CT-8000™

DIGITAL CIRCUIT BREAKER ANALYZER

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 CT-8000, or cause errors in the test results. Vanguard Instruments Company, Inc. assumes no liability for unsafe or improper use of the CT-8000.

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 the CT-8000. All devices under test shall be **off-line** and **fully isolated**. Do not perform test procedures or service unless another person is also present who is capable of rendering aid and resuscitation.

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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 CT-8000 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.

WARNING

Do not remove test leads during a test. Failure to heed this warning can result in electrical shock to personnel and damage to the equipment.

TABLE OF CONTENTS

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http://www.510822245.com

LIST OF TABLES

LIST OF FIGURES

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CONVENTIONS USED IN THIS DOCUMENT

This document uses the following conventions:

- A key or switch on the CT-8000 is indicated as **[KEY]** and **[SWITCH]**.
- Menu options are referenced as (*MENU OPTION*).
- Screen and menu names are referenced as "SCREEN/MENU NAME".
- The terms "test record" and "test shot" are used interchangeably.
- CT-8000 LCD screen output is shown as:

```
1. OPTION 1
2. OPTION 2
3. OPTION 3
4. OPTION 4
```

- When instructions are provided, the menu item that should be selected is shown in **bold** as shown below (option 3 should be selected):

```
1. OPTION 1
2. OPTION 2
3. OPTION 3
4. OPTION 4
```

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- 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 CT-8000 is Vanguard's fifth generation, stand-alone, microprocessor-driven EHV circuit-breaker analyzer. This easy to use analyzer is available in models with either 3 (CT-8000-3) or 6 (CT-8000-6) dry-contact inputs. Both models feature three digital travel transducer input channels. The CT-8000 can operate either in Time-Travel analyzer mode or in Quick-Shot mode (for on-line timing).

Quick-Shot Mode

In Quick-Shot mode, the CT-8000 captures the breaker's trip or close time, the trip/close-coil current "fingerprint," and the battery supply voltage while the breaker is still in service. The trip/close time is derived from the time of trip, or close-coil initiation, to the breaker's bushing current-break-or-make as detected by an AC clamp-on current sensing probe.

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With a simple connection, the Quick-Shot mode can detect a breaker's operating conditions with little or no down time. In Quick-Shot mode, the first trip operation time of the breaker is captured. If a breaker has been in service for a long period of time and sitting in close position, the first trip time of the breaker may be slow possibly due to a sticky mechanism. The Quick-Shot mode is very useful in such cases because traditional breaker timing may not detect this condition since several operations may have occurred before the first timing test is conducted.

Conventional Time-Travel Analysis Mode

In Time-Travel mode, the CT-8000 can fully analyze a circuit-breaker's performance by testing the contact time, stroke, velocity, over-travel, and contact wipe. Contact-motion analysis can be performed for all breaker contact operations (Open, Close, Open – Close, Close – Open, and Open – Close – Open). The CT-8000 S2's timing window is selectable between 1-second, 10-second, or 20-second periods. The 10-second and 20-second timing windows are ideal for timing long duration events such as circuit-switcher contact testing.

Contact Timing Inputs

Dry-contact input channels are used for timing breaker contacts. Each contact input channel can detect main contact and insertion-resistor contact times in milliseconds and cycles.

Voltage Monitoring Inputs

One analog voltage input channel, designated as V1, is dedicated to monitoring a circuit-breaker's DC power supply or coil voltage (0 – 255 volts, DC or peak AC). A second voltage input channel, designated as V2, is dedicated to detecting the voltage on/off status (presence or absence) of an A/B switch.

Trip/Close Current Monitoring

A built-in Hall-effect current sensor records the Trip/Close current level and duration. The breaker's operate-coil current waveform duration (effectively, a performance "fingerprint" or "current profile") can be used as a diagnostic tool for analyzing a breaker's performance.

Breaker Stroke and Velocity

Three digital travel transducer channels are available on the CT-8000 for measuring circuit-breaker velocity, stroke, over-travel, and bounce-back. Unlike other transducer types, the digital transducer requires neither calibration nor setup. A breaker's contact-velocity is calculated based on the contact's travel distance over a period of time. A special feature is also available to "slow-close" test a breaker and obtain a test result report.

Dynamic Contact Resistance

Using a 200-ampere, built-in, DC power supply, the CT-8000 can also perform dynamic-resistance tests. One channel is available for performing a dynamic contact resistance test. The resistance measuring range is from 1 micro-ohm to 1,999 micro-ohms. Using this test, the contact resistance can be monitored during circuit-breaker operation. This important feature can help detect circuit-breaker contact erosion or other contact problems that cannot be detected in static resistance tests. The CT-8000 can also be used as a 200-ampere micro-ohmmeter to test circuit-breaker contact resistance and bus connections, or can be used for other applications where a low-resistance measurement is required.

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Resistor Type Transducer Input

One resistor type input channel is also available on the CT-8000. This input channel allows the unit to measure circuit-breaker motion by directly interfacing with resistive type transducers. The transducer resistance ranges from 200 ohms to 10K Ohms.

Breaker Initiate Features

A built-in solid-state initiate device is used to operate a breaker from the CT-8000. The operational modes include Open, Close, Open – Close, Close – Open, and Open – Close – Open. Multiple operations, such as Open – Close and Open – Close – Open, can be initiated by using programmable delay time or by sensing a breaker's contact condition.

Internal Test Record Storage

The CT-8000 can store up to 150 test records in Flash EEPROM. Test records can be retrieved and printed on the built-in thermal printer, or they can be transferred to a PC via the unit's RS-232C or USB interface.

Internal Breaker Test Plan Storage

The CT-8000 can store up to 99 circuit-breaker test plans. Test plans are comprised of all circuit-breaker performance specifications (stroke, velocity, and contact time). A test plan can be used to immediately test a circuit-breaker. A pass/fail report is then generated by comparing actual performance with the specifications in the stored test plan. Test plans can also be generated on a PC and transferred to the CT-8000 via the unit's RS-232C or USB interface.

Computer Interface

The CT-8000 can be computer-controlled via its RS-232C or USB interface. A Windows® XP/Vista-based Breaker-Analysis software application is provided with each unit. Using this software, circuit-breakers can be timed from the PC. Test records can be retrieved from the CT-8000 and then stored on the PC for future analysis and report generation. Circuit-breaker test plans can also be created on the PC and transferred to the CT-8000. Additionally, test records can be exported in Microsoft® Excel format for further analysis.

User Interface

The CT-8000 features a back-lit LCD screen (20 characters by 4 lines) that is viewable in both bright sunlight and low-light levels. A rugged, 16-key, membrane keypad is used to control the unit.

Built-in Thermal Printer

The CT-8000's built-in 4.5-inch wide thermal printer can print the breaker contact analysis results in both tabular and graphic formats.

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1.2 Furnished Accessories

The CT-8000 comes furnished with the following:

- 1 Ground Cable
- 1 Power Cord
- Contact Cables (3 for model CT-8000-3, 6 for model CT-8000-6)
- Contact Extension Cables (3 for model CT-8000-3, 6 for model CT-8000-6)
- 1 Transducer Cable
- 3 Voltage and Trigger Leads
- 3 Voltage and Trigger Extension Cables
- 1 AC Current Sensor
- 1 Resistor Type Transducer Cable
- 2 Micro-Ohm Meter Current Cables
- 2 Micro-Ohm Meter Sense Cables
- 1 Initiate Cable
- 1 USB Cable
- 1 RS-232C Cable
- Cable carrying bag

1.3 Technical Specifications

Table 1. CT-8000 Technical Specifications

TYPE	Portable circuit-breaker analyzer
PHYSICAL SPECIFICATIONS	16"W x 11"H x 14"D (40.6 cm x 29.9 cm x 35.6 cm); Weight: 25 lbs (11.3 kg)
INPUT POWER	100 – 120 Vac or 200 – 240 Vac (selectable), 50/60Hz
DRY-CONTACT INPUT	3 or 6 dry-input channels (depending on model). Each channel detects main and insertion-resistor contacts
TIMING WINDOWS	1-second, 10-seconds, or 20-seconds
TIMING RESOLUTIONS	±50 micro-seconds @ 1-second duration, ±0.5 milliseconds @ 10-second duration, ±1.00 milliseconds @ 20-second duration
TIMING ACCURACY	0.05% of reading ±50 micro-seconds @ 1-second duration
CONTACT DETECTION RANGE	Closed: less than 20 ohms; Open: greater than 5,000 ohms
RESISTOR DETECTION RANGE	50 – 5,000 Ohms
CT CURRENT SENSOR	One, non-contact, 0 – 100 Amperes
TRIGGER INPUT VOLTAGE	Open/Close: 30 – 300V DC or peak AC
VOLTAGE SENSING INPUT RANGE	V1: analog input; 0 – 255V DC or peak AC; Sensitivity ±1V V2: voltage presence/absence detector input; 30 – 300V DC or peak AC
BREAKER OPERATIONS	Initiate Open, Close, Open– Close, Close – Open, Open – Close – Open
BREAKER INITIATE CAPACITY	25A, 250Vac/dc max (100A Inrush)
INITIATE CURRENT READING RANGE	One, non-contact, Hall-effect sensor, 0 – 20 amp range, dc to 5Khz
TRAVEL TRANSDUCER INPUTS	3 digital travel transducer channels; Linear range, 0.0 – 30.0 in (±0.01 in); Rotary range: 0 – 360 degrees (±0.36 degrees)
CONTACT TRAVEL POINT DIFFERENCE	Measures "slow-close" contact-point distances; results can be printed
DYNAMIC/STATIC RESISTANCE RANGE	0.1 – 1,999 micro-ohms; Accuracy: ±2% of reading, ±5 micro-ohms
RESISTANCE TEST CURRENT	200 Amperes typical
RESISTOR TYPE TRANSDUCER INPUT	200 Ohms – 10K Ohms
DISPLAY	Back-lit LCD Screen (20 characters by 4 lines); viewable in bright sunlight and low-light levels
PRINTER	Built-in 4.5-inch wide thermal printer can print both graphic contact travel waveforms and tabulated test results
INTERNAL TEST RECORD STORAGE	Stores up to 150 test records and 99 test plans
COMPUTER INTERFACES	One RS-232C port, One USB port
PC SOFTWARE	Windows® XP/Vista-based Breaker-Analysis software is included with purchase price
SAFETY	Designed to meet UL 6101A-1 and CAN/CSA C22.2 No 1010.1-92 standards
ENVIRONMENT	Operating: -10°C to 50°C (+15°F to +122°F); Storage: -30°C to70°C (-22°F to +158°F)
HUMIDITY (MAX)	90% RH @ 40˚ C (104˚ F) non-condensing
ALTITUDE (MAX)	2000m (6562 ft) to fully safety specifications
OPTIONS	Transportation case (available for the CT-8000 and the travel transducers)
WARRANTY	One year on parts and labor

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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.

1.4 CT-8000 Controls and Indicators

The CT-8000's controls and indicators are shown in Figure 1 below. A leader line with an index number points to each control and indicator, which is cross-referenced to a functional description in Table 2. The table describes the function of each item on the control panel. The purpose of the controls and indicators may seem obvious, but users should become familiar with them before using the CT-8000. 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.

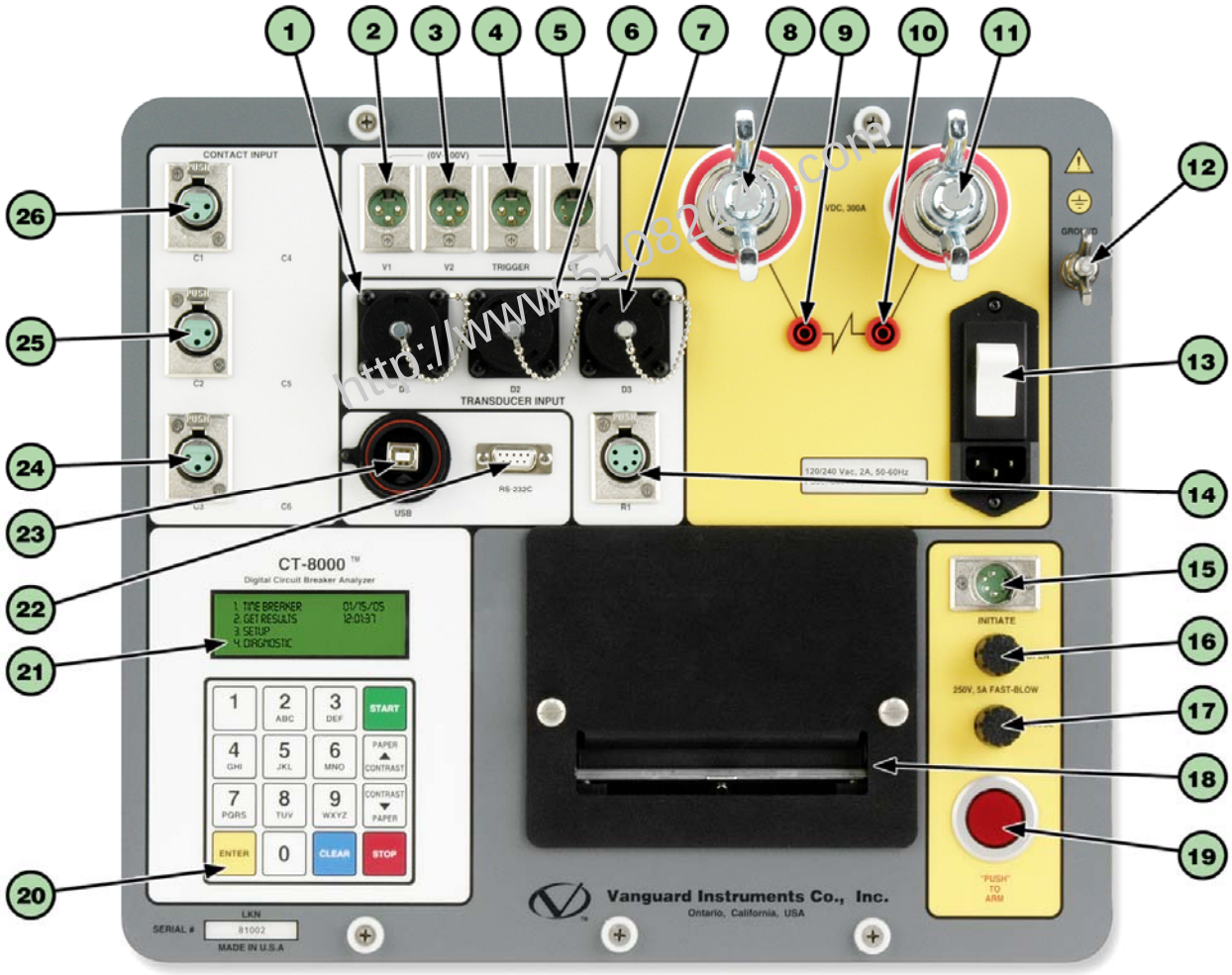

Figure 1. CT-8000 Controls and Indicators

Table 2. Functional Descriptions of CT-8000 Controls and Indicators

Item Number	Panel Markings	Functional Description
1, 6, 7	D1, D2, D3 TRANSDUCER INPUT	16-pin connectors. Digital travel transducer input channels.
2	0-300V V1	3-pin connector. V1 voltage input channel is dedicated to monitoring circuit breaker DC power supply or coil voltages. Voltage sensing range is from 0-255 volts, dc or peak ac.
3	0-300V V2	3-pin connector. V2 voltage input channel is dedicated to detecting voltage on/off status (present or absent) of an A/B switch. Voltage input ranges from 0-300 volts, dc or peak ac.
4	0-300V TRIGGER	3-pin connector. Triggers voltage input for external trigger application. Voltage levels ranging from 30 to 300 V, dc or peak ac.
5	CT	5-pin connector. AC current input channel. Detects CB load current for Quick-Shot application.
8, 11	5VDC, 200A	200A Micro-Ohm Meter current output terminals.
9, 10		Micro-Ohm Meter sense inputs.
12	GROUND	Safety ground terminal.
13	100-120 Vac, 8A, 50-60Hz	Power plug and power switch. Built-in 12 Ampere circuit breaker.
14	R1	5-pin connector. Resistor type transducer input.
15	INITIATE	4-pin connector used for the switching circuit for operating the circuit breaker under test.
16	OPEN 250V, 5A FAST-BLOW	Open circuit fuse: 5 Ampere, 250V, Fast-Blow.
17	CLOSE 250V, 5A FAST-BLOW	Close circuit fuse: 5 Ampere, 250V, Fast-Blow.
18		Built-in 4.5-inch wide thermal printer.
19	"PUSH" TO ARM	Spring-loaded pushbutton switch. Press and hold to complete the Trip or Close circuits for breaker tests.
20		Rugged alpha-numeric membrane keypad.
21		Back-lit LCD screen (20 characters by 4 lines); viewable in bright sunlight and low-light levels.
22	RS-232C	RS-232C serial computer interface port.
23	USB	USB computer interface port.
24, 25, 26	CONTACT INPUT (C1-C6)	Female connectors for the contact channels.

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2.0 PRE-TEST SETUP

2.1 Operating Voltages

The CT-8000's operating voltage is selectable between 110-120 Vac, 50/60 Hz and 220-240 Vac, 50/60 Hz. Operating voltage is set by the voltage selection switch as shown in Figure 2. To change the voltage setting, remove the CT-8000 from its enclosure, locate the voltage setting switch on the right side of the unit, and set the new operating voltage.

Figure 2. CT-8000 Operating Voltage Setting Switch

2.2 LCD Screen Contrast Control

To increase the LCD screen contrast, press and hold the **[PAPER ∧ Contrast]** key for two seconds. Release the button when the desired contrast level has been reached.

To decrease the LCD screen contrast, press and hold the **[PAPER ∨ Contrast]** key for two seconds. Release the button when the desired contrast level has been reached.

2.3 Printer Paper Control

To advance the thermal printer paper, press and release the **[PAPER ∧ Contrast]** key.

To retract the thermal printer paper, press and release the **[PAPER ∨ Contrast]** key.

2.4 Printer Paper

The CT-8000's built-in thermal printer uses 4.5-inch wide thermal paper for printing test results. To maintain the highest print quality and to avoid paper jams, the use of thermal paper supplied by Vanguard Instruments Company is highly recommended. Additional paper can be ordered from the following sources:

Vanguard Instruments Co, Inc.
1520 S. Hellman Avenue
Ontario, CA 91761
Tel: 909-923-9390
Fax: 909-923-9391
Part Number: VIC TP-4 paper

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BG Instrument Co.
13607 E. Trent Avenue
Spokane, WA 99216
Tel: 509-893-9881
Fax: 509-893-9803
Part Number: VIC TP-4 paper

2.5 Replacing the Thermal Printer Paper

The roll of thermal paper is housed inside a dispenser underneath the printer cover. To replace the paper, follow the steps below:

- Unscrew the two large printer cover screws and remove the printer cover.
- Remove the leftover thermal paper roll from the paper holder.
- Unroll the new thermal paper roll.
- Feed the thermal paper into the slot between the paper pocket and the rubber roller. The printer will automatically pull the paper under the thermal head.
- Place the paper roll into the paper holder.
- Lift the thermal head and align the thermal paper if necessary.
- Re-install the printer cover.

NOTE

Thermal paper has a chemical coating on one side of the paper. This side should be facing the thermal print head. Incorrect paper loading may result in blank output on the thermal paper.

The thermal paper will show a red stripe to indicate that the roll is about to run out of paper.

3.0 OPERATING PROCEDURES

3.1 Cable Connections

3.1.1. Contact Cable Connections

A typical contact cable connection to a circuit breaker is shown in Figure 3. Red and black clips are connected across the circuit contact phases A, B, and C. A typical circuit breaker with series contacts is shown in Figure 4.

NOTE It is advisable to ground one side of the contacts for most testing purposes. If a breaker is floating or un-grounded, ensure that the contact channel inputs are protected against static discharge.

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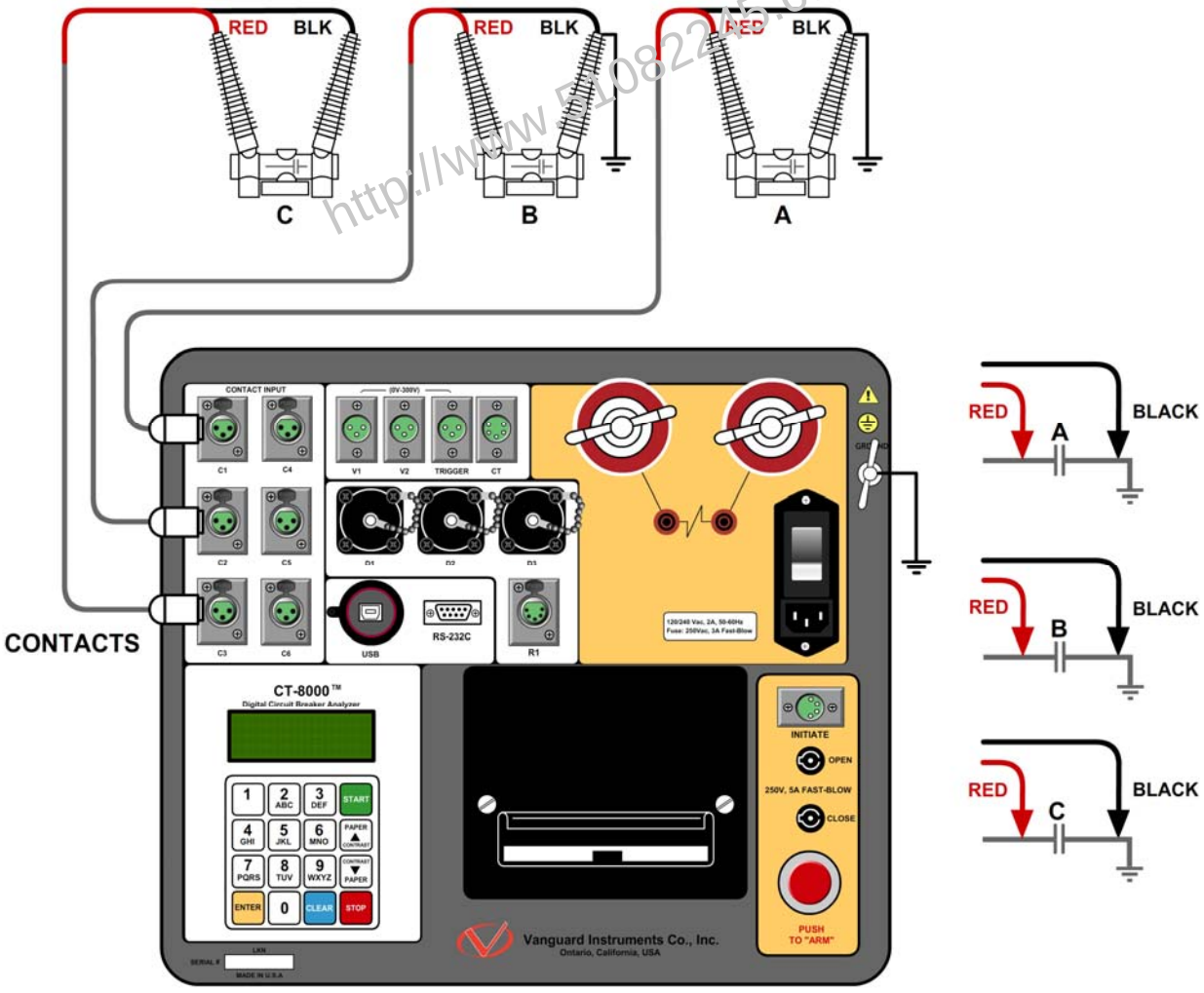

Figure 3. Typical 3-Phase Circuit Breaker Connections

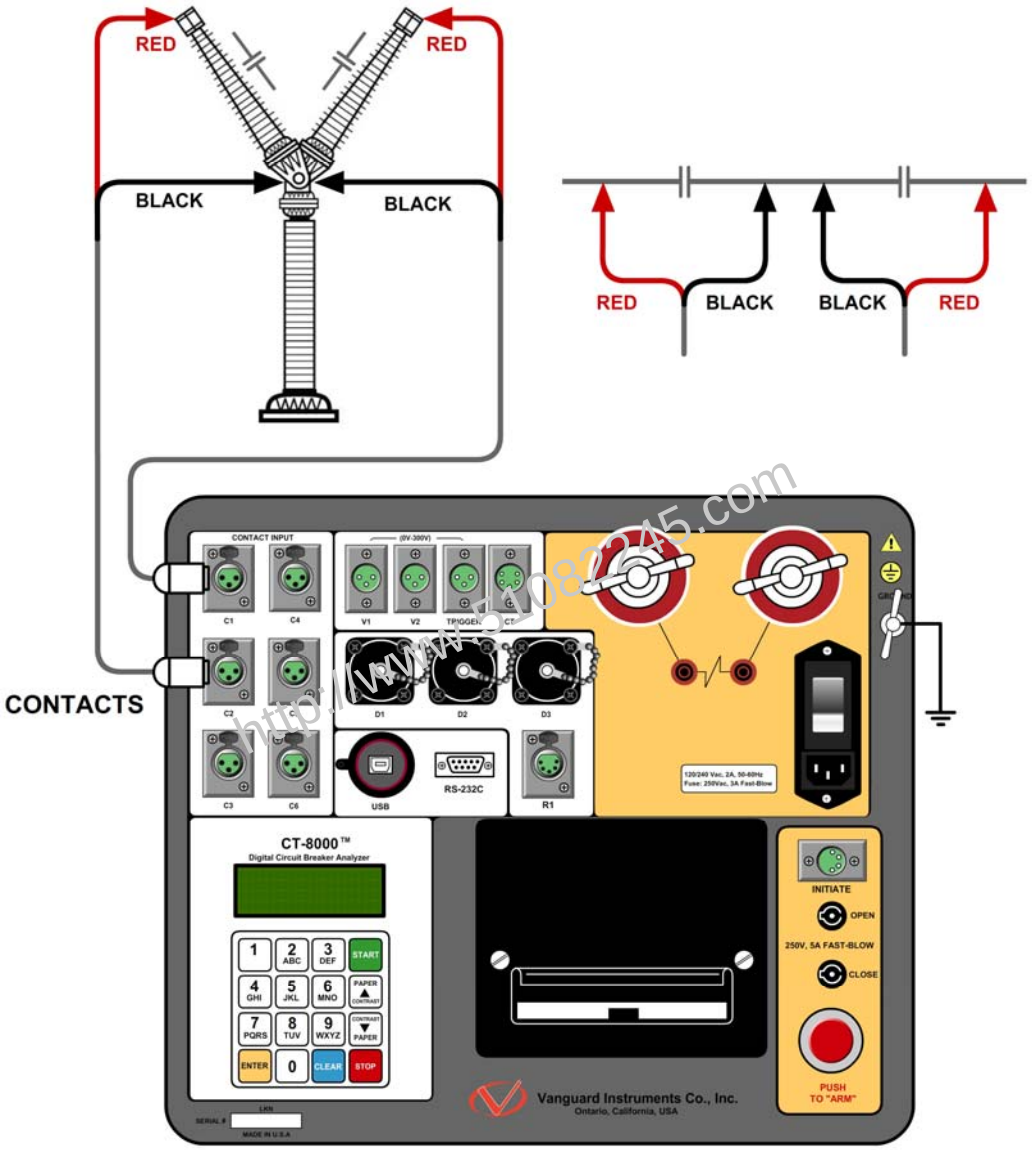

Figure 4. Typical Series Circuit Breaker Connections

3.1.2. Initiate Cable Connections

The CT-8000 can trip or close breakers through a solid-state device operating on any AC or DC control voltage ranging from 10 to 300 Volts. Both the trip and close circuits are protected by 5 Ampere fuses. A typical DC trip and DC close control circuit connection is shown in Figure 5. A typical DC trip and AC close control circuit connection is shown in Figure 6.

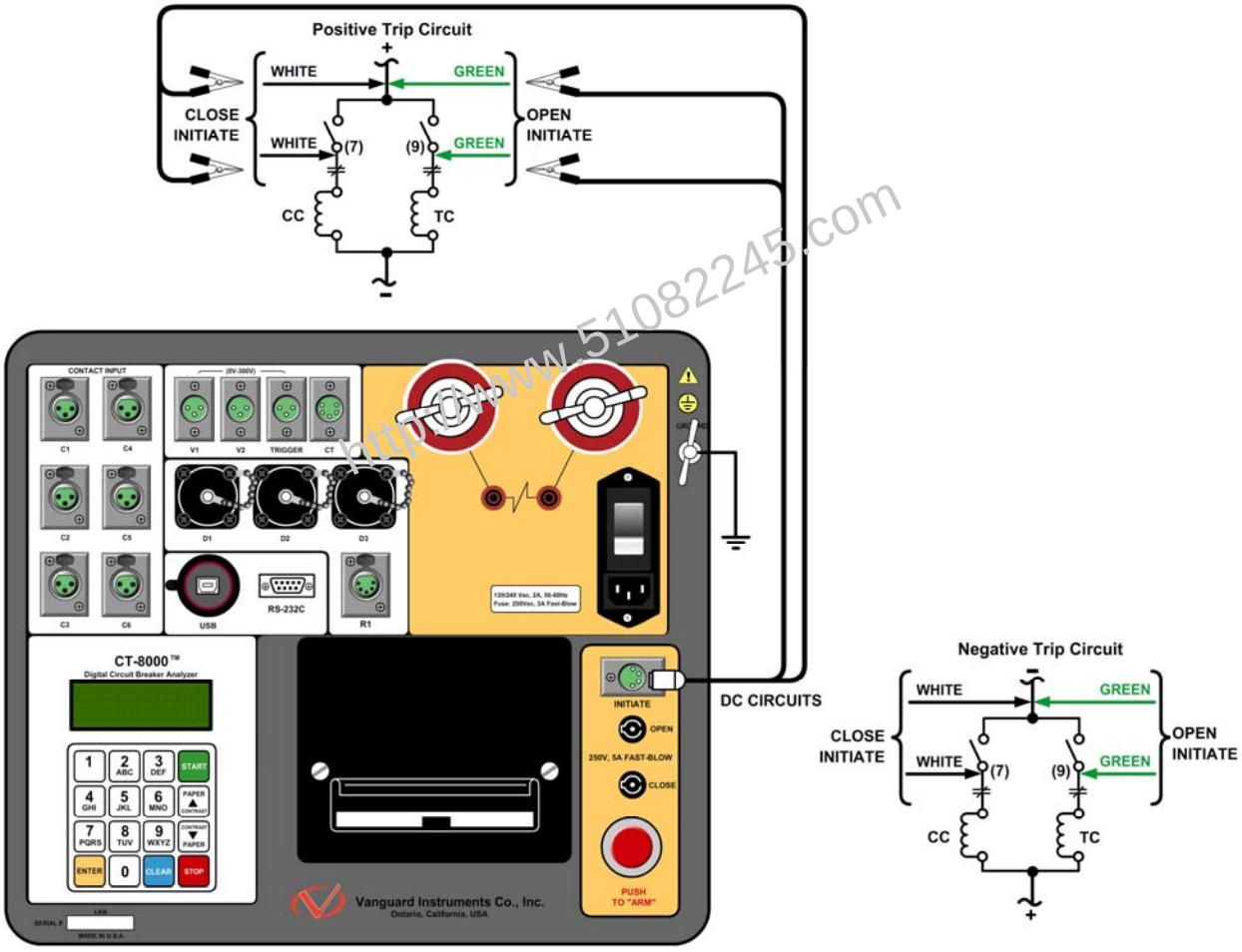

Figure 5. Typical DC Trip and DC Close Control Circuit Connection

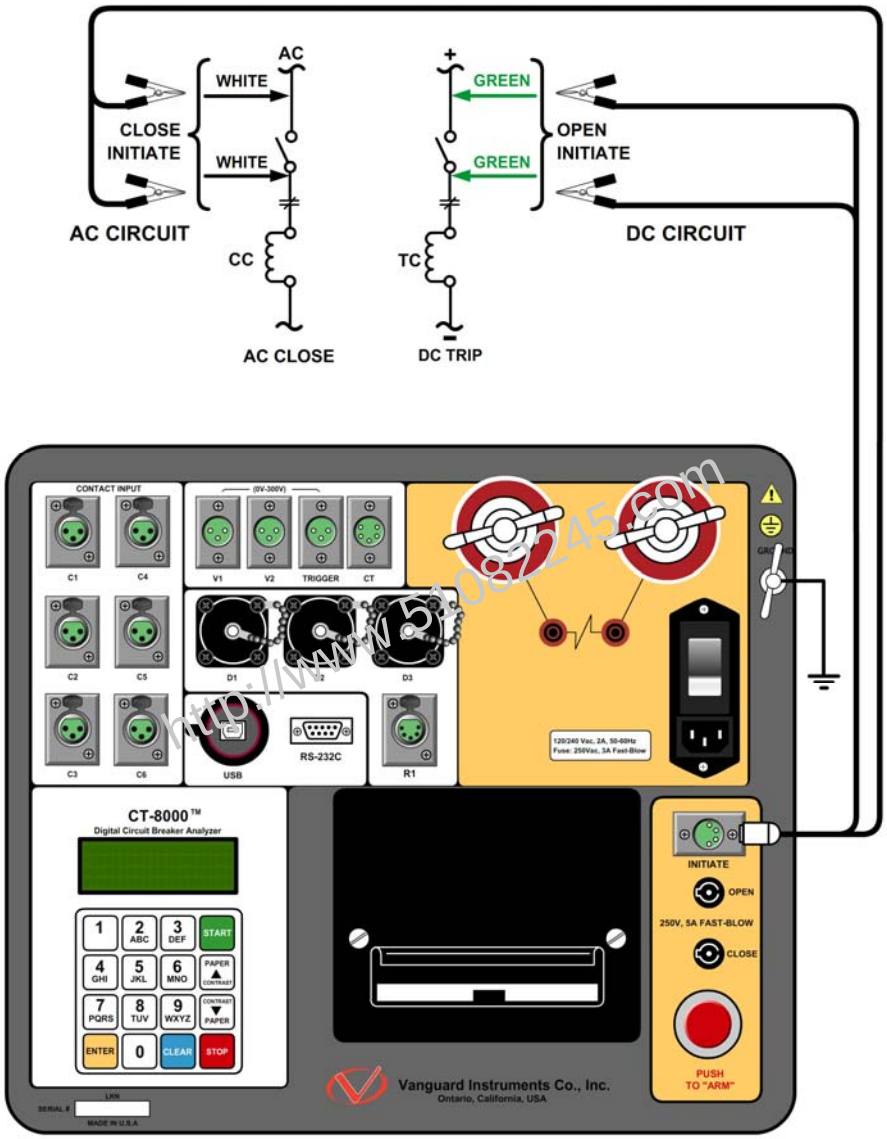

Figure 6. Typical DC Trip and AC Close Control Circuit Connection

3.1.3. Analog and Digital Voltage Monitoring Connections

The analog voltage input "V1" can monitor a breaker's DC control voltage during an operation. The analog voltage input records the nominal DC voltage at no load and the minimum DC voltage while the Trip or Close coil is energized. The nominal and minimal voltage readings are printed on a tabulated report, and the analog waveforms are plotted in graphical format. This allows the user to see the breaker's DC control voltage "dip" under load conditions and helps detect problems such as a poor connection or an excessive voltage drop during operation. Please note that the maximum voltage that can be recorded is 255 Vdc.

The digital voltage input channel "V2" can monitor the voltage status as "ON" or "OFF" states. The voltage "ON" or "OFF" states are plotted on the graphical report. Typical analog ("V1") and digital ("V2") voltage monitoring connections are shown in Figure 7.

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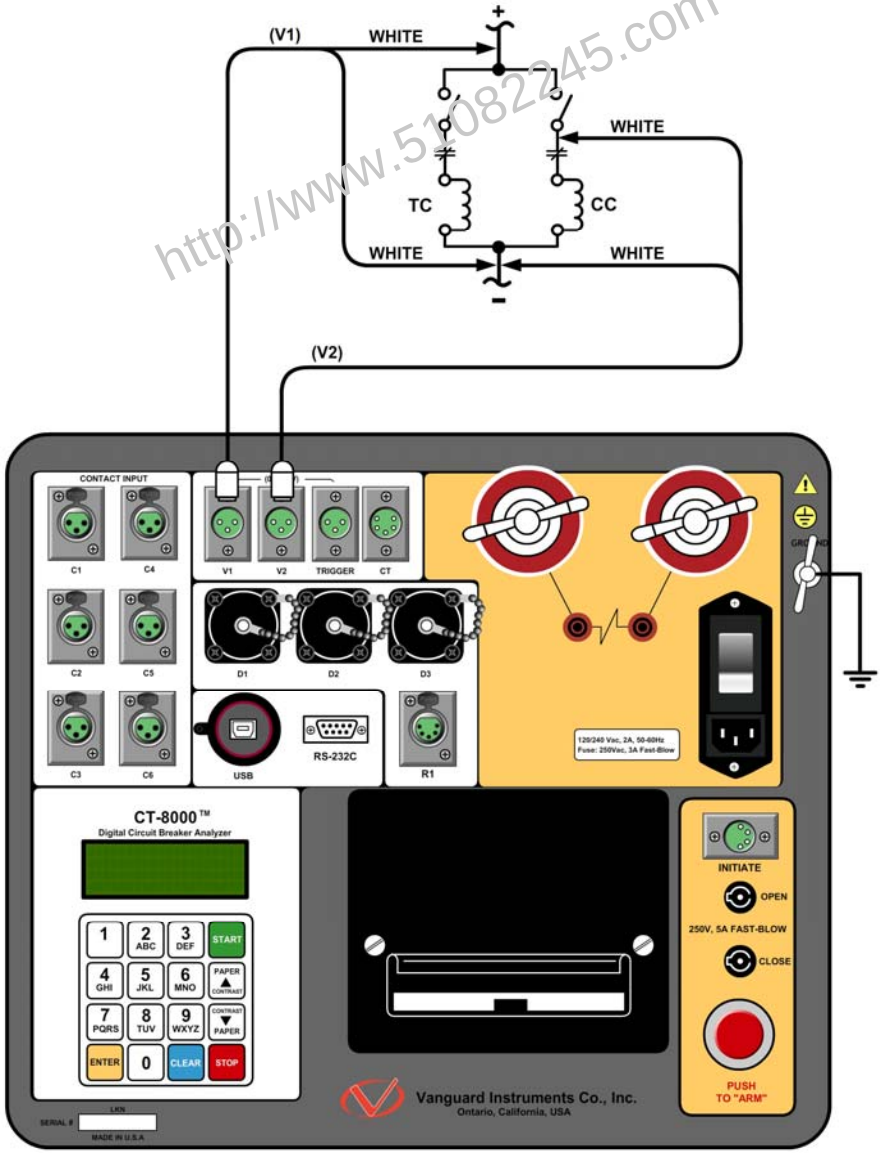

Figure 7. Typical Analog and Digital Voltage Monitoring Connections

3.1.4. External Trigger Input Connections

The External Trigger Mode can be used to start recording data when the CT-8000 senses a voltage. A typical application for the External Trigger Mode is to time a circuit breaker in a Close operation and to start timing only when the Close coil is energized, thus bypassing the 52X relay delay time.

Since the 52X relay carries the Close coil current, the CT-8000's initiate cable must be connected to the Close terminal as shown in Figure 5. The CT-8000 will energize the 52X relay to start the Close operation, which will then start the timing when the CT-8000 senses the voltage across the closing coil. Typical external trigger input connections are shown in Figure 8.

Another application for the External Trigger is to start timing the breaker when the user trips or closes the breaker remotely.

NOTES

- The minimum trigger voltage is 30 Vac/dc. Maximum, continuous voltage is limited to 300 Vac/dc. Different trigger voltages can be set at the factory by request.
- The CT-8000 will start looking for the external trigger voltage when the message "AWAITING TRIGGER…" is displayed on the LCD screen. The external trigger voltage must be sensed by the CT-8000 within 15 seconds after the initiate sequence has begun. The CT-8000 will return to the "START-UP" menu if no voltage is sensed.

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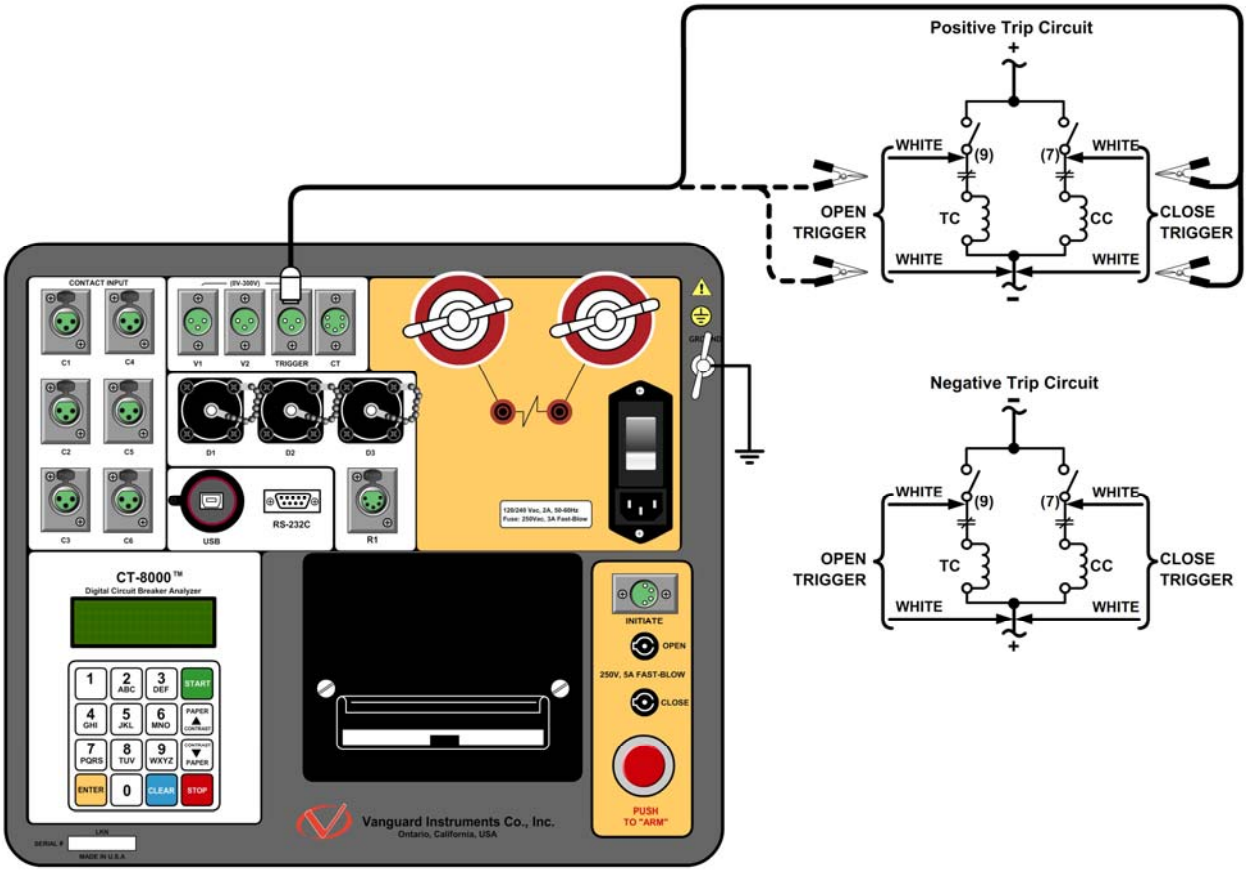

Figure 8. Typical External Trigger Input Cable Connections

3.1.5. Digital Transducer Connection

A typical digital transducer connection is shown in Figure 9.

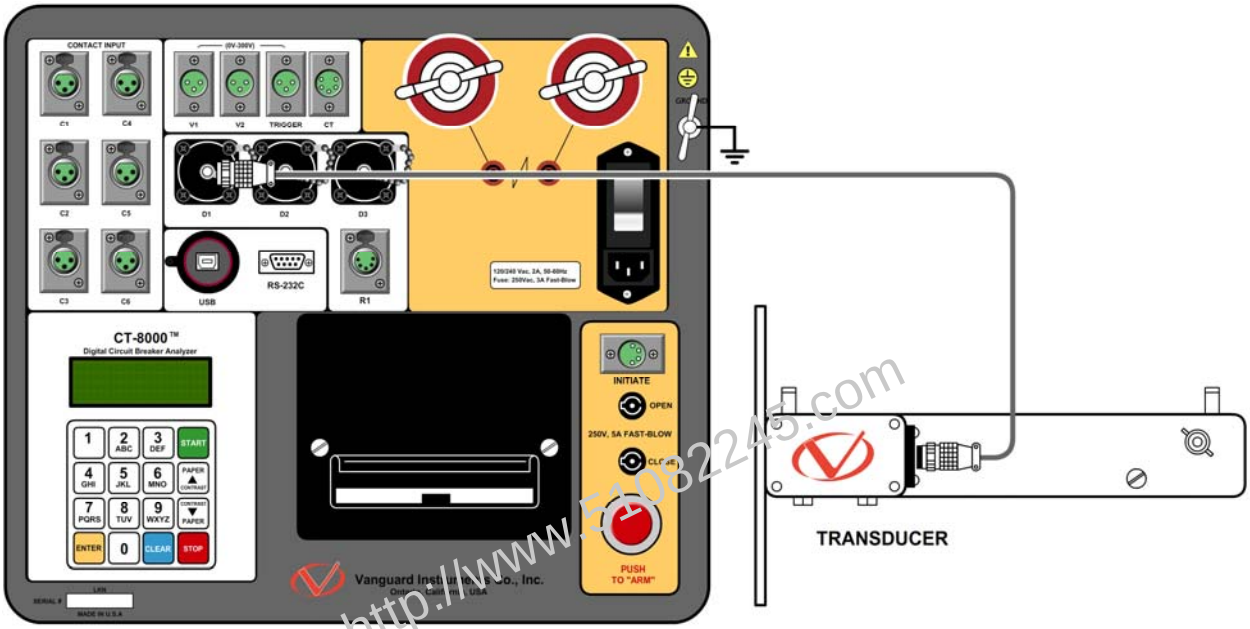

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Figure 9. Typical Digital Transducer Connection

3.1.6. Resistor Type Transducer Connection

The CT-8000 provides one channel for resistor type transducers. The transducer resistance input can range from 200 Ohms to 10K Ohms. The CT-8000 supplies a 5 Vdc reference voltage to power the resistor type transducer. The sense voltage is translated into a travel distance based on the transducer calibration parameters. The user is required to setup the resistor transducer before performing a test. Up to nine transducer setups can be stored in the CT-8000's internal memory. Once a transducer setup is stored, it can be recalled quickly before running a test. A typical resistor type transducer connection is shown in Figure 10.

NOTES

- When a resistor type transducer is used, the test results are shown as travel transducer channel 1 (see Figure 17).
- A 15-foot transducer cable with 3 quick disconnect clips is provided with each CT-8000. The 3 clips are labeled "+5V", "Signal", and "GND".
- See section 3.2.11 for resistor type transducer calibration information.

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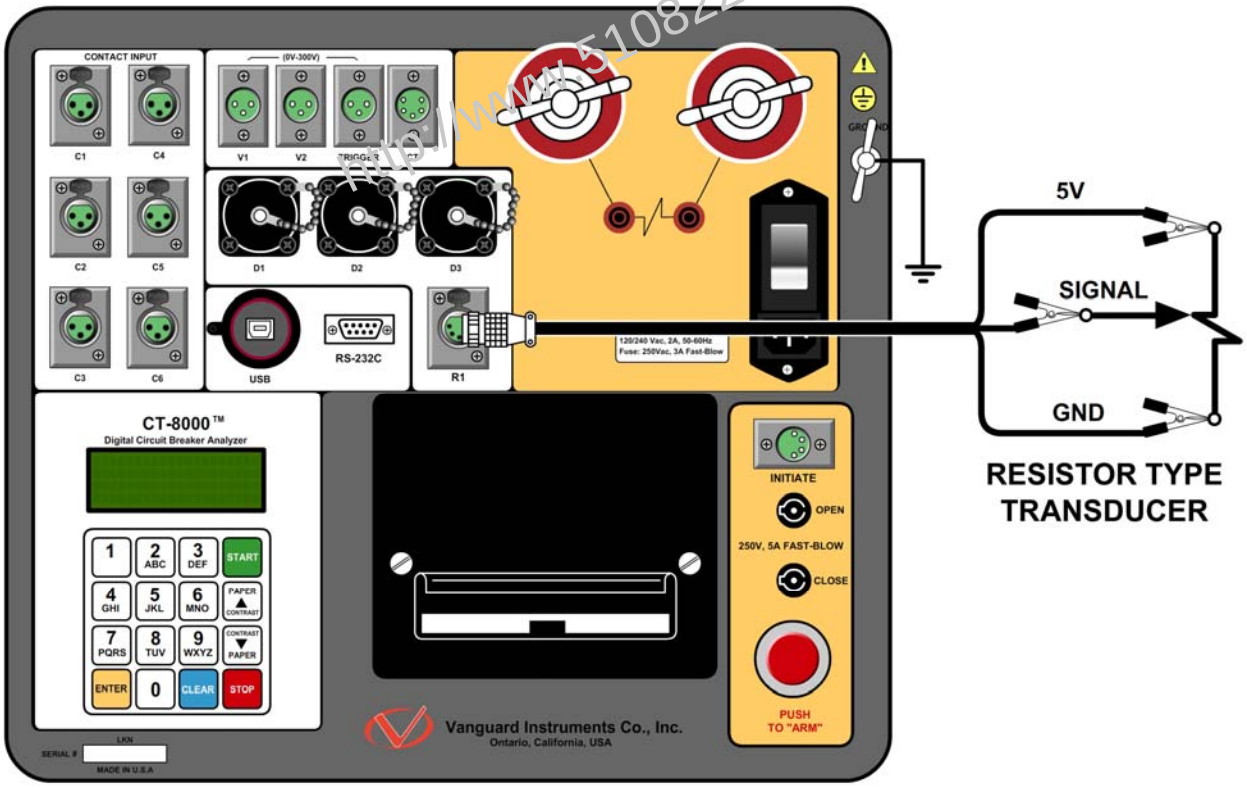

Figure 10. Typical Resistor Type Transducer Connection

3.1.7. Micro-Ohm Meter Connection

A typical CT-8000 micro-ohm meter (for Dynamic Contact Resistance or Static Resistance Test) connection to a circuit breaker contact is shown in Figure 11. The CT-8000 is furnished with two 40-foot #4 AWG current cables with quick disconnect alligator clamps and two 40-foot sense cables.

WARNING Do not modify the length of the CT-8000 current cables.

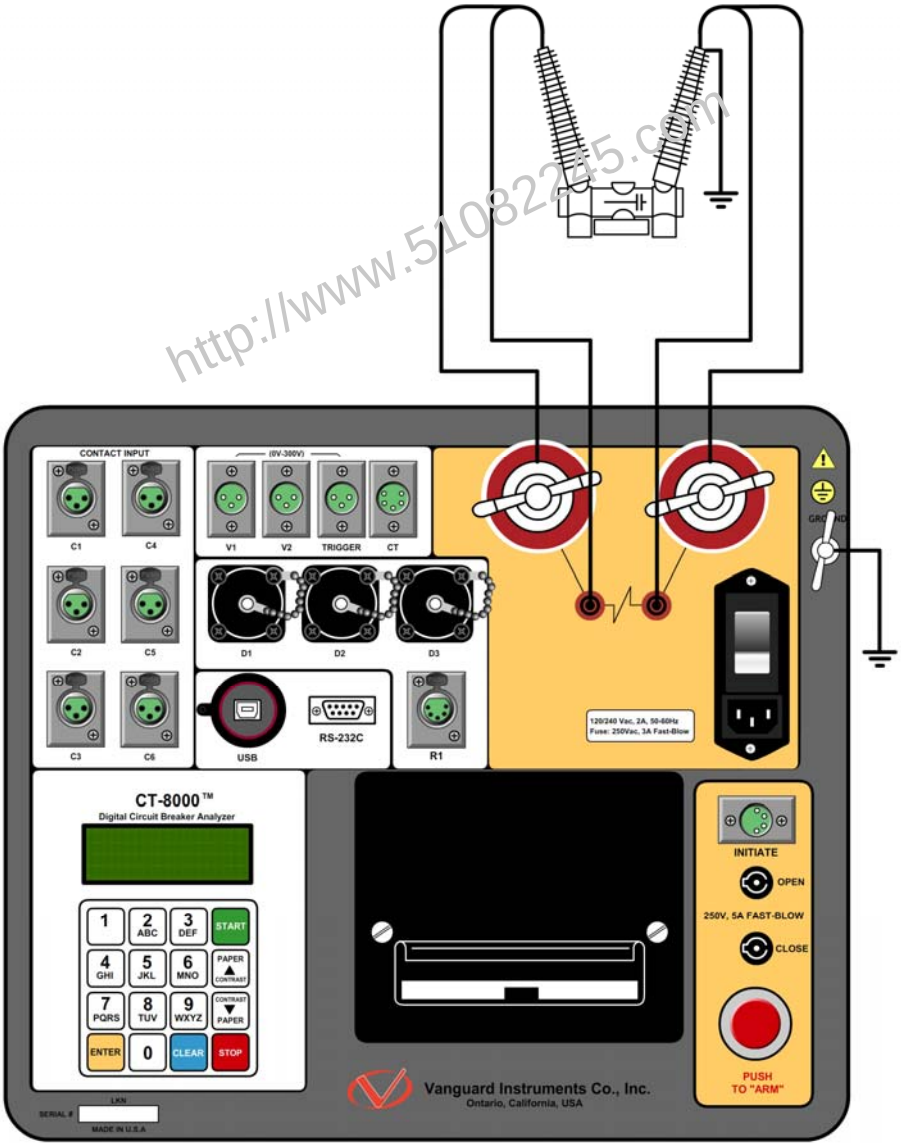

Figure 11. Typical Contact Resistance Cable Connection

3.1.8. On-line Test AC Current Sensor Connection

A typical CT-8000 AC current sensor connection is shown in Figure 12. The non-contact AC current sensor must be connected to one of the circuit breaker bushing CT terminals. A minimum current of 100 mA is required for the CT-8000 AC current sensor.

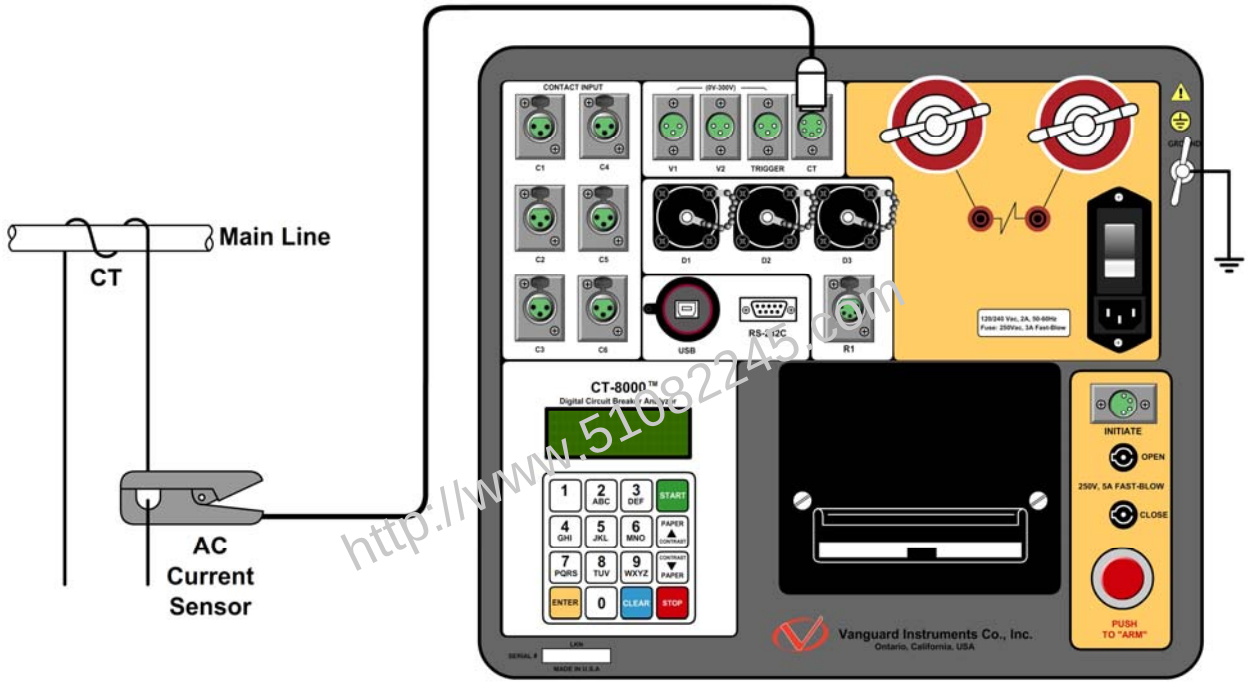

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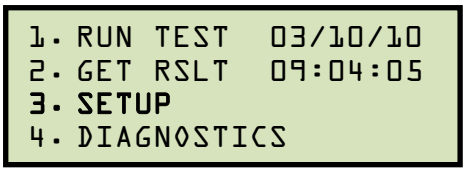
Figure 12. AC Current Sensor Connection

3.2 Pre-Test Setup

3.2.1. Entering Test Record Header Information

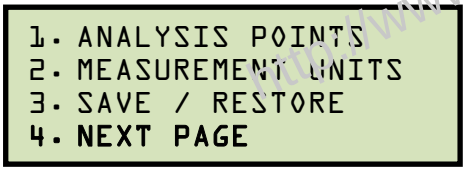
You can enter the test record header information before performing tests. The record header includes identifying information such as the company, station, circuit, model number, etc. Once the header information has been entered, it will apply to all subsequent test records. To enter the header information:

a. When the unit is turned on and the firmware is loaded, you will be presented with the "START-UP" menu as shown below:



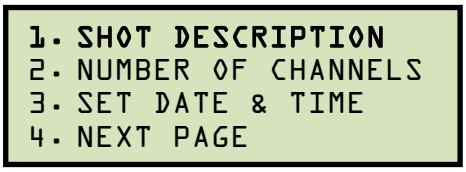
Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[1]** key (*SHOT DESCRIPTION*).

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d. The following screen will be displayed:

```
COMPANY:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the company name using the alpha-numeric keypad.

When pressing a key, the corresponding number on the key will be displayed first. Pressing the key again will display the first letter on the key. Pressing the key again will display the second letter on the key. For example, to type the letter "A", you must press the **[2]** key twice. To erase the character at the cursor position, press the **[CLEAR]** key. Press the **[PAPER ∧ Contrast]** key to move to the next character. Press the **[PAPER ∨ Contrast]** key to move to the previous character. Press the **[ENTER]** key when you are done typing the company name.

e. The following screen will be displayed:

```
STATION:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the station name using the alpha-numeric keypad and then press the **[ENTER]** key.

f. The following screen will be displayed:

```
CIRCUIT:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the circuit information using the alpha-numeric keypad and then press the **[ENTER]** key.

g. The following screen will be displayed:

```
MANUFACTURER:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the manufacturer name using the alpha-numeric keypad and then press the **[ENTER]** key.

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h. The following screen will be displayed:

```
MODEL:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the model information using the alpha-numeric keypad and then press the **[ENTER]** key.

i. The following screen will be displayed:

```
SERIAL NUMBER:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the serial number using the alpha-numeric keypad and then press the **[ENTER]** key.

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j. The following screen will be displayed:

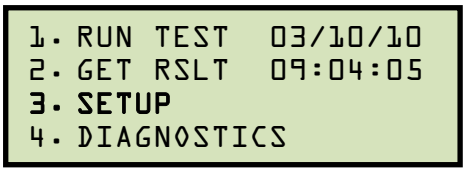
```
OPERATOR:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

Type the operator's name using the alpha-numeric keypad and then press the **[ENTER]** key. All header information will be saved, and you will be returned to the "START-UP" menu.

3.2.2. Setting the Clock

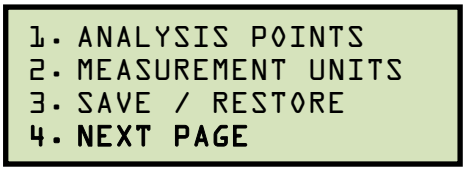
To set the CT-8000's internal clock:

a. Start from the "START-UP" menu:



Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*NEXT PAGE*).

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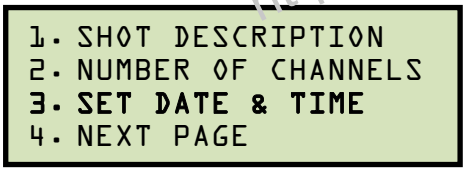
c. The following screen will be displayed:



Press the **[3]** key (*SET DATE & TIME*).

d. The following screen will be displayed:

Enter the month, date, time, hours, minutes, and seconds (in 24-hour format) using the alpha-numeric keypad. When the last digit is entered, the clock will be set and you will be returned to the "START-UP" menu.

3.2.3. Configuring the Automatic Printing Feature

The CT-8000 can be configured to print graphs and tabulated results automatically after each test. To configure the automatic printing feature:

a. Start from the "START-UP" menu:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

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c. The following screen will be displayed:

```
1. SHOT DESCRIPTION
2. NUMBER OF CHANNELS
3. SET DATE & TIME
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

d. The following screen will be displayed:

```
1. SET PRINT MODE
2. SET 50/60 Hz
```

Press the **[1]** key (*SET PRINT MODE*).

e. The following screen will be displayed:

```
   SET PRINT MODE:
1. AUTOMATIC PRINT
2. BY REQUEST ONLY
```

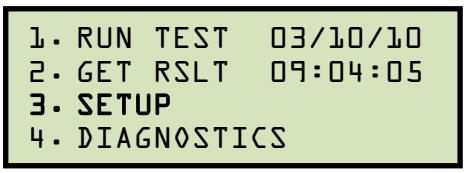
Press the **[1]** key (*AUTOMATIC PRINT*) if you would like to automatically print tabulated and graphic results after each test is performed.

Press the **[2]** key (*BY REQUEST ONLY*) to turn off automatic printing of test results. Please see section 3.3.5 for instructions on how to manually print test results.

3.2.4. Setting the Units of Measure

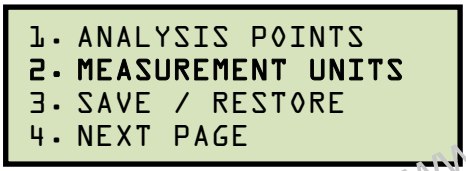
The CT-8000 supports and displays both English and Metric calculations. You can switch between the English and Metric systems using the steps below:

a. Start from the "START-UP" menu:



Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



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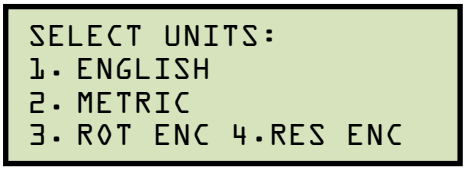
Press the **[2]** key (*MEASUREMENT UNITS*).

c. The following screen will be displayed:



Press the **[1]** key (*ENGLISH*) or the **[2]** key (*METRIC*) to select the corresponding measurement system. The measurement system will be set and you will be returned to the "START-UP" menu.

NOTE

If the measurement system is changed, any relevant values in the working memory will be automatically converted to the new system. Also, if retrieving a test record from the Flash EEPROM, all data will be converted to the new measurement system. There is no need to re-run a test.

3.2.5. Setting the Open Timing Analysis Points

Two analysis points are used to calculate the velocity of the circuit breaker in the open operation. To configure the OPEN timing analysis points:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[1]** key (*ANALYSIS POINTS*).

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c. The following screen will be displayed:

```
1. OPEN TIMING
2. CLOSE TIMING
3. PRINT SETTINGS
4. TEST PLANS
```

Press the **[1]** key (*OPEN TIMING*).

d. The following screen will be displayed:

```
OPEN ANALYSIS PT 1
1. PERCENT OF STROKE
2. DIST FROM CLOSE
3. CONTACT #1
```

1. *PERCENT OF STROKE*

   Press the **[1]** key (*PERCENT OF STROKE*) to set the open analysis point #1 as a percentage of the total stroke value.

NOTE Percentage of stroke is the distance based upon the percentage of the total breaker's stroke distance. The distance is always measured from the starting point at the fully closed position of the breaker contacts.

The following screen will be displayed:

```
OPEN ANALYSIS PT 1
% OF TOTAL STROKE
VALUE:  00%
"ENTER" TO CONFIRM
```

Type the percentage value using the numeric keypad and then press the **[ENTER]** key. **Continue to step e**.

2. *DIST FROM CLOSE*

Press the **[2]** key (*DIST FROM CLOSE*) to set the open analysis point #1 as a distance from the contact's close position.

NOTE The distance from close range is selectable from 00.0 inch to 99.99 inches or from 0.0 to 999.0 millimeters. The distance is referenced from the contact's closed position.

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The following screen will be displayed:

```
OPEN ANALYSIS PT 1
DISTANCE FROM CLOSE
VALUE: 025.4 mm
"ENTER" TO CONFIRM
```

Type the distance value using the numeric keypad and then press the **[ENTER]** key. **Continue to step e**.

3. *CONTACT #1*

Press the **[3]** key (*CONTACT #1*) to set the open analysis point #1 value equal to the contact point #1 value. **Continue to step e**.

NOTE Contact point #1 is the distance from the contact's closed position to the point where it is in transition from the CLOSE to OPEN or the OPEN to CLOSE position.

e. The following screen will be displayed:

```
OPEN ANALYSIS PT 2
1. PERCENT OF STROKE
2. DIST FROM CLOSE
3. CONTACT +/- TIME
```

1. *PERCENT OF STROKE*

   Press the **[1]** key (*PERCENT OF STROKE*) to set the open analysis point #2 as a percentage of the total stroke value. The following screen will be displayed:

```
OPEN ANALYSIS PT 2
% OF TOTAL STROKE
VALUE:  00%
"ENTER" TO CONFIRM
```

   Type the percentage value using the numeric keypad and then press the **[ENTER]** key. The analysis points will be set and you will be returned to the "START-UP" menu.

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2. *DIST FROM CLOSE*

   Press the **[2]** key (*DIST FROM CLOSE*) to set the open analysis point #2 as a distance from the contact's close position. The following screen will be displayed:

```
OPEN ANALYSIS PT 2
DISTANCE FROM CLOSE
VALUE: 127.0 mm
"ENTER" TO CONFIRM
```

   Type the distance value using the numeric keypad and then press the **[ENTER]** key. The analysis points will be set and you will be returned to the "START-UP" menu.

3. *CONTACT +/- TIME*

   Press the **[3]** key to select the *CONTACT +/- TIME* option. The following screen will be displayed:

```
OPEN ANALYSIS PT 2
1. CONTACT PLUS TIME
2. CONTACT MINUS TIME
```

   1. *CONTACT PLUS TIME*

      Press the **[1]** key to select the *CONTACT PLUS TIME* option.

NOTE For the contact plus time, the user enters the time (in milliseconds) after the contact channel #1 made the transition from OPEN to CLOSE or CLOSE to OPEN to define the analysis point #2.

The following screen will be displayed:

```
OPEN ANALYSIS PT 2
ENTER TIME FROM CH1
TIME (mS):   000.0
"ENTER" TO CONFIRM
```

Type the time value using the numeric keypad and then press the **[ENTER]** key. The analysis points will be set and you will be returned to the "START-UP" menu.

2. *CONTACT MINUS TIME*

Press the **[2]** key to select the *CONTACT MINUS TIME* option.

NOTE For the contact minus time, the user enters the time (in milliseconds) before the contact channel #1 makes the transition from OPEN to CLOSE or CLOSE to OPEN to define the analysis point #2.

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The following screen will be displayed:

```
OPEN ANALYSIS PT 2
ENTER TIME FROM CH1
TIME (mS):   000.0
"ENTER" TO CONFIRM
```

Type the time value using the numeric keypad and then press the [ENTER] key. The analysis points will be set and you will be returned to the "START-UP" menu.

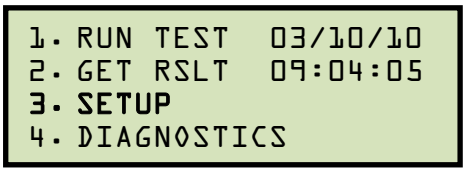
NOTES

- Average velocity through the arc zone is calculated using the following formula: **V_{avg} = Distance / Time**
- The breaker contact velocity can be recalculated based on the data stored in the memory after any new analysis points are selected. The user does NOT need to operate the breaker again to acquire new contact velocity data after changing the analysis points because the new velocity will be calculated from the travel data stored in the memory from the last operation.
- For complex velocity calculations, the user can create a test plan using the included CT-8000 Breaker Analysis PC Software. The test plan can then be downloaded to the CT-8000 and recalled before running timing tests.

3.2.6. Selecting the Contact Cycle Reading Frequency

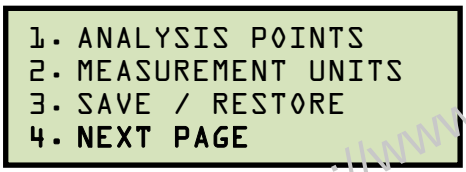
The contact time is printed on the tabulated test results printout in both milliseconds and cycles. The cycle readings can be in 50 Hz or 60 Hz. You can select the preferred frequency using the steps below:

a. Start from the "START-UP" menu:



Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



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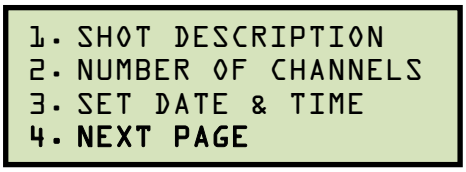
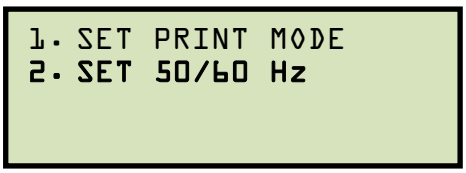
Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



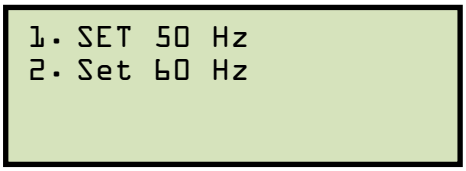
Press the **[4]** key (*NEXT PAGE*).

d. The following screen will be displayed:



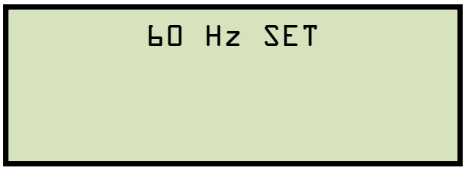
Press the **[2]** key (*SET 50/60 Hz*).

e. The following screen will be displayed:



Press either the **[1]** key (*SET 50 Hz*) or the **[2]** key (*SET 60 Hz*) to set the frequency to the corresponding value.

f. The following confirmation screen will be displayed:



Press any key to return to the "START-UP" menu. Sample tabulated test results are shown in Figure 13 and Figure 14.

NOTE If the frequency value is changed, the cycle values are automatically re-calculated by the CT-8000.

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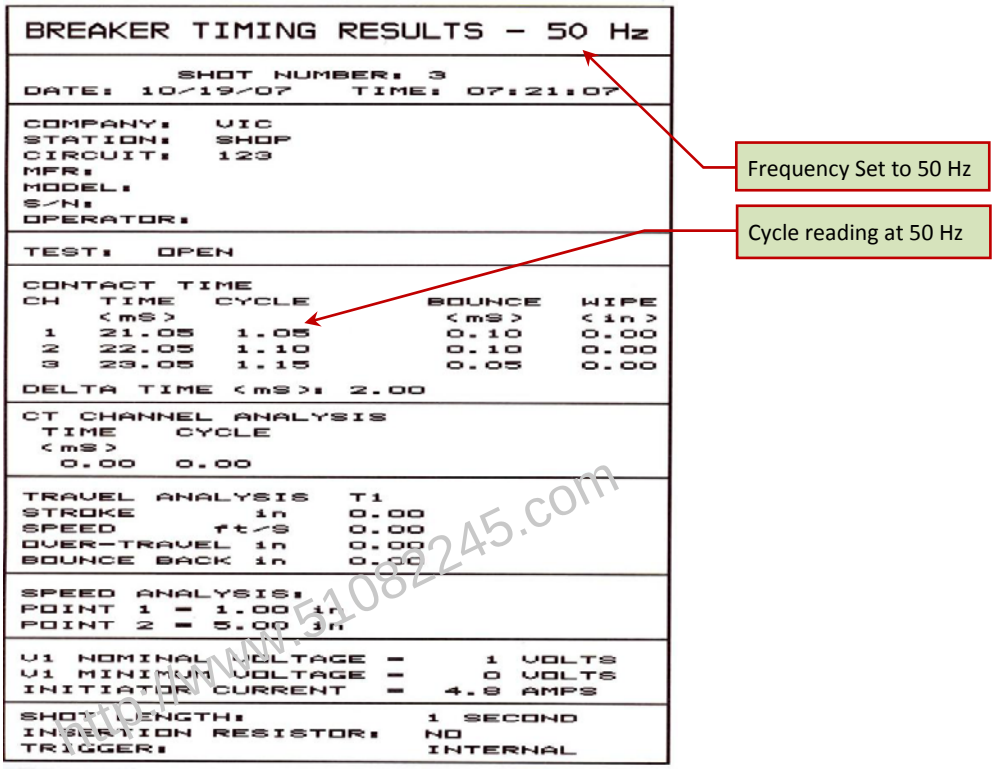


Figure 13. Typical 50 Hz Tabulated Test Results

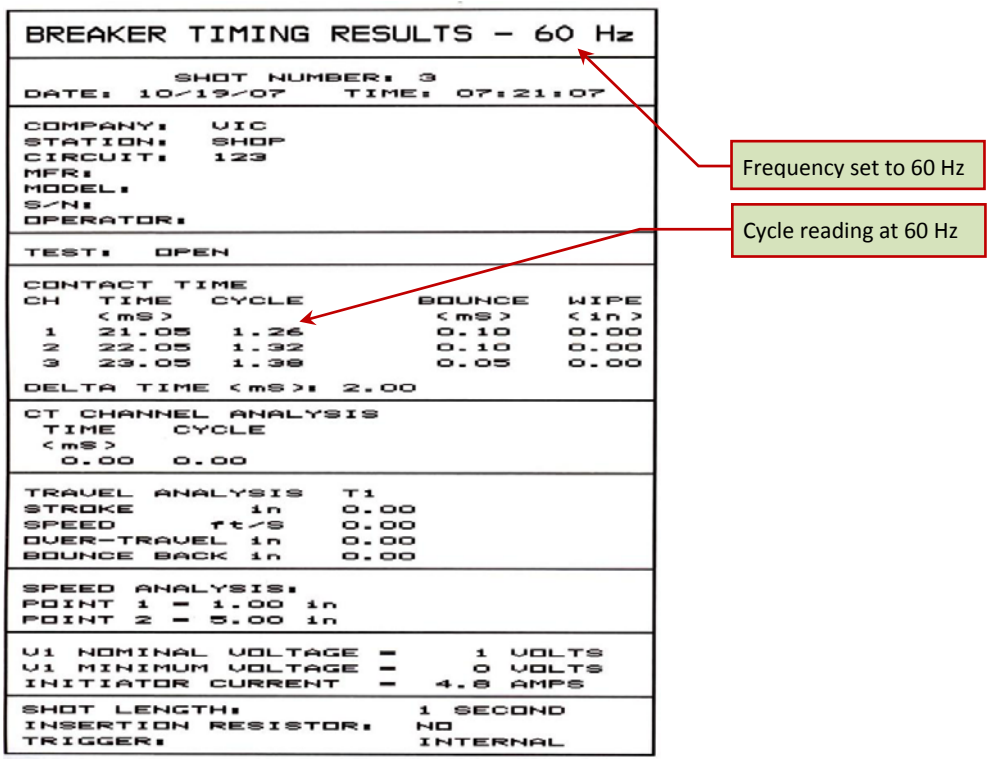
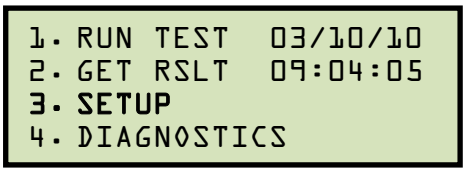


Figure 14. Typical 60 Hz Tabulated Test Results

3.2.7. Configuring the Channel Settings

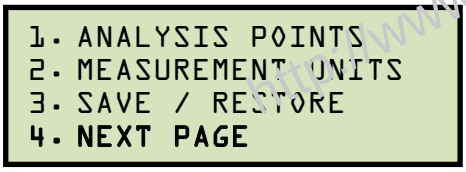
The CT-8000 is available with 3 or 6 contact inputs. Since most common timing applications require the use of only 3 contact timing channels and one travel transducer channel, there is no need to print data for more than 3 timing channels and one transducer channel on the graphic and tabulated reports. The CT-8000's is configured to print 3 contact channels by default (channels 1, 2, and 3) and one transducer channel (transducer channel #1). The default settings can be changed using the steps below:

a. Start from the "START-UP" menu:



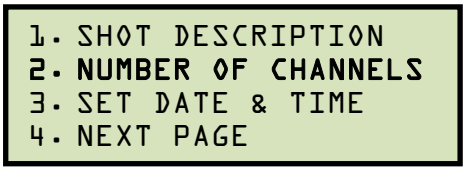
Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[2]** key (*NUMBER OF CHANNELS*).

d. The following screen will be displayed:

Press either the **[1]** key (3 CONTACTS) or the **[2]** key (6 CONTACTS) to select the corresponding number of contact channels.

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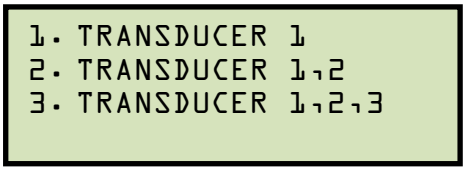
e. The following screen will be displayed:



Select the number of transducer channels by pressing either the **[1]**, **[2]**, or **[3]** key. The configuration information will be saved and you will be returned to the "START-UP" menu.

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3.2.8. Configuring the Contact Filter Settings

Although the CT-8000 automatically detects the contact time using its own algorithm, it also allows the user to enter a custom filter value. The value can be between 1 and 300. A filter setting of 1 allows the CT-8000 to pick up the first contact transition time after the resistor contact activity is detected. A filter setting of 300 allows the CT-8000 to pick up the last contact transition time after the resistor contact activity is detected. Use the steps below to set the contact filter value:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:

```
1. SLOW CLOSE TEST
2. CHECK HOOKUP
3. TEST TRANSDUCER
4. NEXT PAGE
```

Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:

```
1. PRINT DATA
2. ENCODER FILTER
3. CONTACT FILTER
```

Press the **[3]** key (*CONTACT FILTER*).

d. The following screen will be displayed:

```
 ENTER FILTER SETTING
       (1 - 300)
CURRENT SETTING: 1
NEW SETTING?
```

Type the new filter value using the numeric keypad and then press the **[ENTER]** key. The contact filter value will be set and you will be returned to the "START-UP" menu.

NOTE The filter value will be reset to the automatic setting when the unit's power is cycled.

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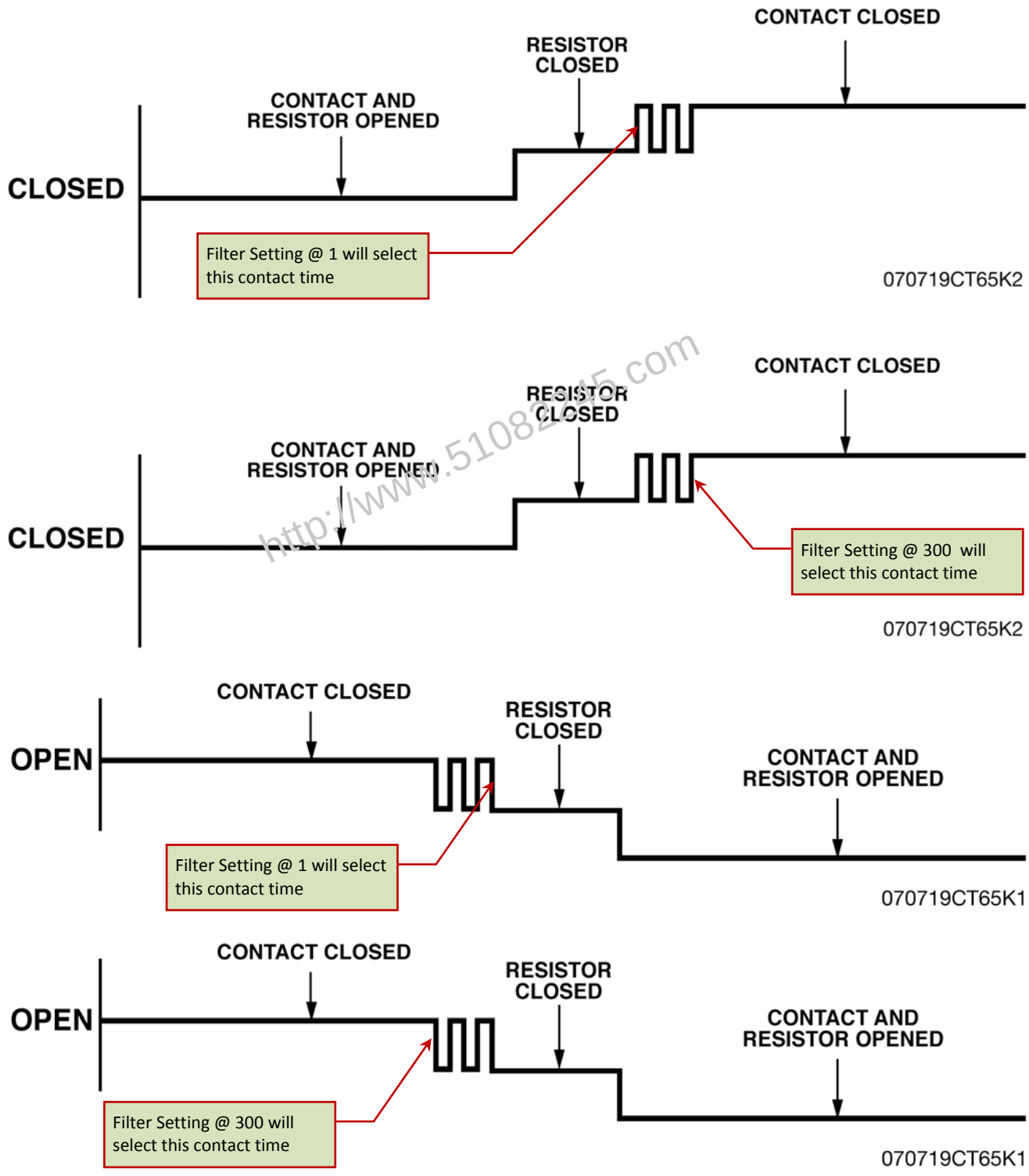

Figure 15. Contact Filter Setting Illustrations

3.2.9. Configuring the Transducer Encoder Filter Setting

In a typical 1-second timing record, the CT-8000 records 20,000 data points for each of the contact channels, digital transducer channels, voltage input channels, CT channel, DCR channel, resistor transducer channel, and initiate current channel. In most circuit breaker timing applications, the breaker activities end after 200 milliseconds. A common problem found in the field is that after the breaker activities have ended, the CT-8000 may record erroneous data on the transducer channels due to vibration. The erroneous data may be due to the transducer not being secured properly to the mounting plate or due to a poor linkage problem between the transducer and the circuit breaker mechanism.

To address this problem, the CT-8000's transducer encoder filter setting can be used to stop recording the transducer channel data after a specific time. This feature can filter out the unwanted motion picked up by the transducer after the breaker activities have ended. The CT-8000's default filter value is set to "No Filter" when the unit is powered on. Use the steps below to change the transducer encoder filter setting:

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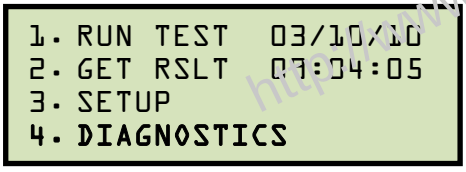
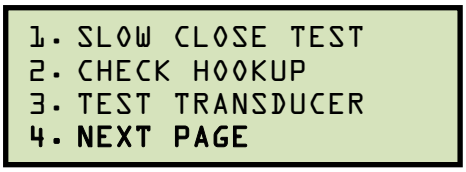
a. Start from the "START-UP" menu:



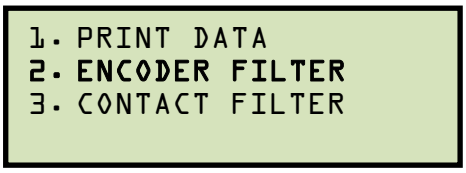
Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:



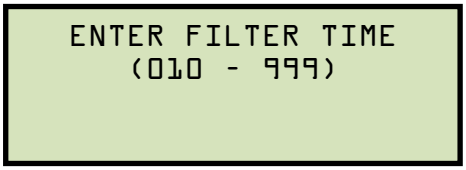
Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[2]** key (*ENCODER FILTER*).

d. The following screen will be displayed:



Type the filter time (in milliseconds) using the numeric keypad, and then press the **[ENTER]** key to return to the "START-UP" menu. The CT-8000 will not record any transducer encoder data after this time.

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3.2.10. Configuring the Digital Rotary Transducer Settings

A rotary transducer requires the user to enter the defined linear distance in millimeters or inches per one degree of rotary motion. Follow the steps below to configure the settings for a digital rotary transducer:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[2]** key (*MEASUREMENT UNITS*).

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c. The following screen will be displayed:

```
SELECT UNITS
1. ENGLISH
2. METRIC
3. ROT ENC 4.RES ENC
```

Press the **[3]** key (*ROT ENC*).

d. The following screen will be displayed:

```
ROTARY ENCODER:
1. ENGLISH (In./deg)
2. METRIC  (MM/deg)
```

1. *ENGLISH (In./deg)*

   Press the **[1]** key to enter the rotary encoder linear distance per degree using English units. The following screen will be displayed:

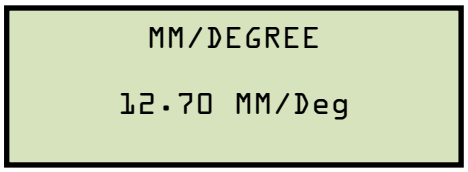
```
     INCHES/DEGREE

     5.535 In/Deg
```

   Type the desired value using the numeric keypad. You can press the **[CLEAR]** key to reset the value to 0.000 In/Deg. Press the **[ENTER]** key to save the new value. You will be returned to the "START-UP" menu.

2. *METRIC (MM/deg)*

Press the **[2]** key to enter the rotary encoder linear distance per degree using Metric units. The following screen will be displayed:



Type the desired value using the numeric keypad. You can press the **[CLEAR]** key to reset the value to 0.000 MM/Deg. Press the **[ENTER]** key to save the new value. You will be returned to the "START-UP" menu.

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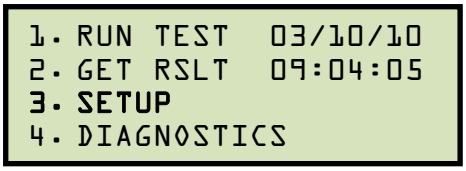
3.2.11. Configuring the Resister Type Transducer Settings

The CT-8000 provides one channel for a resistor type transducer. The transducer must be configured before it can be used with the CT-8000. Up to 9 resistor transducer setups can be stored in the CT-8000's Flash EEPROM. When a resistive transducer is used with the CT-8000, it is shown as transducer #1 on the timing report as shown in Figure 17.

Creating a New Resistor Type Transducer Setup

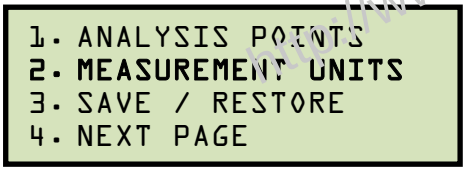
Follow the steps below to create a new resistor type transducer setup:

a. Start from the "START-UP" menu:



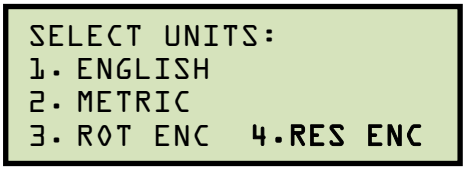
Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



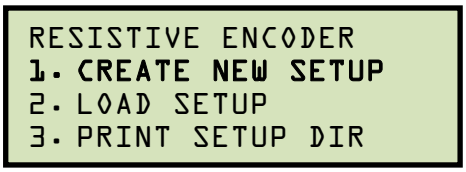
Press the **[2]** key (*MEASUREMENT UNITS*).

c. The following screen will be displayed:



Press the **[4]** key (*RES ENC*).

d. The following screen will be displayed:



Press the **[1]** key (*CREATE NEW SETUP*).

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e. The following screen will be displayed:

```
RESISTIVE ENCODER
1. ENGLISH (IN/Volt)
2. METRIC (MM/Volt)
```

Press the **[1]** key to enter the transducer travel distance per volt using English units, or press the **[2]** key to enter the transducer travel distance per volt using Metric units.

f. The following screen will be displayed:

```
MOVE RES ENCODER TO
REFERENCE POSITION.

"ENTER" TO CONTINUE
```

Move the transducer to the reference position and press the **[ENTER]** key.

g. The following screen will be displayed:

```
MOVE RES ENCODER A
KNOWN DISTANCE...

"ENTER" TO CONTINUE
```

Move the transducer a known distance and press the **[ENTER]** key.

h. The following screen will be displayed (the units of measure displayed will depend on your choice in step e):

```
ENTER THE DISTANCE
      MOVED:
            IN
"ENTER" TO CONTINUE
```

Using the numeric keypad, enter the distance the transducer was moved and then press the **[ENTER]** key.

i. The following screen will be displayed:

```
ENTER SETUP NOTE:

↑↓ TO POSITION
"ENTER" TO ACCEPT
```

If you prefer, you can enter a note to be associated with the setup using the alpha-numeric keypad. Press the **[ENTER]** key when done typing.

http://www.510322245.com

j. The following screen will be displayed:

```
ENTER SETUP NUMBER
 TO SAVE (1-9):
```

Enter a setup number from 1 to 9 using the numeric keypad.

k. The following screen will be displayed:

```
"ENTER" TO SAVE
SETUP NUMBER 1
```

Press the **[ENTER]** key to save the setup.

NOTE

If a setup already exists at the selected memory location, it will be over-ridden by the new setup values.

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l. The following screen will be displayed while the setup is being saved:

```
   SAVE IN PROGRESS

    PLEASE WAIT...
```

The following screen will be displayed when the setup has been saved:

```
     SETUP SAVED!
```

Press any key to return to the "START-UP" menu.

Loading a Resistor Type Transducer Setup

Follow the steps below to load a resistor type transducer setup:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[2]** key (*MEASUREMENT UNITS*).

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c. The following screen will be displayed:

```
SELECT UNITS:
1. ENGLISH
2. METRIC
3. ROT ENC   4.RES ENC
```

Press the **[4]** key (*RES ENC*).

d. The following screen will be displayed:

```
RESISTIVE ENCODER
1. CREATE NEW SETUP
2. LOAD SETUP
3. PRINT SETUP DIR
```

Press the **[2]** key (*LOAD SETUP*).

e. The following screen will be displayed:

```
ENTER SETUP NUMBER
 TO LOAD (1-9):
```

Type the setup number to load using the numeric keypad.

NOTE

If there is no setup stored in the selected memory location, the following screen will be displayed:

```
SETUP NOT FOUND
```

Press any key to return to the "START-UP" menu.

f. The following screen will be displayed:

```
SETUP NUMBER: 1
NOTE
ENGLISH
"ENTER" TO CONTINUE
```

Press the **[ENTER]** key to load the selected setup.

g. The following screen will be displayed:

```
    SETUP LOADED!
```

Press any key to return to the "START-UP" menu.

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Printing a Resistor Type Transducer Setup Directory

You can print a directory of the stored resistor type transducer setups on the built-in thermal printer using the steps below:

a. Start from the "START-UP" menu:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[2]** key (*MEASUREMENT UNITS*).

c. The following screen will be displayed:

```
SELECT UNITS:
1. ENGLISH
2. METRIC
3. ROT ENC  4.RES ENC
```

Press the **[4]** key (*RES ENC*).

d. The following screen will be displayed:

```
RESISTIVE ENCODER
1. CREATE NEW SETUP
2. LOAD SETUP
3. PRINT SETUP DIR
```

Press the **[3]** key (*PRINT SETUP DIR*). The setup directory will be printed and you will be returned to the "START-UP" menu. A sample resistor type transducer setup directory printout is shown in Figure 16.

http://www.5108245.com

```
RESISTIVE ENCODER SETUP DIRECTORY

SETUP NUMBER 1
SETUP NOTE:
UNITS:          ENGLISH
SETTING:        2.465 INCHES/VOLT

SETUP NUMBER 2
SETUP NOTE:     ABB
UNITS:          ENGLISH
SETTING:        2.040 INCHES/VOLT

SETUP NUMBER 3
SETUP NOTE:     2V OR5 IN
UNITS:          ENGLISH
SETTING:        0.249 INCHES/VOLT

SETUP NUMBER 4
SETUP NOTE:     OR5 V    24 IN
UNITS:          ENGLISH
SETTING:        47.768 INCHES/VOLT

SETUP NUMBER 5
SETUP NOTE:     OR5 V    30 IN
UNITS:          ENGLISH
SETTING:        59.874 INCHES/VOLT

SETUP NUMBER 6
SETUP NOTE:     1V   10MM
UNITS:          METRIC
SETTING:        10.1 MM/VOLT

SETUP NUMBER 7
SETUP NOTE:     1V 50MM
UNITS:          METRIC
SETTING:        49.3 MM/VOLT

SETUP NUMBER 8
SETUP NOTE:     5V 305MM MET
UNITS:          METRIC
SETTING:        62.1 MM/VOLT

SETUP NUMBER 9
SETUP NOTE:     ABB AHMB
UNITS:          ENGLISH
SETTING:        1.622 INCHES/VOLT
```

Figure 16. Sample Resistor Type Transducer Setup Directory

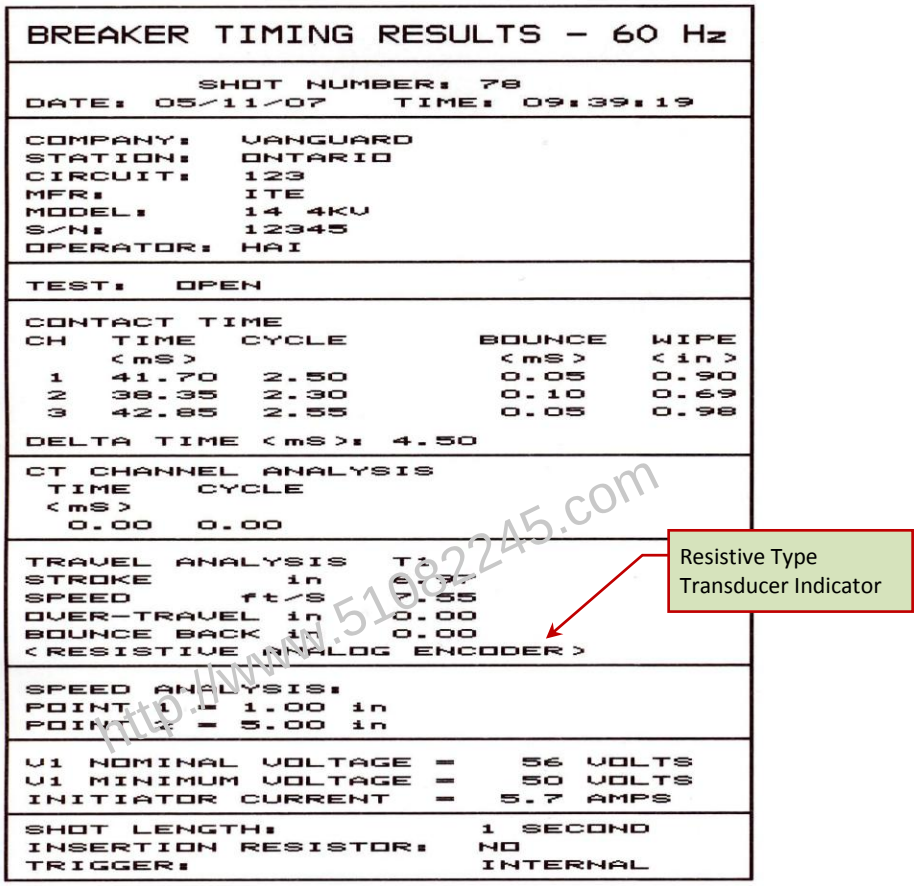

Figure 17. Sample Timing Report Using a Resistor Type Transducer

3.3 Performing Circuit Breaker Timing Tests

The CT-8000 can initiate the breaker operation and perform a timing test on the following operations:

- OPEN
- CLOSE
- OPEN-CLOSE
- CLOSE-OPEN
- OPEN-CLOSE-OPEN

The CT-8000 can start the OPEN-CLOSE operations without a delay or by using a programmable delay between the OPEN and CLOSE commands.

The CLOSE-OPEN operation can be started by the CT-8000 using several options:

- Contact #1 CLOSE

  The CT-8000 can initiate a CLOSE command and then an OPEN command after detecting the closing of the breaker's contact. The CT-8000 detects the closing of the contact through contact channel #1. This option is recommended for the CLOSE-OPEN operation since it truly represents when the circuit breaker closed and then opened.

- Set DELAY

  The CT-8000 can initiate a CLOSE command and then an OPEN command after a programmable delay set in milliseconds.

- No DELAY

  The CT-8000 can initiate a CLOSE command and then an OPEN command without any delay. Since the circuit breaker is in the OPEN state, the breaker's 52B contact allows the CLOSE coil to be energized, which can start the CLOSE command. When the circuit breaker is making the transition from an OPEN state to a CLOSE state, the 52A contact will close allowing the breaker to initiate the OPEN command.

The OPEN-CLOSE-OPEN operation can be initiated by the CT-8000 by using a programmable delay between each of the operations. The delays can be set between the OPEN to CLOSE commands and between the CLOSE to OPEN commands.

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3.3.1. Timing an OPEN Operation

The CT-8000 can time breakers with or without insertion resistors. The insertion resistance can range from 10 to 7,000 Ohms. Any insertion resistance greater than 7,000 Ohms is detected as an open circuit. The timing results will show the main contact time and the insertion resistor contact time. Graphic reports will show the main contact and the resistor contact activities on each of the channels. Use the steps below to time an OPEN operation.

a. When the unit is turned on and the firmware has been loaded, you will be presented with the "START-UP" menu as shown below:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[1]** key (*RUN TEST*).

b. The following screen will be displayed:

```
1. TIME BREAKER
2. STATIC RES TEST
3. DYNAMIC RES TEST
```

Press the **[1]** key (*TIME BREAKER*).

c. The following screen will be displayed:

```
INSERTION RESISTOR?

1. NO
2. YES
```

1. NO

Press the **[1]** key if you are timing a circuit breaker without insertion resistors. **Continue to step d**.

2. YES

Press the **[2]** key if you are timing a circuit breaker with insertion resistors. The following screen will be displayed:

```
RESISTOR VALUE:
1. LESS THAN 1000 OHM
2. 1000 to 2000   OHM
3. MORE THAN 2000 OHM
```

Select the resistance value by pressing the corresponding key (**[1]**, **[2]**, or **[3]**). **Continue to step d**.

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d. The following screen will be displayed:

```
TIMING WINDOW:
1. WINDOW = 1  SEC
2. WINDOW = 10 SEC
3. WINDOW = 20 SEC
```

Press the **[1]** key (*WINDOW = 1 SEC*).

NOTE

The 1-second timing window is used for breaker timing. The 10 and 20-second timing windows are used for long timing events such as for timing circuit-switchers.

e. The following screen will be displayed:

```
TRIGGER MODE:

1. INTERNAL TRIGGER
2. EXTERNAL TRIGGER
```

Press the **[1]** key (*INTERNAL TRIGGER*).

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f. The following screen will be displayed:

```
TIMING MODE:
1. OPEN      2. CLOSE
3. O-C       4. C-O
5. O-C-O
```

Press the **[1]** key (*OPEN*).

g. The following screen will be displayed:

```
Hold "ARM" until
test completes.
"START" to Begin
"STOP" to ABORT
```

Hold down the **[ARM]** switch and press the **[START]** key.

h. The following screen will be displayed:

```
TEST IN PROGRESS
Hold "ARM" until
test completes.
(Up to 25 seconds)
```

Continue to hold down the **[ARM]** switch until testing is finished. You will be returned to the "START-UP" menu once testing is finished.

NOTES

- Please see section 3.3.5 for information about printing test results.
- The CT-8000 can be configured to print tabulated and graphics reports automatically after performing a test. Please see section 3.2.3 for further information.

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3.3.2. Timing a CLOSE-OPEN Operation Using Contact Channel #1

The CLOSE-OPEN operation of a breaker simulates a condition where a breaker is closed on a fault. There are three options when timing a CLOSE-OPEN operation:

1. Contact #1 CLOSE

   The CT-8000 will initiate a CLOSE operation. The open operation is then initiated after contact channel #1 is closed. This option closes simulates the breaker closing on a fault condition in the field.

2. Set DELAY

   A delay from 10 to 500 ms can be set between the CLOSE command and the OPEN command. The CT-8000 will initiate the CLOSE operation and start the delay counter. The OPEN operation will be initiated when the delay time has elapsed.

3. No DELAY

   Both the CLOSE and OPEN commands are initiated by the CT-8000 simultaneously. The OPEN coil is energized when the OPEN auxiliary switch makes.

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Follow the steps below to time a CLOSE-OPEN operation:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

   Press the **[1]** key (*RUN TEST*).

b. The following screen will be displayed:

```
1. TIME BREAKER
2. STATIC RES TEST
3. DYNAMIC RES TEST
```

   Press the **[1]** key (*TIME BREAKER*).

c. The following screen will be displayed:

```
INSERTION RESISTOR?

1. NO
2. YES
```

   Press the **[1]** key (*NO*).

d. The following screen will be displayed:

```
TIMING WINDOW:
1. WINDOW = 1  SEC
2. WINDOW = 10 SEC
3. WINDOW = 20 SEC
```

Press the **[1]** key (*WINDOW = 1 SEC*).

e. The following screen will be displayed:

```
TRIGGER MODE:

1. INTERNAL TRIGGER
2. EXTERNAL TRIGGER
```

Press the **[1]** key (*INTERNAL TRIGGER*).

f. The following screen will be displayed:

```
TIMING MODE:
1. OPEN      2. CLOSE
3. O-C       4. C-O
5. O-C-O
```

Press the **[4]** key (*C-O*).

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g. The following screen will be displayed:

```
C-0 Second Trigger
1. Contact #1 CL0SE
2. Set DELAY
3. No DELAY
```

1. Contact #1 CLOSE

Press the **[1]** key if you would like the open operation to be initiated after contact channel #1 is closed. **Continue to step h**.

2. Set DELAY

Press the **[2]** key to set a delay time between the CLOSE command and the OPEN command. The following screen will be displayed:

```
C-0 Delay in mS:
     (10 - 500)
         mSec
ENTER when done
```

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Type the delay time using the numeric keypad and then press the **[ENTER]** key. **Continue to step h**.

3. No DELAY

Press the **[3]** key to initiate the CLOSE and OPEN commands simultaneously. **Continue to step h**.

h. The following screen will be displayed:

```
Hold "ARM" until
test completes.
"START" to Begin
"ST0P" to AB0RT
```

Hold down the **[ARM]** switch and press the **[START]** key.

i. The following screen will be displayed:

```
TEST IN PR0GRESS
Hold "ARM" until
test completes.
(Up to 25 seconds)
```

Continue to hold down the **[ARM]** switch until testing is finished. You will be returned to the "START-UP" menu once testing is finished.

3.3.3. Timing an OPEN-CLOSE-OPEN Operation

The OPEN-CLOSE-OPEN operation requires the user to enter two time delays (in milliseconds) between the circuit breaker operations. The first delay is from the first OPEN command to the CLOSE command, and the second delay is from the CLOSE command to the second OPEN command. Follow the steps below to time an OPEN-CLOSE-OPEN operation:

a. Start from the "START-UP" menu:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[1]** key (*RUN TEST*).

b. The following screen will be displayed:

```
1. TIME BREAKER
2. STATIC RES TEST
3. DYNAMIC RES TEST
```

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Press the **[1]** key (*TIME BREAKER*).

c. The following screen will be displayed:

```
INSERTION RESISTOR?

1. NO
2. YES
```

Press the **[1]** key (*NO*).

d. The following screen will be displayed:

```
TIMING WINDOW:
1. WINDOW = 1  SEC
2. WINDOW = 10 SEC
3. WINDOW = 20 SEC
```

Press the [1] key (*WINDOW = 1 SEC*).

e. The following screen will be displayed:

```
TRIGGER MODE:

1. INTERNAL TRIGGER
2. EXTERNAL TRIGGER
```

Press the **[1]** key (*INTERNAL TRIGGER*).

f. The following screen will be displayed:

```
TIMING MODE:
1. OPEN      2. CLOSE
3. O-C       4. C-O
5. O-C-O
```

Press the **[5]** key (*O-C-O*).

g. The following screen will be displayed:

```
O-C Delay in mS:
     (10 - 350)
      200 mSec
ENTER when done
```

Using the numeric keypad, enter the time for the delay between the first OPEN command and the CLOSE command. Press the **[ENTER]** key.

h. The following screen will be displayed:

```
C-O Delay in mS:
     (10 - 350)
      200 mSec
ENTER when done
```

Using the numeric keypad, enter the time for the delay between the CLOSE command and the second OPEN command. Press the **[ENTER]** key.

i. The following screen will be displayed:

```
Hold "ARM" until
test completes.
"START" to Begin
"STOP" to ABORT
```

Hold down the **[ARM]** switch and press the **[START]** key.

j. The following screen will be displayed:

```
TEST IN PROGRESS
Hold "ARM" until
test completes.
(Up to 25 seconds)
```

Continue to hold down the **[ARM]** switch until testing is finished. You will be returned to the "START-UP" menu once testing is finished. See Figure 18 and Figure 19 for a sample O-C-O test results graph and tabulated test results printout, respectively.

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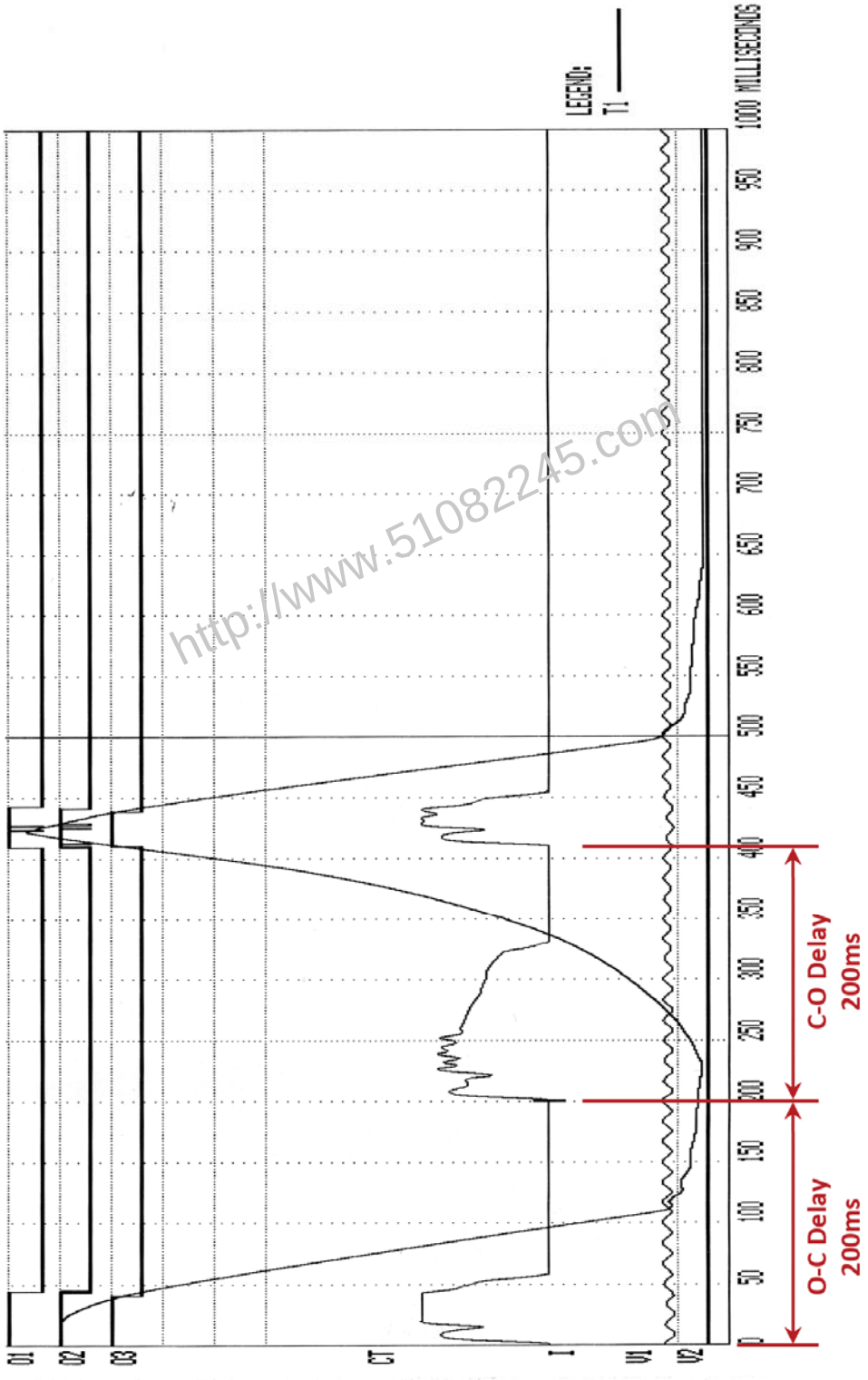

http://www.51082245.com

Figure 18. Typical O-C-O Test Results Graph

```
BREAKER TIMING RESULTS - 60 Hz

          SHOT NUMBER:  10
DATE:  02/17/10     TIME:  14:29:85

COMPANY:    VANGUARD
STATION:    ONTARIO
CIRCUIT:    123
MFR:
MODEL:      CT-8000
S/N:        81002
OPERATOR:   HAI

TEST:  OPEN-CLOSE-OPEN

CONTACT OPEN TIME #1
CH     TIME    CYCLES    BOUNCE
       <mS>               <mS>
 1    43.70      2.62      0.10
 2    42.70      2.56      2.35
 3    40.40      2.42      0.10

CONTACT RECLOSE TIME
CH     TIME    CYCLES    BOUNCE
       <mS>               <mS>
 1  408.45     24.51      1.15
 2  408.15     24.49      4.00
 3  407.65     24.46      2.90

CONTACT OPEN TIME #2
CH     TIME    CYCLES    BOUNCE
       <mS>               <mS>
 1  442.10     26.53      0.25
 2  440.90     26.45      1.35
 3  437.85     26.27      0.95

CONTACT DEAD TIME
CH     TIME    CYCLES
       <mS>
 1  364.75     21.88
 2  365.45     21.93
 3  367.25     22.01

CONTACT LIVE TIME
CH     TIME    CYCLES
       <mS>
 1   33.65      2.02
 2   32.75      1.95
 3   30.20      1.81

PEAK TO PEAK TRAVEL <in>
   T1
  7.02

V1 NOMINAL VOLTAGE =     56 VOLTS
V1 MINIMUM VOLTAGE =     50 VOLTS
INITIATOR CURRENT  =    5.7 AMPS

SHOT LENGTH:              1 SECOND
INSERTION RESISTOR:      NO
TRIGGER:                 INTERNAL
O-C DELAY:                200 mS
C-O DELAY:                200 mS
```

http://www.5108225.com

Figure 19. Typical Tabulated Test Results Printout for an O-C-O Operation

3.3.4. Running CT-8000's in Tandem

Two or more CT-8000's can be used to time a circuit breaker in cases where more than 6 timing contact channels are required. A typical application is to use one CT-8000 with 6 channels (CT-8000-6) and one CT-8000 with 3 channels (CT-8000-3) to create a 9 contact timing apparatus. Use the steps below to configure the CT-8000's:

a. Connect the CT-8000-6 to phase A and B of the circuit breaker.

b. Connect the CT-8000-3 to phase C of the circuit breaker.

c. Connect the CT-8000-6's initiate cable to the breaker control circuit. This unit will operate the circuit breaker.

d. Connect the CT-8000-3's external trigger cable to the OPEN coil for the OPEN test and CLOSE coil for the CLOSE test. This unit will operate as a slave device.

e. Start running a test from the CT-8000-3 using the *EXTERNAL TRIGGER* option.

f. Run a test from the CT-8000-6 using the *INTERNAL TRIGGER* option.

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The CT-8000-6 will operate the circuit breaker and start the timing sequence. The CT-8000-3 will start its timing sequence as soon as it senses the voltage applied to the breaker coil. The timing report of the CT-8000-6 will show the contact time of phase A and B. The timing report of the CT-8000-3 will show the contact time for phase C. If the results are downloaded to a PC using the included software, the two reports can be combined to generate a 9-channel test report.

3.3.5. Printing or Viewing Timing Results

Follow the steps below to print or view the timing results after performing a circuit breaker timing test:

a. After performing a timing test you will be returned to the "START-UP" menu:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[2]** key (*GET RSLT*).

b. The following screen will be displayed:

```
1. PRINT TEST RESULTS
2. PLOT FULL CHART
3. PLOT EXPANSION
4. PLOT 0 - 200MS
```

http://www.51082245.com

1. PRINT TEST RESULTS

Press the **[1]** key to view the test results on the screen or to print the tabulated test results WITHOUT the graph. The following screen will be displayed:

```
SELECT PRINTER:
1. THERMAL PRINTER
2. DISPLAY RESULTS
```

Press the **[1]** key (*THERMAL PRINTER*) to print the tabulated test results on the built-in thermal printer. The tabulated results will be printed, and you will be returned to the "START-UP" menu. A typical tabulated results printout is shown in Figure 20.

Press the **[2]** key (*DISPLAY RESULTS*) to display the test results on the unit's LCD screen. The following screen will be displayed:

```
UP/DWN ARROWS TO
SCROLL RESULTS...

"STOP" TO EXIT
```

Press the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys to scroll through the test results. Press the **[STOP]** key to return to the "START-UP" menu.

2. PLOT FULL CHART

Press the **[2]** key to print the tabulated results WITH the full graph of the results. You will be returned to the "START-UP" menu when printing is finished. A typical test result graph is shown in Figure 21.

3. *PLOT EXPANSION*

Press the **[3]** key to print the tabulated results along with a time expansion plot of the test results. The following screen will be displayed:

```
EXPANSION FROM:

"ENTER" TO CONFIRM
```

You will be asked to enter the start point for the expansion. The start point can be selected in 100 millisecond increments by typing the first digit of the starting time. For example, to select 500ms, simply press the **[5]** key. The screen will be updated as shown:

```
EXPANSION FROM:
500MS

"ENTER" TO CONFIRM
```

http://www.510822345.com

Press the **[ENTER]** key.

The following screen will be displayed:

```
EXPANSION TO:

"ENTER" TO CONFIRM
```

Enter the end point for the expansion by typing the first digit of the 100 millisecond increment. For example, to select 900ms, press the **[9]** key. The screen will be updated as shown:

```
EXPANSION TO:
900MS

"ENTER" TO CONFIRM
```

Press the **[ENTER]** key.

The graph expansion will be printed along with the tabulated test results. You will be returned to the "START-UP" menu when printing is finished. A sample expansion graph is shown in Figure 22.

4. *PLOT 0 – 200MS*

Press the **[4]** key to print the tabulated test results along with the graphic test results from 0 – 200 milliseconds. The graph and tabulated results will be printed

on the thermal printer. You will be returned to the "START-UP" menu when printing is finished.

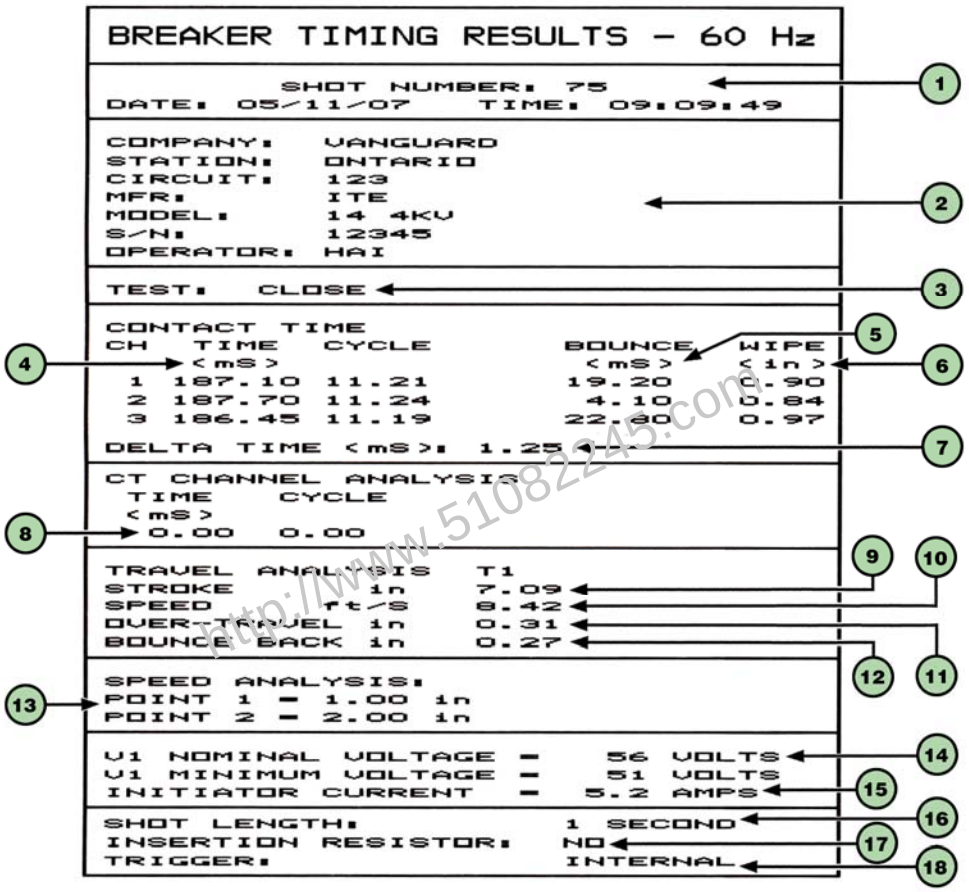

Figure 20. Typical Tabulated Test Results Printout for a CLOSE Operation

Table 3. Descriptions of Tabulated Test Results Elements

Item Number	Description
1	Test record number and the date and time the test was performed.
2	Test record header information (Company, Station, Circuit, etc.).
3	Type of test performed (OPEN, CLOSE, O-C, C-O, or O-C-O).
4	Contact channel times shown in milliseconds and cycles.
5	Contact channel bounce times shown in milliseconds.
6	Contact channel wipe distances in inches.
7	Contact delta time in milliseconds. This is the difference between the slowest contact time and the fastest contact time.
8	Current transformer time in milliseconds and cycles. This is the circuit breaker open or close time when using the CT-8000 AC current sensor for on-line testing.
9	Breaker contact stroke in inches.
10	Contact velocity in feet per second.
11	Contact over-travel distance in inches.
12	Contact bounce-back distance in inches.
13	Contact velocity calculation points.
14	DC power supply nominal and minimum voltage (if DC power supply was monitored during testing).
15	Initiate current.
16	Timing shot duration.
17	Insertion time (if breaker had an insertion resistor) or "NO" if there was no resistor.
18	Trigger mode (Internal or External)

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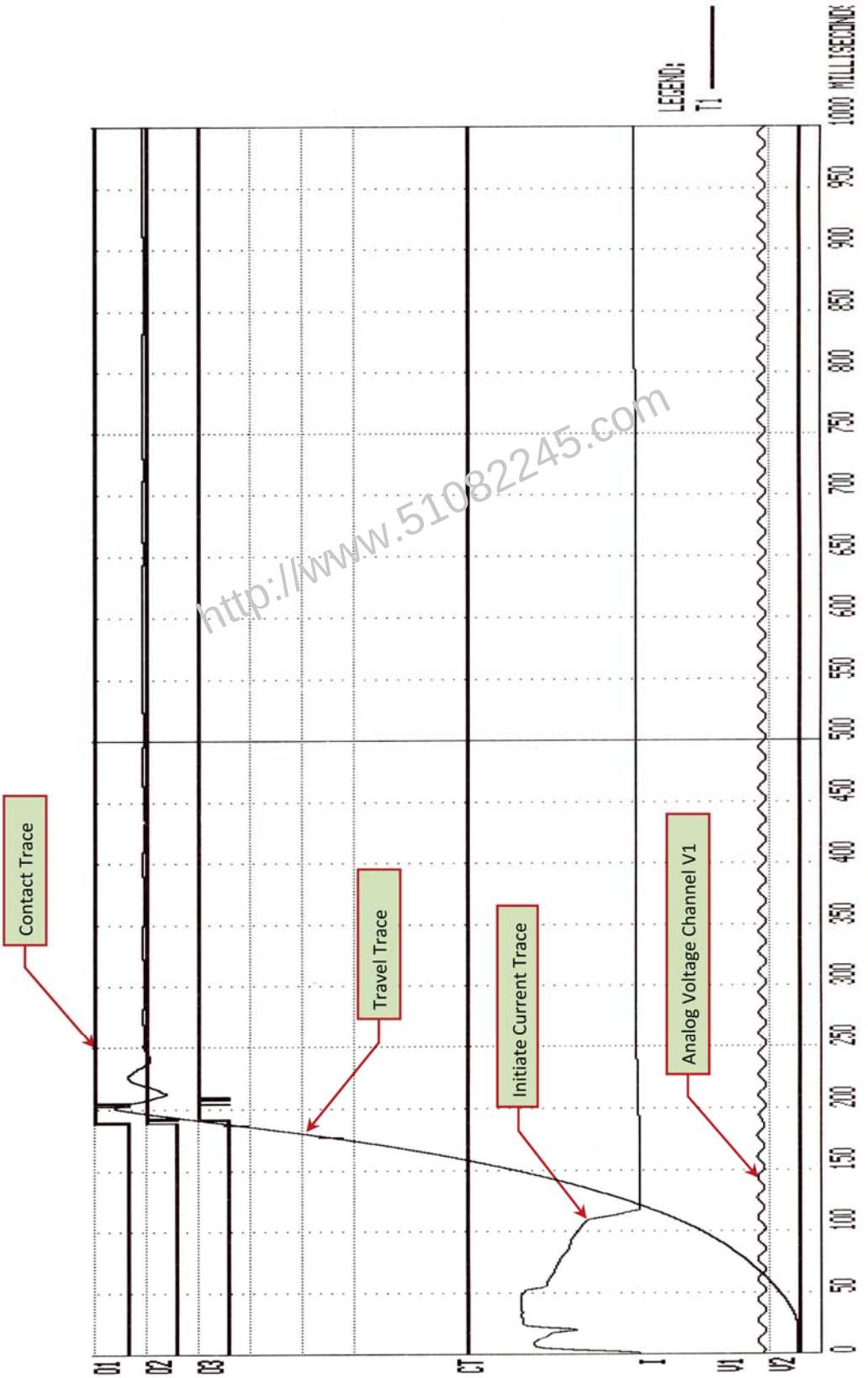

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Figure 21. Typical Test Results Graph

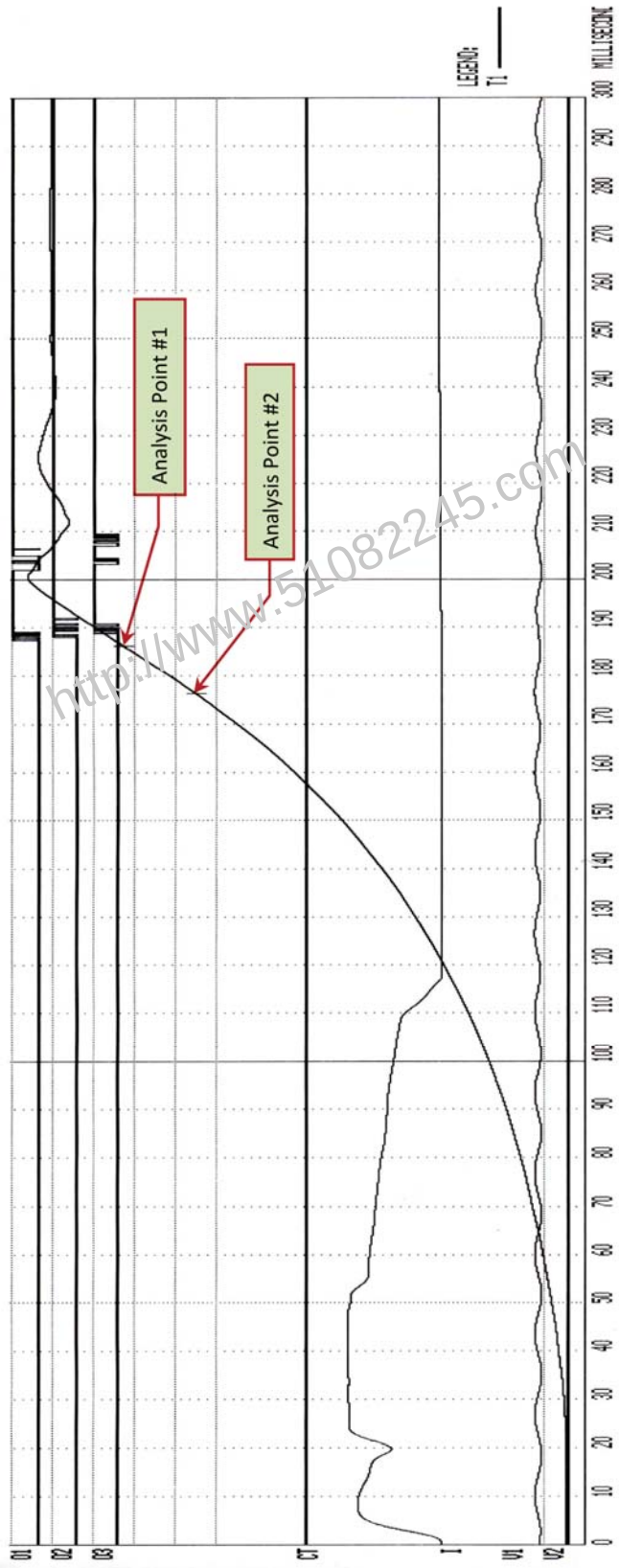

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Figure 22. Expansion Graph from 0ms to 300ms

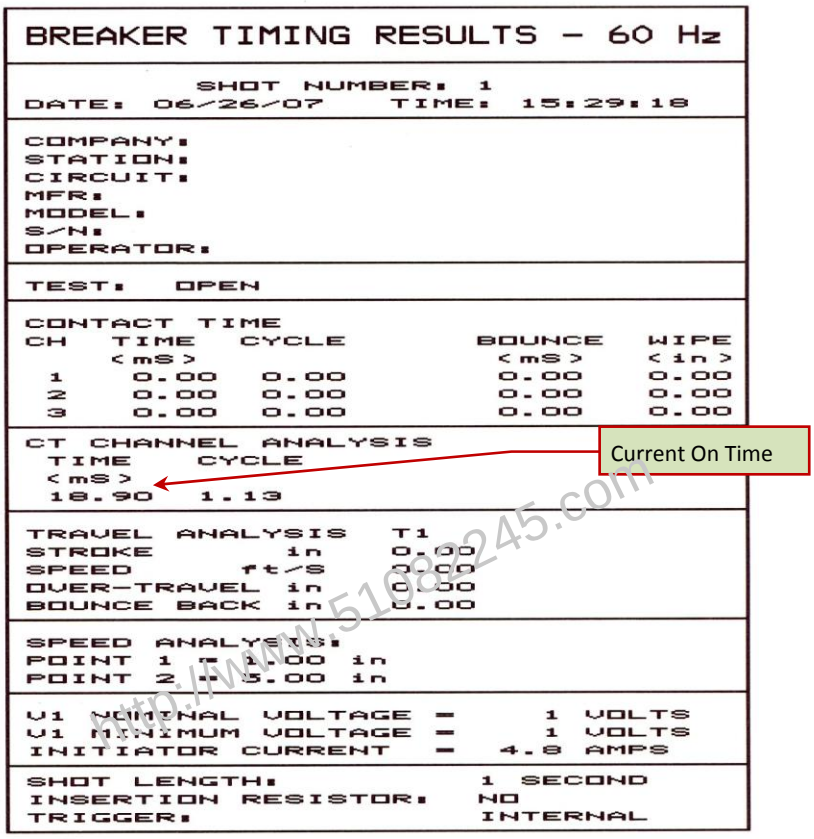

Figure 23. On-Line Timing Test Report Printout

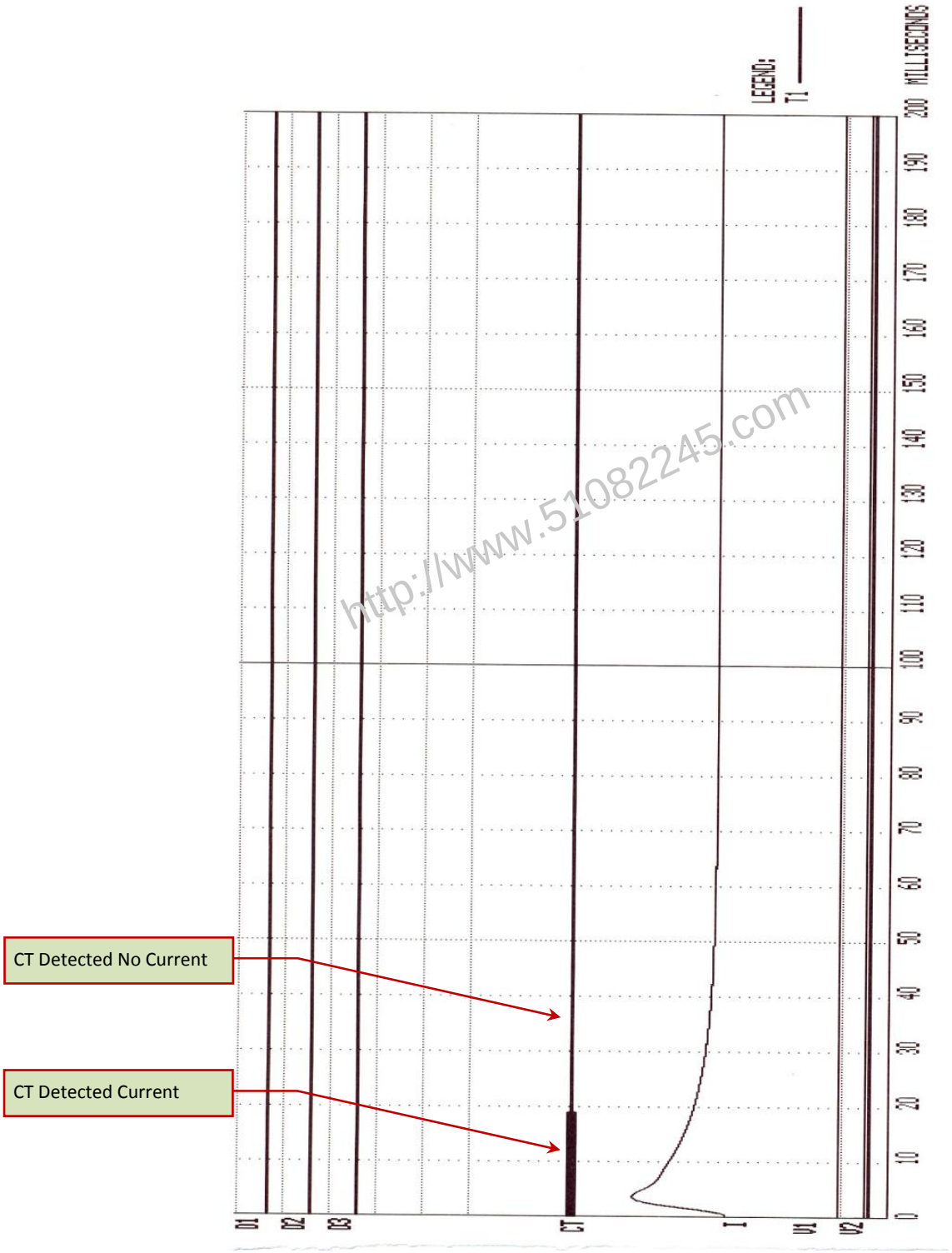

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Figure 24. On-Line Test Graphic Report

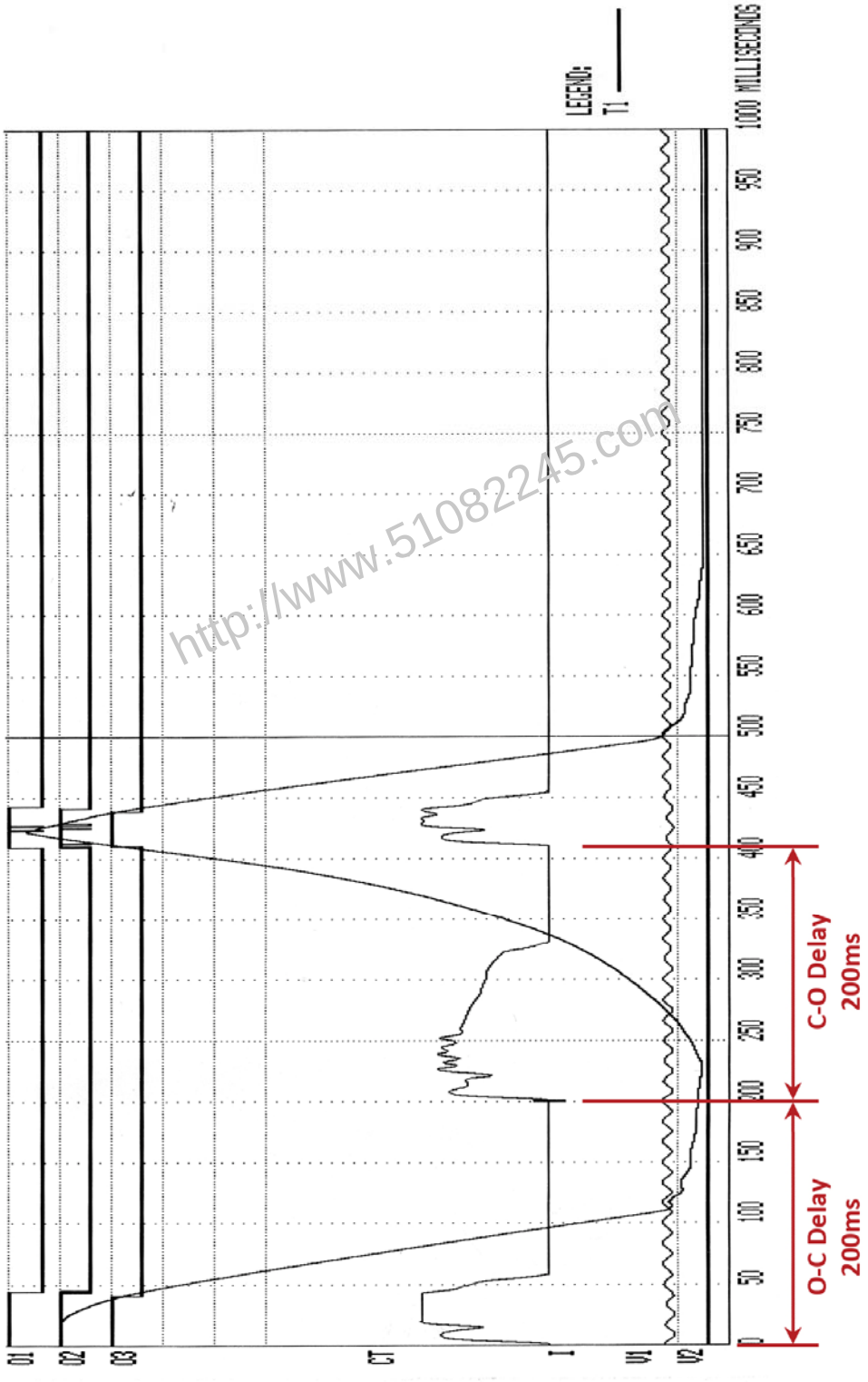

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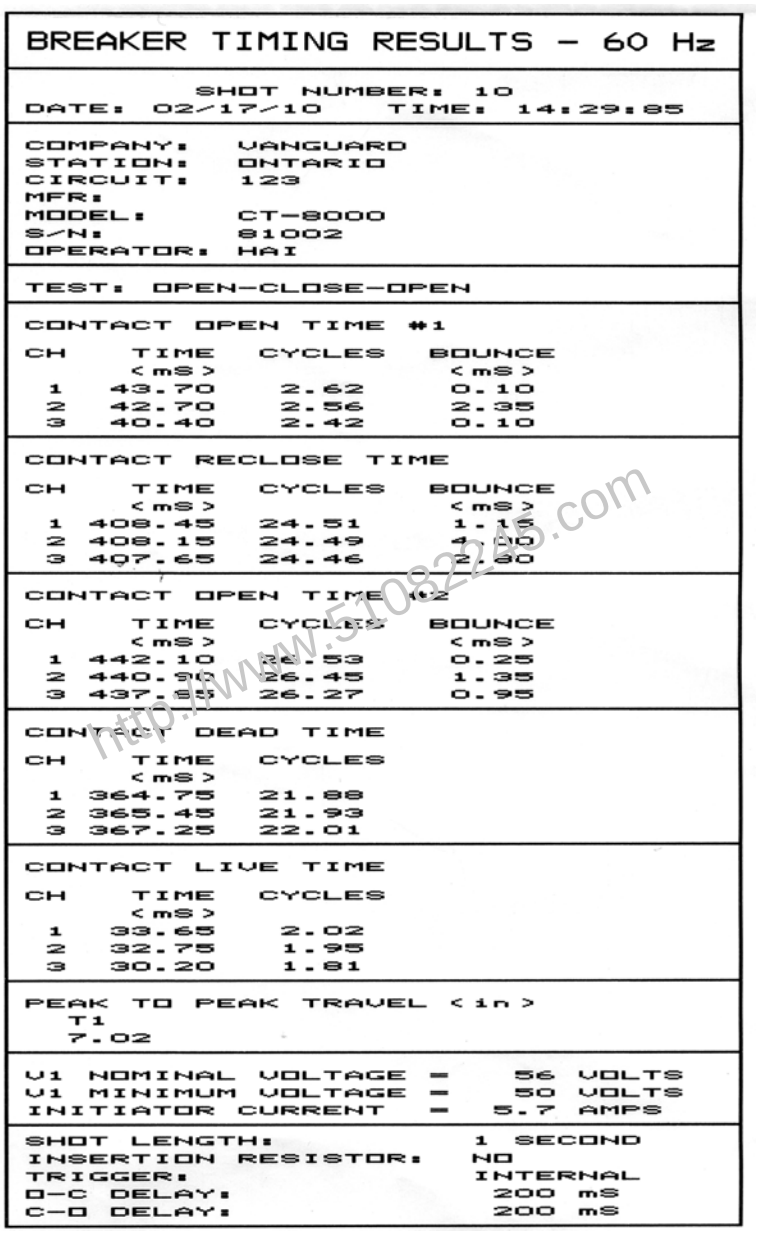
Figure 25. Typical O-C-O Test Results Graph



BREAKER TIMING RESULTS – 60 Hz

SHOT NUMBER: 10
DATE: 02/17/10 TIME: 14:29:85

COMPANY: VANGUARD
STATION: ONTARIO
CIRCUIT: 123
MFR:
MODEL: CT-8000
S/N: 81002
OPERATOR: HAI

TEST: OPEN-CLOSE-OPEN

CONTACT OPEN TIME #1

CH	TIME <mS>	CYCLES	BOUNCE <mS>
1	43.70	2.62	0.10
2	42.70	2.56	2.35
3	40.40	2.42	0.10

CONTACT RECLOSE TIME

CH	TIME <mS>	CYCLES	BOUNCE <mS>
1	408.45	24.51	1.15
2	408.15	24.49	4.00
3	407.65	24.46	2.90

CONTACT OPEN TIME #2

CH	TIME <mS>	CYCLES	BOUNCE <mS>
1	442.10	26.53	0.25
2	440.90	26.45	1.35
3	437.85	26.27	0.95

CONTACT DEAD TIME

CH	TIME <mS>	CYCLES
1	364.75	21.88
2	365.45	21.93
3	367.25	22.01

CONTACT LIVE TIME

CH	TIME <mS>	CYCLES
1	33.65	2.02
2	32.75	1.95
3	30.20	1.81

PEAK TO PEAK TRAVEL <in>
T1
7.02

V1 NOMINAL VOLTAGE = 56 VOLTS
V1 MINIMUM VOLTAGE = 50 VOLTS
INITIATOR CURRENT = 5.7 AMPS

SHOT LENGTH: 1 SECOND
INSERTION RESISTOR: NO
TRIGGER: INTERNAL
O-C DELAY: 200 mS
C-O DELAY: 200 mS

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Figure 26. Typical Tabulated Test Results Printout for an O-C-O Operation

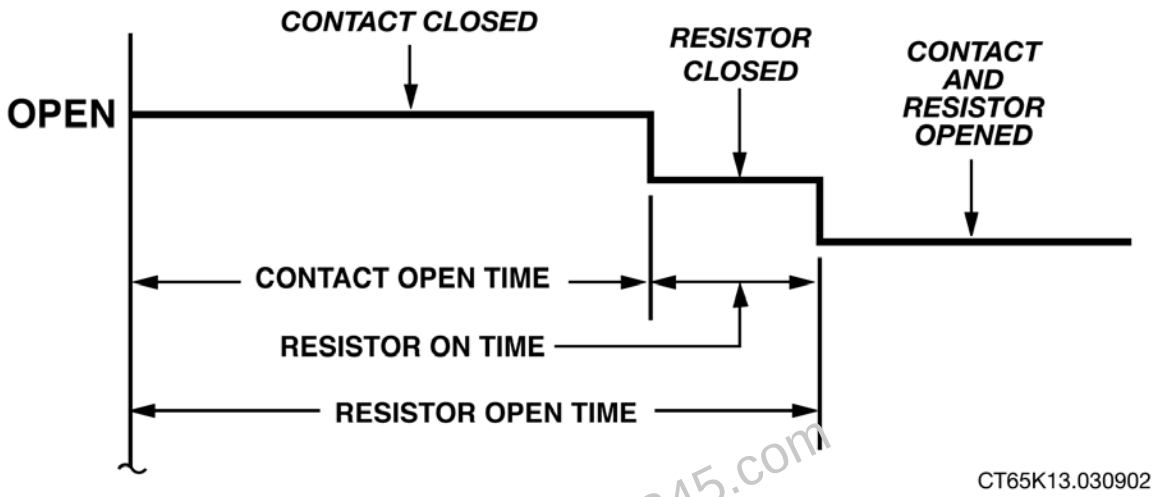

Figure 27. Graphical Interpretation of an OPEN Timing Shot

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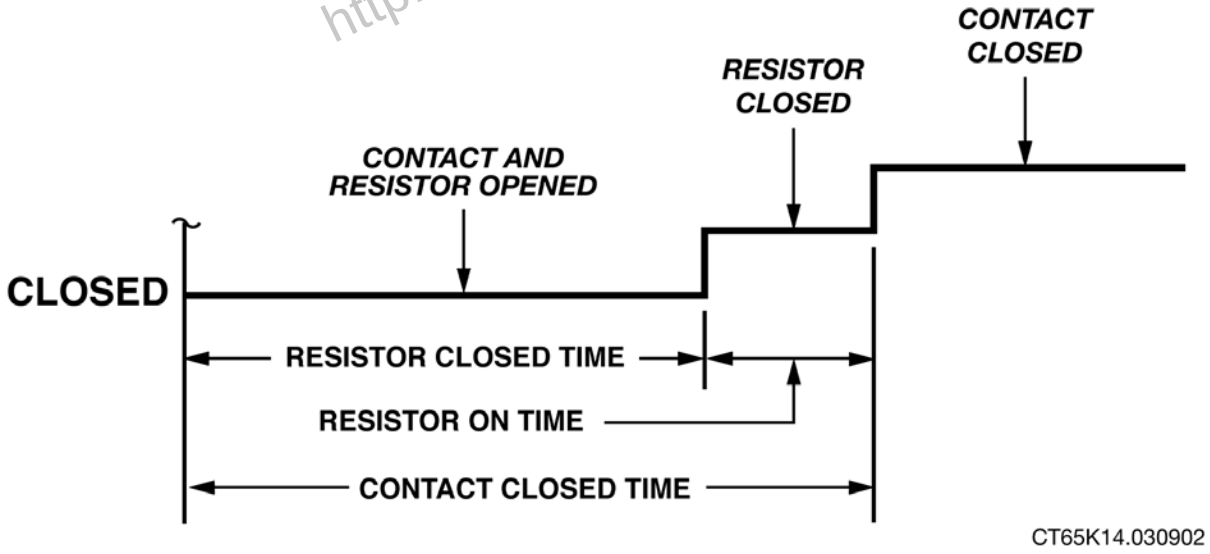
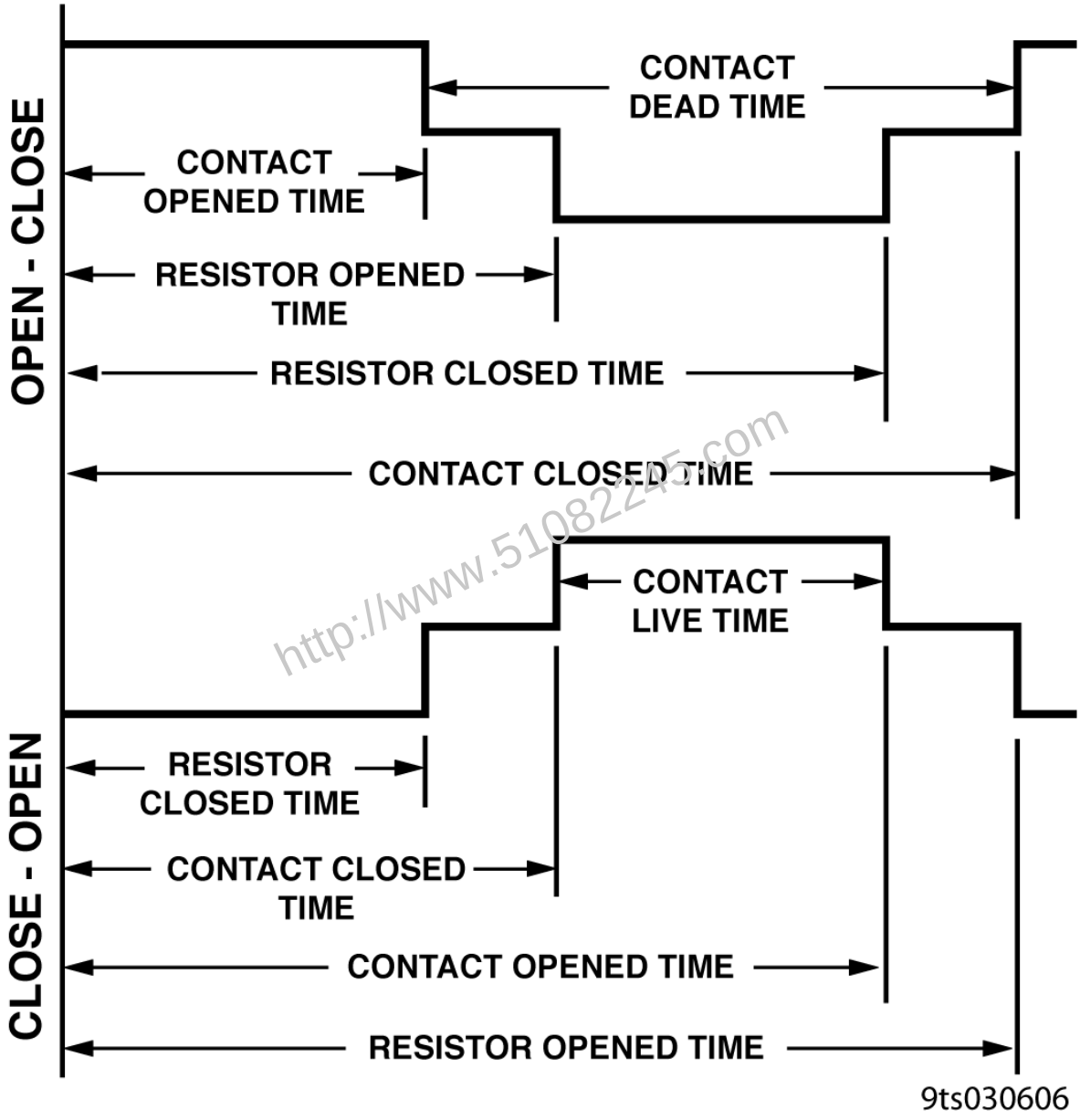


Figure 28. Graphical Interpretation of a CLOSE Timing Shot



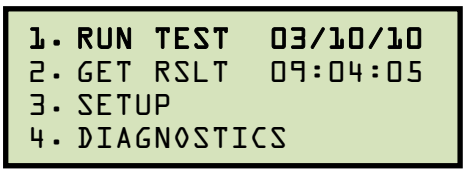
http://www.5108224[illegible].com

Figure 29. Graphical Interpretations of an OPEN-CLOSE and CLOSE-OPEN Timing Shot

3.4 Performing a Static Resistance Test

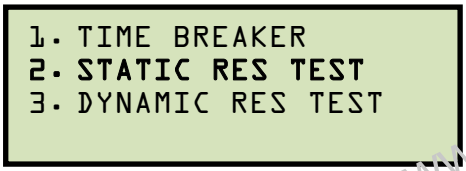
The CT-8000 can also be used as a 200 Ampere micro-ohmmeter. A typical connection for this application is shown in Figure 11. Follow the steps below to perform a static resistance test:

a. Start from the "START-UP" menu:



Press the **[1]** key (*RUN TEST*).

b. The following screen will be displayed:



Press the **[2]** key (*STATIC RES TEST*).

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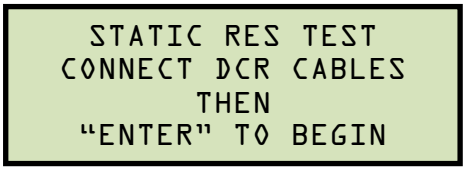
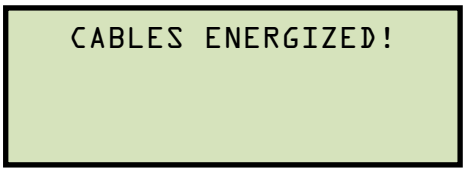
c. The following screen will be displayed:

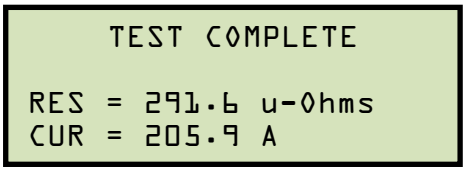


Press the **[ENTER]** key.

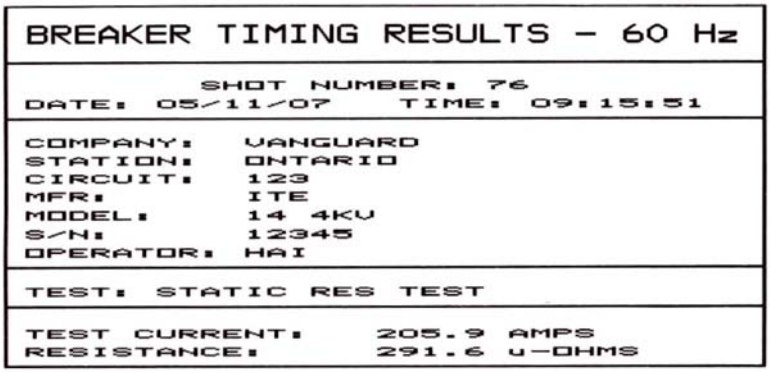
d. The following screen will be displayed momentarily:



Once the test is complete, the results will be displayed as shown below:



Press any key to return to the "START-UP" menu. You can print the test results using the instructions in section 3.3.5. A typical static resistance report is shown in Figure 30.



BREAKER TIMING RESULTS – 60 Hz

SHOT NUMBER: 76
DATE: 05/11/07 TIME: 09:15:51

COMPANY: VANGUARD
STATION: ONTARIO
CIRCUIT: 123
MFR: ITE
MODEL: 14 4KV
S/N: 12345
OPERATOR: HAI

TEST: STATIC RES TEST

TEST CURRENT: 205.9 AMPS
RESISTANCE: 291.6 u-OHMS

Figure 30. Typical Static Resistance Test Report

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3.5 Performing a Dynamic Resistance Test

The Dynamic Resistance Test can graph the circuit breaker contact resistance during the circuit breaker operation and can help detect circuit contact problems during operation. Follow the steps below to perform a Dynamic Resistance Test:

a. Start from the "START-UP" menu:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[1]** key (*RUN TEST*).

b. The following screen will be displayed:

```
1. TIME BREAKER
2. STATIC RES TEST
3. DYNAMIC RES TEST
```

Press the **[3]** key (*DYNAMIC REST TEST*).

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c. The following screen will be displayed:

```
INSERTION RESISTOR?

1. NO
2. YES
```

1. NO

Press the **[1]** key if you are timing a circuit breaker without insertion resistors. **Continue to step d**.

2. YES

Press the **[2]** key if you are timing a circuit breaker with insertion resistors. The following screen will be displayed:

```
RESISTOR VALUE:
1. LESS THAN 1000 OHM
2. 1000 to 2000   OHM
3. MORE THAN 2000 OHM
```

Select the resistance value by pressing the corresponding key (**[1]**, **[2]**, or **[3]**). **Continue to step d**.

d. The following screen will be displayed:

```
TRIGGER MODE

1. INTERNAL TRIGGER
2. EXTERNAL TRIGGER
```

Press the **[1]** key (*INTERNAL TRIGGER*).

e. The following screen will be displayed:

```
TIMING MODE:
1. OPEN      2. CLOSE
3. O-C       4. C-O
5. O-C-O
```

Press the **[1]** key (*OPEN*).

f. The following screen will be displayed:

```
Hold "ARM" until
test completes.
"START" to Begin
"STOP" to ABORT
```

Hold down the **[ARM]** switch and press the **[START]** key.

g. The following screen will be displayed:

```
TEST IN PROGRESS
Hold "ARM" until
test completes.
(Up to 25 seconds)
```

Continue to hold down the **[ARM]** switch until testing is finished. You will be returned to the "START-UP" menu once testing is finished. **Continue to step h to print the test results**.

h. The "START-UP" menu will be displayed as shown:

```
1. RUN TEST  03/10/10
2. GET RSLT  09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[2]** key (*GET RSLT*).

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i. The following screen will be displayed:

```
1. PRINT TEST RESULTS
2. PLOT FULL CHART
3. PLOT EXPANSION
4. PLOT 0 - 200MS
```

Press the **[4]** key (*PLOT 0 – 200MS*).

j. The following screen will be displayed:

```
DYNAMIC RES PLOT:
1. 0 - 400 u-Ohms
2. 0 - 2000 u-Ohms
3. 10 - 2000 SemiLog
```

The Dynamic Resistance graph can be printed with a 0 to 400 micro-ohm linear scale, a 0 to 2000 micro-ohm linear scale, or a 0 to 2000 micro-ohm semi-log scale. For this example, the graph will be printed using the 0 to 400 micro-ohm linear scale option.

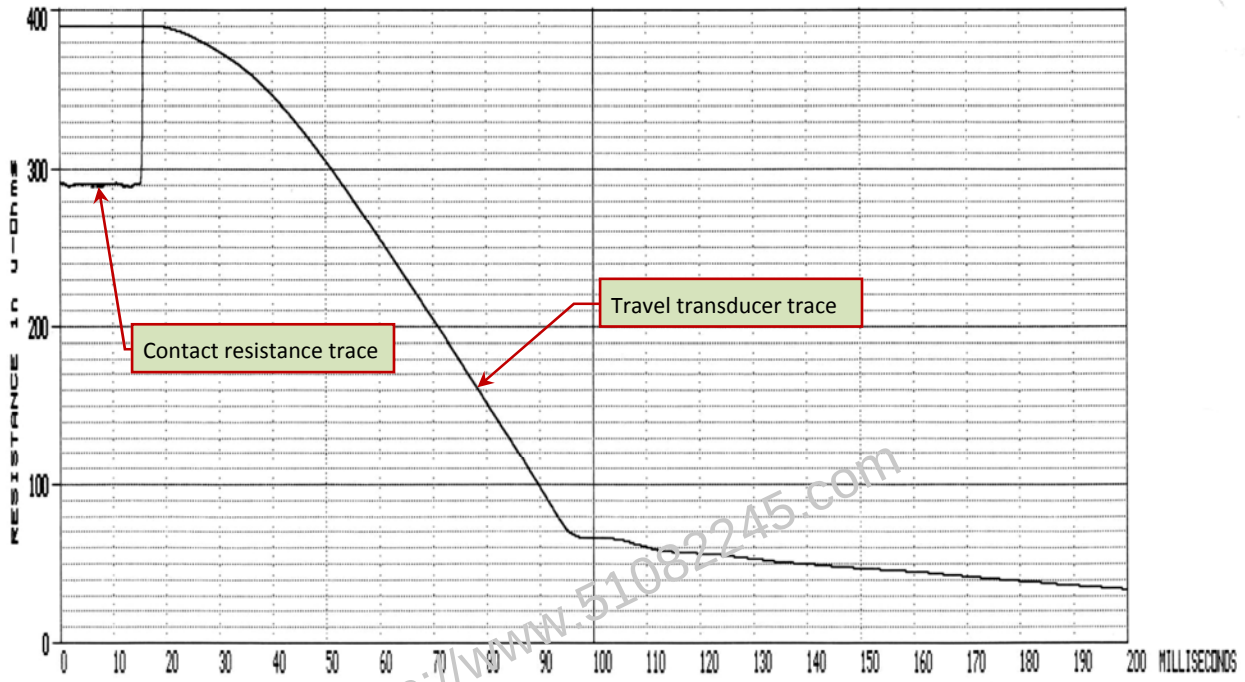
Press the **[1]** key (*0 – 400 u-Ohms*).

k. The following screen will be displaying while the graph is being printed on the thermal printer:

```
    PLEASE WAIT
  PLOTTING GRAPH
```

You will be returned to the "START-UP" menu when printing is finished. Sample Dynamic Resistance Graphs are shown in Figure 31, Figure 32, and Figure 33.

http://www.510822345.com



http://www.510822245.com

Figure 31. Dynamic Resistance Graph (0 - 400 micro-ohm linear scale)

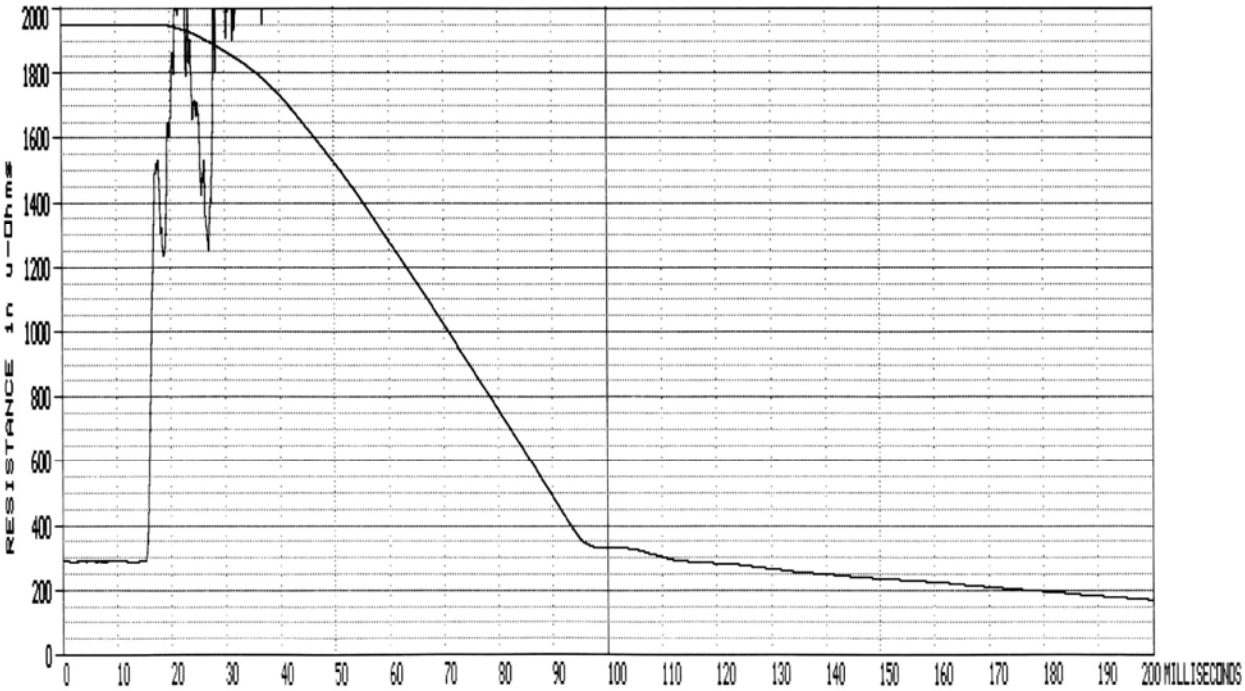


Figure 32. Dynamic Resistance Graph (0 - 2000 micro-ohm linear scale)

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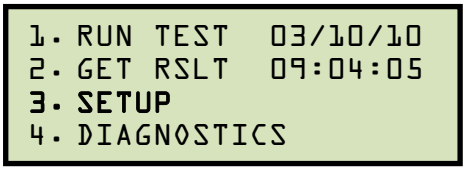
Figure 33. Dynamic Resistance Graph in Semi-Log Scale

3.6 Working with Test Records

3.6.1. Saving a Timing Record in Flash EEPROM

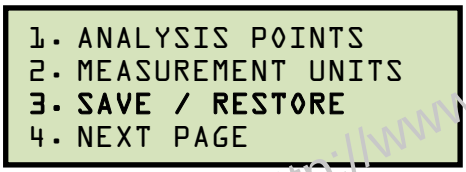
After performing a test, you can store the results in the CT-8000's Flash EEPROM. To save a test record:

a. Start from the "START-UP" menu:



Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



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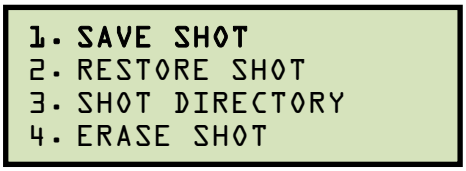
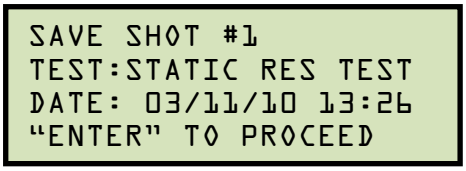
Press the **[3]** key (*SAVE / RESTORE*).

c. The following screen will be displayed:



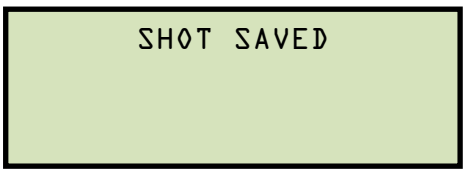
Press the **[1]** key (*SAVE SHOT*).

d. The following screen will be displayed:



Press the **[ENTER]** key to save the test shot.

e. The following screen will be displayed:

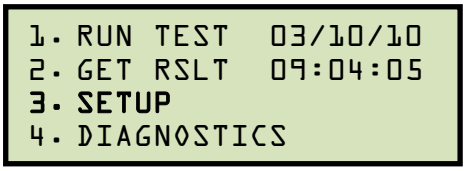


Press any key to return to the "START-UP" menu.

3.6.2. Printing a Test Record Directory

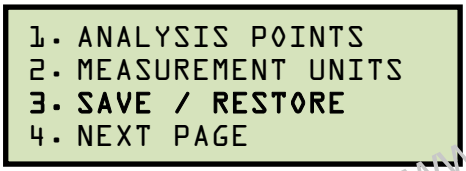
You can print a directory of all the test records stored in the CT-8000's Flash EEPROM by using the steps below:

a. Start from the "START-UP" menu:



Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:



Press the **[3]** key (*SAVE / RESTORE*).

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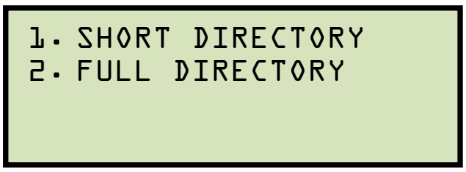
c. The following screen will be displayed:

Press the **[3]** key (*SHOT DIRECTORY*).

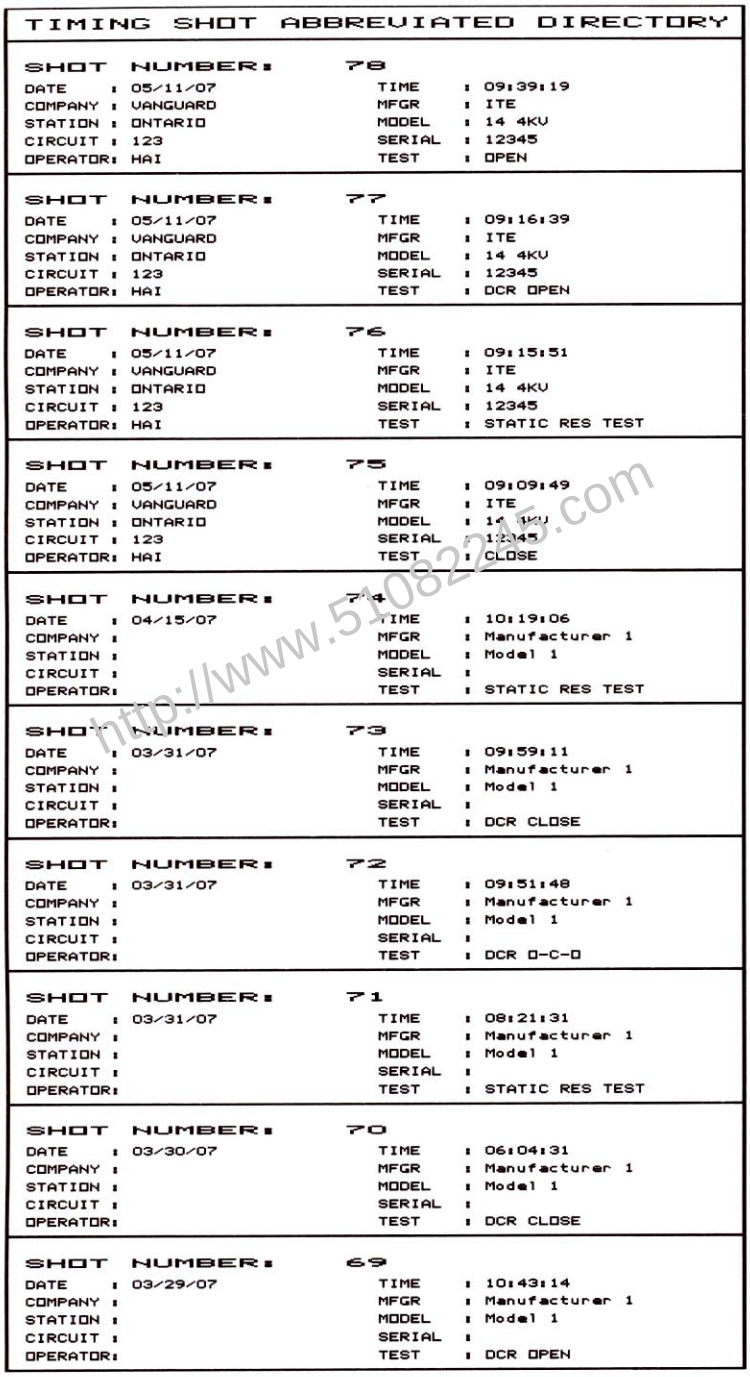
d. The following screen will be displayed:



Press the **[1]** key (*SHORT DIRECTORY*) to print a directory of the last ten shots stored in the EEPROM. The short directory will be printed, and you will be returned to the "START-UP" menu.

Press the **[2]** key (*FULL DIRECTORY*) to print a directory of all the shots stored in the EEPROM. The full directory will be printed, and you will be returned to the "START-UP" menu.

A sample shot directory is shown in Figure 34.



TIMING SHOT ABBREVIATED DIRECTORY

SHOT NUMBER: 78
DATE : 05/11/07 | TIME : 09:39:19
COMPANY : VANGUARD | MFGR : ITE
STATION : ONTARIO | MODEL : 14 4KV
CIRCUIT : 123 | SERIAL : 12345
OPERATOR: HAI | TEST : OPEN

SHOT NUMBER: 77
DATE : 05/11/07 | TIME : 09:16:39
COMPANY : VANGUARD | MFGR : ITE
STATION : ONTARIO | MODEL : 14 4KV
CIRCUIT : 123 | SERIAL : 12345
OPERATOR: HAI | TEST : DCR OPEN

SHOT NUMBER: 76
DATE : 05/11/07 | TIME : 09:15:51
COMPANY : VANGUARD | MFGR : ITE
STATION : ONTARIO | MODEL : 14 4KV
CIRCUIT : 123 | SERIAL : 12345
OPERATOR: HAI | TEST : STATIC RES TEST

SHOT NUMBER: 75
DATE : 05/11/07 | TIME : 09:09:49
COMPANY : VANGUARD | MFGR : ITE
STATION : ONTARIO | MODEL : 14 4KV
CIRCUIT : 123 | SERIAL : 12345
OPERATOR: HAI | TEST : CLOSE

SHOT NUMBER: 74
DATE : 04/15/07 | TIME : 10:19:06
COMPANY : | MFGR : Manufacturer 1
STATION : | MODEL : Model 1
CIRCUIT : | SERIAL :
OPERATOR: | TEST : STATIC RES TEST

SHOT NUMBER: 73
DATE : 03/31/07 | TIME : 09:59:11
COMPANY : | MFGR : Manufacturer 1
STATION : | MODEL : Model 1
CIRCUIT : | SERIAL :
OPERATOR: | TEST : DCR CLOSE

SHOT NUMBER: 72
DATE : 03/31/07 | TIME : 09:51:48
COMPANY : | MFGR : Manufacturer 1
STATION : | MODEL : Model 1
CIRCUIT : | SERIAL :
OPERATOR: | TEST : DCR O-C-O

SHOT NUMBER: 71
DATE : 03/31/07 | TIME : 08:21:31
COMPANY : | MFGR : Manufacturer 1
STATION : | MODEL : Model 1
CIRCUIT : | SERIAL :
OPERATOR: | TEST : STATIC RES TEST

SHOT NUMBER: 70
DATE : 03/30/07 | TIME : 06:04:31
COMPANY : | MFGR : Manufacturer 1
STATION : | MODEL : Model 1
CIRCUIT : | SERIAL :
OPERATOR: | TEST : DCR CLOSE

SHOT NUMBER: 69
DATE : 03/29/07 | TIME : 10:43:14
COMPANY : | MFGR : Manufacturer 1
STATION : | MODEL : Model 1
CIRCUIT : | SERIAL :
OPERATOR: | TEST : DCR OPEN

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Figure 34. Sample Test Record Directory Printout

3.6.3. Recalling a Test Record from the Flash EEPROM

Follow the steps below to recall a test record from the CT-8000's Flash EEPROM:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[3]** key (*SAVE / RESTORE*)

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c. The following screen will be displayed:

```
1. SAVE SHOT
2. RESTORE SHOT
3. SHOT DIRECTORY
4. ERASE SHOT
```

Press the **[2]** key (*RESTORE SHOT*).

d. The following screen will be displayed:

```
  ENTER SHOT NUMBER
    TO BE RESTORED

 "ENTER" TO CONFIRM
```

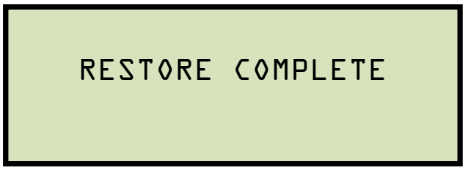
Using the keypad, type the record number that you would like to restore. If you do not know the record number, you can first print a test record directory using the instructions in section 3.6.2. Press the **[ENTER]** key.

e. A confirmation screen will be displayed with some details about the selected test as shown below:

```
RESTORING SHOT #1
TEST: STATIC RES
DATE: 03/11/10 13:26
"ENTER" TO CONFIRM
```

Press the **[ENTER]** key.

f. The following screen will be displayed:



Press any key to continue. You will be returned to the "START-UP" menu. The test record is now loaded in the working memory. Please see section 3.3.5 for instructions on how to view or print the test record details.

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3.6.4. Deleting Test Records from the Flash EEPROM

You can delete one or all test records stored in the CT-8000's Flash EEPROM. To delete test records:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[3]** key (*SAVE / RESTORE*).

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c. The following screen will be displayed:

```
1. SAVE SHOT
2. RESTORE SHOT
3. SHOT DIRECTORY
4. ERASE SHOT
```

Press the **[4]** key (*ERASE SHOT*).

d. The following screen will be displayed:

```
1. ERASE SHOT
2. ERASE ALL SHOTS!
```

1. ERASE SHOT

Press the **[1]** key if you would like to erase a single shot from the Flash EEPROM. The following screen will be displayed:

```
  ENTER SHOT NUMBER
    TO BE ERASED

 "ENTER" TO CONFIRM
```

Using the numeric keypad, type the test record number that you would like to erase. If you do not know the record number, you can first print a test record directory using the instructions in section 3.6.2. Press the **[ENTER]** key.

The following confirmation screen will be displayed:

```
ERASE SHOT #1
TEST: STATIC RES
DATE: 03/11/10 13:26
"ENTER" TO CONFIRM
```

Press **[ENTER]** to erase the test record.

If you do NOT want to erase the test record, press the **[STOP]** key and you will be returned to the "START-UP" menu.

The following screen will be displayed while the test record is being erased:

```
ERASE IN PROGRESS

PLEASE WAIT...
```

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The following screen will be displayed when the test record has been completely erased:

```
    ERASE COMPLETE
```

Press any key to return to the "START-UP" menu.

2. *ERASE ALL SHOTS!*

Press the **[2]** key to erase all test records from the CT-8000's Flash EEPROM. The following screen will be displayed:

```
ALL SHOTS WILL BE
ERASED!

"ENTER" TO CONTINUE
```

Press the **[ENTER]** key to erase all test records.

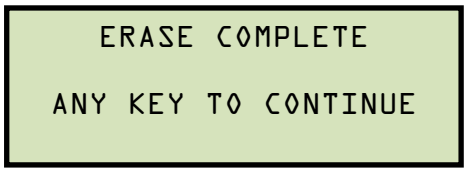
If you do NOT want to delete all the test records, press the **[STOP]** key and you will be returned to the "START-UP" menu.

The following screen will be displayed while the test records are being erased:

```
ERASE IN PROGRESS

PLEASE WAIT...
```

The following screen will be displayed when all the test records have been completely erased:



Press any key to return to the "START-UP" menu.

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3.7 Working With Test Plans

The CT-8000 comes with the Vanguard Circuit Breaker Analysis PC Software that can be used to create circuit breaker test plans. The test plans can then be transferred to the CT-8000. The CT-8000 can store up to 99 circuit breaker test plans in its Flash EEPROM.

A circuit breaker test plan contains breaker maximum/minimum parameters and can be used to quickly test a breaker. A typical list of operating parameters in a test plan includes the following:

- Max/Min Contact/Resistor Trip Time
- Max/Min Contact/Resistor CLOSE time
- Max Contact Spread Time
- Max Resistor Contact Spread Time
- Max/Min Contact CLOSE-OPEN Time
- Max/Min Contact OPEN-CLOSE Time
- Max/Min Resistor CLOSE-OPEN Time
- Max/Min Resistor OPEN-CLOSE Time
- Max/Min Breaker Stroke
- Max/Min Breaker Trip Velocity
- Max/Min Breaker CLOSE Velocity
- Max/Min Breaker Over-Travel
- Max/Min Breaker Bounce-Back
- Trip Velocity Analysis Calculation Points
- CLOSE Velocity Analysis Calculation Points

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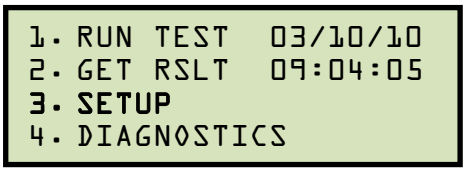
If a timing test is executed with a breaker test plan, the timing report will display a Pass/Fail indicator for each of the parameters tested. The Pass/Fail status is determined by comparing the values in the test plan to the timing test results.

3.7.1. Recalling a Breaker Test Plan for Use

Use the steps below to recall a breaker test plan to use for a timing test:

a. Start from the "START-UP" menu:



Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[1]** key (*ANALYSIS POINTS*).

c. The following screen will be displayed:

```
1. OPEN TIMING
2. CLOSE TIMING
3. PRINT SETTINGS
4. TEST PLANS
```

Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:

```
1. LOAD TEST PLAN
2. PRINT TEST PLAN
3. PRINT DIRECTORY
```

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Press the **[1]** key (*LOAD TEST PLAN*).

e. The first test plan stored in the CT-8000's Flash EEPROM will be listed:

```
TEST PLAN # 01
BZ0-145-20-7
SIEMENS
DEMO TEST PLAN 1
```

You can scroll through the list of test plans by pressing the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys. Once you have located the test plan that you would like to load, press the **[ENTER]** key. The test plan will be loaded and you will be returned to the "START-UP" menu. The test plan will be used for all subsequent timing tests. A typical test results printout with Pass/Fail indicators is shown in Figure 35.

NOTE

The following screen will be displayed if there are no test plans stored in the CT-8000's Flash EEPROM:

```
NO TEST PLANS FOUND


"ENTER" TO CONTINUE
```

Press the **[ENTER]** key to return to the "START-UP" menu.

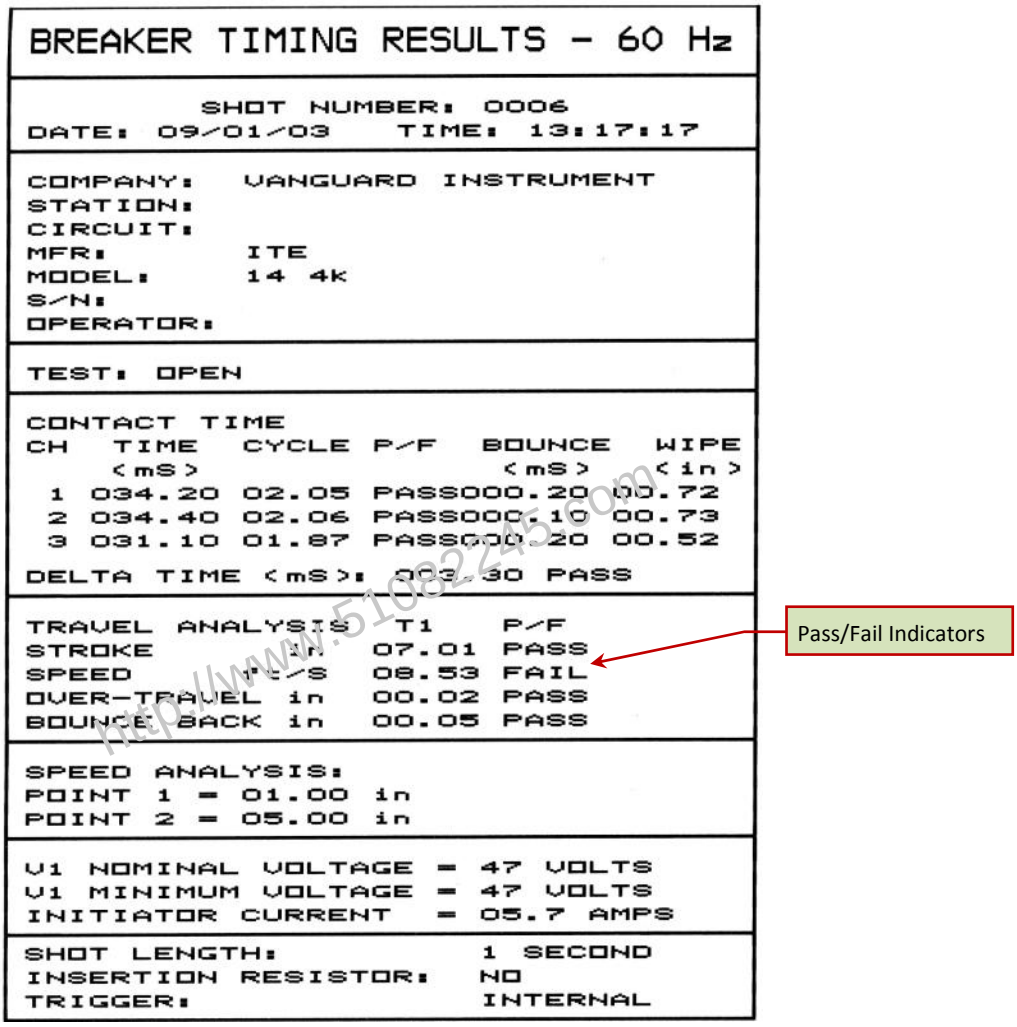

Figure 35. Typical Test Results Printout with Pass/Fail Indicators

3.7.2. Printing a Directory of Test Plans Stored in the CT-8000's Memory

You can print a directory of all the test plans stored in the CT-8000's Flash EEPROM using the steps below:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[1]** key (*ANALYSIS POINTS*).

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c. The following screen will be displayed:

```
1. OPEN TIMING
2. CLOSE TIMING
3. PRINT SETTINGS
4. TEST PLANS
```

Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:

```
1. LOAD TEST PLAN
2. PRINT TEST PLAN
3. PRINT DIRECTORY
```

Press the **[3]** key (*PRINT DIRECTORY*). The test plan directory will be printed on the built-in thermal printer and you will be returned to the "START-UP" menu. A sample test plan directory is shown in Figure 36.

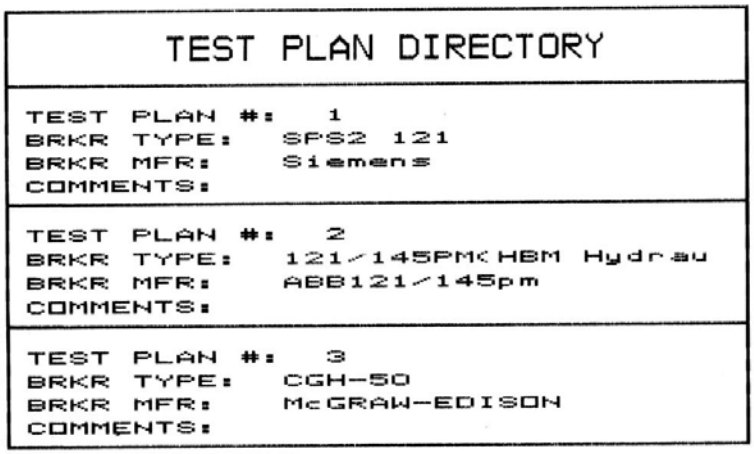

Figure 36. Typical Test Plan Directory Printout

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3.7.3. Printing a Breaker Test Plan

Follow the steps below to print a breaker test plan stored in the CT-8000's Flash EEPROM:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[3]** key (*SETUP*).

b. The following screen will be displayed:

```
1. ANALYSIS POINTS
2. MEASUREMENT UNITS
3. SAVE / RESTORE
4. NEXT PAGE
```

Press the **[1]** key (*ANALYSIS POINTS*).

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c. The following screen will be displayed:

```
1. OPEN TIMING
2. CLOSE TIMING
3. PRINT SETTINGS
4. TEST PLANS
```

Press the **[4]** key (*TEST PLANS*).

d. The following screen will be displayed:

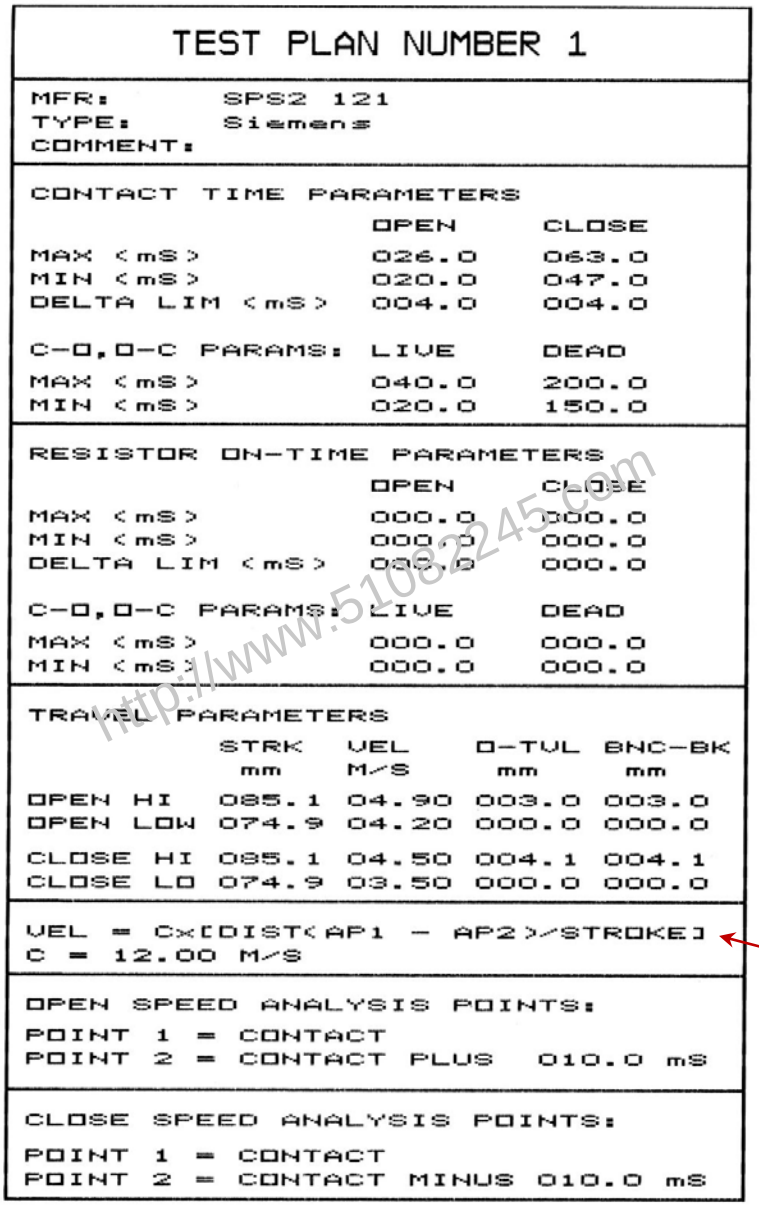
```
1. LOAD TEST PLAN
2. PRINT TEST PLAN
3. PRINT DIRECTORY
```

Press the **[2]** key (*PRINT TEST PLAN*).

e. The first test plan stored in the CT-8000's Flash EEPROM will be listed:

```
TEST PLAN # 01
BZ0-145-20-7
SIEMENS
DEMO TEST PLAN 1
```

You can scroll through the list of test plans by pressing the **[PAPER ∧ Contrast]** and **[PAPER ∨ Contrast]** keys. Once you have located the test plan that you would like to print, press the **[ENTER]** key. The test plan will be printed on the built-in thermal printer and you will be returned to the "START-UP" menu. A sample breaker test plan printout is shown in Figure 37.



TEST PLAN NUMBER 1

MFR: SPS2 121
TYPE: Siemens
COMMENT:

CONTACT TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	026.0	063.0
MIN <mS>	020.0	047.0
DELTA LIM <mS>	004.0	004.0
C-O,O-C PARAMS:	LIVE	DEAD
MAX <mS>	040.0	200.0
MIN <mS>	020.0	150.0

RESISTOR ON-TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	000.0	000.0
MIN <mS>	000.0	000.0
DELTA LIM <mS>	000.0	000.0
C-O,O-C PARAMS:	LIVE	DEAD
MAX <mS>	000.0	000.0
MIN <mS>	000.0	000.0

TRAVEL PARAMETERS

	STRK mm	VEL M/S	O-TVL mm	BNC-BK mm
OPEN HI	085.1	04.90	003.0	003.0
OPEN LOW	074.9	04.20	000.0	000.0
CLOSE HI	085.1	04.50	004.1	004.1
CLOSE LO	074.9	03.50	000.0	000.0

VEL = C×[DIST<AP1 - AP2>/STROKE]
C = 12.00 M/S

OPEN SPEED ANALYSIS POINTS:
POINT 1 = CONTACT
POINT 2 = CONTACT PLUS 010.0 mS

CLOSE SPEED ANALYSIS POINTS:
POINT 1 = CONTACT
POINT 2 = CONTACT MINUS 010.0 mS

Velocity Calculation Formula

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Figure 37. Typical Breaker Test Plan Printout

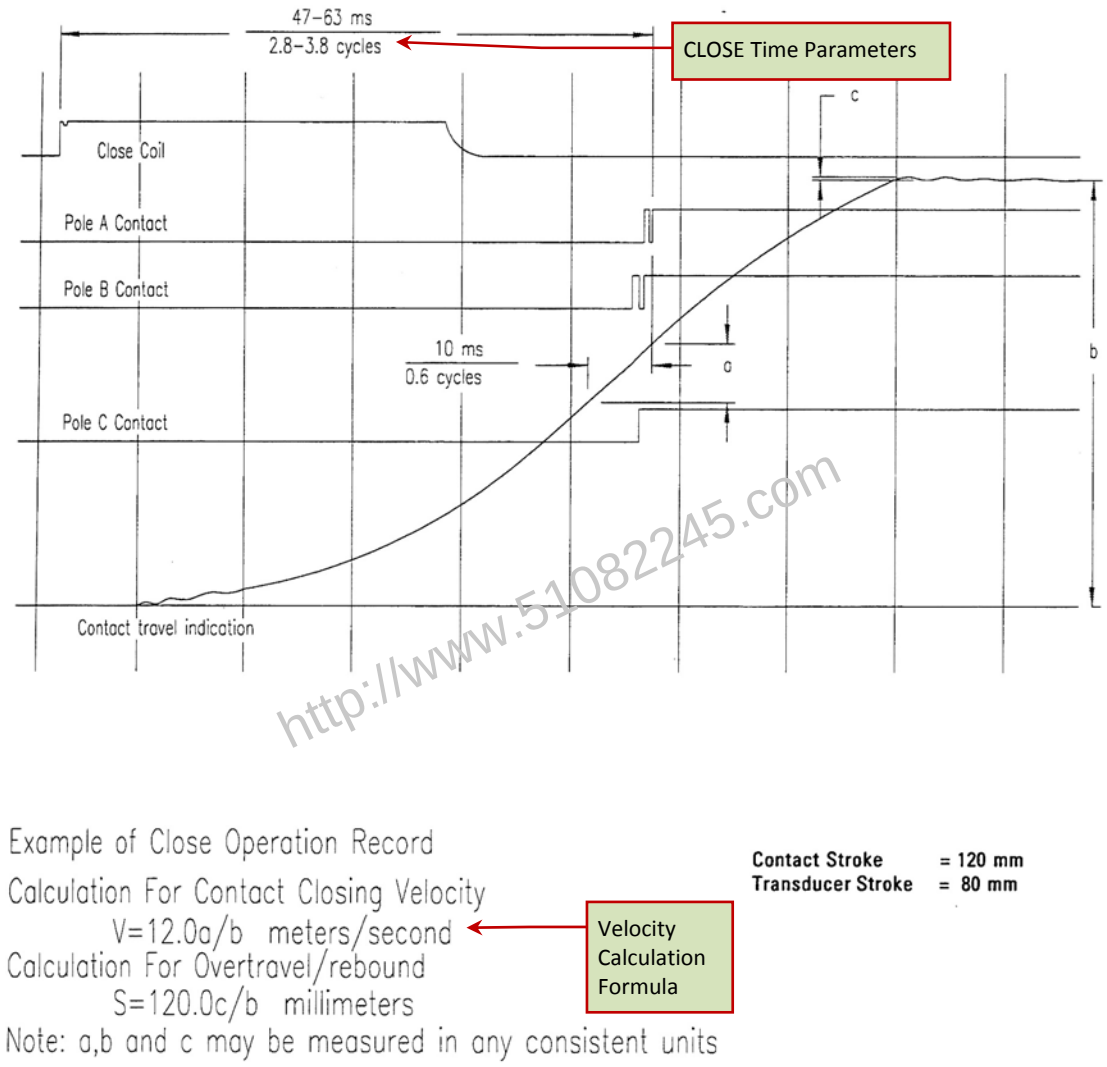
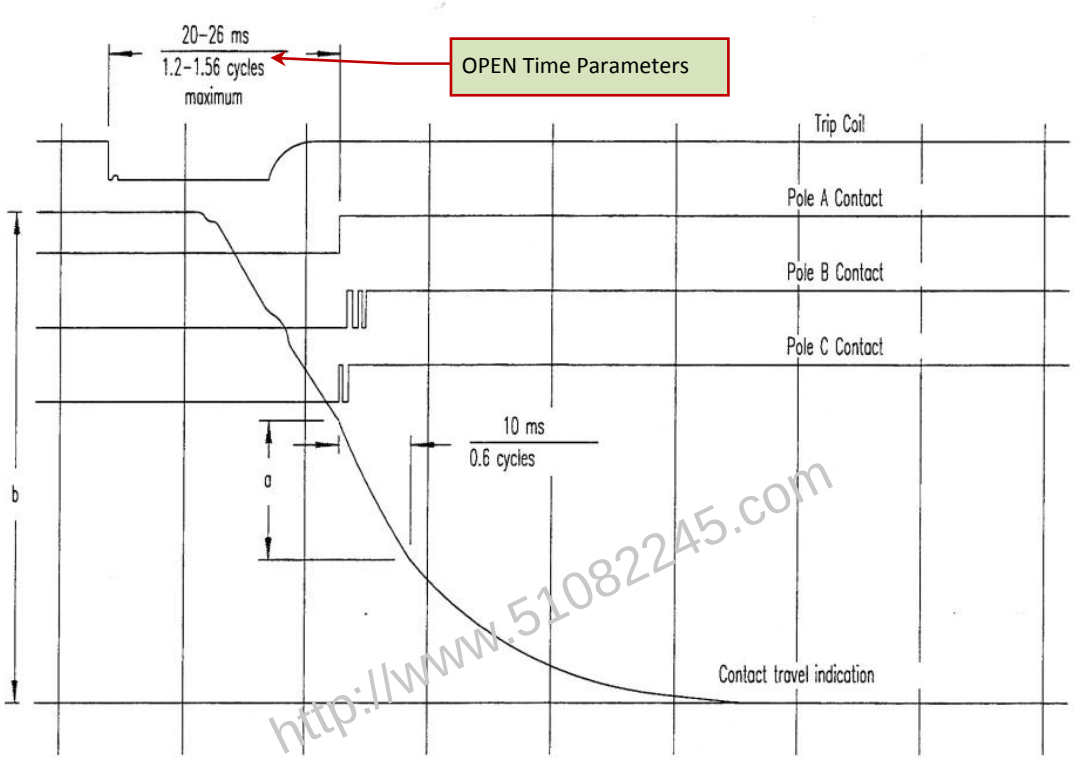


Figure 38. Siemens SPS2 121 CLOSE Timing Illustration



Example of Opening Operation Record

Calculation For Contact Opening Velocity
V=12.0a/b meter/second

Note: a,b and may be measured in any consistant units

Contact Stroke = 120mm
Transducer Stroke = 80 mm

Figure 39. Siemens SPS2 121 OPEN Timing Illustration

4.0 DIAGNOSTICS, VERIFICATION, AND TROUBLESHOOTING

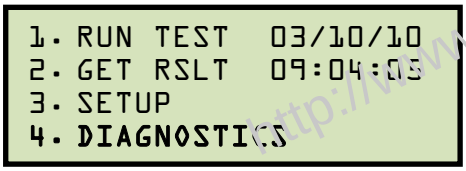
4.1 Performing a Slow-Close Test

The CT-8000 offers a unique "Slow-Close" test feature. This test measures the distance a breaker's contact travels from the fully opened position to the point of contact or "touch" position, and the contact wipe or penetration distance. The test requires the operator to manually jack the breaker's contact from the fully open position to the fully closed position.

Contact channels 1, 2, and 3 and transducer channel 1 are used for "Slow-Close" testing. The CT-8000 measures the contact touch and contact wipe for each contact channel. Contact touch is the distance measured from the contact being fully open to the first position where the contact channel is electrically closed. Contact wipe, or penetration, is the distance measured from the contact's first electrically closed position to the final closed, latching position.

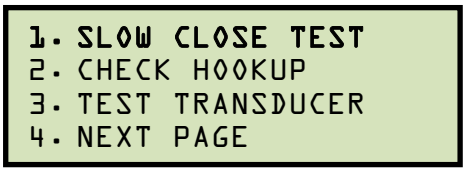
Follow the steps below to perform a "Slow-Close" test:

a. Start from the "START-UP" menu:



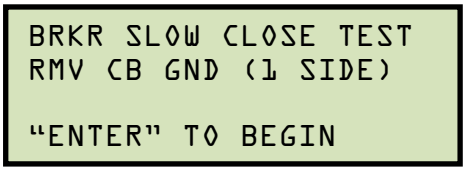
Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:



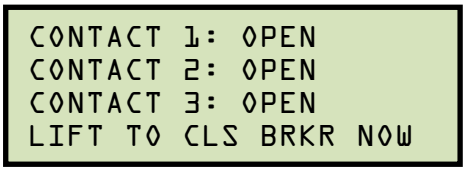
Press the **[1]** key (*SLOW CLOSE TEST)*.

c. The following screen will be displayed:



Press the **[ENTER]** key to begin the test.

d. The following screen will be displayed:



Manually start closing the breaker.

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e. The following screen will be displayed:

```
LIFT BRKR TO CLS POS
THEN PRESS "ENTER"
TO FIND CONTACT WIPE
```

Finish closing the breaker manually and then press the "ENTER" key. The test results will be printed and you will be returned to the "START-UP" menu. A typical test results printout is shown in Figure 40.

```
BREAKER TIMING RESULTS - 50 Hz

              SHOT NUMBER: 0005
DATE: 12/28/00      TIME: 07:41:30

COMPANY:
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
OPERATOR:

TEST: SLOW CLOSE

          CT TOUCH      CT WIPE
CH 1      08.23 in      00.86 in
CH 2      08.41 in      00.68 in
CH 3      08.40 in      00.69 in
```

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Figure 40. Typical Slow-Close Test Results Printout

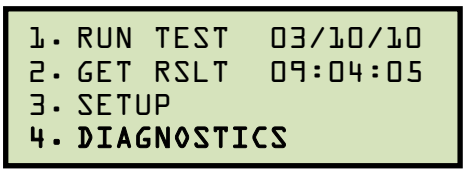
NOTE

The breaker's stroke is the sum of the contact touch and contact wipe distances.

4.2 Performing a Transducer Self-Test

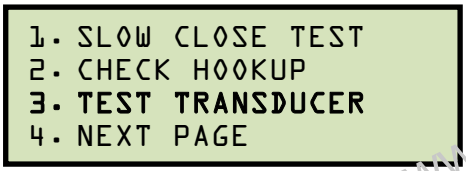
You can check the transducer electronics by connecting the transducer to the CT-8000 and running a transducer self-test using the instructions below:

a. Start from the "START-UP" menu:



Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:



Press the **[3]** key (*TEST TRANSDUCER*).

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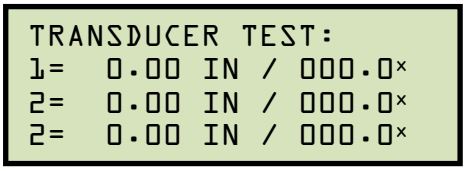
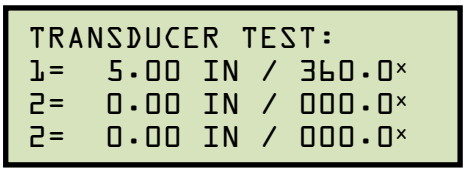
c. The following screen will be displayed:



Move the transducer slider to a known distance and observe the display.

d. The screen will be updated with the new transducer position information:



If the transducer was moved 5 inches, the screen should display 5.00 IN. You can continue to move the transducer slider and observe the screen values to make sure they are correct. Press the **[STOP]** key to end the test and return to the "START-UP" menu.

4.3 Testing the Cable Hookups

You can check the CT-8000 contact cable connections to the circuit breaker using the steps below:

a. Start from the "START-UP" menu:

```
1. RUN TEST   03/10/10
2. GET RSLT   09:04:05
3. SETUP
4. DIAGNOSTICS
```

Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:

```
1. SLOW CLOSE TEST
2. CHECK HOOKUP
3. TEST TRANSDUCER
4. NEXT PAGE
```

Press the **[2]** key (*CHECK HOOKUP*).

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c. The following screen will be displayed:

```
MAKE SURE BREAKER IS
 IN CLOSED POSITION

 THEN PRESS "START"
```

Make sure the breaker is in the CLOSED position and then press the **[START]** key.

d. The screen will be updated to show the status of each contact as shown:

```
  1  2  3
  C  -  -
"START" to RETEST
"STOP" to EXIT
```

A report will also be printed on the thermal printer showing the status of each contact. A contact closure is shown as "C" on the screen and on the printout. An open contact is shown as "-" on the screen and on the printout.

Press the **[START]** key to retest the cable connections, or press the **[STOP]** key to end the test and return to the "START-UP" menu.

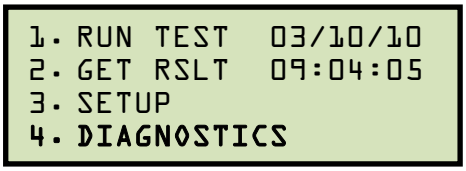
4.4 Printing Raw Test Record Data

You can print the raw hexadecimal timing data collected by the CT-8000 using the "PRINT DATA" command. This feature is used mainly for factory diagnostic testing.

The CT-8000 collects 20,000 data points in the one-second timing window. As a result, each data sample is 0.05 ms apart. By looking at the time marker and the data point, you can find the channel activities vs. time in the timing record.

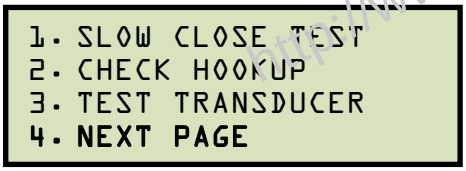
To print the CT-8000 timing data from memory:

a. Start from the "START-UP" menu:



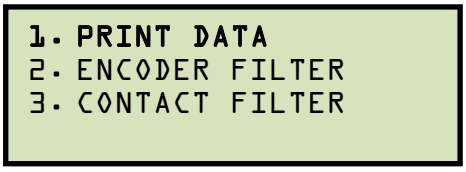
Press the **[4]** key (*DIAGNOSTICS*).

b. The following screen will be displayed:



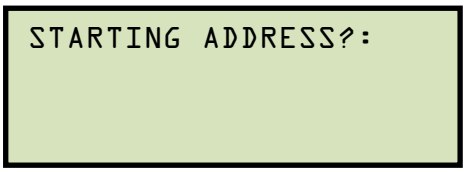
Press the **[4]** key (*NEXT PAGE*).

c. The following screen will be displayed:



Press the **[1]** key (*PRINT DATA*).

d. The following screen will be displayed:



Enter the starting address boundary by typing a number from 0 to 9. Pressing the **[0]** key will start printing the data at address location 0, or the first data point. Pressing the **[1]** key will start printing the data at address location .10000 second.

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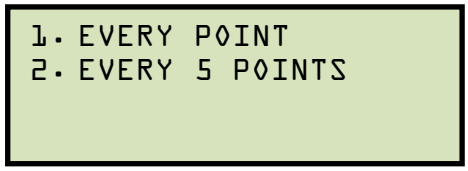
e. The following screen will be displayed:



Press the **[1]** key to print every data point. The data points will be printed and you will be returned to the "START-UP" menu.

Press the **[2]** key to print every 5 data points. The data points will be printed and you will be returned to the "START-UP" menu.

A partial data points printout is shown in Figure 41.

WARNING

Due to the large number of data points even selecting the "Every 5 Points" option will produce a very long report printout!

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TIME	CH1	CH2	CH3	CH4	CH5	CH6	DCI	DCR	V1	V2	I	CT	TRU1	TRU2	TRU3
:10000	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CB	80D5	80D5
:10005	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CC	80D5	80D5
:10010	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CC	80D5	80D5
:10015	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CC	80D6	80D6
:10020	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CC	80D6	80D6
:10025	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CC	80D6	80D6
:10030	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CC	80D6	80D6
:10035	FFF	FFF	FFF	FFF	FFF	FFF	000	000	370	000	8F0	000	80CD	80D7	80D7

Figure 41. Partial Data Points Printout

4.5 Troubleshooting Guide

PROBLEM DESCRIPTION	Suggested Solution

CT-8000 will neither trip nor close the breaker.	• Make sure you hold down the **[ARM]** switch during each test.
	• Check the OPEN or CLOSE fuses.
	• Check the initiate leads.
	  ○ For a "Positive Trip" circuit, one CLOSE lead and one OPEN lead should be connected to the positive side of the power supply.
	  ○ For a "Negative Trip" circuit, one CLOSE lead and one OPEN lead should be connected to the negative side of the power supply.

Getting following message when using external trigger: TRIGGER FAULT NO TRIGGER	• Trigger voltage was not detected by the CT-8000. • Check the external trigger input to the CT-8000. • Make sure the external trigger signal is present when the CT-8000 displays the "AWAITING TRIGGER" message on the screen.
Missing timing or transducer channels on report and graphic output.	• Timing or transducer channels were not turned on. See section 3.2.7 for instructions on how to turn on the contact and transducer channels.
No contact time (0 ms) in Trip or CLOSE test.	• Make sure only one side of the breaker is grounded. • Make sure the breaker operates on the OPEN or CLOSE test only. A dual operation OPEN-CLOSE or CLOSE-OPEN will result in a 0ms reading. • The CT-8000 contact channels may be damaged or the cables may be bad. Try the "Check Hook-UP" test (see section 4.3).
No contact time (0 ms) in CLOSE-OPEN test.	• Make sure the breaker contacts complete the transition from the OPEN (initial state) to the CLOSE state, then to the OPEN (final state). You can see the transition by looking at the timing chart. • Make sure the contact CLOSE state is longer than 10ms. The CT-8000 has a 10ms de-bounce time so any contact state less than or equal to 10ms is invalid. • Try the CLOSE-OPEN test using contact channel #1.
When performing an OPEN-CLOSE test, the breaker opens but will not close.	• Delay between OPEN to CLOSE is probably too short. Increase the delay time.

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No data or erratic reading on travel transducer.	• Bad transducer. Perform a transducer diagnostic test using the instructions in section 4.2. • Transducer slider is not secured to timing rod. • Transducer is not secured properly.
No activity on "V2" voltage input channel.	• The "V2" voltage input channel requires a voltage change greater than 30V.
How do I turn on automatic printing of test reports?	• Please see section 3.2.3.

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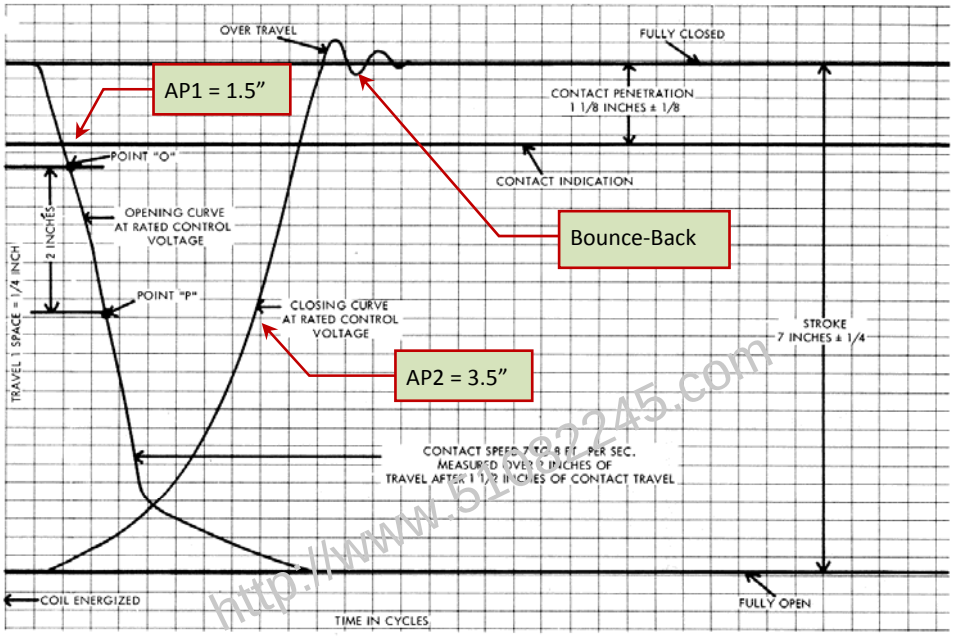
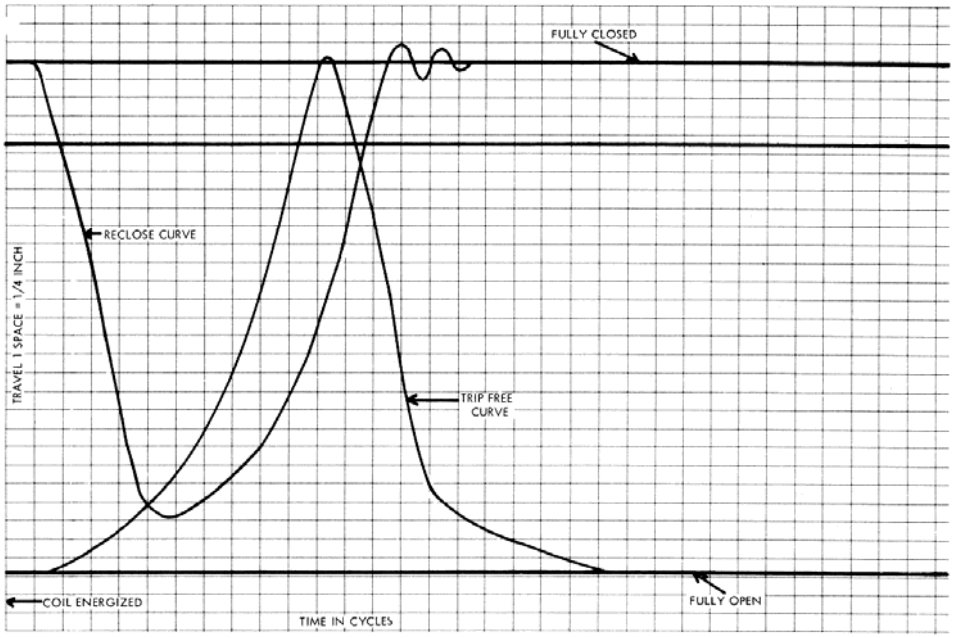
5.0 APPENDICES

5.1 APPENDIX A – ITE Model 14.4K Circuit Breaker Timing Charts and Reports

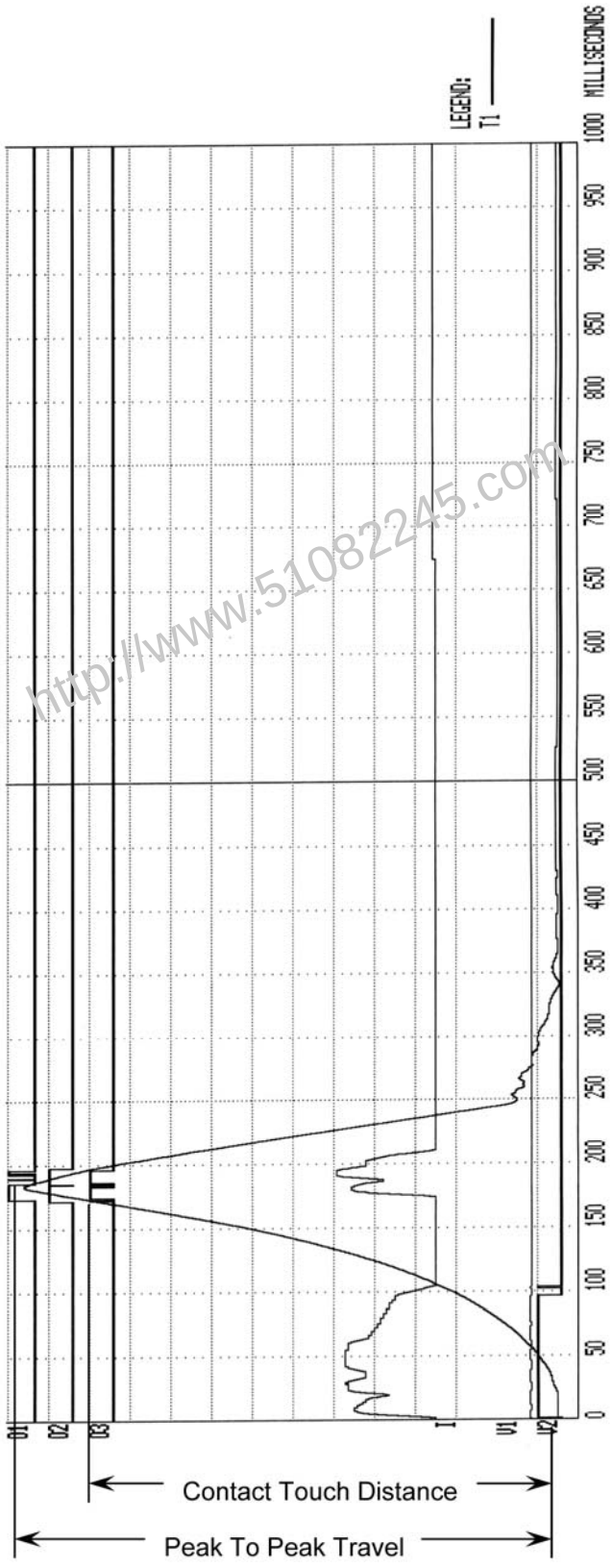


TYPICAL NO LOAD TRAVEL CURVES FOR OPENING AND CLOSING OPERATIONS
AT RATED CONTROL VOLTAGE



TYPICAL NO LOAD TRAVEL CURVES FOR RECLOSING AND TRIP-FREE OPERATIONS
AT RATED CONTROL VOLTAGE

ITE Model 14.4K Circuit Breaker Timing Charts



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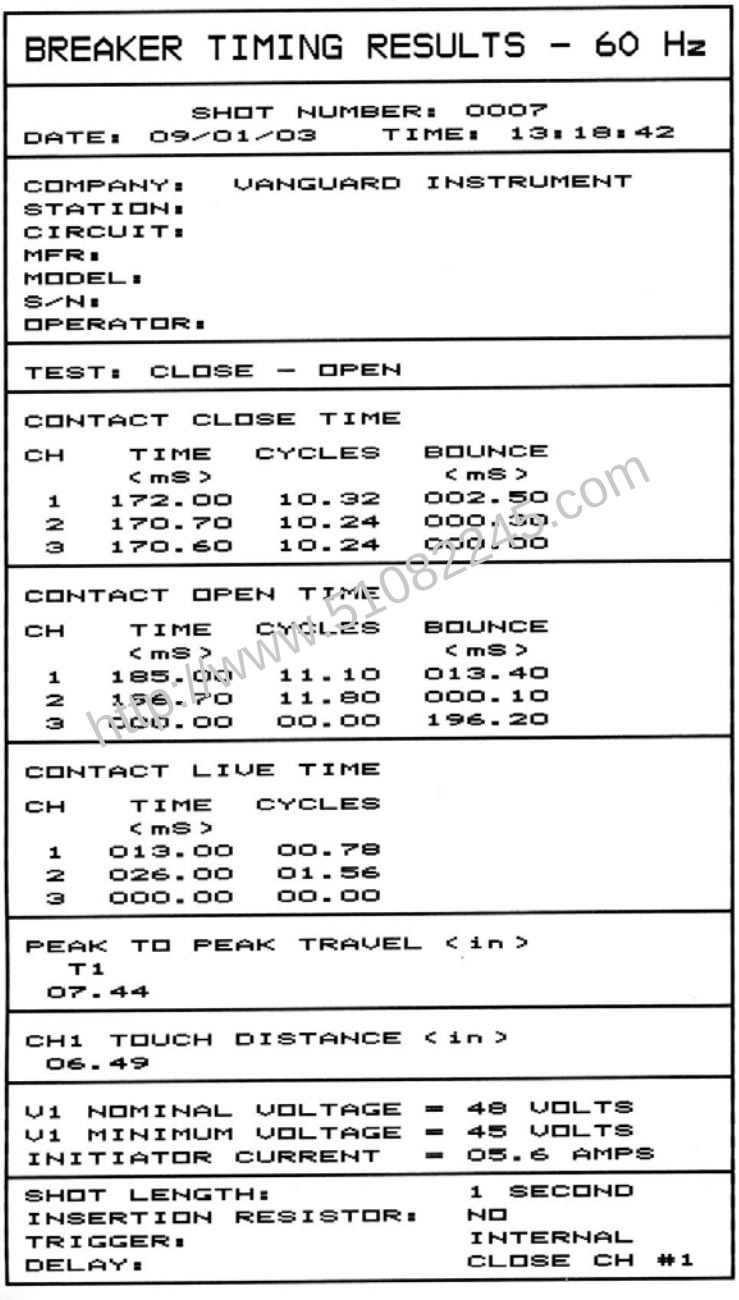
ITE Model 14.4K Circuit Breaker CLOSE-OPEN Timing Chart



BREAKER TIMING RESULTS - 60 Hz

SHOT NUMBER: 0007
DATE: 09/01/03 TIME: 13:18:42

COMPANY: VANGUARD INSTRUMENT
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
OPERATOR:

TEST: CLOSE - OPEN

CONTACT CLOSE TIME

CH	TIME (mS)	CYCLES	BOUNCE (mS)
1	172.00	10.32	002.50
2	170.70	10.24	000.00
3	170.60	10.24	000.00

CONTACT OPEN TIME

CH	TIME (mS)	CYCLES	BOUNCE (mS)
1	185.00	11.10	013.40
2	196.70	11.80	000.10
3	000.00	00.00	196.20

CONTACT LIVE TIME

CH	TIME (mS)	CYCLES
1	013.00	00.78
2	026.00	01.56
3	000.00	00.00

PEAK TO PEAK TRAVEL (in)

T1
07.44

CH1 TOUCH DISTANCE (in)
06.49

V1 NOMINAL VOLTAGE = 48 VOLTS
V1 MINIMUM VOLTAGE = 45 VOLTS
INITIATOR CURRENT = 05.6 AMPS

SHOT LENGTH: 1 SECOND
INSERTION RESISTOR: NO
TRIGGER: INTERNAL
DELAY: CLOSE CH #1

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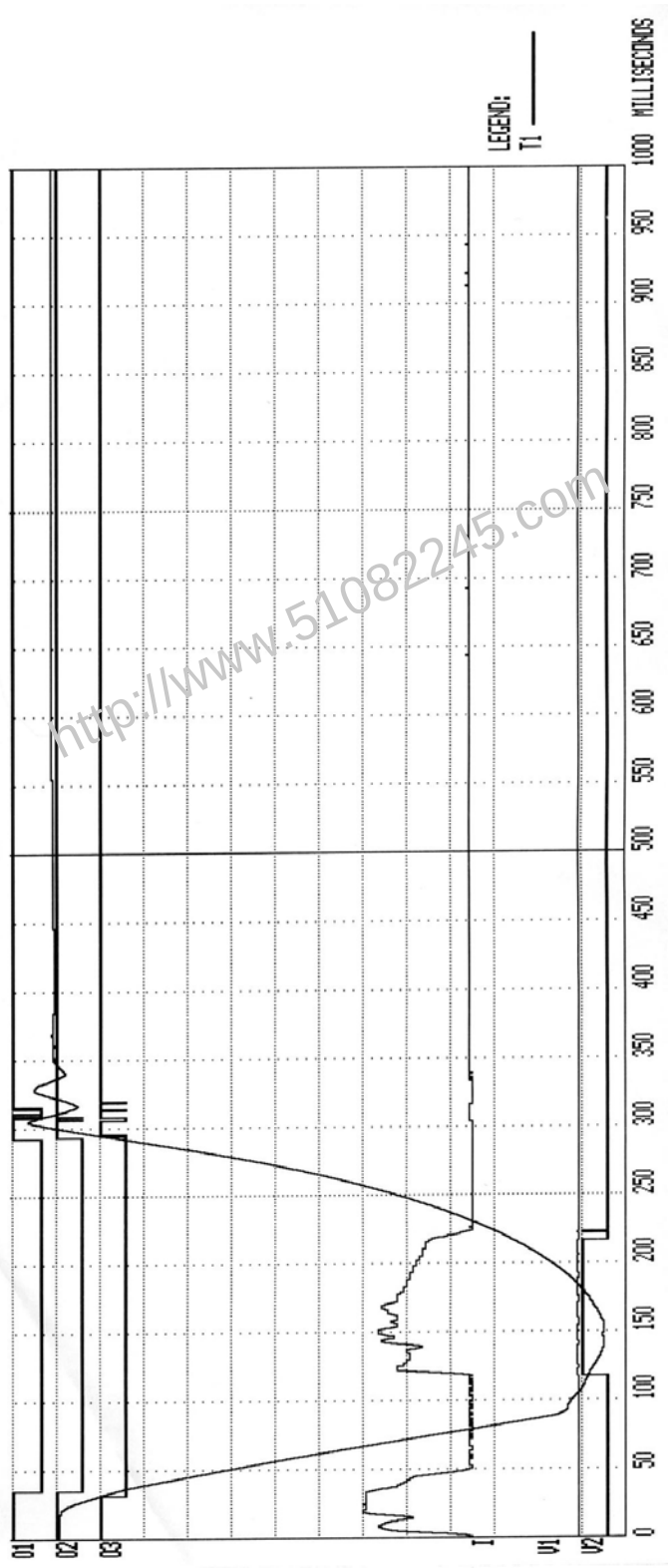
ITE Model 14.4K Circuit Breaker CLOSE-OPEN Tabulated Report



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ITE Model 14.4K Circuit Breaker OPEN-CLOSE Timing Chart

BREAKER TIMING RESULTS - 60 Hz

SHOT NUMBER: 0008
DATE: 09/01/03 TIME: 13:20:37

COMPANY: VANGUARD INSTRUMENT
STATION:
CIRCUIT:
MFR:
MODEL:
S/N:
OPERATOR:

TEST: OPEN - CLOSE

CONTACT OPEN TIME

CH	TIME (mS)	CYCLES	BOUNCE (mS)
1	034.30	02.06	001.90
2	034.20	02.05	000.20
3	030.60	01.84	000.70

CONTACT RECLOSE TIME

CH	TIME (mS)	CYCLES	BOUNCE (mS)
1	291.10	17.47	023.50
2	292.30	17.54	015.60
3	292.80	17.57	025.80

CONTACT DEAD TIME

CH	TIME (mS)	CYCLES
1	256.80	15.41
2	258.10	15.49
3	262.20	15.73

PEAK TO PEAK TRAVEL (in)

T1
07.21

V1 NOMINAL VOLTAGE = 48 VOLTS
V1 MINIMUM VOLTAGE = 47 VOLTS
INITIATOR CURRENT = 05.7 AMPS

SHOT LENGTH: 1 SECOND
INSERTION RESISTOR: NO
TRIGGER: INTERNAL
DELAY: 100 mS

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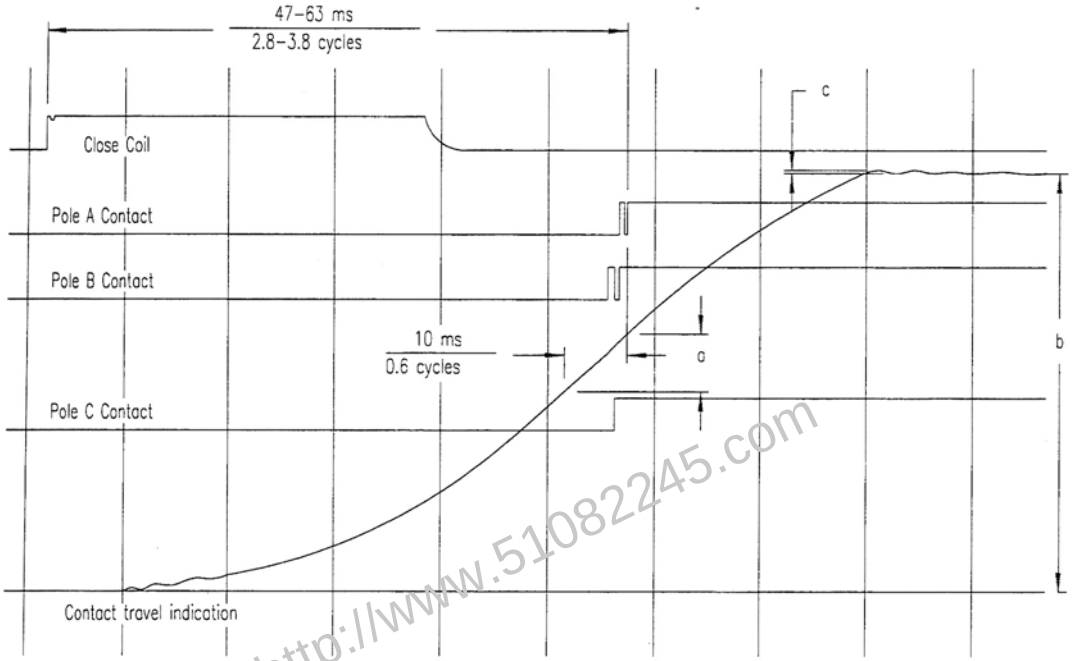
ITE Model 14.4K Circuit Breaker OPEN-CLOSE Tabulated Report

5.2 APPENDIX B – Siemens TCP Breaker Velocity Calculation



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Example of Close Operation Record

Calculation For Contact Closing Velocity

V=12.0a/b meters/second

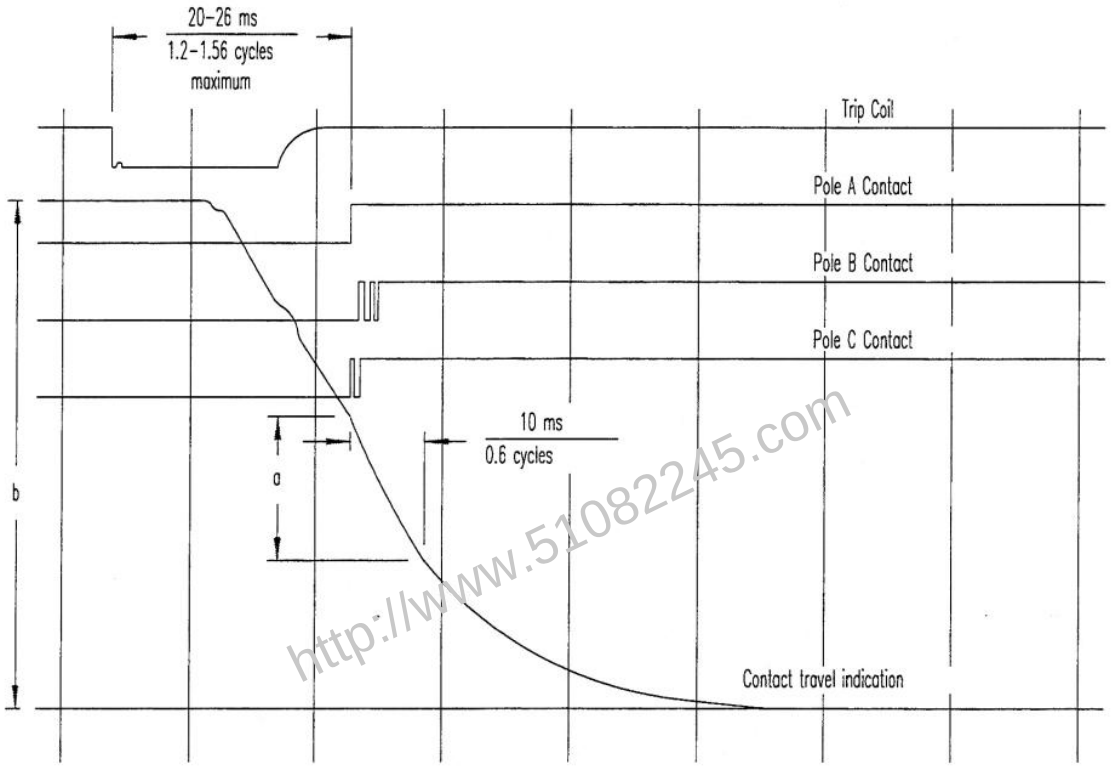
Calculation For Overtravel/rebound

S=120.0c/b millimeters

Note: a,b and c may be measured in any consistent units

Contact Stroke = 120 mm
Transducer Stroke = 80 mm

5.3 APPENDIX C – Siemens SPS2 Breaker Velocity Calculation



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Example of Opening Operation Record

Contact Stroke = 120mm
Transducer Stroke = 80 mm

Calculation For Contact Opening Velocity
V=12.0a/b meter/second

Note: a,b and may be measured in any consistant units

5.4 APPENDIX D – CT-8000 Test Plan for Siemens SPS2

TEST PLAN NUMBER 1

MFR: SPS2 121
TYPE: Siemens
COMMENT:

CONTACT TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	026.0	063.0
MIN <mS>	020.0	047.0
DELTA LIM <mS>	004.0	004.0
C-O,O-C PARAMS:	LIVE	DEAD
MAX <mS>	040.0	200.0
MIN <mS>	020.0	150.0

RESISTOR ON-TIME PARAMETERS

	OPEN	CLOSE
MAX <mS>	000.0	000.0
MIN <mS>	000.0	000.0
DELTA LIM <mS>	000.0	000.0
C-O,O-C PARAMS:	LIVE	DEAD
MAX <mS>	000.0	000.0
MIN <mS>	000.0	000.0

TRAVEL PARAMETERS

	STRK mm	VEL M/S	O-TVL mm	BNC-BK mm
OPEN HI	085.1	04.90	003.0	003.0
OPEN LOW	074.9	04.20	000.0	000.0
CLOSE HI	085.1	04.50	004.1	004.1
CLOSE LO	074.9	03.50	000.0	000.0

VEL = C×[DIST<AP1 - AP2>/STROKE]
C = 12.00 M/S

OPEN SPEED ANALYSIS POINTS:
POINT 1 = CONTACT
POINT 2 = CONTACT PLUS 010.0 mS

CLOSE SPEED ANALYSIS POINTS:
POINT 1 = CONTACT
POINT 2 = CONTACT MINUS 010.0 mS

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5.5 APPENDIX E – CT-8000 Transducer Illustrations


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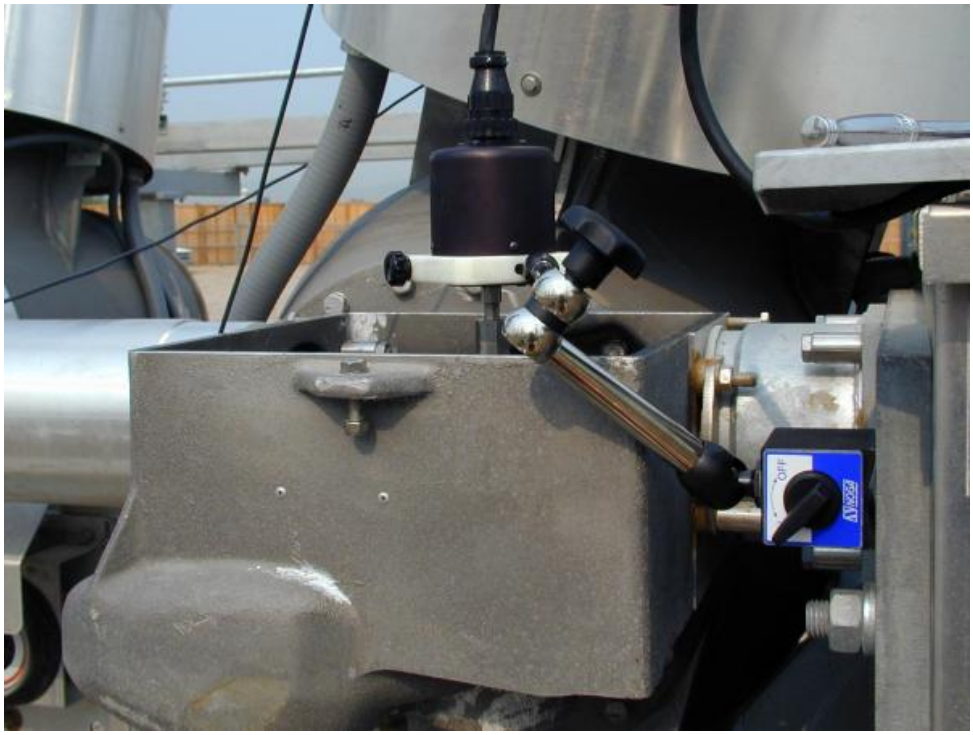
Linear Transducer on an OCB



Rotary Transducer on Alsthom HE 1014 Circuit Breaker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Rotary Transducer on ABB HMB Mechanism

Rotary Transducer on Federal Pacific Circuit Breaker

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Resistor Transducer on Vacuum Circuit Breaker

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