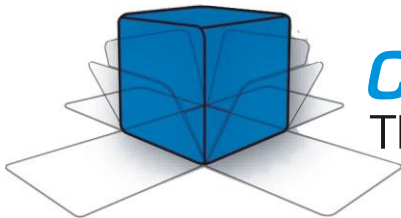


# CDT-240

CAPACITOR DISCHARGE TESTER

## Instruction Manual



***COMPLIANCE WEST USA***  
The blue box that tests. And tests.





*Dear Customer:*

*Congratulations! Compliance West USA is proud to present you with your CDT-240 Capacitor Discharge Tester. Your instrument features a logic-controlled circuit for a Residual Voltage Meter.*

*To fully appreciate all the features of your new meter, we suggest that you take a few moments to review this manual. If the need arises, please don't hesitate to call on us.*

*Thank you for your trust and confidence.*



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# **Section 1**

## **Introduction and Safety**

### **An Introduction to Residual Voltage measurements with CDT-240 Tester**

Quite often, electrical devices and appliances use discrete capacitors connected from Line to Neutral and from Line to Ground in order to meet conducted electromagnetic emissions requirements. These requirements are mandated by the FCC and other regulatory authorities. When the power cord of the device is unplugged (especially near the peak of the AC line voltage), a voltage can remain on the capacitors that presents a shock hazard at the prongs of the power cord. Safety regulations restrict the amount of stored energy and voltage that could present a shock hazard to the device user. The CDT-240 is used to measure the remaining voltage that is stored on these capacitors when the power cord is unplugged.

### **Safety Precautions**

The CDT-240 tester can connect to voltages in excess of 264V at potentially lethal current levels. Currents of as little as 5mA at 120 volts can cause death; the CDT-240 can pass through currents of more than 8 Amps. The potential for serious injury or death exists and personnel should be aware when they conduct this test.

### **Test Personnel**

Personnel require special training to conduct the test. They should understand electrical fundamentals clearly, and be aware that high voltage is adept and creative at completing a path to ground. Instructions should include a warning against any metal jewelry. Operators should not allow others in the testing area, especially when tests are being conducted. Organization is to be stressed. The operator should keep the area free of unused leads and equipment.

### **Testing Area**

The area used for conducting the test should be as remote as possible from normal production line activities. Only personnel actually conducting the test should be allowed in the area, and it should be taped or roped off to preclude casual entry by other employees. In addition, the area should be marked "WARNING - HIGH VOLTAGE TESTING" or the equivalent to warn others of the nature of the testing taking place.

The bench being used should be non-conductive, and any exposed metal parts should be tied together and grounded. If a conductive surface must be used, it should be grounded.

### **Safety Techniques**

The internal circuitry of the CDT-240 can be shut off at any time by turning OFF the rear power switch. There are separate power connections on the rear panel of the CDT-240 to connect the Equipment Under Test (EUT) to a power source. To completely remove power to the CDT-240 and the EUT, all power cords must be unplugged.



## **Section 2**

### **Getting Started**

#### **Unpacking your Tester**

The CDT-240 tester unit is shipped in a special protective container that prevents damage to the instrument during shipping. Check the shipping order against the contents of the container and report any damage or incomplete shipment to Compliance West USA. The container should include the following:

- Qty 1 PN:00-CDT-240 (CDT-240, Capacitor Discharge Tester)
- Qty 2 PN:70-101 (AC Power cord, 18AWG, 4ft long)
- Qty 1 PN:00-HVTL-CDT-G-4 (Test Lead for CDT, Green, 4ft long)
- Qty 1 PN:00-HVTL-CDT-B-4 (Test Lead for CDT, Black, 4ft long)
- Qty 1 PN:00-HVTL-CDT-W-4 (Test Lead for CDT, White, 4ft long)
- Qty 1 PN:00-CBX (Calibration Box for CDT-240)
- Qty 1 Instruction Manual.
- Qty 1 NIST Traceable Calibration Certificate to MIL-STD45662-A

If reshipment of the instrument is necessary, please use the original shipping container. If the original shipping container is not available, be sure that adequate protection is provided to prevent damage during shipment. We recommend that the instrument be surrounded by three inches of shock-absorbing material on all sides of the container. Remove the tester from its container and place it on a test bench.

#### **AC Line Voltage Requirements**

AC line voltage requirements for your tester are noted on the rear panel of the instrument. Do not connect the instrument to a different voltage source, use the power cord and make sure you have a ground connection in your building before you start testing.

#### **Fuse Replacement**

There are two user replaceable fuses located on the rear panel of the instrument. Fuses rating are noted on the rear panel. Do not attempt to replace it with a fuse of any other rating.

The first fuse is located on the bottom right side behind a door in the Inlet-Power Switch-Fuse Holder device. This fuse protects the internal circuitry of the CDT-240. Do not attempt to replace it with a fuse of any other rating. Use the following procedure to replace the fuse:

- Turn the power switch to the OFF position.
- Unplug the instrument from the source of supply.
- Remove the power inlet cord from the instrument.
- Using a small screwdriver, pry open the fuse holder door at the power inlet connector.
- Replace the fuse with a new one of the correct rating.
- Replace the fuse holder door and power inlet cord.

The second fuse is located on the bottom left side of the rear enclosure panel. This fuse provides over current protection to the EUT. Use the following procedure to replace the fuse:

- Turn the power switch to the OFF position.
- Unplug the instrument from the any source of supply.
- Push and turn counterclockwise the fuse holder to remove the fuse.
- Replace the fuse with a new one of the correct rating.
- Replace the fuse holder and power inlet cords.

## Section 3

### Specifications and Controls

#### Specifications

##### **TESTING CIRCUITRY**

Minimum / Maximum Test Voltage	90Vrms min/ 270Vrms max
Maximum Test Current	8A for CDT-240 8A / or CDT-240 15A option
Fuse (CDT-240 8A option)	10A, 250V, time delay, 1-1/4" x 1/4"
Fuse (CDT-240 15A option)	20A, 250V, time delay, 1-1/4" x 1/4"
Probe Impedance	> 100 M $\Omega$ , < 25pF (See appendix A for measurement method)
AC Peak Detection Accuracy	EUT disconnect within 5% of supply voltage peak
Test Time Range	0.50 – 10.00 Seconds
Voltage Setting/Measurement Range	+/-30 to 388V
Voltage Setting Resolution	1V
Test Time Accuracy	+/- 1% for times $\geq$ 1 second, +/- 10mS for less than 1 second
Voltage Meter Accuracy	+/- 1.5% of instrument measuring range; +/- 2% +/- 0.8V up to 270Vrms (See Appendix E for accuracy information with respect to voltage readings and accuracy)
Frequency	50-60Hz

##### **ELECTRICAL**

Rated Input Voltage	110-240 V
Frequency	50/60 Hz
Fuse	2 A, 250V, time delay, 5 x 20 mm

##### **ENVIRONMENTAL**

Operation Temperature	15 - 40 °C
Relative Humidity Range	0 – 90 % Non-Condensing

##### **SAFETY**

(XI) Safety Interlock operation	2 pin terminal block on rear panel, shorted for tester operation
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##### **GENERAL**

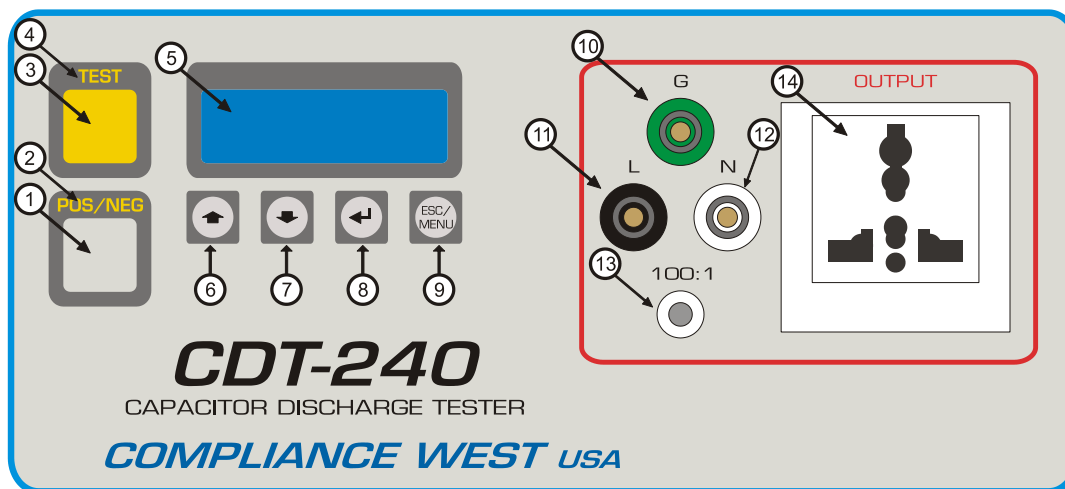
Dimensions	9-1/4" Wide x 4-3/4" High x 10" Deep
Weight	5.8 lbs.

##### **BNC OUTPUT**

Referenced to ground, 100:1 of measured voltage +/-2% (L-N, L-G, N-G)

## Front Panel Features

Before using the CDT-240 tester, take a few minutes to become familiar with the use of its controls, indicators, and connectors. The front panel features of the CDT-240 tester are shown on Figure 3.1 and described in Table 3.1.



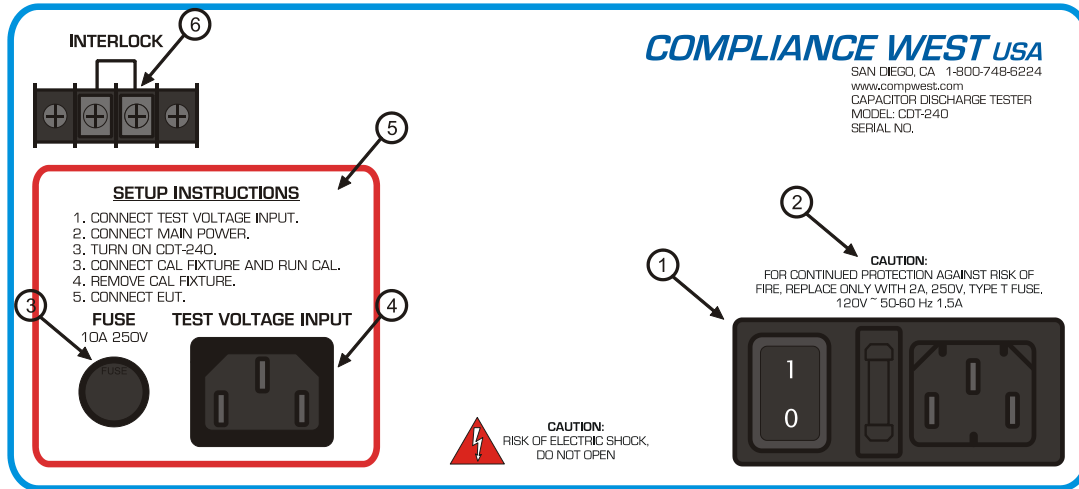
**Figure 3.1 Front Panel Controls, Indicators and Connectors**

ITEM	NAME	FUNCTION
1	POS/NEG Button	POS/NEG Button, N/A.
2	POS/NEG LED	POS/NEG LED indicate the polarity selected.
3	TEST Button	TEST Button is used to ARM and START the test.
4	TEST LED	TEST LED flashes after pressing TEST button indicating the unit is ARM. Second press of TEST button runs the test.
5	LCD Display	3 x 16 LCD display
6	UP Button	UP Button is used to move UP in the menu and to increase value when editing a parameter.
7	DOWN Button	DOWN Button is used to move DOWN in the menu and to decrease value when editing a parameter.
8	ENTER (RTN)	ENTER (RTN) Button is use to Enter/Select in the menu and to save changes when editing a parameter.
9	ESC/MENU	ESC/MENU is used to escape and go to Main Menu
10	EUT Ground	Individual jack for Ground where EUT can be connected
11	EUT Line	Individual jack for Line where EUT can be connected
12	EUT Neutral	Individual jack for Neutral where EUT can be connected
13	100:1 BNC	BNC 100:1 voltage output for connection to an oscilloscope. The signal is used for reference viewing of the residual voltage signal
14	EUT Output Jack	Universal output jack where EUT will be connected. This Jack carries Line, Neutral and Ground.

**Table 3.1 Front Panel Controls, Indicators and Connectors**

## Rear Panel Features

Before using the CDT-240 tester, take a few minutes to become familiar with the use of its controls, indicators, and connectors. The rear panel features are shown on Figure 3.2 and described in Table 3.2



**Figure 3.2 Rear Panel Controls, Indicators and Connectors**

ITEM	NAME	FUNCTION
1	Appliance Inlet / Fuse holder / Power Switch	Use supplied cord set to connect tester to appropriate source of supply. Replace line fuse. Turn Tester ON/OFF.
2	Fuse replacement warning / Rating of supply	Specifies replacement fuse and required supply voltage for the CDT-240 tester.
3	FUSE (Test Voltage, EUT)	Fuse 10A, 250V, time delay, 1- $\frac{1}{4}$ " x $\frac{1}{4}$ ". For CDT-240 8A Fuse 20A, 250V, time delay, 1- $\frac{1}{4}$ " x $\frac{1}{4}$ ". For CDT-240 15A
4	TEST VOLTAGE INPUT	Voltage supply for the EUT.
5	SETUP INSTRUCTIONS	Instructions of how to setup your CDT-240.
6	Interlock Switch	Emergency Stop. Short: Enables the tester buttons for operation. Open: Stops any process in the tester and disables the buttons.

**Table 3.2 Rear Panel Controls, Indicators and Connectors.**

### Factory Settings.

The CDT-240 comes with the factory setting described on table 3.3

LOCATION	STANDARD	TEST TYPE	VOLTAGE	TIME	TRIGGER	REFERENCE	EDITABLE
Memory 1	IEC 60950	Delay	-	3.0s	Negative	L-G	Yes
Memory 2 *	IEC 60950	Voltage	50.0V	-	Positive	L-G	Yes
Memory 3	IEC 60950	Delay	-	1.0s	Negative	L-G	Yes
Memory 4	IEC 60950	Delay	-	1.0s	Positive	L-G	Yes
Standard 1	IEC 61010	Delay	-	5.0s	Positive	L-N	No
Standard 2	IEC 60065	Delay	-	2.0s	Positive	L-N	No
Standard 3	IEC 60335	Delay	-	1.0s	Positive	L-N	No

**Table 3.3 Factory Settings.**

\*Voltage must be adjusted, see testing IEC 60950 for details.

All memories can be edited. Standard 1, 2 and 3 are fixed.

# Section 4

## Operating Instructions

### Test Definitions

The CDT-240 Plug Discharge tester is capable to perform two different types of residual voltage measurements: Delay Test and Voltage Test.

The Delay Test allows the CDT-240 to measure the residual voltage after a specified amount of time has elapsed (for example, measure the residual voltage one second after the power is disconnected).

The Voltage Test allows the CDT-240 to measure the elapsed time until the voltage has dropped from the peak of the AC voltage (when power to the EUT is disconnected) to a specific voltage level.

### Test Setup

#### Safety

1. Before connecting the equipment under test make sure the CDT-240 is armed (refer to “Running a test” pg.13)
2. Make sure cables are not exposed and always remove the G,N,L test leads from the front panel when using a power cord on the output and vice versa.

#### Using the AC power cord of the EUT

1. Always follow the safety instructions before operating the CDT-240.
2. Connect the power cord of your equipment under test to the output on the front panel, see image 4.1

#### Using the L,N,G test leads

1. Always follow the safety instructions before operating the CDT-240.
2. Connect the Green test lead (G) to the ground of the EUT.
3. Connect the Black test lead (L) to the line input of the EUT.
4. Connect the White test lead (N) to the neutral of the EUT, see image 4.2

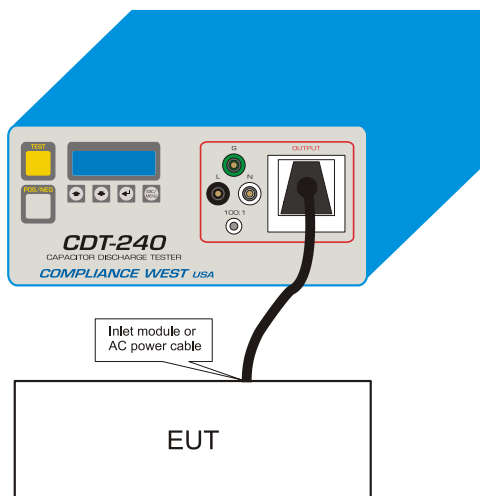


Image 4.1

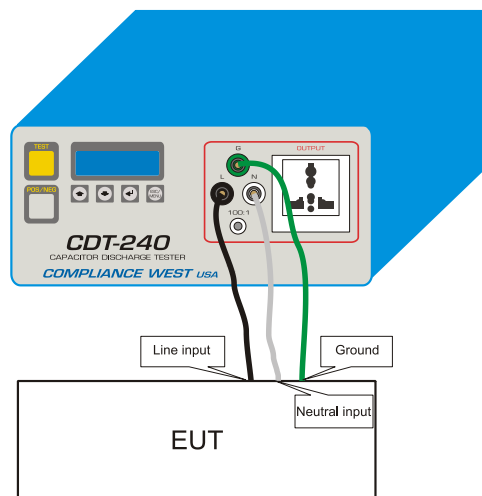
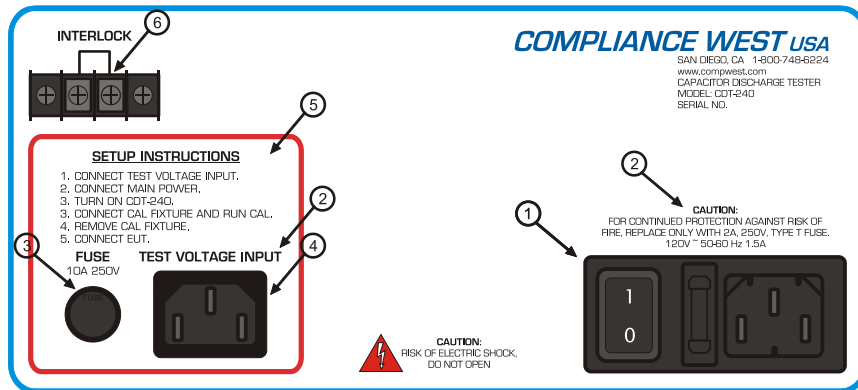


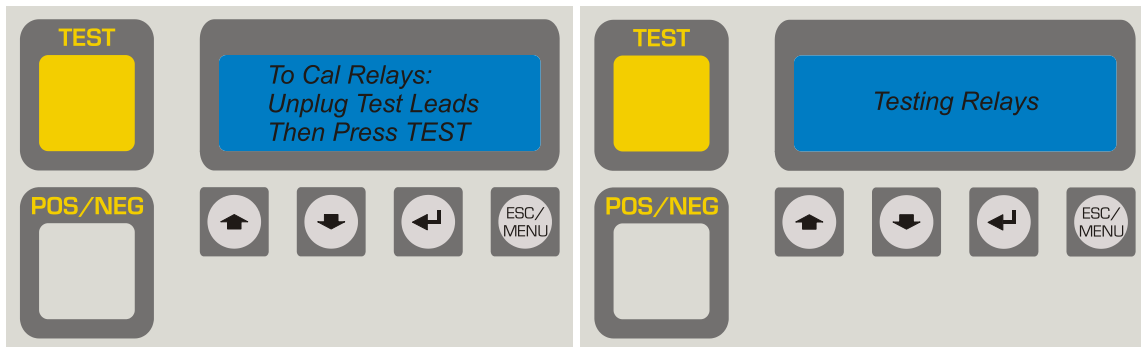
Image 4.2

## Starting the CDT-240

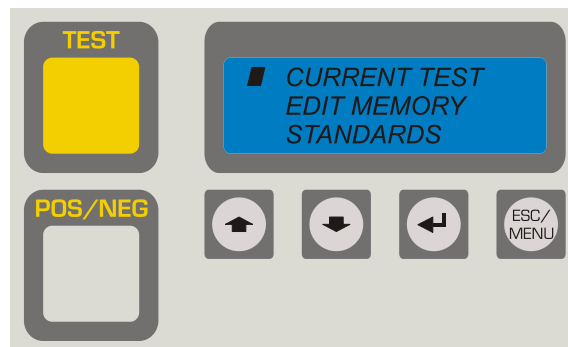
1. Connect the voltage input. Plug the CDT-240 to a main voltage supply. See image below (1)
2. Connect the TEST VOLTAGE INPUT with the desired test voltage. See image below (2)



3. The tester requires to run the calibration on every start up.
4. Turn on the CDT-240.
5. A message to Cal Relays will appear.
6. Press TEST, the “Testing Relays” message will appear for a few seconds.

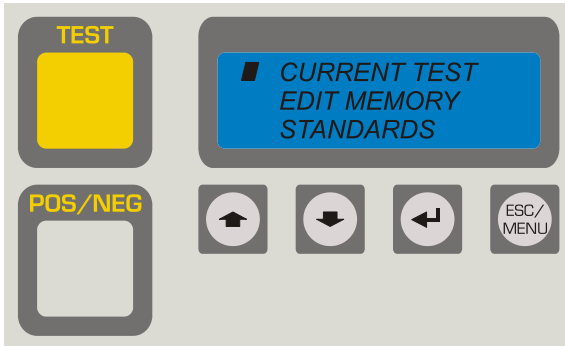


7. After calibration is finished, the CDT-240 will display the main menu.



## Main Menu

The main menu includes 3 options, use ▲ and ▼ buttons and press ENTER (RTN) to select.



CURRENT TEST - To view current test settings.

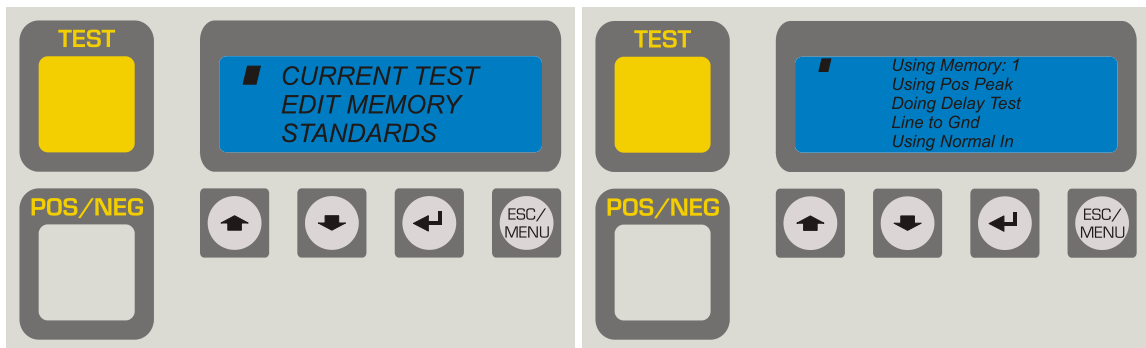
EDIT MEMORY - To edit a memory setting.

STANDARDS - Displays the pre-set standards available.

## View Current Test Settings

Use this option to select/review the settings saved in a specific memory/standard.

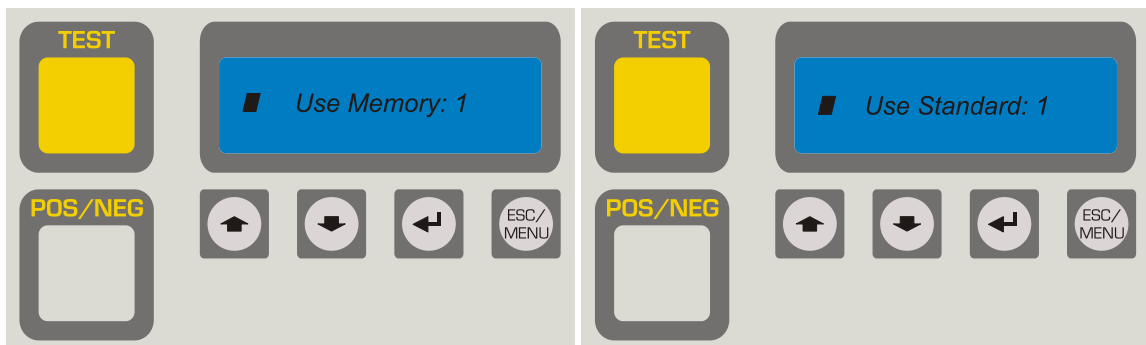
1. Select CURRENT TEST from main menu and press ENTER (RTN). (left image below)
2. To view current test settings use ▲ and ▼ buttons, press ESC to go back. (right image)
3. To view the settings saved on a different memory follow the instructions under **Select Test Memory/Standard**



## Select Test Memory/Standard

Use this option to select or change the test memory/standard.

1. Select CURRENT TEST from main menu and press ENTER (RTN).
2. Select Using Memory and press ENTER (RTN)
3. Select the desired memory/standard using ▲ and ▼ buttons and press ENTER (RTN).

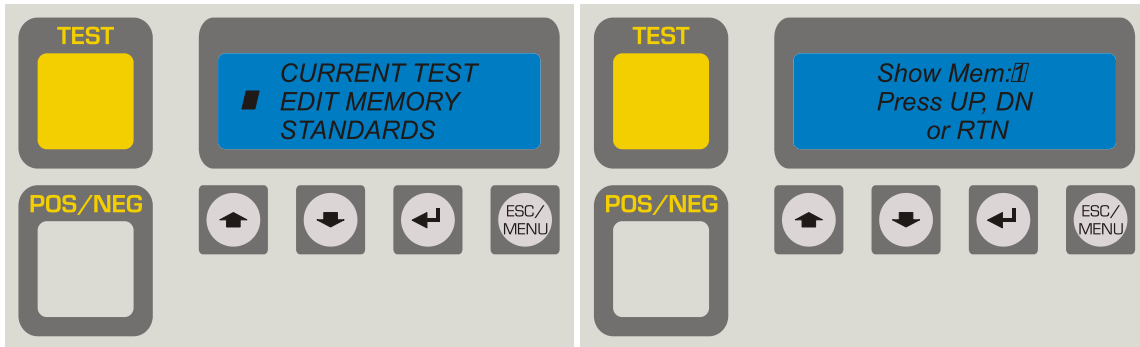




## Edit Memory

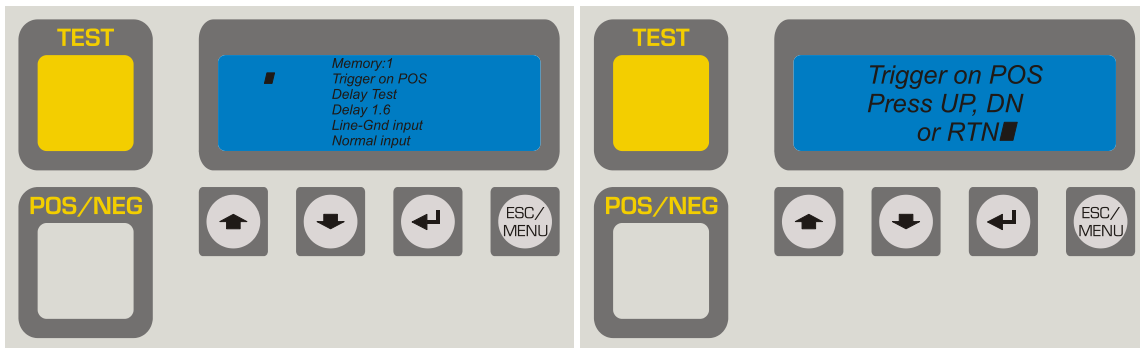
Use this option to edit the settings saved in a specific memory. The preset standards parameters can't be edited, refer to table 3.3 for factory settings and standard parameters. Standard 1 for IEC 61010, standard 2 for IEC 60065 and Standard 3 for IEC 60335.

1. Select EDIT MEMORY from main menu. (left image below)
2. Select the memory to edit using ▲ and ▼ buttons and press ENTER (RTN). (right image)
3. Press ESC/MENU to go back to main menu anytime.

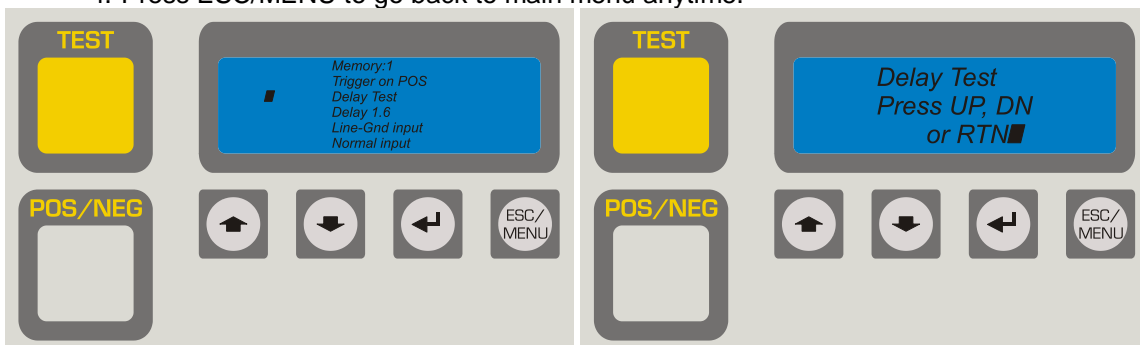


4. Select the setting to edit using ▲ and ▼ buttons and press ENTER.

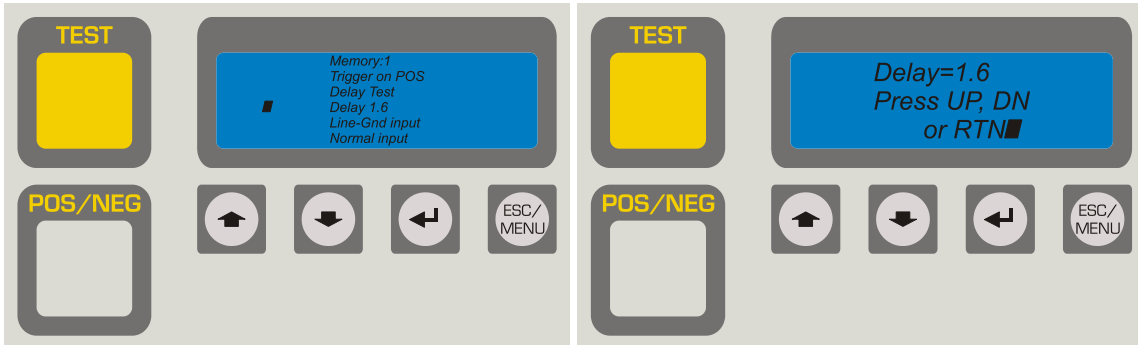
- a. To Change the trigger polarity, select Trigger from EDIT MEMORY menu. (left image below)
- b. Use ▲ and ▼ buttons to select POS or NEG and press ENTER (RTN) to save. (right image)
- c. Press ESC/MENU to go back to main menu anytime.



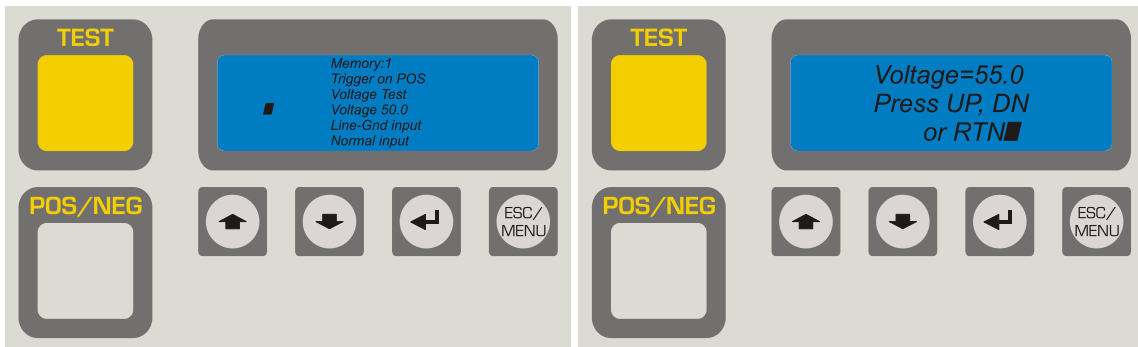
- d. Test type: select Delay or Voltage Test from EDIT MEMORY menu. (left image)
- e. Use ▲ and ▼ buttons to select test type and press ENTER (RTN). (right image below)
- f. Press ESC/MENU to go back to main menu anytime.



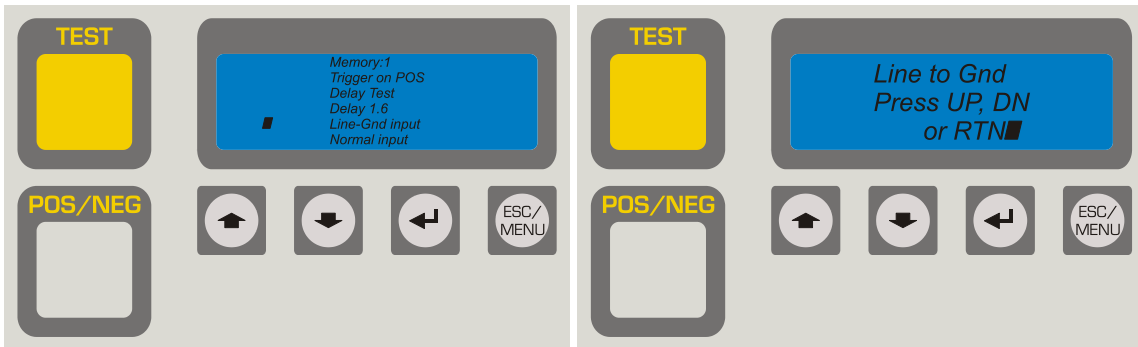
- g. To change the Delay time, select the Delay = “seconds” from the EDIT MEMORY menu. (left image)
  - h. Use ▲ and ▼ buttons to set the time in seconds and press ENTER (RTN). (right image below)
- If voltage test is selected the time can't be changed.



- i. To change the Voltage “value” select “Voltage” from the selected MEMORY menu.
  - j. Use ▲ and ▼ buttons to set the voltage and press ENTER (RTN). (right image below)
  - k. Press ESC/MENU to go back to main menu anytime.
- If delay test is selected the voltage can't be changed.

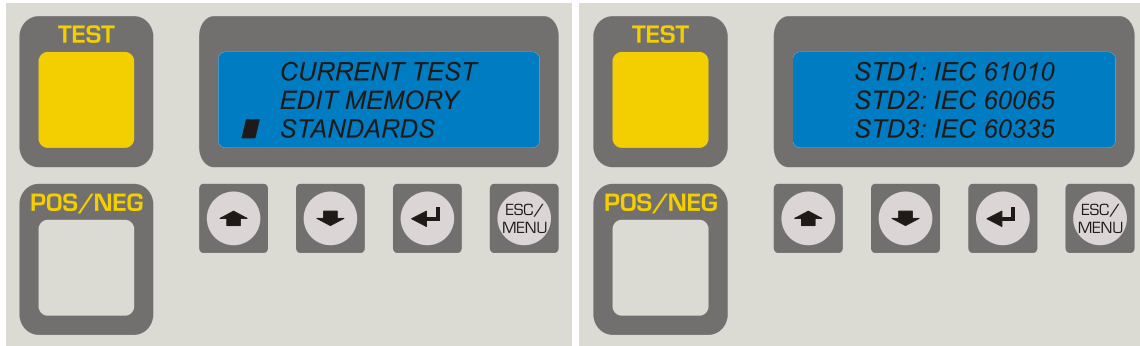


- l. To change the reference select “Line- Gnd input” from the selected MEMORY menu. (left image)
- m. Use ▲ and ▼ buttons to select Line to Gnd, Line to Neutral, Neutral to Gnd and press ENTER (RTN). (right image)
- n. Press ESC/MENU to go back to main menu anytime.



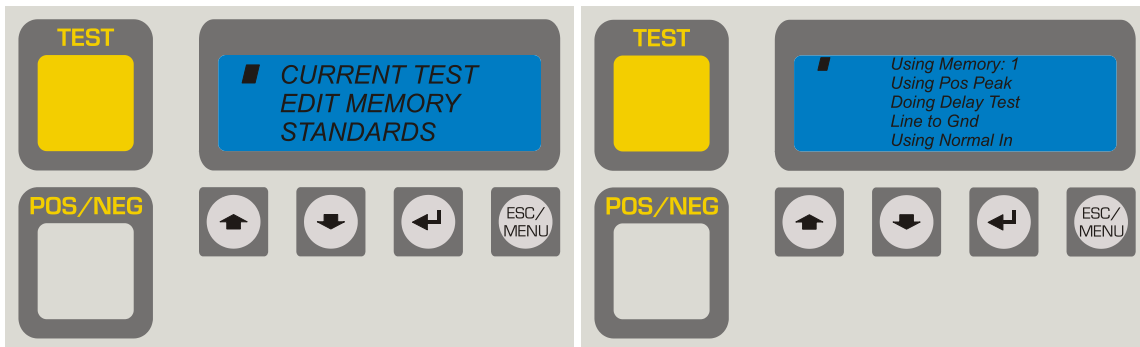
## View Available Standards

1. To view the available preset standards, select STANDARDS from main menu. (left image below)
2. Available standards are shown on display. (right image below)
3. Press ESC/MENU to return to main menu.

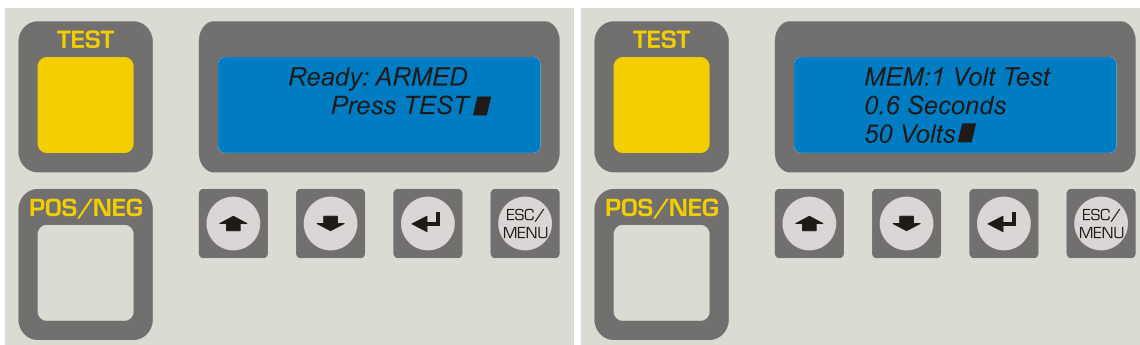


## Running a Test

1. Go to main menu. Press ESC/MENU. (left image below)
2. Select CURRENT TEST and press ENTER (RTN) to see which test is being conducted. (right image)
3. Press ESC/MENU to return to main menu.



4. Press TEST to ARM the CDT-240.  
**Warning:** The voltage will be present on the front panel output when ARMED. (left image below)
5. Press TEST again and the CDT-240 will run the test.
6. After the test is finished the result of the test will be displayed. (right image below)
7. To run the test again press ESC/MENU and repeat step 4 and 5.



## BNC Setup and Operation

The CDT-240 is equipped with a BNC 100:1 output. This output signal can be connected to an oscilloscope for reference. In the oscilloscope can be captured the residual voltage in the EUT.

A straight-through BNC-to-BNC cable can be used to connect the BNC output of the CDT-240 to the Channel 1 input of an oscilloscope. Alternatively, a standard oscilloscope probe can be used with an adaptor to connect to the BNC connector on the CDT-240.

The voltage measurement output of the BNC is automatically switched between Line to Ground, Line to Neutral, and Neutral to Ground when the measurement point is selected during test setup.

### Voltage Test:

When the TEST button is pressed to ARM the output (test voltage is applied to the EUT front panel connector), the BNC output will show a ground referenced, 100:1 representation of the EUT Test voltage (L-G, L-N, or N-G). When the TEST button is pressed a second time, the Test is triggered and the R-C decay appears on the BNC output. Refer to Figure 4.2 for details. Trigger settings on the oscilloscope will vary depending on the oscilloscope used in order to capture an image similar to Figure 4.2.

#### Oscilloscope typical trigger settings for Voltage Test are:

- Normal Trigger (display stops refreshing when no trigger event is detected).
- Trigger Level set to just below the peak voltage (use the negative peak if a POS test is conducted, and the positive peak if a NEG test is conducted).
- Trigger time should be set to 10% (near the left side of the display).

### Delay Test:

When the TEST button is pressed to ARM the output (test voltage is applied to the EUT front panel connector), the BNC output will show a ground referenced, 100:1 representation of the EUT Test voltage (L-G, L-N, or N-G). When the TEST button is pressed a second time, after the specified Delay time, the CDT-240 will measure the voltage, the R-C time constant voltage decay can be seen all the time. Refer to Figure 4.3 for an example of the waveform.

#### Oscilloscope typical trigger settings for Voltage Test are:

- Normal Trigger (display stops refreshing when no trigger event is detected).
- Trigger Level set to just below the peak voltage (use the negative peak if a POS test is conducted, and the positive peak if a NEG test is conducted).
- Trigger time should be set to 10% (near the left side of the display).

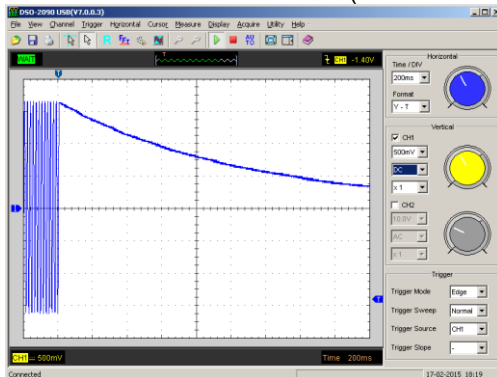


Figure 4.2

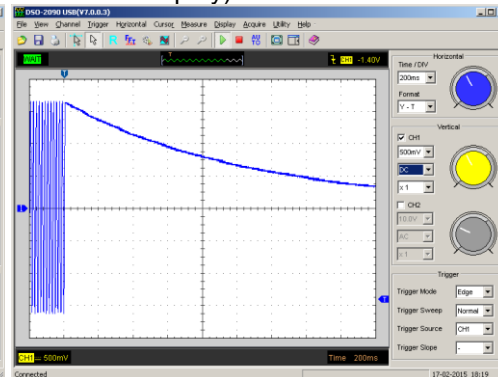


Figure 4.3

## Testing IEC 60950

The IEC 60950 standard specifies that the time constant for the voltage decay be less than 1 second (for normal equipment with a power cord). This measurement can be accomplished by the CDT-240 in two ways:

- **Select a Voltage Test**, and set the Voltage level to 37% of the peak voltage level. For example, if testing at 240Vrms, the peak voltage is 340 Volts ( $1.41 \times 240$ ). 37% of 340 is 126 Volts. So, the voltage level should be set for 126 Volts. When the test is performed, if the measured time to reach 126 Volts is less than 1 second, the EUT meets the requirement from IEC 60950.

The factory settings of Memory 2 can be used to conduct the Voltage Test. Please note that the Voltage setting of 50.0V must be changed. For the example noted above, the Voltage Setting must be reset to 126V.

Use the following Memory Locations for these tests:

Memory 2: Line-Ground, Positive trigger

(If using the BNC output, set the scope as noted in Section "BNC Setup and Operation", "Delay Test", Page 14.)

To change the Voltage Setting:

- a. Verify that Memory 2 is the current test being conducted by selecting "CURRENT TEST" from the main menu and pressing ENTER. If Memory 2 is displayed, press ESC. If Memory 2 is not displayed, select it using the up and down buttons, and then pressing ESC to return to the Main Menu.
- b. Select EDIT MEMORY from the main menu, then select Memory 2 using the up and down buttons. Press the ENTER key.
- c. Select "Voltage 50.0" and press the ENTER key.
- d. Using the Up arrow, change the voltage to 126.0V and press the ENTER key.
- e. Press the ESC key until the Main Menu is displayed.
- f. Verify that Voltage 126.0 is being tested by selecting CURRENT TEST and pressing the ENTER key.
- g. Conduct the 126V test as described in "Running a Test", page 13.

If results between other lines are desired, or a Negative Trigger is desired, change the Test Parameters. Follow the method described in "Select Test Memory / Standard", page 10.

- **Select a Delay Test**, and set the Delay time to 1 second. If testing at 240Vrms, the peak voltage is 340 Volts (1.41 x 240). 37% of 340 is 126 Volts. When the test is performed, if the voltage measured after a 1 second delay is less than 126 Volts, the EUT meets the requirement of IEC 60950.

The factory settings of Memory 3 and Memory 4 can be used to conduct the Delay Test.

The factory settings are for evaluation at 1 second, in accordance with EN60950, for testing between line and ground (L-G). The pass/fail point will need to be calculated depending on the maximum rated voltage of the EUT. If the maximum rated voltage of the EUT is 240V, then the value of 126V noted above is used as the Pass/Fail criterion. If the maximum rated voltage of the EUT differs from this value, the Pass/Fail criterion can be calculated as noted above, using this calculation:  $.37(V_{max} \times 1.41)$ .

Use the following Memory Locations for these tests:

Memory 3: Line-Ground, Negative trigger

Memory 4: Line-Ground, Positive trigger

(If using the BNC output, set the scope as noted in Section "BNC Setup and Operation", "Delay Test", Page 14.)

If results between other lines are desired, change the Test Parameters.

The following example assumes that Memory 4 is being used to conduct a Positive Trigger test; and testing of Line to Neutral is desired. Follow the method described in "Select Test Memory / Standard", page 10.

a. Verify that Memory 4 is the current test being conducted by selecting "CURRENT TEST" from the main menu and pressing ENTER. If Memory 4 is displayed, press ESC. If Memory 4 is not displayed, select it using the up and down buttons, and then pressing ESC to return to the Main Menu.

b. Select EDIT MEMORY from the main menu, then select Memory 4 using the up and down buttons. Press the ENTER key.

c. Select "Line-Ground Input" and press the ENTER key.

d. Select "Line-Neutral Input" and press the ENTER key.

e. Press the ESC key until the Main Menu is displayed.

f. Verify that Line-Neutral is being tested by selecting CURRENT TEST and pressing the ENTER key.

g. Conduct the Line-Neutral test as described in "Running a Test", page 13.

## Testing Line to Neutral Only

The standards generally dictate that the capacitor discharge (stored energy at mains connection) test only be conducted if the capacitance is greater than 0.1uF. The implied premise is that capacitors smaller than this value do not present a significant shock hazard because the stored energy is small.

These capacitors are generally used for EMI filtering, and can be connected Line to Ground, Neutral to Ground, and Line to Neutral. Capacitors that are connected from Line to Ground or Neutral to Ground contribute to Leakage Current (Touch Current) that is present during normal operation. The standards specify the maximum amount of leakage current that is allowed. For normal pluggable equipment, the allowed level is 3.5 mA (in IEC 60950). Other standards have a lower limit for leakage current (e.g. 0.5mA in IEC 60065).

The leakage current limits dictate the maximum amount of capacitance that can be connected from Line to Ground and Neutral to Ground. The impedance of a capacitor is  $1/\omega C$ , where  $\omega$  is the line frequency in radians ( $=2\pi f$ , where  $f$  is the frequency in Hz). At 50 Hz, the impedance of a 0.1 uF capacitor is 31.8kOhms. At 60 Hz, the impedance of a 0.1 uF capacitor is 26.5kOhms (the higher the frequency, the lower the impedance). Therefore, if a product is rated 50Hz only, and the line to ground capacitance is 0.1uF, the leakage current will exceed 3.5mA if the test voltage is greater than 111 V. Similarly, a product that is rated 60Hz (or 50/60Hz since the leakage current test is conducted at the highest rated line frequency): if the line to ground capacitance is 0.1uF, the leakage current will exceed 3.5mA if the test voltage is greater than 93V.

What this means is that it is a rare or unusual circumstance when the line to ground or neutral to ground capacitance exceeds 0.1uF. Examples are: a product that is rated 100V, 50Hz only, or industrial equipment with locking power cords where higher leakage current limits apply. For this reason, it is generally only necessary to perform a Line to Neutral Capacitance Discharge Test, because the capacitance from Line to Ground and Neutral to Ground is invariably less than 0.1uF.

## Section 5

### CBX – CDT-240 Calibration Box

#### CDT-240 Calibration Verification with the CBX



The CBX contains two RC circuits, one with a 1sec. time constant and the other one with a 0.1sec. time constant. The CBX verifies the proper functionality of the CDT, below are the instructions on how to perform the CDT-240 calibration verification using the CBX.

1. Unplug all the test leads from the front panel of the CDT-240.
2. Connect the CDT-240 to the main power.
3. Connect the Test Voltage input on the back of the CDT-240. We recommend 120V for this test.
4. Turn on the CDT-240.
5. Press TEST to calibrate relays.
6. Select a Delay Test at 1sec. L-N, Positive Peak.
7. Connect the 1sec. RC of the CBX to the CDT-240 L and N.
8. Press Test to ARM.
9. Press Test again to run the test.
10. Record the voltage result (A perfectly 120V line the voltage result is 62.45V)
11. Select a Voltage Test @ "recorded value" L-N, Positive Peak.
12. Press Test to ARM
13. Press TEST again to run the test.
14. The correct result is 1sec.

#### Notes:

Any line voltage fluctuation can affect the result of the test, if the line is not perfectly stable expect a value close to the 1sec.

This test can be performed using the 0.1sec.

The verification can also be done for the N-L, and G-N.



## **Section 6**

### **Technical Assistance**

#### **Contact Information**

Technical Assistance from Compliance West USA is available:

**Phone:** (800) 748-6224

**Hours:** 8:30 AM - 4:30 PM Pacific Time.

Also available on our web site at: **[www.compwest.com](http://www.compwest.com)**

#### **Contact:**

Compliance West USA  
650 Gateway Center Way Suite D  
San Diego, CA 92102  
United States of America.

**Phone:** (619) 878-9696

**FAX:** (619) 794-0404

## **Section 7**

### **Maintenance and Calibration**

#### **WARNING:**

THESE SERVICE INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

#### **Service Information**

The CDT-240 Tester is warranted to the original purchaser for a period of 1 year. This warranty does not cover problems due to misuse or neglect.

Malfunctions which occur within the limits of the warranty will be corrected at no charge. Mail the instrument post paid to the manufacturer. Dated proof of purchase is required for all in-warranty repairs.

The manufacturer is also available for calibration and/or repair of instruments that are beyond their warranty period. Contact the manufacturer for a cost quotation. Ship the instrument and your remittance according to the instructions given by the manufacturer.

#### **Cleaning**

##### **CAUTION**

**Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These solutions will react with the plastic materials used in the instrument.**

Clean the front panel and case with a mild solution of detergent and a damp sponge. Clean dust from the PWB with clean, dry, low pressure (<20 psi).

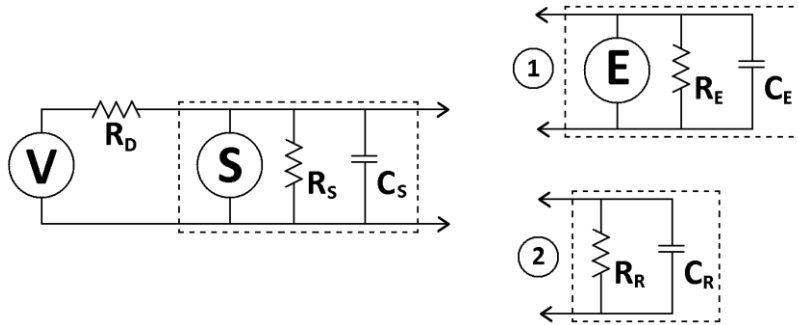
#### **Calibration Information**

The CDT-240 tester has been fully calibrated at the factory in accordance to our published specifications. It is recommended that you have this instrument re-calibrated and safety check done at least once per year.

Contact Compliance West USA for the latest calibration procedure and have ready the serial number of the tester.

# Appendix A

## Impedance Evaluation



### Legend and Test Setup:

$V$ : Voltage source, (a) 100 Vdc and (b) 240Vac  
 $R_D$ : Voltage divider resistor, 25M $\Omega$ , 1%  
 $S$ : Tektronix DPO3012 oscilloscope and Tektronix P6015 1000x probe  
 $R_S$ : Resistance of scope and probe, 100 M $\Omega$   
 $C_S$ : Capacitance of scope and probe, 3pF  
 $E$ : Equipment being evaluated, Compliance Products CDT-240  
 $R_E$ : Resistance of equipment being evaluated  
 $C_E$ : Capacitance of equipment being evaluated  
 $R_R$ : Reference resistor, 100M $\Omega$ , 1%  
 $C_R$ : Reference capacitor, 25pF, 1%

### Test Method:

Important Safety Information: Hazardous voltages are present during this test. Appropriate care must be taken to ensure operator safety.

Note: The circuits being measured and evaluated are very high impedance. Therefore the measurements are subject to significant levels of noise which can contribute to errors in measurement. To reduce noise from stray line-frequency fields, additional isolation was employed during testing, as follows:

- The oscilloscope mains input was powered by an external 1:1 isolation transformer with no ground connection to the scope.
- The equipment being evaluated mains input was powered by an external 1:1 isolation transformer with no ground connection to the chassis of the equipment.
- The voltage sources (a) and (b) were isolated from mains.

Prior to making voltage measurements, it was verified that line-frequency noise had been minimized before proceeding.

Voltage sources (a) and (b) are connected in turn, and the open-circuit voltage is measured using the oscilloscope and probe. Note that the actual voltage of the voltage sources and the resistance of  $R_D$  are not critical; other values may be used.

Connect circuit (1), the equipment being evaluated, and measure the voltage using the oscilloscope and probe. The measured voltage is expected to be lower than the open-circuit voltage because of the additional load of the equipment being evaluated. If the equipment being evaluated has more than one operating mode, measure the voltage in all operating modes.

Remove circuit (1) and connect circuit (2). Measure the voltage of the oscilloscope and probe. The measured voltage is expected to be lower than the open-circuit voltage.

# **Appendix B**

## **Theory of Operation:**

### **Theory:**

Because the equipment being evaluated has active circuitry, it is not possible to make accurate measurements using an LCR meter or similar instruments. The equipment being evaluated must be energized (turned on) and configured in the appropriate state so that the true input impedance of the circuitry is presented.

The open-circuit voltage measurements that are performed first are technically not open-circuit, because the 100M $\Omega$ , 25pF load of the oscilloscope probe causes a significant amount of voltage to be dropped across the voltage divider resistor  $R_D$ . The actual voltages measured when (a) and (b) are connected are not critical, but are simply for reference.

When voltage source (a) is connected (an AC voltage source), the combined resistive and capacitance impedances are measured. When voltage source (b) is connected, only the resistive element of the circuit impedance is measured because the capacitance appears as an open-circuit.

When the equipment being evaluated (1) is connected, the voltages measured by the oscilloscope and probe will be lower than the "open-circuit" measurements because of the additional load of the equipment being evaluated. Similarly, the voltages measured by the oscilloscope and probe will be lower than the "open-circuit" measurements when (1) is removed and circuit (2) is connected.

Circuit (2) represents the nominal impedance that is the pass/fail threshold of 100M $\Omega$  in parallel with 25pF that is referenced in the CTL Decision Sheet P-DSH-0716 (refer to Appendix C for details).

If the voltages measured when circuit (1) is connected are higher than the voltages measured when (2) is connected, then the impedance of circuit (1) (both the AC and DC impedance) is higher than the impedance of circuit (2). Conversely if the voltages measured when (1) is connected are lower than the voltages measured when (2) is connected, the impedance of circuit (1) is lower than the impedance of circuit (2).

### **Conclusion:**

The actual test results are presented in Table 1. Because the voltages measured in tests 6 to 8 are the same as the voltage measured in test 10 (slightly higher), the resistive input impedance of circuit (1) is the same as (slightly higher) than the resistive impedance of circuit (2). Because the voltages measured in tests 3 to 5 are the same as the voltage measured in test 9 (slightly higher), the overall input impedance of circuit (1) is the same as the overall impedance of circuit (2). This result also indicates that the capacitance of circuit (1) is lower than the capacitance of circuit (2), i.e. the capacitive impedance of circuit (1) is higher than the capacitive impedance of circuit (2).

Based on these results, the equivalent input resistance of the equipment being evaluated is greater or equal to 100M $\Omega$ , and the equivalent input capacitance is less than or equal to 25pF.

Test no.	Voltage Source	Circuit Connected	Configuration	Measured Voltage (RMS)	Comments
1	AC (a)	scope only (open circuit)	N/A	120	Voltage on the source side of RD will be about twice as high
2	DC (b)	scope only (open circuit)	N/A	50.8	Voltage on the source side of RD will be about twice as high
3	AC (a)	(1)	Line to Neutral Measurement	94.2	Measured voltage is higher ( $\approx$ same) as test 9
4	AC (a)	(1)	Line to Ground Measurement	93.5	Measured voltage is higher ( $\approx$ same) as test 9
5	AC (a)	(1)	Neutral to Ground Measurement	93.3	Measured voltage is higher ( $\approx$ same) as test 9
6	DC (b)	(1)	Line to Neutral Measurement	41.8	Measured voltage is higher ( $\approx$ same) as test 10
7	DC (b)	(1)	Line to Ground Measurement	41.8	Measured voltage is higher ( $\approx$ same) as test 10
8	DC (b)	(1)	Neutral to Ground Measurement	41.6	Measured voltage is same as test 10
9	AC (a)	(2)	N/A	93.2	
10	DC (b)	(2)	N/A	41.6	

**Table 1**

## Appendix C

### CTL Decision Sheet P-DSH-0716

## CTL PROVISIONAL DECISION SHEET

<b>Standard(s):</b> IEC 60065 IEC 60335 IEC 60950 IEC 61010 + any other as applicable	<b>Subclause(s):</b> 9.1.6 22.5 2.1.1.7 6.1.2, 6.10.3 ...	<b>No.</b> P-DSH-0716	<b>Year</b> 2008
<b>Category:</b> HOUS, MEAS, OFF, TRON, Various...		<b>Developed by:</b> WG2 WG4	
<b>Subject:</b> Probe impedance for plug discharge test	<b>Key words:</b> - Probe impedance - Plug discharge - $\geq 100\text{ M}\Omega$ - 25 pF or less	To be approved at the 2009 CTL Plenary Meeting	
<p><b>Question:</b></p> <p>When the plug discharge test is performed using a voltage probe and oscilloscope for direct measurement of the voltage decay, what probe impedance shall be used to ensure uniform and comparable results?</p> <p><i>Note: IEC 60950-1/2005 specifies <math>100\text{ M}\Omega \pm 5\text{ M}\Omega</math> in parallel with an input capacitance of <math>20\text{ pF} \pm 5\text{ pF}</math>.</i></p> <p><b>Decision:</b></p> <p>If the relevant standard does not contain contradictory requirements, a voltage probe having an input impedance of <math>100\text{ M}\Omega</math> or greater in parallel with an input capacitance of 25 pF or less, shall be used for this test.</p> <p>For other (automatic) equipment with special measurement techniques equivalent measures shall be taken to ensure comparable results.</p> <p><b>Explanatory Notes:</b></p> <p>This issue was raised at the 2008 CTL meeting after discussing the proficiency testing program on plug discharge 2007/2008. Participants used several different probe impedances, which caused inconsistent results.</p>			

## **Appendix D**

### **Measuring Neutral to Ground**

In the normal test setup, the EUT Test Voltage, the input voltage power source is between Line and Neutral, with the Neutral referenced to Ground (somewhere in the building, or intentionally tied from Neutral to Ground if the power source is isolated. This configuration is necessary for accurate detection of the peak of the Line voltage, and for accurate voltage measurements.

In some cases, it is necessary to measure the capacitance discharge from Line to Ground and/or from Neutral to Ground (the more typical case is to measure from Line to Neutral only). Because the Neutral must be tied to ground as described in the paragraph above, The N-G voltage prior to disconnect is 0 volts. After disconnect, depending on the EUT, the stored voltage from Line to Neutral may cause a voltage spike to occur from Neutral to Ground. This can be measured by the CDT-240 by selecting a Neutral to Ground voltage measurement.

It is also possible test the Neutral to Ground capacitance of the EUT when there is voltage applied to the Neutral. This is accomplished by reversing the Line and Neutral leads on the front panel of the CDT-240 where the EUT is connected. Then, the "Neutral" designated terminal of the EUT is connected to "L" on the CDT-240, and the "Line" designated terminal is connected to "N" on the CDT-240. In this case, the CDT-240 should be set up to measure from Line to Ground (not Neutral to Ground).

# Appendix E

## Instrument Accuracy Information

The CDT-240 Voltage measurement accuracy is specified as:

- +/- 1.5% of the instrument measuring range, and
- +/- 2% +/- 0.8V up to 270Vrms

The instrument measuring range is 270Vrms (sinusoidal), which equates to a peak-to-peak voltage of 764V. The instrument is capable of measuring any voltage from -382V to +382V. The internal circuitry of the CDT has some headroom beyond this; the overall voltage measurement range is +/- 390V, or 780V.

The CDT-240 instrument uses a 10-bit Digital-to-Analog converter. This is 4 times more resolution than the typical oscilloscope which uses an 8-bit D to A converter. A 10-bit measurement means that the overall voltage range is divided into 1024 different levels (10 bits =  $2^{10} = 1024$ ). For the CDT-240 voltage range of 780V this means that the measurement resolution is  $780 / 1024 = 0.76V$ . This is rounded up to 0.8V, which is the vertical resolution of the instrument. Consequently, an 8-bit oscilloscope that is set to read +/- 400V would have a vertical resolution of  $800 / 256 = 3.1V$ .

The stated accuracy of +/- 1.5% of the instrument measuring range is the minimum accuracy requirement that is specified in CTL Decision Sheet CTL 251b for voltages up to 1kHz. While this accuracy specification would seem "tighter" than a specification of +/- 2% +/- 0.8V of the measured voltage, it is not. A comparison of the two specifications is shown in Tables E1 and E2.

The most critical voltages that are measured during the capacitor discharge test are voltages that are close to the Pass/Fail limit of the EUT. For most standards, the Pass/Fail limit is within the range of 50 to 70V in normal conditions, and up to 120V in single-fault conditions. Inspection of Table E2 shows that at 50V, the measurement tolerance specification from CTL DSH 251b would allow a measurement error of almost 35% at 50V. This is clearly not an acceptable tolerance for measurements during the capacitor discharge test. The guard-band of an instrument with this tolerance would require that any test result with a voltage measurement between 37.5V and 62.5V is an inconclusive test result: it can not be determined if the EUT passes or fails the test.

A more reasonable (higher) specification for accuracy is 5% of the measured voltage. This is a generally-accepted limit that is specified in some standards. For a capacitor discharge test with a 50V Pass/Fail threshold, this would require a measurement guard-band of 47.5 to 52.5V. At 50V, the measurement guard-band of the CDT-240 is 48.2 to 51.8V (+/- 2% +/- 0.8V): +/- 3.6% of the measured voltage. In fact, the CDT-240 is capable of measuring voltages as low as 30V with an accuracy of +/- 5%.



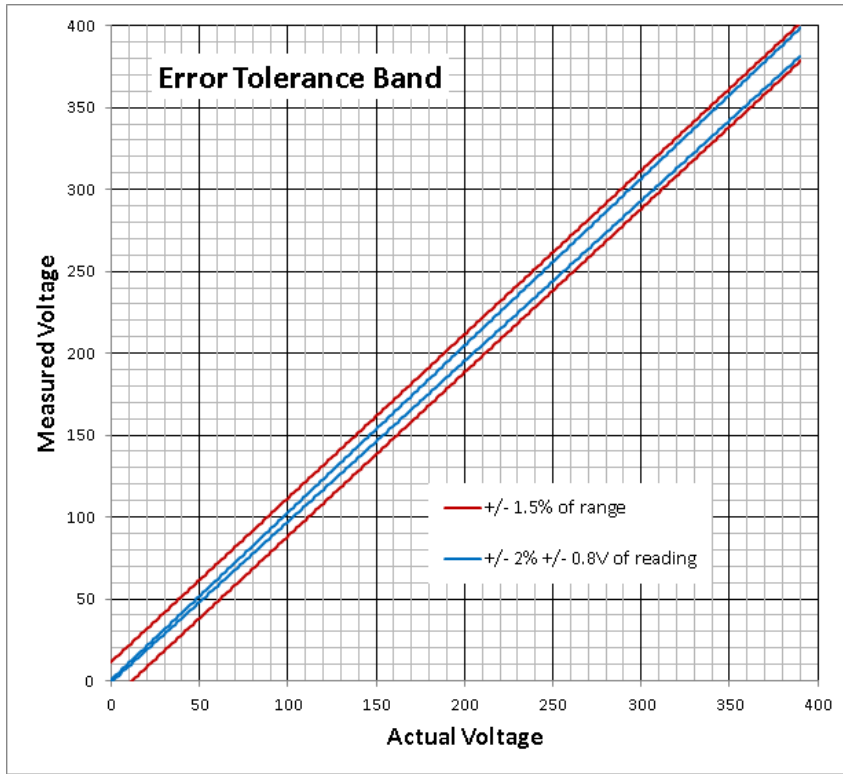


Table E1: Comparison of tolerance specifications over the measured voltage range

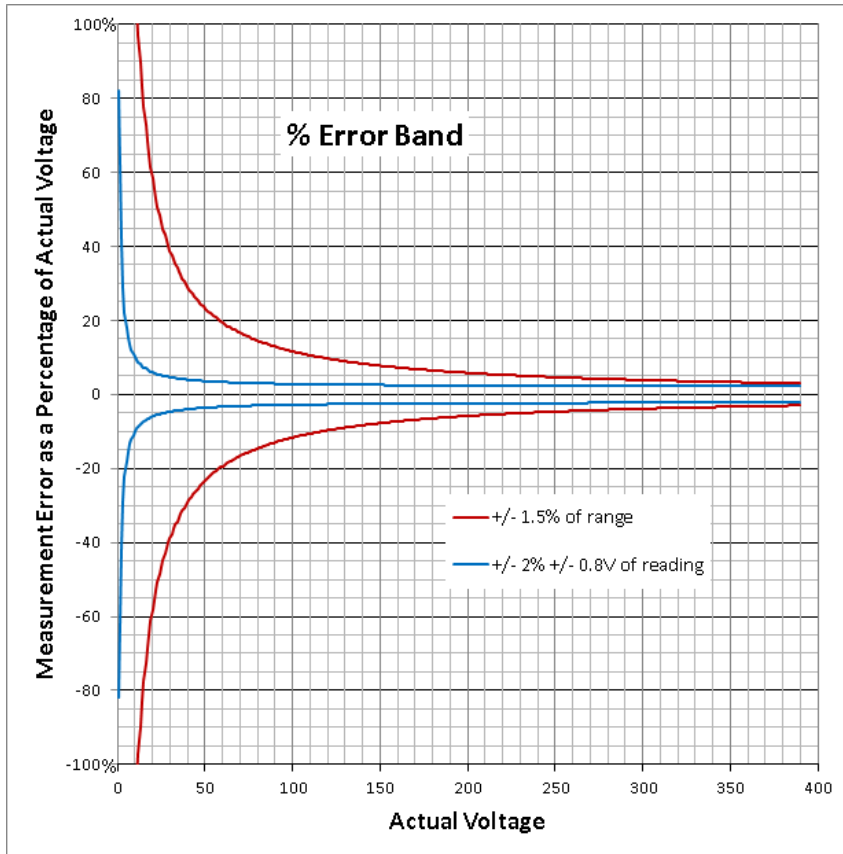


Table E2: Comparison of tolerance specifications as a percentage of measured voltage