

RFD-200 S3 PORTABLE RELAY TEST SET

USER'S MANUAL



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SAFETY SUMMARY

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in this User's Manual may create one or more safety hazards, may damage the RFD-200 S3, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the RFD-200 S3.

All safety precautions provided in this manual must be observed during all phases of testing including test preparation, test lead connection, actual testing, and test lead disconnection.

SAFETY WARNINGS AND CAUTIONS

Only trained operators shall use this device. **All devices under test shall be off-line and fully isolated.**

DO NOT MODIFY TEST EQUIPMENT

To avoid the risk of introducing additional or unknown hazards, do not install substitute parts or perform any unauthorized modification to any RFD-200 S3 test unit. To ensure that all designed safety features are maintained, it is highly recommended that repairs be performed only by Vanguard Instruments Company factory personnel or by an authorized repair service provider. Unauthorized modifications can cause safety hazards and will void the manufacturer's warranty.

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CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- A key, switch, input, or knob on the RFD-200 S3 is indicated as **[KEY]**, **[SWITCH]**, **[INPUT]**, **[KNOB]**.
- RFD-200 S3 LCD screen output is shown as:

```
0mS  0.0CY
V Mtr: -0.003 V
Int I:  0.080 A
Ext I: -0.001A
```

- Warning messages are indicated as:



Warning message

WARNING

- Important notes are indicated as:



Note details

NOTE

1.0 INTRODUCTION

1.1 General Description and Features

The RFD-200 S3 is a portable relay test set that delivers performance verification testing of electromechanical, electronic, and microprocessor-based protective relays in their operating installations. The RFD-200 S3 is a rugged test set suitable for testing a variety of protection relays operated in both indoor and outdoor environments. The unit's ergonomic design and intuitive control panel layout make it ideal for first-time users who have little or no training.

Built-in Digital Timer

The RFD-200 S3's digital timer features independent start and stop trigger inputs designed to measure the time between event transitions and to display the elapsed time in both milliseconds and cycles. The RFD-200 S3's timer has three different trigger inputs – Internal Trigger, Dry-Contact, or Wet-Contact. The Internal Trigger can start or stop the timer by sensing the application or removal of the unit's voltage or current source. The Dry-Contact can trigger the timer by detecting a change in state of the dry-contact input. Similarly, the Wet-Contact can trigger the timer by detecting a change in state of the voltage input. Thus, the three inputs can trigger the timer by the presence or removal of the unit's voltage or current source or by changes in voltage or current states.

AC Current Source

An AC current source with three outputs (10A, 40A, and 100A) provides test current to relays. The current source output can be programmed to synchronize with the RFD-200 S3's timer. After a test is completed, the test current reading is latched and displayed on the LCD screen. This feature reduces the possibility of overheating the relay coils.

Auxiliary Output Contact

A set of NO/NC dry contacts (240 Vac/3A) change state when a test is initiated.

AC Voltage Source

An AC voltage source (0-250 Vac) is available. The AC voltage source output can be programmed to synchronize with the RFD 200 S3's timer.

DC Voltage Source

A 0 – 300 Vdc voltage source is also available. The DC voltage source can also be programmed to synchronize with the RFD-200 S3's timer

Volt Meter

One volt meter input (0 to 600 V input range) is available on the RFD-200 S3.

Ampere Meters

The test current is displayed on the unit's backlit LCD screen that is viewable in both bright sunlight and low-light levels. The current measuring range is from 0.00 to 250 A. A second ampere meter is also available and can be used to read an external current input. The external current input is rated at 6 A max and is protected by a circuit-breaker.

Auxiliary AC/DC Power Supplies

The RFD-200 S3 provides three power supplies (24 Vdc, 48 Vdc and 124 Vdc) for powering solid-state or microprocessor-based relays.

Built-in Power Resistor

The RFD-200 S3 features built-in power resistors for fine current adjustment.

1.2 RFD-200 S3 Technical Specifications

Table 1. RFD-200 S3 Technical Specifications

TYPE	Portable relay test set
INPUT POWER	100 – 120 Vac or 200 – 240 Vac (factory pre-set), 50/60 Hz
PHYSICAL SPECIFICATIONS	Dimensions: 16.8"W x 12.6"H x 12"D (42.7 cm x 32.0 cm x 30.5 cm); Weight: 35 lbs (15.9 kg)
AMPERE METER INPUT RANGES	Internal input range: 0 – 250 A; Accuracy: 2% of reading ±10 mA External AC input range: 0 – 6A; Accuracy: 1% of reading ±10mA External DC input range: 0 – 6A; Accuracy: 0.5% of reading ±1 count Measurement Method: True RMS for AC
VOLT METER INPUT RANGE	0 – 600.0V; AC accuracy: 1% of reading ±1 count; DC accuracy 0.5% of reading ±1 count Measurement Method: True RMS for AC
POWER RESISTORS	5 Ω/50 W, 1 Ω/50 W, 25 Ω/50 W, 100 Ω/50 W, 500 Ω/50 W
DRY CONTACT OUTPUT	3A, 240 Vac or 120 Vdc
AUXILIARY POWER SUPPLIES	24 Vdc @ 1 A, 48 Vdc @ 0.25 A, 124 Vdc @ 0.125 A
SAFETY	Designed to meet IEC61010 (1995), UL61010A-1, CSA-C22.2 standards
ENVIRONMENT	Operating: -10°C to +50°C (+15°F to +122°F); Storage: -30°C to +70°C (-22°F to +158°F)
HUMIDITY	90% RH @ 40°C (104°F) non-condensing
ALTITUDE	2,000 m (6,562 ft) to full safety specifications
OPTIONS	Transportation case
WARRANTY	One year on parts and labor



NOTE

The above specifications are valid at nominal operating voltage and at a temperature of 25°C (77°F). Specifications may change without prior notice.

Table 2. RFD-200 S3 Output Specifications

AC CURRENT OUTPUT				
Range	No-Load Voltage	Load Voltage	Load Current	Load/Unload Times
10A	90 Vac	75 Vac	10 A	2 min / 15 min
40 A	25 Vac	20 Vac	40 A	1 min / 15 min
100 A	10 Vac	7.25 Vac	100 A	1 min / 15 min
100 A	10 Vac	3 Vac	250 A	1 sec / 5 min
AC VOLTAGE OUTPUT				
Range	No-Load Voltage	Load Voltage	Load Current	Load/Unload Times
250 Vac	260 Vac	240 Vac	3 A	10 min / 45 min
DC VOLTAGE OUTPUT				
Range	No-Load Voltage	Load Voltage	Load Current	Load/Unload Times
300 Vdc	300 Vdc	250 Vdc	2A	10 min / 45 min

Table 3. RFD-200 S3 Timing Accuracy

RFD-200 S3 TIMER SECOND DISPLAY IN SECONDS AND CYCLES (50/60 HZ PROGRAMMABLE)		
Range	Resolution	Accuracy
0 to 9.999 sec	1 ms	$\pm (1 \text{ ms} + 0.01\%)$
10.00 to 99.99 sec	10 ms	$\pm (10 \text{ ms} + 0.01\%)$
100.00 to 999.999 sec	100 ms	$\pm (100 \text{ ms} + 0.01\%)$
TIMER CYCLES DISPLAY		
Range	Resolution	Accuracy
0 to 9.999 cycles	0.1 cycle	$\pm (0.1 \text{ cycle} + 0.01\%)$
1,000 to 49,999 cycles / 50 Hz	1 cycle	$\pm (1 \text{ cycle} + 0.01\%)$

1.3 Controls and Indicators

The RFD-200 S3's controls and indicators are shown in Figure 1. The purpose of the controls and indicators may seem obvious, but users should become familiar with them before using the RFD-200 S3. Accidental misuse of the controls will usually cause no serious harm. Users should also be familiar with the safety summary found on the front page of this User's Manual.

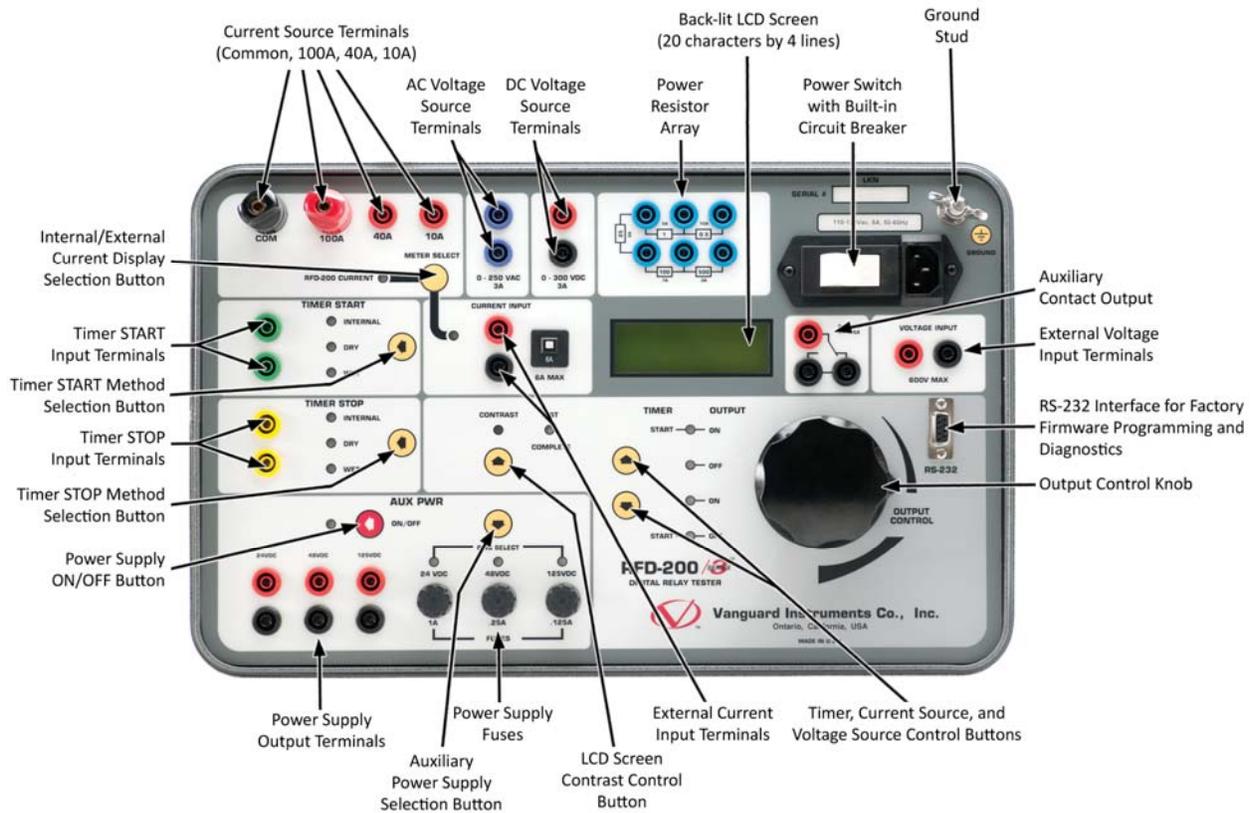
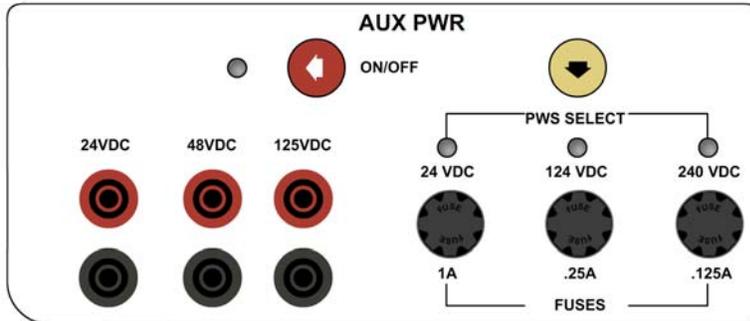


Figure 1. RFD-200 S3 Controls and Indicators

2.0 FUNCTIONAL DESCRIPTION

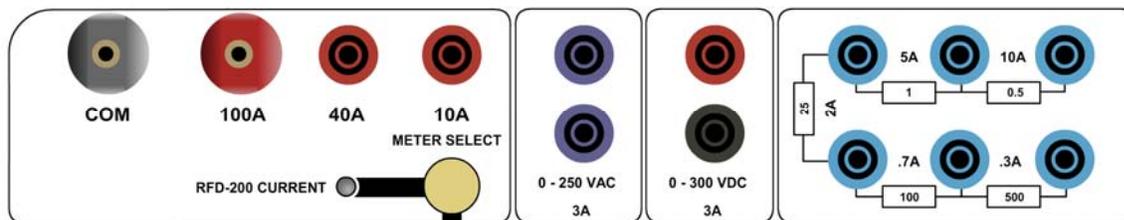
2.1 RFD-200 S3 Auxiliary Power Supply



The RFD-200 S3 provides 3 auxiliary power supplies (24 Vdc, 48 Vdc, and 125 Vdc) for powering electronic relays. Each power supply is fuse-protected. The power supply outputs are controlled by the auxiliary power supply **[ON/OFF]** button. The LED next to the **[ON/OFF]** button is illuminated when the power supply output is turned on.

Only one auxiliary power supply can be selected at a time. The **[PWS SELECT]** button (item 21 in Figure 1) is used to select the power supply. The active power supply is indicated by an illuminated LED above the corresponding voltage label.

2.2 RFD-200 S3 Current and Voltage Sources

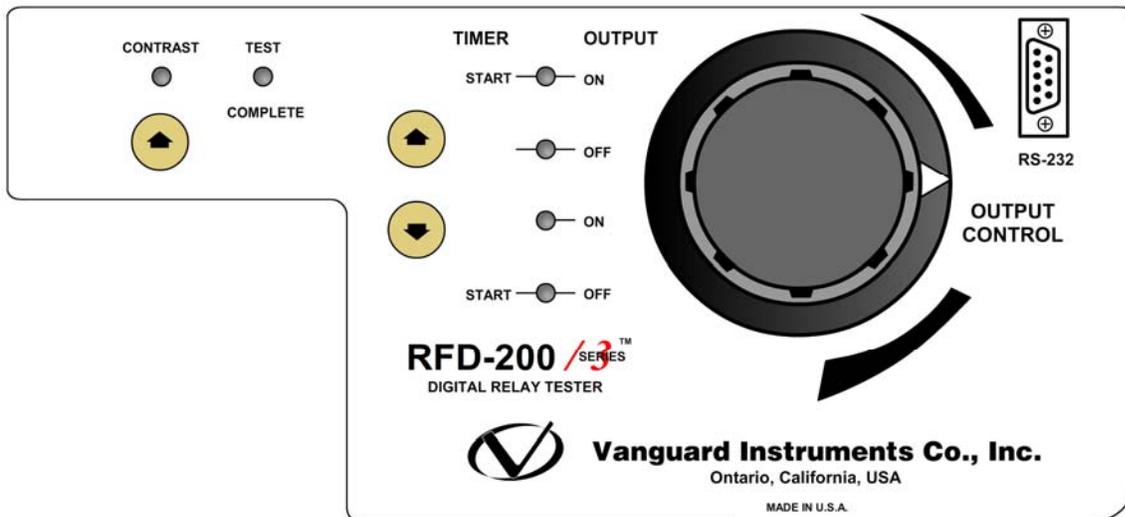


The RFD-200 S3 front panel offers three AC current source terminals (100A, 40A, 10A). Only one current source should be used at a time. The **[METER SELECT]** button is used to select whether to display the current generated by the RFD-200 S3 or the current input at the **[EXT INPUT CURRENT]** terminals. The **[RFD-200 CURRENT]** LED will be illuminated when an internal RFD-200 current source is in use and the output current is displayed on the LCD. The internal current is labeled as “Int I:” on the LCD screen as shown below:



Two isolated voltage sources are also available, one 0-250 Vac and one 0-300 Vdc. Both the current and voltage sources are controlled by the **[OUTPUT CONTROL]** knob .

2.3 Control Switches



2.3.1. Voltage and Current Source Output Controls

The RFD-200 S3's voltage and current source outputs are controlled by the **[UP ARROW]** and **[DOWN ARROW]** buttons. There are four control settings for the voltage/current sources:

- **START-ON**
When this mode is selected, the RFD-200 S3 turns on the voltage/current sources and starts the timer.
- **OFF**
When this mode is selected, the voltage/current sources are turned off and the timer is stopped.
- **ON**
In this mode, both the voltage and current sources are simply turned on and remain on until turned off by the user. The timer is not used in this mode. This mode is used to set the voltage or current before performing a test.
- **START-OFF**
In this mode, the RFD-200 S3 turns off the voltage/current sources and starts the timer.

The selected mode is indicated by an illuminated LED next to the label.

The voltage and current source settings are controlled by the **[OUTPUT CONTROL]** knob.

2.3.2. LCD Contrast Control

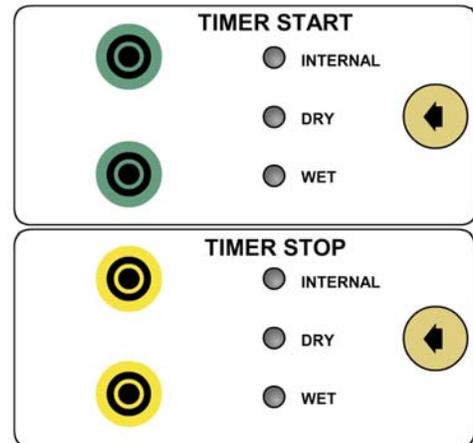
To change the LCD screen's contrast, press and hold the **[CONTRAST]** button. The screen contrast will increase until it reaches the darkest setting. Then it will return to the lightest setting and begin increasing the contrast again. Release the **[CONTRAST]** button when the desired contrast level has been reached. The contrast setting will be stored in the RFD 200 S3's memory.

2.4 Timer Start and Timer Stop Inputs

The RFD-200 S3's built-in timer displays the test results in both milliseconds and cycles.

There are three selections for the **[TIMER START]** input:

- **INTERNAL**
Timer starts when voltage/current sources are turned on or off (user selects Start-On mode or Start-Off mode).
- **DRY**
A change in state of a dry contact input after the user has selected the Start-On mode or Start-Off mode will start the timer.
- **WET**
A change in state of a voltage input (voltage/no voltage) after the user has selected the Start-On mode or Start-Off mode will start the timer.



There are three selections for the **[TIMER STOP]** input:

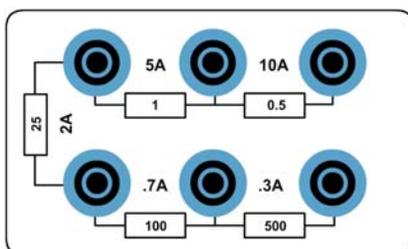
- **INTERNAL**
Timer stops when the user selects OFF mode.
- **DRY**
A change in state of a dry contact input after the timer has started will stop the timer.
- **WET**
A change in state of a wet contact input after the timer has started will stop the timer.



NOTES

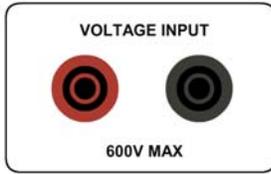
1. For the WET input, A voltage level from 20 to 255 Vac/dc is considered as "ON". Voltage less than 10 Vac/dc is considered as "OFF". The input is not polarity sensitive.
2. The dry contact input detects contact closed (shorted) or contact opened.
3. Applying a voltage to the timer "Dry" contact input may damage the RFD-200 S3

2.5 RFD-200 S3 Power Resistors



Five power resistor connections are available on the RFD-200 S3. A finer control of the current output can be achieved by connecting one or more resistors in series with the current source.

2.6 RFD-200 S3 External Voltage Input



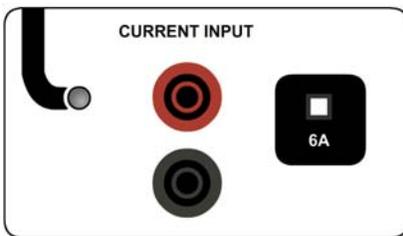
One external voltage input is available on the RFD-200 S3. Maximum input voltage is 600V. The external voltage is labeled as “V Mtr:” on the LCD screen as shown below:

```

0mS  0.0CY
V Mtr: -0.003 V
Int I:  0.080 A
TMR: Single Input
    
```

External Voltage

2.7 RFD-200 S3 External Current Input



The RFD-200 S3 features one external current input. The maximum input current is 6A. The external current is labeled as “EXT I:” on the LCD screen as shown below:

```

0mS  0.0CY
V Mtr: -0.003 V
Int I:  0.080 A
Ext I: -0.001A
    
```

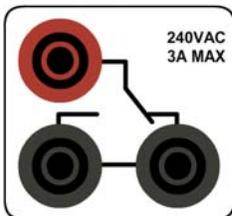
External Current



The **[EXT INPUT CURRENT]** LED must be illuminated in order to display the external current on the LCD screen.

NOTE

2.8 Auxiliary Contact Output



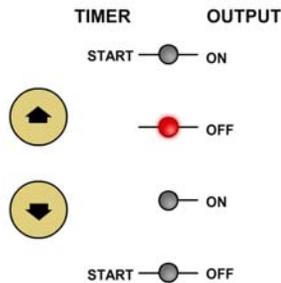
The RFD-200 S3 features a set of NO/NC dry contacts (rated at 3A, 240 Vac/120 Vdc) that change state when a test is initiated.

3.0 OPERATING PROCEDURES

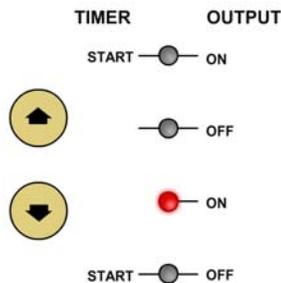
3.1 Setting the Voltage or Current Source

Use the steps below to set the voltage or current source:

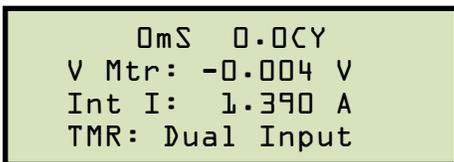
- a. Ensure that the RFD-200 S3 output is off. When the unit is first turned on, the output will be off by default.



- b. Connect the device under test (DUT) to an RFD-200 S3 voltage or current output. If the RFD-200 S3 voltage source is used, the voltage can be monitored using the RFD-200 S3's **[EXTERNAL VOLTAGE INPUT]**. To monitor the voltage, connect the RFD-200 S3 voltage source output to the RFD-200 S3's **[VOLTAGE INPUT]** terminals.
- c. Turn the **[OUTPUT CONTROL]** knob counter-clockwise to the zero position (until the knob will no longer turn).
- d. Select ON by pressing the **[DOWN ARROW]** key in the control mode area. The **[ON]** LED will be illuminated and the unit will start beeping.



- e. Turn the **[OUTPUT CONTROL]** knob clockwise up to the desired voltage or current. The voltage or current settings will be displayed on the LCD screen as shown below.



NOTES

1. Press the **[UP ARROW]** key in the control mode area to select OFF and turn off the voltage/current source.
2. The RFD-200 S3 current source output is displayed on the LCD screen when the **[RFD-200 CURRENT]** LED is illuminated.

3.2 Setting the RFD-200 S3 for a Time Delay Test

Use the steps below to measure an over-current relay time delay:

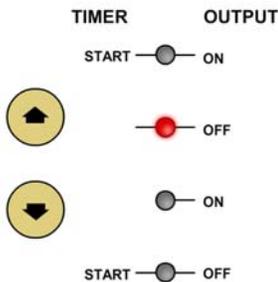
- a. Connect the RFD-200 S3 current source output across the relay coil as shown in Figure 2.
- b. Select INTERNAL for the **[TIMER START]** input by pressing the **[LEFT ARROW]** key in the TIMER START section until the **[INTERNAL]** LED light is illuminated. When the RFD-200 S3 is first turned on, this mode will be selected by default.



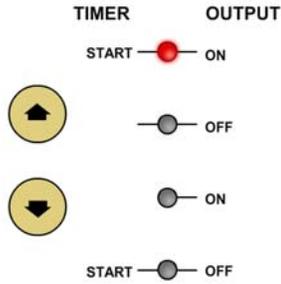
- c. Connect the **[TIMER STOP]** input across the relay dry contact output as shown in Figure 2.
- d. Select DRY for the **[TIMER STOP]** input by pressing the **[LEFT ARROW]** key in the TIMER STOP section until the **[DRY]** LED light is illuminated. When the unit is first turned on, this mode will be selected by default.



- e. Set the test current (see section 3.1).
- f. Turn off the current source by selecting OFF from the control mode area.



- g. Select START-ON from the control mode area.



The RFD-200 S3's timer will start when it energizes the coil voltage, and it will stop when the relay dry contact changes state. The elapsed time and test current will be displayed during the test in seconds and cycles on the LCD screen:

```

15.7000S  1057CY
V Mtr: -0.003 V
Int I:  2.080 A
TMR: Dual Input
    
```

- h. The **[TEST COMPLETE]** LED and the data on the LCD screen will flash when the test has finished (a change of state in the **[TIMER STOP]** input is detected):



The time delay will be displayed on the LCD screen in milliseconds and cycles. The injected test current is also displayed on the LCD screen. A typical test results screen is shown below (actual screen will be flashing):

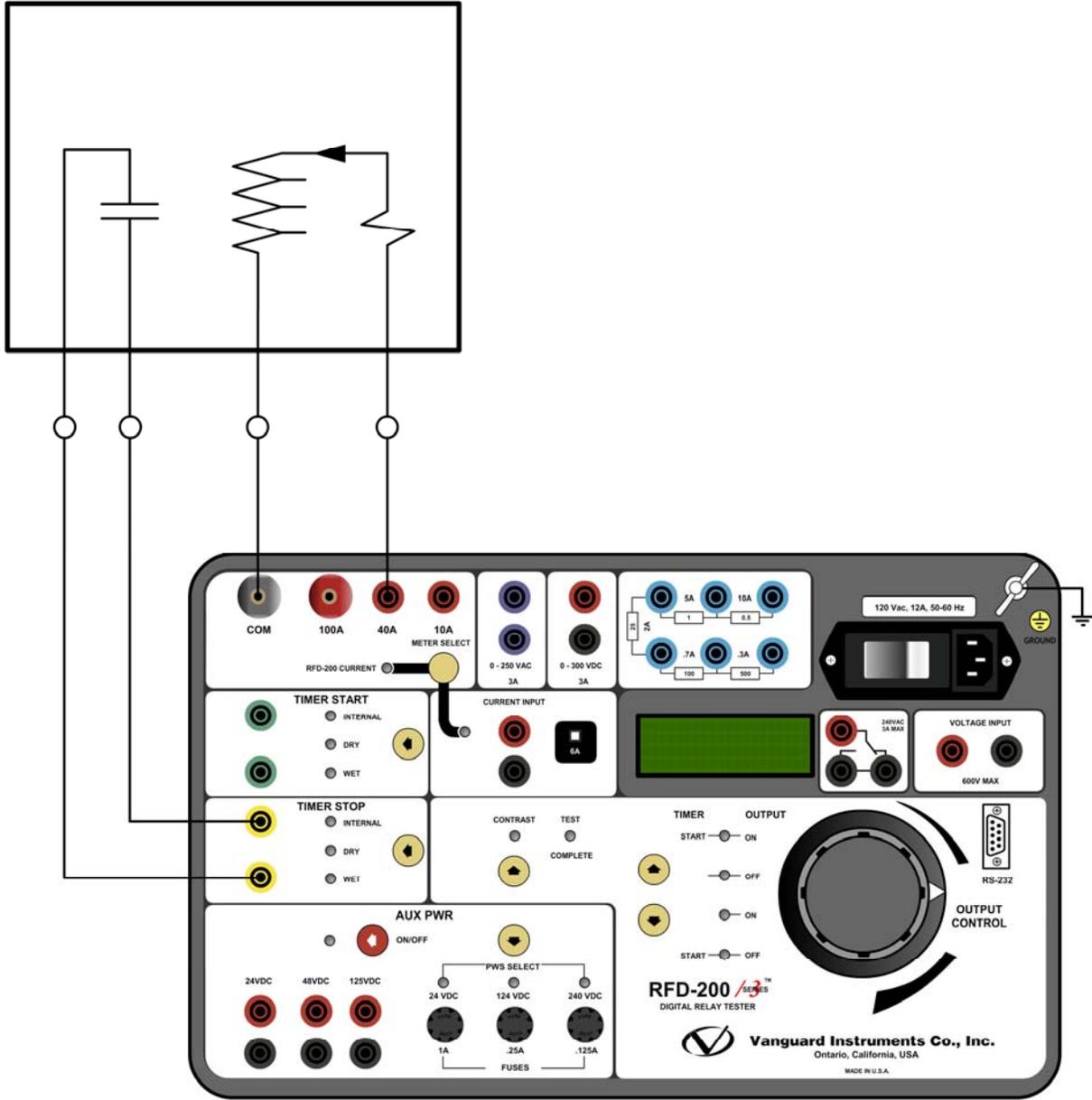
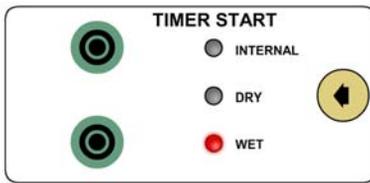


Figure 2. Typical Over Current Relay Connection

3.3 Using the RFD-200 S3's Timer to Test Circuit Breaker Response Time

Use the steps below to use the RFD-200 S3's timer to measure the opening time of a circuit breaker. The timer will start when the RFD-200 S3 detects the voltage being applied to the circuit breaker trip coil. The timer will stop when the RFD-200 S3 detects that the circuit breaker contact has opened.

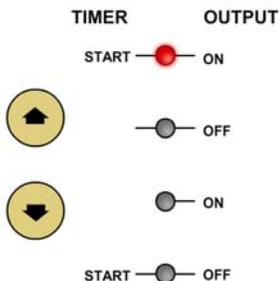
- Connect the **[TIMER START]** input to the circuit breaker coil terminals as shown in Figure 3.
- Select WET for the **[TIMER START]** input. The timer will start when the trip coil is energized.



- Connect the **[TIMER STOP]** input to the circuit breaker dry contact as shown in Figure 3.
- Select DRY for the **[TIMER STOP]** input. The timer will stop when the circuit breaker contact is opened.



- Turn the **[VOLTAGE CONTROL]** knob counter-clockwise to zero (until it can no longer be turned).
- Select START-ON from the control mode area.



- Open the circuit breaker. The RFD-200 S3's timer will start when the circuit breaker coil voltage is detected, and it will stop when the circuit breaker contact has opened.
- The **[TEST COMPLETE]** LED will be illuminated when the test has finished. The time will be displayed on the LCD screen in milliseconds and cycles.

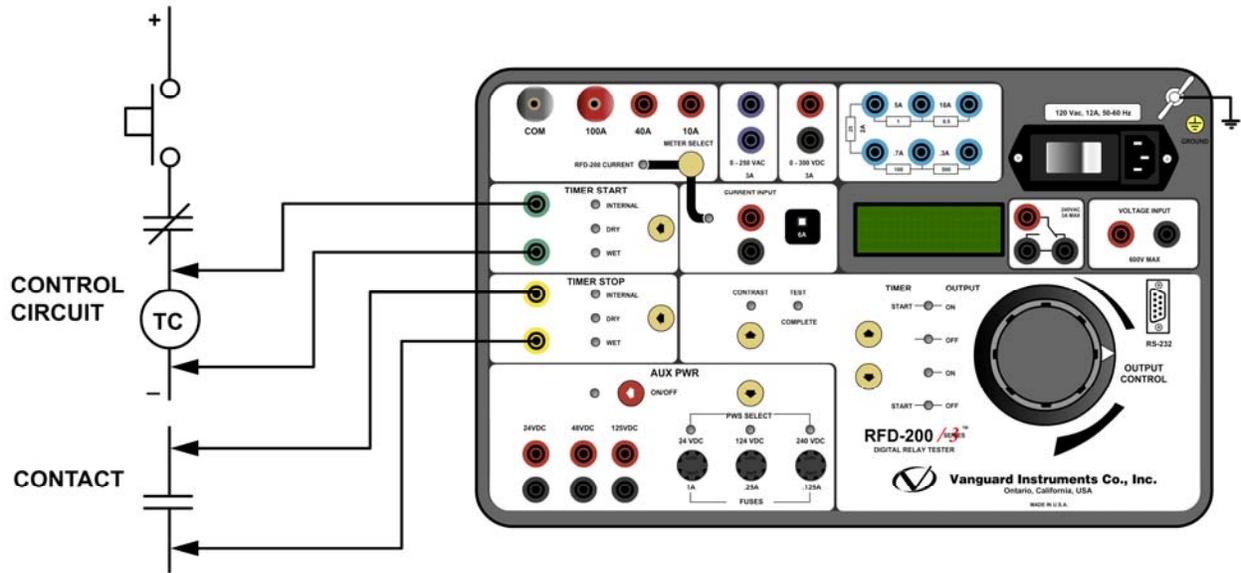
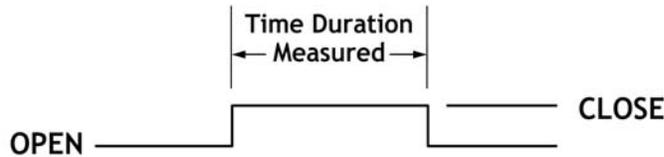


Figure 3. Typical Circuit Breaker Timing Connection

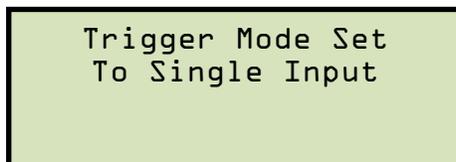
3.4 Using the RFD-200 S3's Timer in Single Input Mode

The RFD-200 S3's timer can also be started and stopped with only the **[TIMER START]** input. This feature is handy for measuring the time duration of the **[TIMER START]** input when it changes states and then returns to the previous state as shown below:



This feature works only with the DRY or WET mode of the **[TIMER START]** input.

To select the single input mode, press and hold the **[TIMER STOP ARROW]** key for 2 seconds. The following screen will be displayed momentarily:

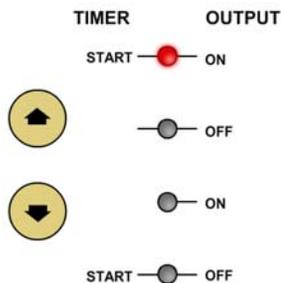


Use the steps below to measure the time a relay contact remains open:

- Press and hold the **[TIMER STOP ARROW]** key for 2 seconds to select Single Input Mode.
- Connect the **[TIMER START]** inputs to the relay's (Normally Closed) contact.
- Select DRY mode for the **[TIMER START]** input.

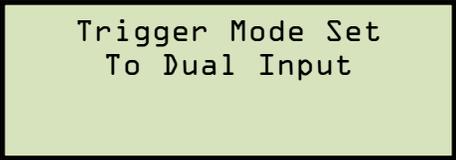


- Select START-ON from the control mode area.



- Energize the relay coil to open the relay's Normally Closed contact. The RFD-200 S3's timer will start and the time will be displayed on the LCD screen.
- De-energize the relay coil to close the relay contact. The RFD-200 S3's timer will stop and the time will be displayed on the LCD screen.

- g. Press and hold the **[TIMER STOP ARROW]** key for 2 seconds to return the RFD-200 S3's timer to dual input mode. The following screen will be displayed momentarily:

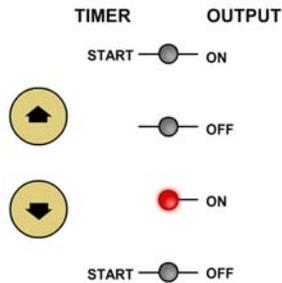


Trigger Mode Set
To Dual Input

3.5 Using the RFD-200 S3 to Plot a Current Transformer Excitation Curve

Use the steps below to find the excitation curves of a current transformer (CT):

- Connect the RFD-200 S3 AC voltage source to the CT secondary winding in series with the external current input as shown in Figure 4.
- Connect the RFD-200 S3 AC voltage source to the RFD-200 S3 external voltage meter as shown in Figure 4.
- Select ON from the control mode area.



- Slowly raise the AC test voltage. Observe and record the excitation voltage and current displayed on the LCD screen.
- Continue to raise the test voltage and record the excitation voltage and current readings.
- When the excitation current reaches saturation (from 1.5A to 2.0A), lower the voltage to zero.
- You can now plot the CT excitation curves using the collected voltage and current readings.

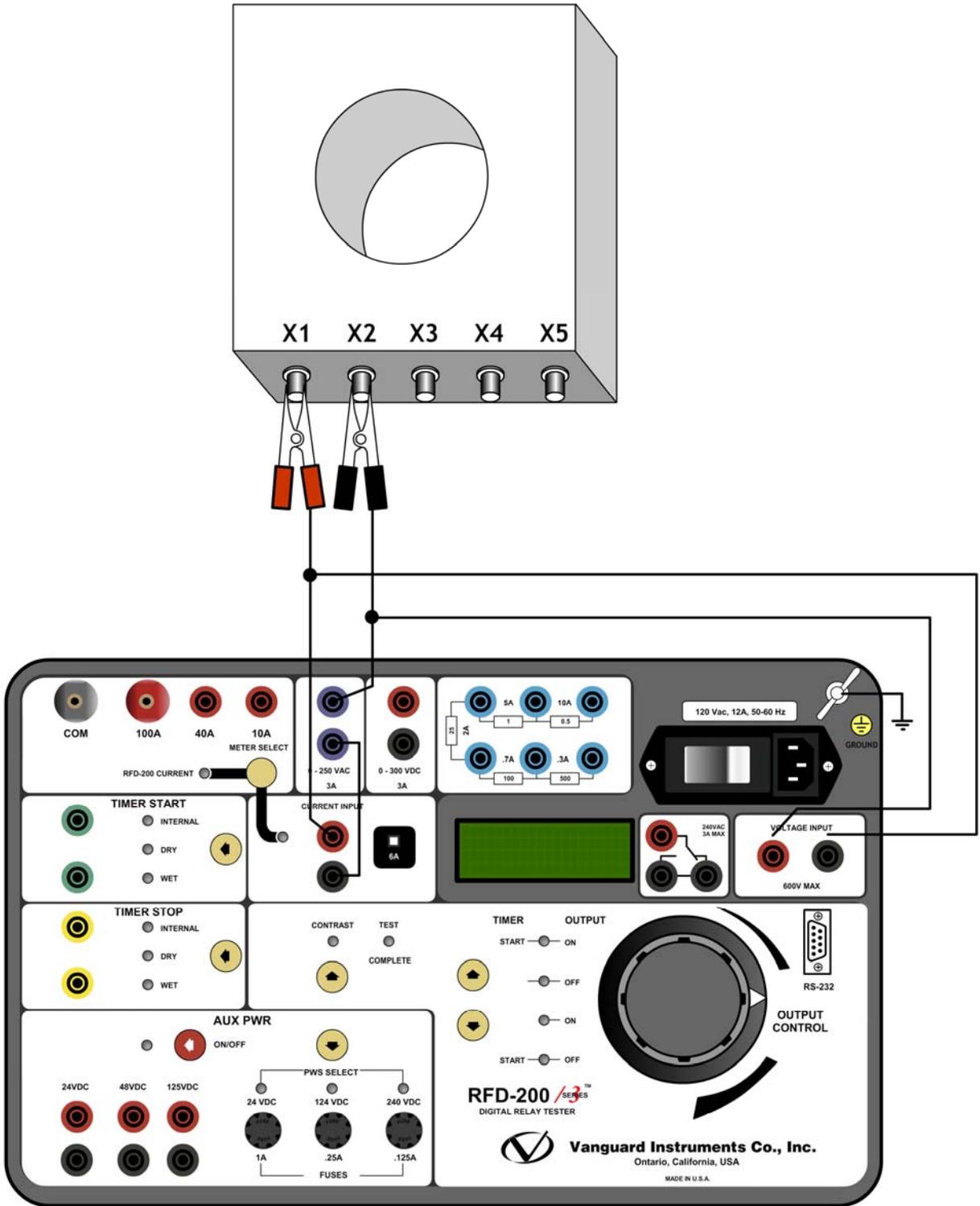
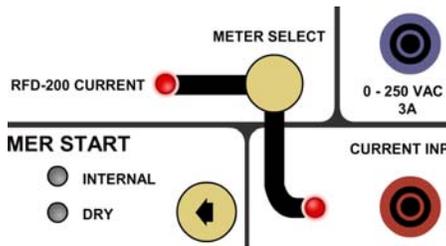


Figure 4. Typical CT Excitation Test Connection

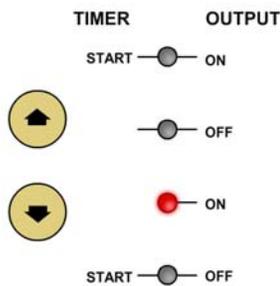
3.6 Using the RFD-200 S3 to Measure CT Primary and Secondary Currents

Use the steps below to measure the CT primary and secondary currents with the RFD-200 S3:

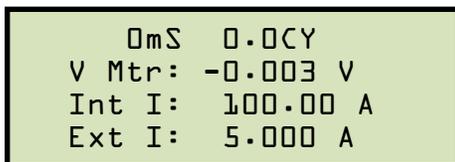
- Connect the RFD-200 S3 current source through the CT primary current path as shown in Figure 5.
- Connect the CT secondary winding to the RFD-200 S3 **[EXT INPUT CURRENT]** input as shown in Figure 5.
- Turn on internal and external current display on the RFD-200 S3 by pressing the **[METER SELECT]** key. You may have to press the key a few times till both the **[RFD-200 CURRENT]** and the **[EXT INPUT CURRENT]** LED's are illuminated.



- Select ON from the control mode area.



- Raise the test current to the desired setting.
- The primary and secondary current readings will be displayed on the LCD screen as shown below:

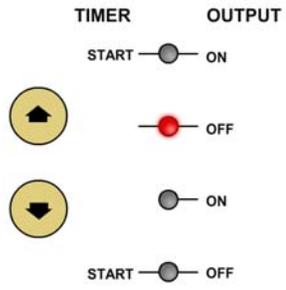


 The CT turns ratio can be calculated using the primary and secondary current readings.

NOTE

- Return the test current to zero.

h. Select OFF from the control mode area.



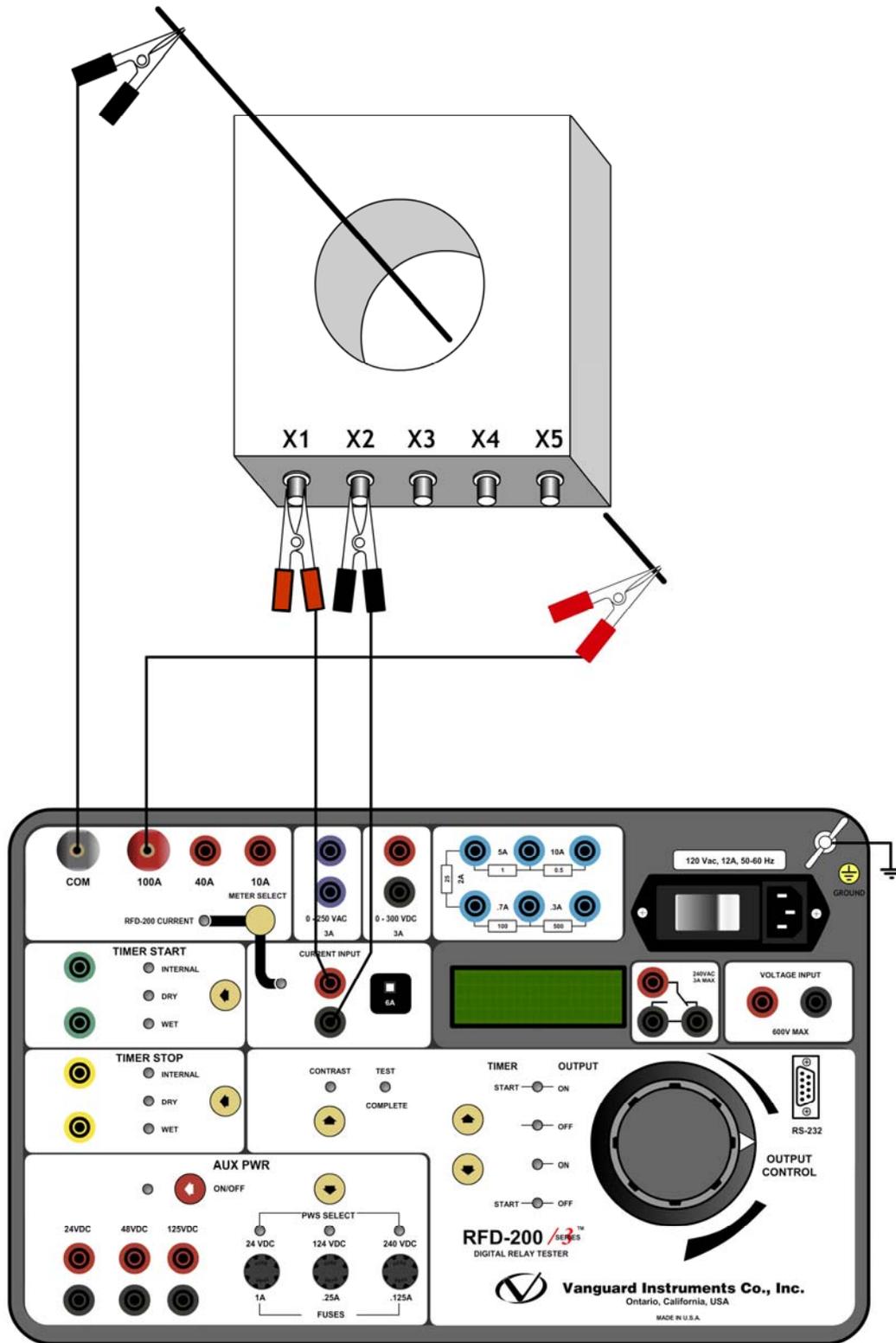


Figure 5. Typical CT Turns Ratio Test Connection



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