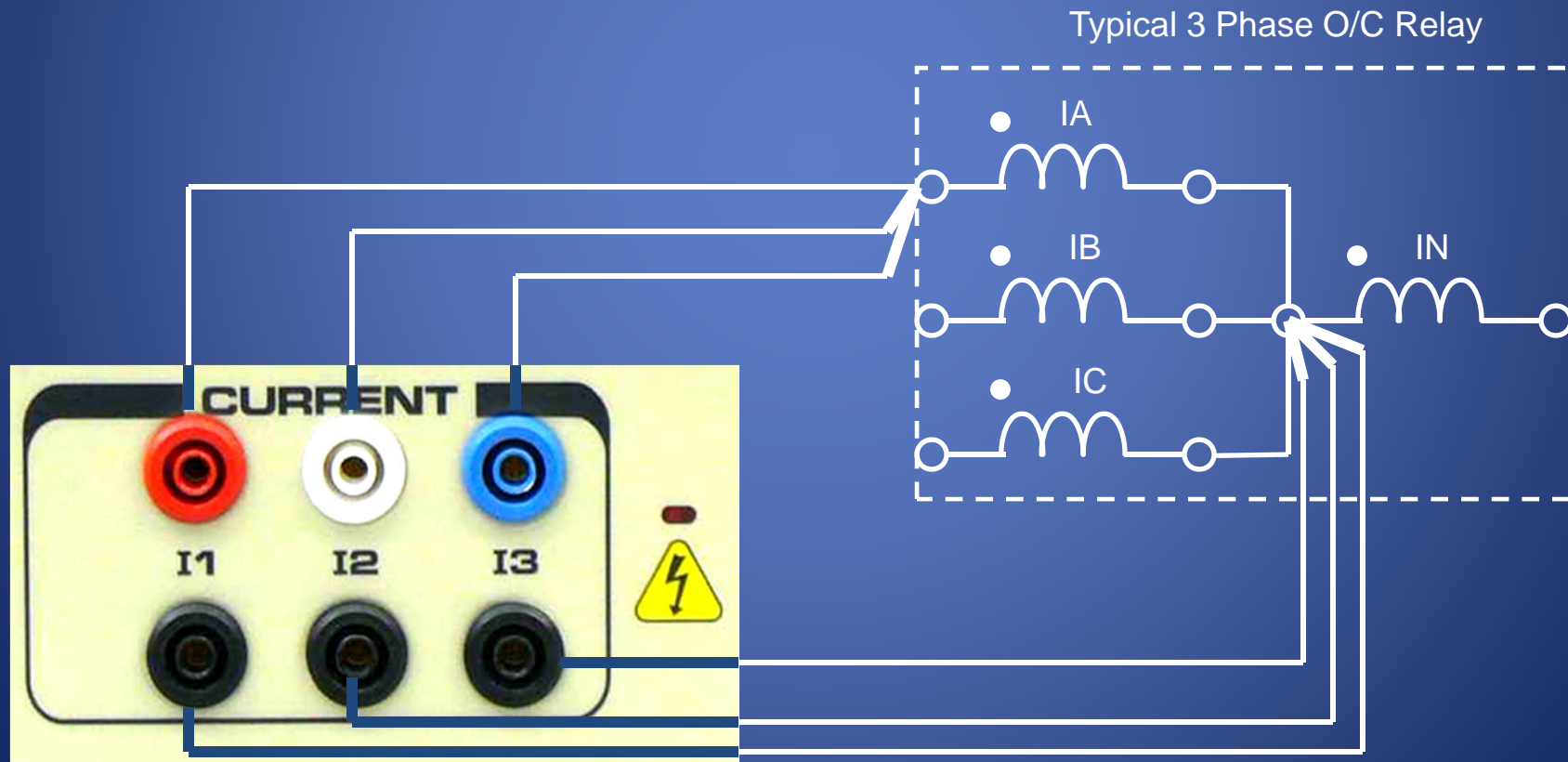
Current Amplifier Connections (three phase with residual):



# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

Current Amplifier Connections (Paralleled for high current):





# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

### 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.

# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

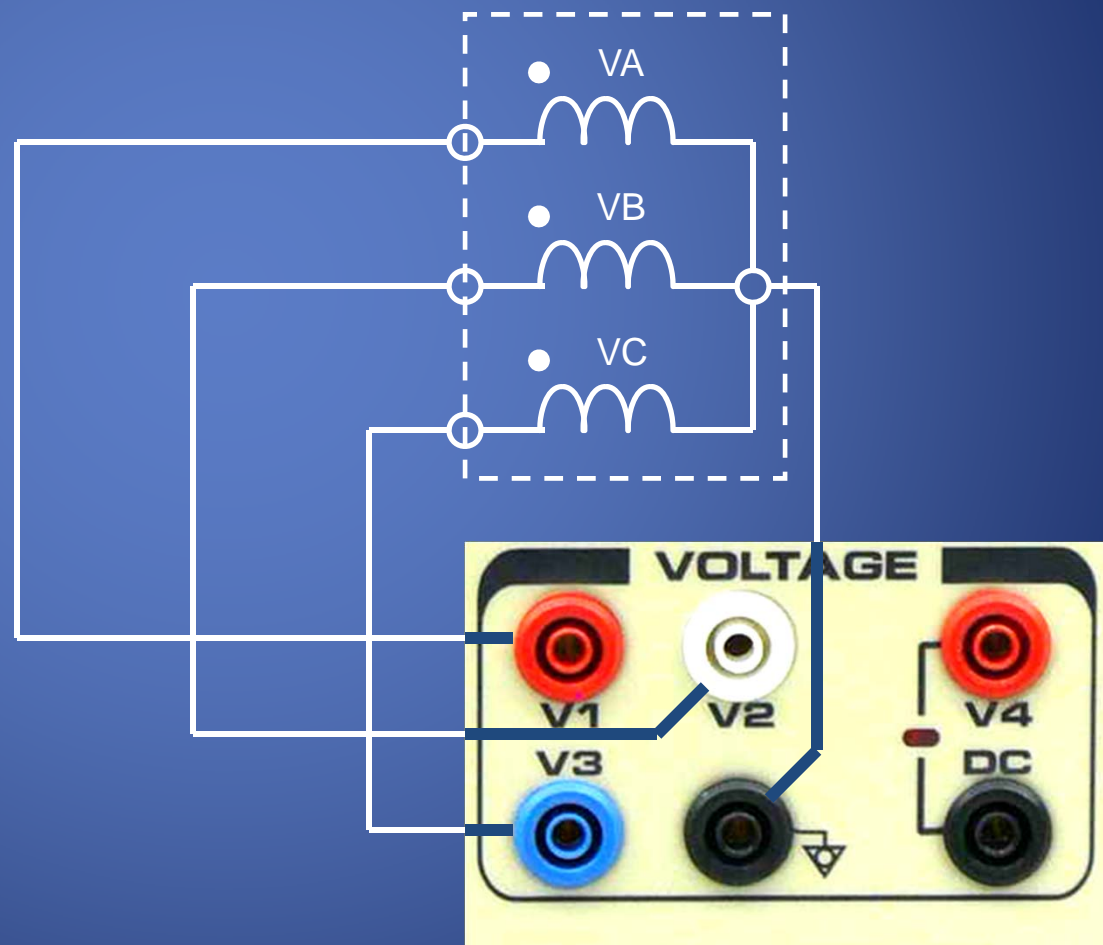
### Voltage Amplifier Specifications:

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

# Hands On Relay School-Relay Test Equipment Basics

## Amplifiers

Voltage Amplifier Connections (three phase relay):



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- Binary Outputs
- Avoiding Damage

# Hands On Relay School-Relay Test Equipment Basics

## Binary Inputs

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

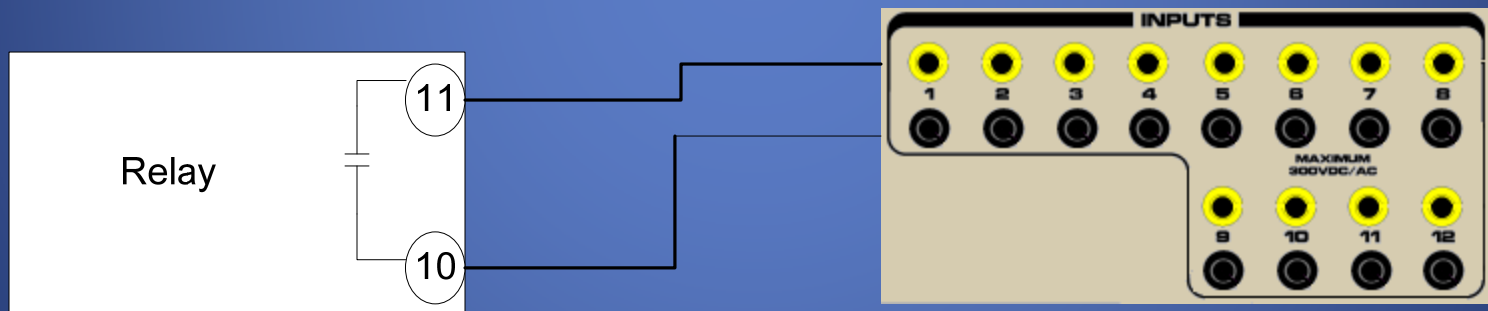
- Internally wetted: Test set supplies a wetting voltage to determine the status of a contact
- Externally wetted: Test set relies on external voltage source to determine the status of a contact

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

# Hands On Relay School-Relay Test Equipment Basics

## Binary Inputs

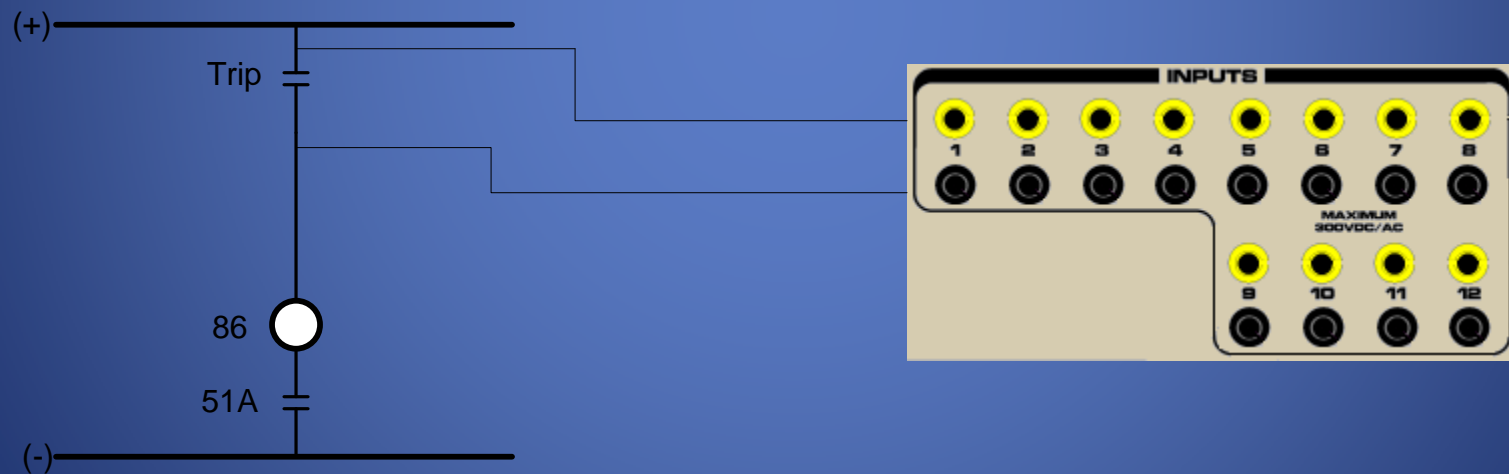
Binary Input Connections (internally wet connection):



# Hands On Relay School-Relay Test Equipment Basics

## Binary Inputs

Binary Input Connections (externally wet connection):



# Hands On Relay School

## Relay Test Equipment Basics

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- **Binary Outputs**
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# Hands On Relay School-Relay Test Equipment Basics

## 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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- **Avoiding Damage**

# Hands On Relay School-Relay Test Equipment Basics

## Avoiding Damage

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. Do 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.