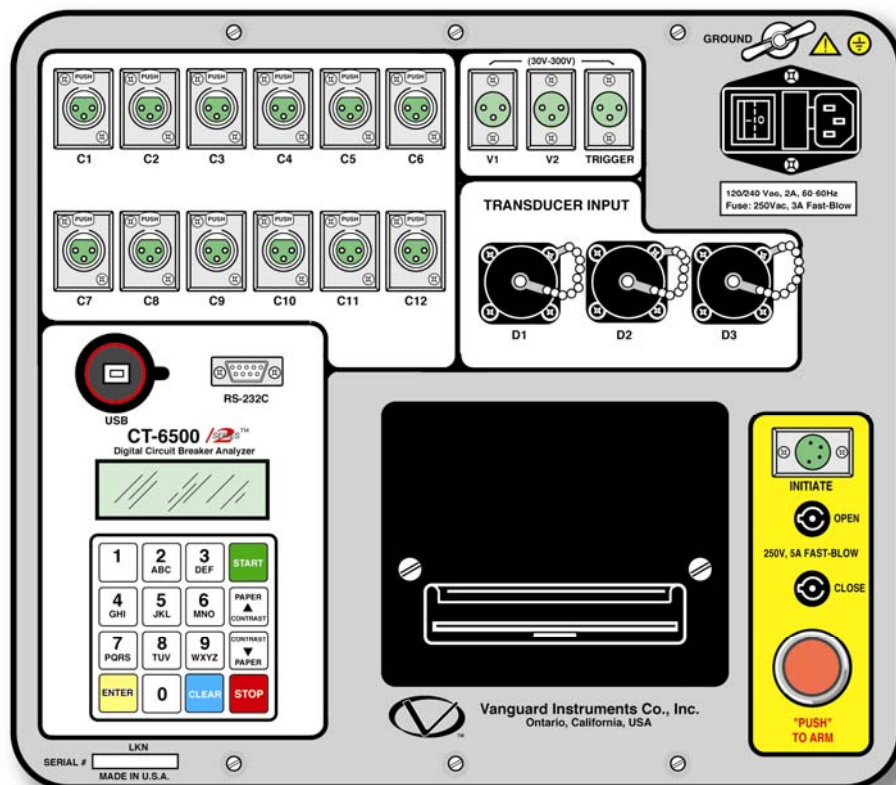

OPERATING INSTRUCTIONS for the **CT-6500 Series 2** Digital Circuit Breaker Analyzer



060905A627



Vanguard Instruments Company
1520 South Hellman Avenue
Ontario, California 91761, USA

TEL: (909) 923-9390
FAX: (909) 923-9391

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CT-6500 Series 2 Operating Instructions

SAFETY WARNINGS AND CAUTIONS

Only trained operators shall use the device. All circuit breakers under test shall be **off line and fully isolated**.

DO NOT SERVICE OR TEST ALONE

Do not perform test procedures or service unless another person is also present who is capable of rendering aid and resuscitation.

DO NOT MODIFY TEST EQUIPMENT

Due to the added risk of introducing additional or unknown hazards, do not install substitute parts or perform any unauthorized modifications to any CT-6500 test unit. To ensure that all designed safety features are maintained, it is recommended that repairs be performed only by Vanguard Instruments Company's factory personnel or by an authorized repair and service center. Unauthorized modifications can cause serious safety hazards and will nullify the manufacturer's warranty.

FOLLOW EXACT OPERATING PROCEDURES

Any deviation from the procedures described in the operator's manual may create one or more safety hazards, damage the CT-6500, the test circuit breaker or cause errors in the test results. Vanguard Instruments Company, Incorporated assumes no liability for unsafe or improper use of the CT-6500.

WARRANTY

The CT-6500's warranty is only valid to the original purchaser to be free from defects in material and workmanship for a period of one year. The warranty does not apply to normal wear or damage from misuse, abuse, improper storage, installation, accident, unauthorized repair or alterations.

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CT-6500 Series 2 Operating Instructions

1.0 Introduction

The CT-6500 is the fifth generation microprocessor-based, digital time travel circuit breaker analyzer developed by Vanguard Instruments Co. The CT-6500 can fully analyze a utility circuit breaker's performance by measuring: the contact time, stroke, velocity, over-travel, bounce-back and contact wipe.

The circuit breaker contact motion analysis includes: Open, Close, Open-Close, Close-Open and Open-Close-Open operations. A timing window of one second, ten second or twenty second can be selected. The ten and twenty second windows allow timing of long timing events such as circuit switcher contact activities.

The conventional Time-Travel test mode allows the user to fully analyze the circuit breaker contact time and contact travel information. Additional circuit breaker information such as: Operating-coil current reading, breaker DC coil power supply voltage reading are also available.

The CT-6500 is available with the following configurations:

CT-6500-3:

- Three Contact-Input channels
- Three Digital Travel Transducer Input channels
- One Analog Voltage Monitor Input channel
- One Digital Voltage Monitor Input channel
- One Trip/Close Current Monitor channel

CT-6500-6:

- Six Contact-Input channels
- Three Digital Travel Transducer Input channels
- One Analog Voltage Monitor Input channel
- One Digital Voltage Monitor Input channel
- One Trip/Close Current Monitor channel

CT-6500-12:

- Twelve Contact-Input channels
- Three Digital Travel Transducer Input channels
- One Analog Voltage Monitor Input channel
- One Digital Voltage Monitor Input channel
- One Trip/Close Current Monitor channel

There are two different modes of operation for the CT-6500 which are Stand Alone Mode and Computer Control Mode. The manual will focus on the Stand Alone Mode. The Computer Control Mode is covered under the Circuit Breaker Analyzer Software Series 2 manual.

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2.0 CT-6500 Description

2.1 Contact Timing Channels

A breaker's interruption of contacts are timed with the dry-contact input channels. Each contact channel can detect the main contacts and the insertion resistor contact times in milliseconds and cycles.

The CT-6500 applies a test voltage of 35Vdc to each of the contact channels thus allowing an analog to digital converter (A/D) to determine if a close, an open or an insertion resistor was the state of the contact. The CT-6500 records into the memory 20,000 readings from the A/Ds and the transducer position counters. The contact time, circuit breaker stroke and velocity is then derived from the data that was stored in the memory.

NOTE

The CT-6500 can detect insertion resistors ranging from 10 to 7,000 Ohms. Resistances over 7,000 Ohms are detected as an open contact.

2.2 Analog Voltage Monitoring Channel

One analog voltage, input channel, "V1" is dedicated to monitoring the breaker's DC power supply or coil voltages from 0 to 255Vdc or peak Vac.

NOTE

Maximum input voltage is 300Vdc or peak Vac. Recording voltage readings are from 0 to 255Vdc.

2.3 Digital Voltage Monitoring Channel

One digital voltage, input channel, "V2" monitors the status voltage as "ON" or "OFF." Voltages from 30 to 255Vdc are considered as "ON" status. Voltages less than 30Vdc are considered as "OFF" status.

2.4 Trip/Close Current Monitoring

A built-in, hall-effect, current sensor measures the trip and close coil current levels and duration. The coil current waveform can be graphically plotted onto a printout. The coil current reading is also printed in the tabulated report. The CT-6500 initiate circuit is capable of carrying up to 30 amperes. Maximum coil current reading is 20 amperes.

2.5 Travel Transducer Input Channels

Each CT-6500 has three digital transducer input channels. The CT-6500 uses up-down counters to sense the breaker's transducer reading. The CT-6500 travel transducer employs optical encoders to send quadrature signals to the CT-6500's counters. With the use of digital transducers and counters, the need to set up or calibrate the transducers is eliminated.

The CT-6500 will interface with a linear, a rotary and other special transducers developed by Vanguard Instruments Company. Please refer to Appendix I for more details.

2.6 Breaker Initiate Capability

A built-in, solid-state, initiate device allows the user to operate the circuit breaker from the CT-6500. Operational modes include: Open, Close, Open-Close, Close-Open and Open-Close-Open. The multiple operations of: Open-Close, Close-Open and Open-Close-Open can be initiated with a programmable delay time or by sensing the breaker's contact state.

The solid-state switching implemented in the initiate circuitry allows the CT-6500 to switch a

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breaker's AC or DC control circuit. . The CT-6500 initiate circuit is capable of carrying up to 30 amperes. Separate 5 Ampere, fast-blow fuses protect each trip and close circuits. An interlock "ARM" switch action is required by the operator to operate the initiate circuit.

2.7 Built-in Thermal Printer

The breaker's contact analysis results can be printed in both tabular and graphical formats by a built-in, 4.5 inch wide, thermal printer. Refer to paragraph 7.5 for ordering thermal paper.

2.8 Computer Interface Capabilities

Built-in, RS-232C and USB ports allow the CT-6500 to be interfaced with an IBM-compatible personal computer. A Windows XP Circuit Breaker Analyzer software is supplied with each CT-6500. The software allows the user to:

- Control CT-6500 from a personal computer.
- Retrieve timing records stored in the CT-6500.
- Transfer circuit breaker test plans to CT-6500.
- Recall timing records from a hard drive for reanalysis at an office PC.

2.9 Timing Records Storage Capabilities

The CT-6500 uses Electrically Erasable Programmable Read-Only-Memory (EEPROM) to store timing-shot data. Unlike other media, EEPROMs are immune to temperature, shock and humidity. Stored shots can be recalled to reanalyze the test data, to reprint test reports or to transfer data to a personal computer for record keeping. Up to 100 timing records can be stored in the EEPROMs. The number of test records stored in the EEPROMs may vary depending upon the size of the records.

2.10 Diagnostic Capabilities

The CT-6500 is designed with self-diagnostic capability to check the integrity of the electronics. Self testing of the contact cable hook-up and transducers permits the user to examine the CT-6500's components whenever verification is required.

2.11 CT-6500 Display and Control Switches

An alphanumeric keypad enables the users to operate the CT-6500 and to enter the breaker's nameplate data such as: the substation name, breaker model and other descriptions. A 4-line by 20-character LCD readout displays user messages and menus. The LCD is back-lighted to allow messages to be viewed in low light conditions.

3.0 Test Result Tabulation

3.1 Timing Test Measurement Results

In the Time Travel Mode, each CT-6500 contact channel provides the following test results:

- Contact Close time
- Contact Open time
- Insertion Resistor Contact Open and Close times
- Contact Bounce time
- Resistor On time
- Contact Spread time

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NOTE

The CT-6500 can detect insertion resistors ranging from 10 to 7,000 Ohms. Resistances over 7,000 Ohms are detected as an open contact.

3.2 Mechanical Measurement Results

In the Time Travel Mode, the digital transducer channels provide the following test results:

- CB contact stroke
- CB contact over travel
- CB Contact bounce back
- CB Contact wipe
- CB Contact velocity

Breaker contact speed calculations are based upon a contact's travel distance over a period of time, which is defined by the manufacturer's specifications.

NOTE

When the resistor type transducer channel is used, the test results are shown as transducer channel 1.

CB contact mechanical measurement can be shown in "English" or "Metric" units.

3.3 Analog Voltage Input Results

The analog voltage, input channel, "V1" measures the breaker's DC control voltage during an operation. Printed voltage readings include nominal voltage (when the supply voltage has no load) and minimum voltage (when the supply voltage is under load or when a coil is energized). The "V1" connection allows the user to monitor the DC power supply's voltage fluctuations during a breaker operation. This feature is effective in detecting breaker power supply problems, which normally can not be seen by using a voltmeter.

NOTE

Printed voltage readings can range from 0 to 255Vdc.

3.4 Digital Voltage Input Results

The digital voltage, input channel, "V2" monitors the voltage status as "ON" or "OFF" conditions and graphs the result. A voltage level above 30Vdc is considered as the "ON" state. The input channel is dedicated to monitor the breaker's auxiliary switch action during a breaker operation.

NOTE

The input voltage ranges from 0 to 300Vdc or peak ac.

3.5 Initiate Current Results

The CT-6500 not only plots the trip or close current waveforms, but also prints the steady-state current readings of the trip and close coils during an operation. A typical circuit breaker timing report is shown in Figure 11.0.

3.6 Slow-Close Test Results

A Slow-Close test determines the contact touch distance and penetration by using the travel transducer and dry contact channels. See section 9.13 for Slow-Close test Procedure.

4.0 Test Result Graphics

4.1 Thermal Printer Graphic Printout

A 4.5 inch wide, built-in, thermal printer can output graphic waveforms of the contact channels, travel curves and actuator-coil currents. Using the Zoom Graphics Mode, the user can enlarge the graphical outputs by specifying the timing zone. Typical graphical results are shown in Figures 12.0 and 13.0.

5.0 CT-6500 Controls and Display

Before using the CT-6500, users should become familiar with all of the controls and display indications. The keypad and display are used to operate the CT-6500. Figure 1.0 represents the control panel and the numbered lines pointing to each control and indicator refer to Table 1.0, which describes the function of each control and indicator.

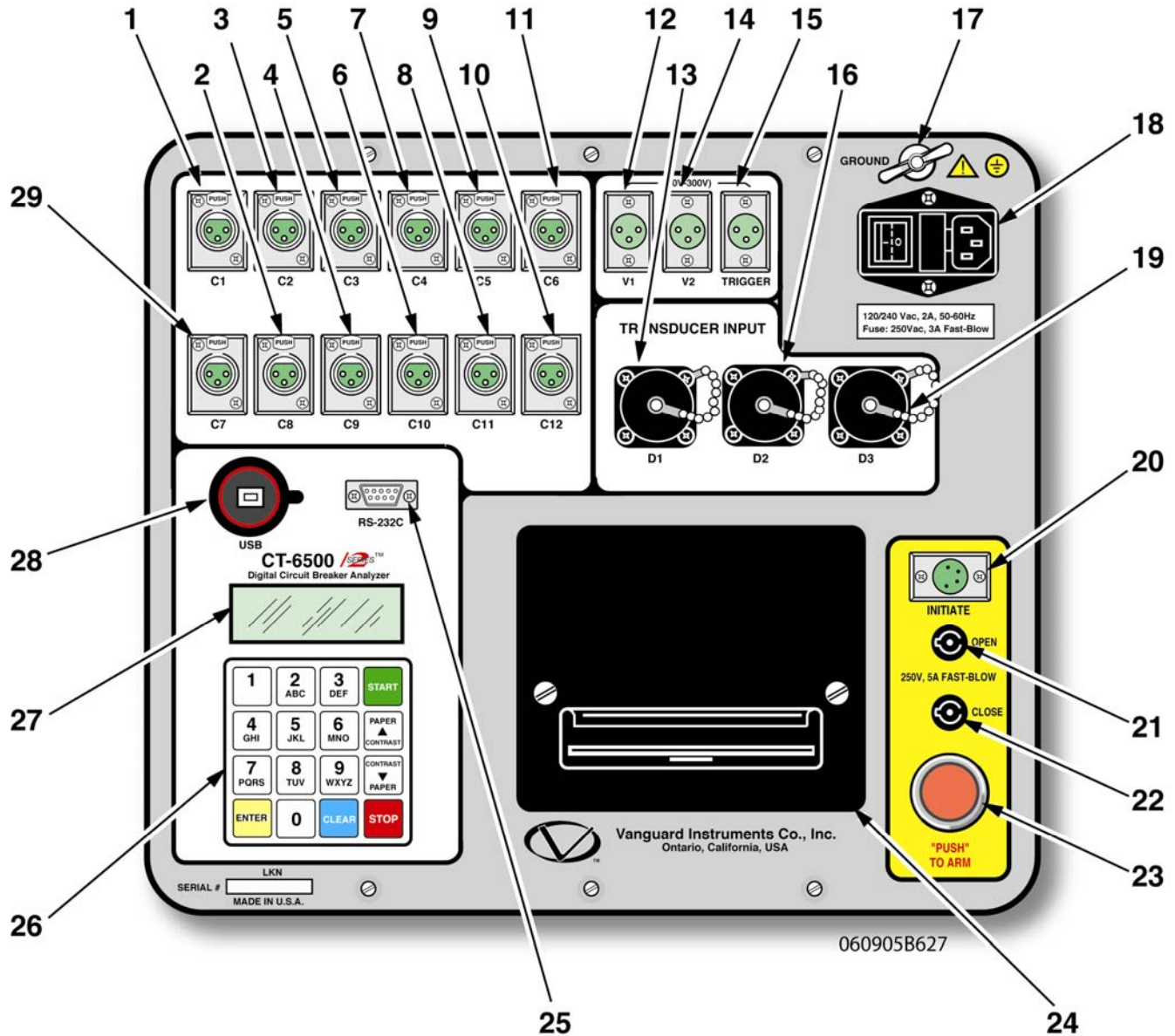


Figure 1.0 CT-6500 Control Panel

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Table 1.0 CT-6500 Controls and Displays

Fig. 1.0 Index no.	PANEL MARKING	FUNCTIONAL DESCRIPTION
1-11 & 31	CONTACT INPUT (C1–C12)	Female connectors for the contact channels.
12	0-300V V1	3-pin connector. V1 voltage input channel is dedicated to monitor circuit breaker DC power supply or coil voltages. Voltage sensing range is from 0-255 volts, dc or peak ac.
13, 16, 19	D1, D2, D3 TRANSDUCER INPUT	16-pin connectors. Digital travel transducer input channels.
14	0-300V V2	3-pin connector. V2 voltage input channel is dedicated to detect voltage on/off status (present or absent) of an A/B switch. Voltage input ranges from 0-300 volts, dc or peak ac.
15	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.
17	GROUND	Safety, ground terminal. 5/16-18 thread stud, with wing nut.
18	120/240Vac, 2A, 50-60Hz Fuse: 250V 3A, Fast Blow	3-wire power plug. 3 Ampere, AC fuses. The ON/OFF switch is a 2-pole rocker.
20	INITIATE	4-pin connector used for the switching circuit for operating the circuit breaker under test.
21	OPEN 250V, 5A FAST-BLOW	Open circuit fuse: 5 Ampere, 250V, Fast-Blow.
22	CLOSE 250V, 5A FAST-BLOW	Close circuit fuse: 5 Ampere, 250V, Fast-Blow.
23	“PUSH” TO ARM	Spring-loaded, pushbutton switch. Press and hold to complete the Trip or Close circuits for breaker tests.
24	(Printer; No panel marking)	Thermal printer. Microprocessor controlled printer that uses specially treated, 4.5 inch wide paper.

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Table 1.0 CT-6500 Controls and Displays (Continued)

Fig. 1.0 Index no.	PANEL MARKING	FUNCTIONAL DESCRIPTION
25	RS-232C	RS-232C serial computer interface port.
26	1-9, 0, ENTER, START, STOP, CLEAR, ↑ PAPER LCD, ↓ PAPER LCD	16 button keypad. The keys are momentary-contact, pushbutton switches. Allows users to make menu selections, enter alphanumeric data, adjust the LCD contrast and reposition the printer paper.
27	(Display; no panel marking)	4-line by 20-character, backlit LCD. Displays menus, options, prompts and test result data.
28	USB	Computer interface, USB Port.

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6.0 CT-6500 Analyzer Specifications

PHYSICAL SPECIFICATIONS	16" W by 11"H by 14"D (40.6 cm x 29.9 cm x 35.6 cm) Weight: 25lbs (11.3Kg).
INPUT POWER	8 Amperes, 90-120Vac or 200-240Vac (selectable), 50/60 Hz.
DRY-CONTACT INPUT	3 or 6 or 12 contact channels. All contact inputs are grounded until testing is started. Each contact detects main and insertion resistor contacts.
TIMING WINDOW	Selectable between: 1, 10, or 20 second.
TIMING RESOLUTION	±50 microseconds at 1 second duration. ±0.5 millisecond at 10 second duration. ±1.0 millisecond at 20 second duration.
TIMING ACCURACY	0.05% of reading, ±50 micro-seconds at 1-second duration.
CONTACT DETECTION RANGE RANGE	CLOSED: less than 20 Ohms. OPEN: greater than 10,000 Ohms.
RESISTOR DETECTION RANGE	Ranges from 50 to 5,000 Ohms.
EXTERNAL TRIGGER INPUT	Open/Close: 30 to 300Vdc, peak Vac.
VOLTAGE SENSING INPUTS	V1: analog input, 0-255V dc or peak ac. Sensitivity: ±1V; V2: voltage detector (present/absent).Input: 30-300V, dc or peak ac.
BREAKER OPERATION	Open, Close, Open-Close, Close-Open, and Open-Close-Open.
BREAKER INITIATE CAPACITY	30A/250V ac/dc max (100A inrush).
INITIATE CURRENT READING RANGE	One, Non-contact, hall-effect sensor ranging from 0-20 Amperes, DC to 5 kHz.
TRAVEL TRANSDUCER INPUT BREAKER SLOW-CLOSE TEST	3 travel-transducer channels. Linear motion from 0.0 to 30.0 inches (±0.01) inch. Rotary ranges from 0 to 360° (± 0.36°). Measures "Slow-Close" the contact point distance (hard copy printout).
DISPLAY	Back-lit LCD screen, 4-lines by 20-characters, sunlight viewable.
PRINTOUT	Both graphic contact-travel waveforms & tabulated results are printed on 4.5 inch thermal paper.
STORAGE CAPABILITIES	Store up to 100 timing records.
COMPUTER INTERFACE	RS-232C Port, USB Port.
PC SOFTWARE (included)	Furnished Circuit Breaker Analyzer PC software. Windows XP and Windows Vista compatible. The analysis software can be installed on an IBM-compatible computer for graphical display, numerical reports and database utility for office use.
SAFETY	Designed to meet UL 61010A-1 Certification and CAN/CSA C22.2 No 1010.1-92.

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ENVIROMENT	Operating: -10°C to 50°C (+15°F to +122°F). Storage: -30°C to 70°C (-22°F to +158°F).
OPTIONS	Hard shipping case for CT-6500. Hard shipping case for Travel Transducers.
WARRANTY	One year warranty on parts and labor.

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7.0 CT-6500 Special Features

7.1 CT-6500 Supplied Cables

Table 2.0 CT-6500 Cable set

ITEM	DESCRIPTION	QTY
1	GND Cable	1
2	Power Cord	1
3	Contact Cable	3 or 6 or 12
4	Contact Extension Cable	3 or 6 or 12
5	Transducer cable	1
6	Voltage & Trigger Leads	3
7	Voltage & Trigger Extension cables	3
8	Initiate Lead	1
9	Initiate Extension Cable	1
10	USB Cable	1
11	RS-232C Cable	1

7.2 CT-6500 Operating Voltages

The CT-6500 operating voltage is selectable between 110-120Vac, 50/60 Hz or 220-240Vac, 50/60 Hz. Operating voltage is set by the voltage selection switch as shown in Figure 2.0. To change the voltage setting, remove the CT-6500 from the case, locate the voltage setting switch and set the new operating voltage.



Figure 2.0 CT-6500 Operating Voltage Setting

7.3 CT-6500 Main Power Switch & Circuit Breaker

The CT-6500 uses an AC input module that contains the AC receptacle, power switch and fuse holder. A 3AG, 250Vac, 3 ampere, fast-blow type fuse is recommend.

7.4 Initiate Circuit Protection Fuses

The OPEN and CLOSE initiate circuits are protected by 5 Ampere fuses (3AG, 250Vac, fast-blow types).

7.5 CT-6500 Printer and Printer Paper

The built-in, thermal printer uses 4.5 inch wide, thermal paper for printing test results. To maintain the highest, quality printing and to avoid paper jamming, it is highly recommended that the thermal paper be supplied by the factory. Additional paper can be ordered from either of the two sources listed below:

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

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

7.6 Replacing CT-6500 Thermal Paper

The roll of thermal paper resides inside a pocket underneath the printer cover. To replace the paper, follow the steps below:

- Remove the printer cover.
- Remove the leftover thermal paper roll from the paper holder.
- Unroll the new thermal paper.
- 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.
- Replace the printer cover back.

NOTE

The paper should feed from the bottom of the roll.

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

7.7 CT-6500 Printer Paper Control

To advance the paper from the printer, press and release the “↑ PAPER LCD” button. To retract the thermal paper from the printer, press and release the “↓ PAPER LCD” button.

7.8 CT-6500 LCD Contrast Control

To darken the LCD screen, press and hold the “↑ PAPER LCD” button to decrease the contrast of the LCD screen, press and hold the “↓ PAPER LCD” until the desired contrast is reached.

8.0 Test Hook-up Connections

8.1 Contact Cable Hookup

A typical, contact cable connection to a circuit breaker is shown in Figure 3.0. Red and black clips are connected across the circuit breaker contact phase A, B and C.

A typical circuit breaker with series contacts is shown in Figure 4.0. In the below example, the circuit breaker has 2 contacts in series per phase. Contact timing channel 1 and 2 are used in the illustration.

NOTE

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

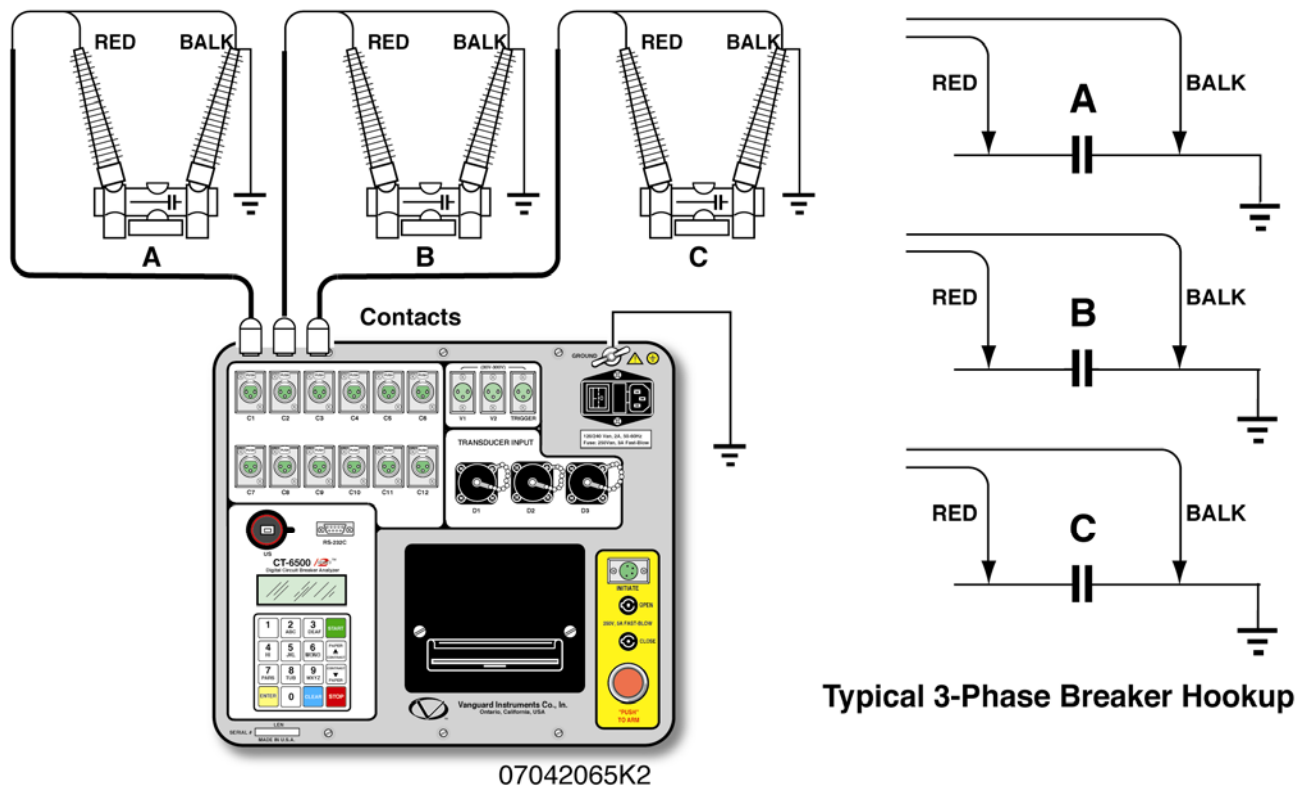


Figure 3.0 Contact Cable Connection

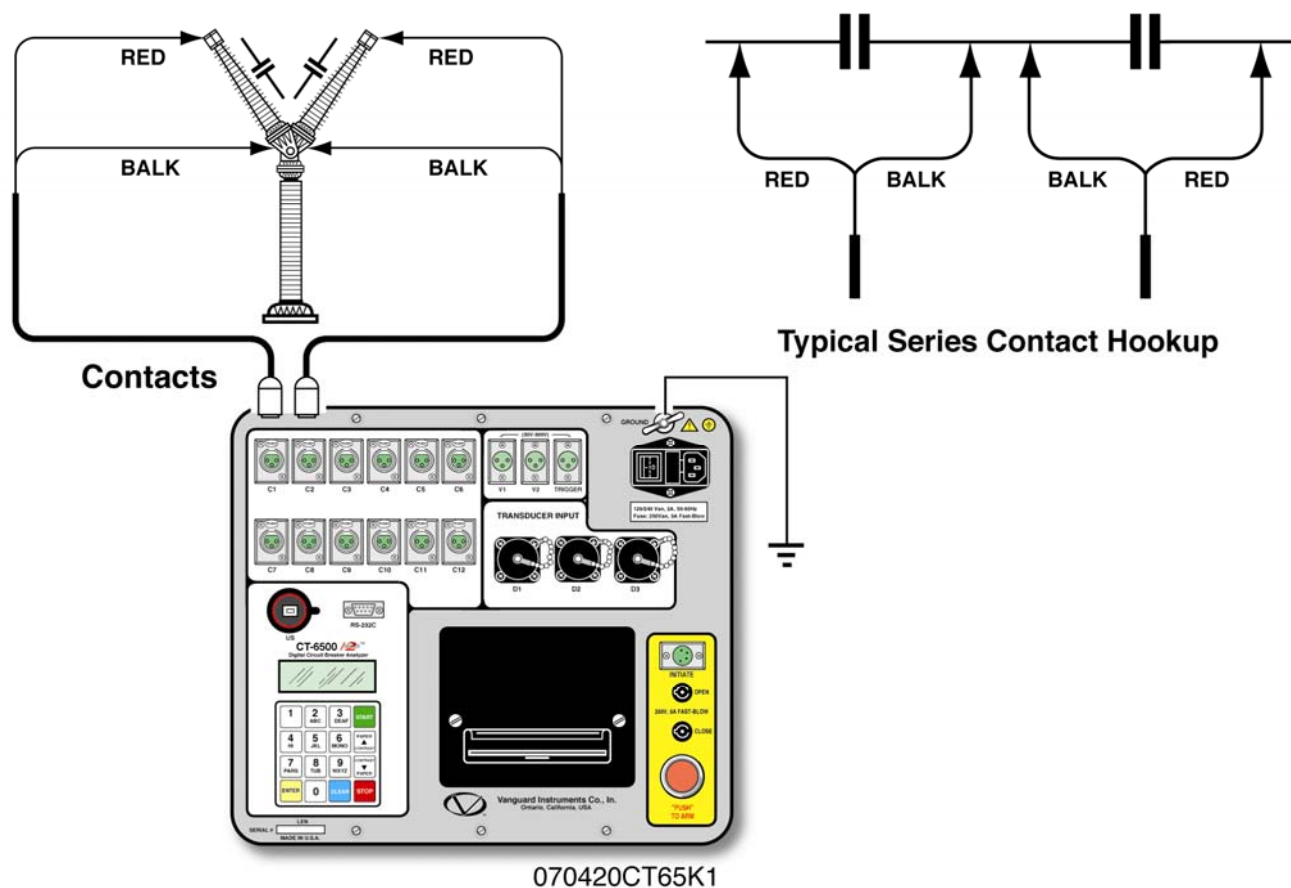


Figure 4.0 Series Contact Cable Connection

8.2 Initiate Cable Hookup

The CT-6500 will trip or close breakers through a solid-state device, which will operate 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 test hookup is shown in Figure 5.0.

A typical DC trip and AC close, control circuit test hookup is shown in Figure 6.0.

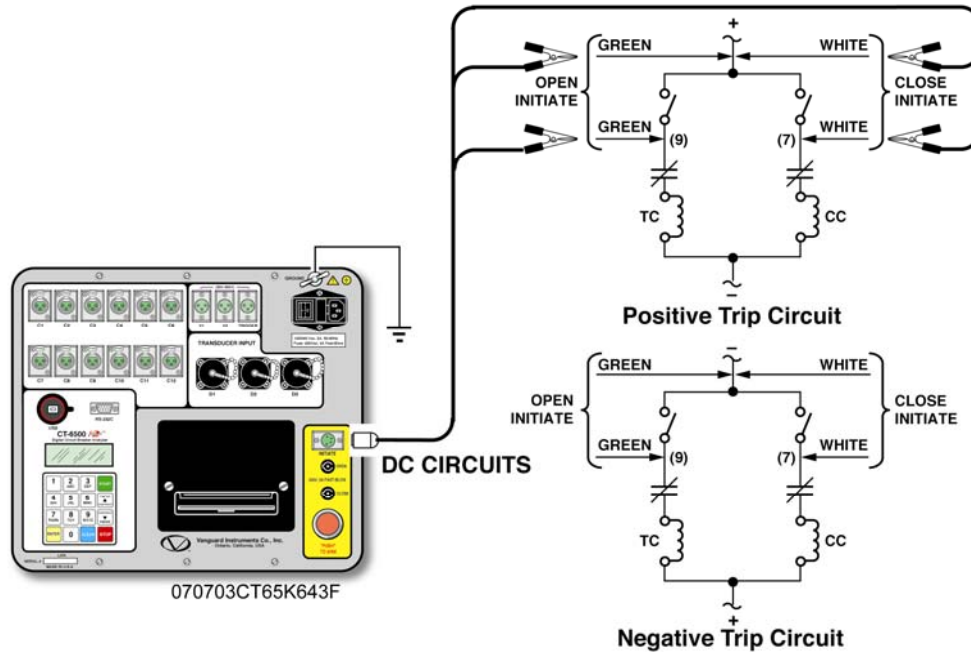


Figure 5.0 DC Trip and DC Close, Initiate Circuit Cable Hook-Up

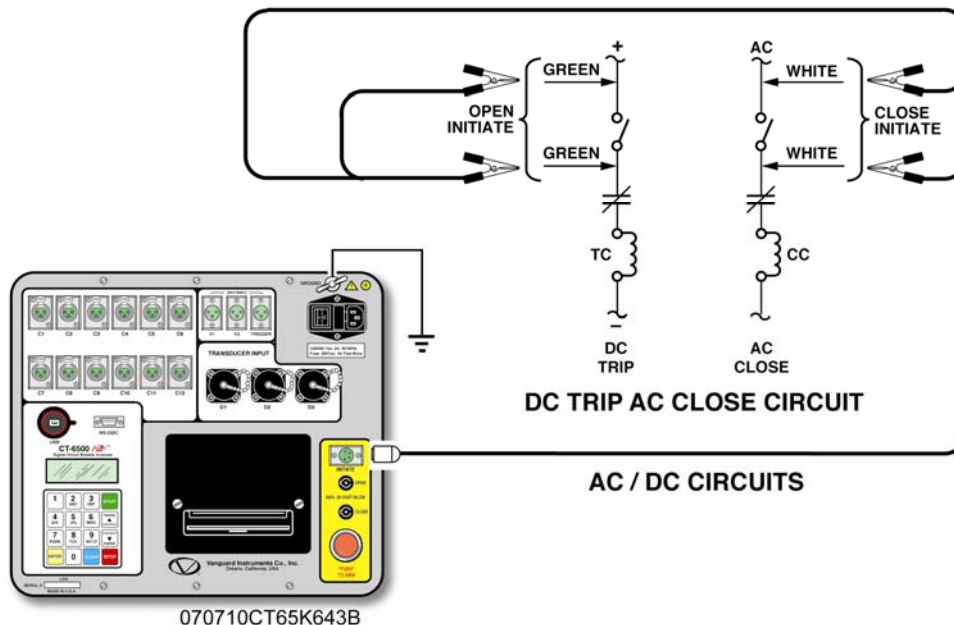


Figure 6.0 DC Trip and AC Close, Initiate Circuit Cable Hook-Up

8.3 Analog Voltage Monitor Hookup

The analog voltage input, "V1" permits the user to monitor a breaker's DC control voltage during an operation. The analog voltage input will record 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 will be printed on a tabulated report. Analog waveforms will also be plotted in a graphical format. Thus, the user is able to see the breaker's DC control voltage "dip" under load conditions. Problems, such as a poor connection or an excessive voltage drop, during the circuit breaker operation can be easily detected.

A typical voltage monitoring hook up scheme is shown on Figure 7.0.

NOTE

The maximum voltage that can be recorded is 255 Vdc.

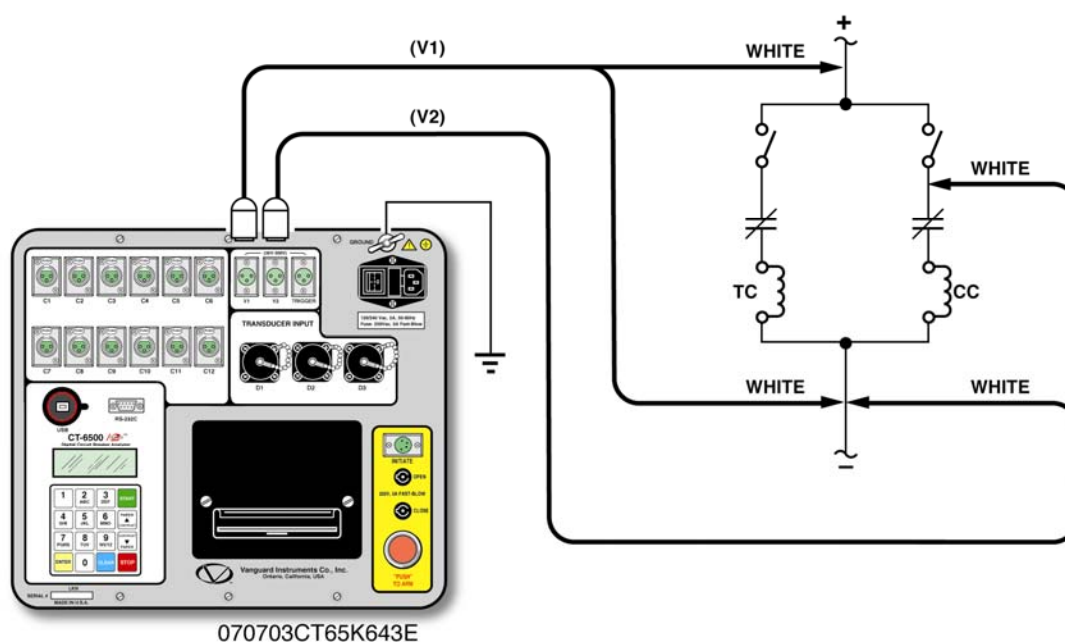


Figure 7.0 Voltage Monitoring Cable Hook-Up

8.4 Digital Voltage Monitor Hookup

The digital, voltage input channel, "V2" permits the user to monitor the voltage status as "ON" or "OFF" states. The voltage "ON" or "OFF" states will be plotted on the graphical report. A typical hook up is shown in Figure 7.0.

8.5 External Trigger Input

The External Trigger Mode enables the user to start recording data when the CT-6500 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 user will need to connect the CT-6500's initiate cable to the close terminal shown in Figure 5.0. The CT-6500 will energize the 52X relay to start the close operation, which will then start the timing when the CT-6500 senses the voltage across the closing coil. See Figure 8.0 for a typical test hookup. Another application for external trigger is to start timing the breaker when the user trips or closes the breaker remotely.

NOTE

Minimum trigger voltage is set for 30 Vac/dc. Maximum, continuous voltage is limited to 300 Vac/dc. Different trigger voltages can be set at the factory, based upon specific requests.

The CT-6500 will start looking for the external trigger voltage when the message, "AWAITING TRIGGER..." is shown on the LCD screen. The external trigger voltage needs to be sensed by the CT-6500 within 15 seconds after the initiate sequence has begun. The CT-6500 will return to the main menu if no voltage is sensed.

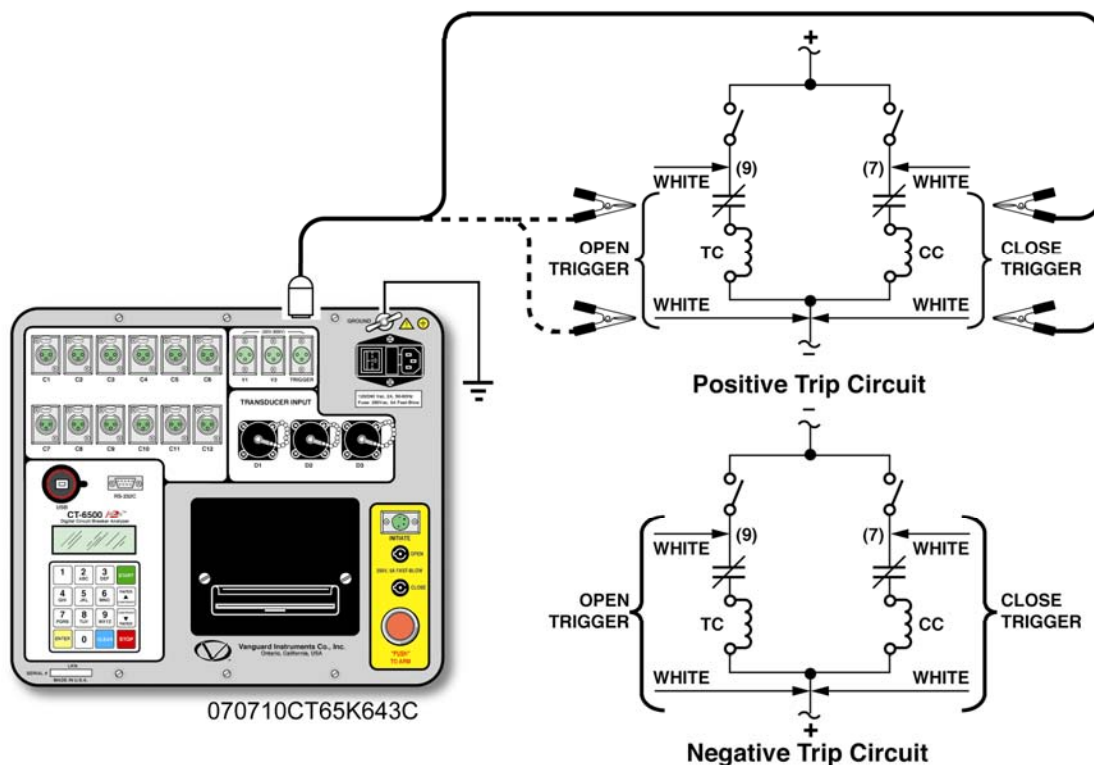


Figure 8.0 External Trigger Cable Hook-Up

8.6 Digital Transducer Connection

A typical transducer connection is shown on Figure 9.0. See Appendix I for more transducer connections.

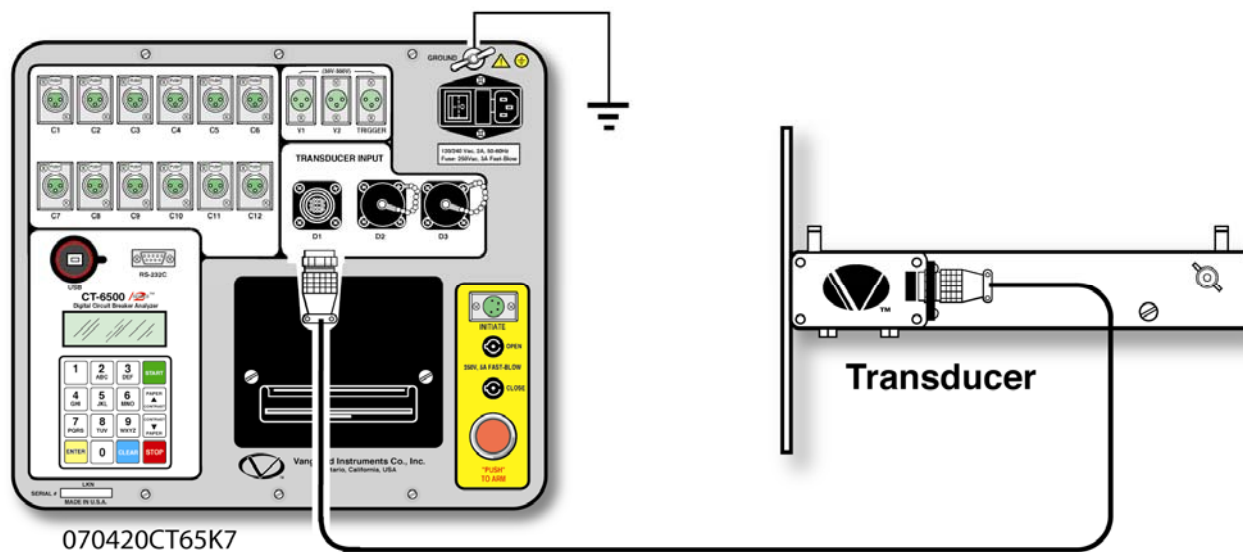


Figure 9.0 Transducer Connection

CT-6500 Series 2 Operating Instructions

9.0 Operating Procedures

The main steps to time a circuit breaker are listed in Figure 10.0.

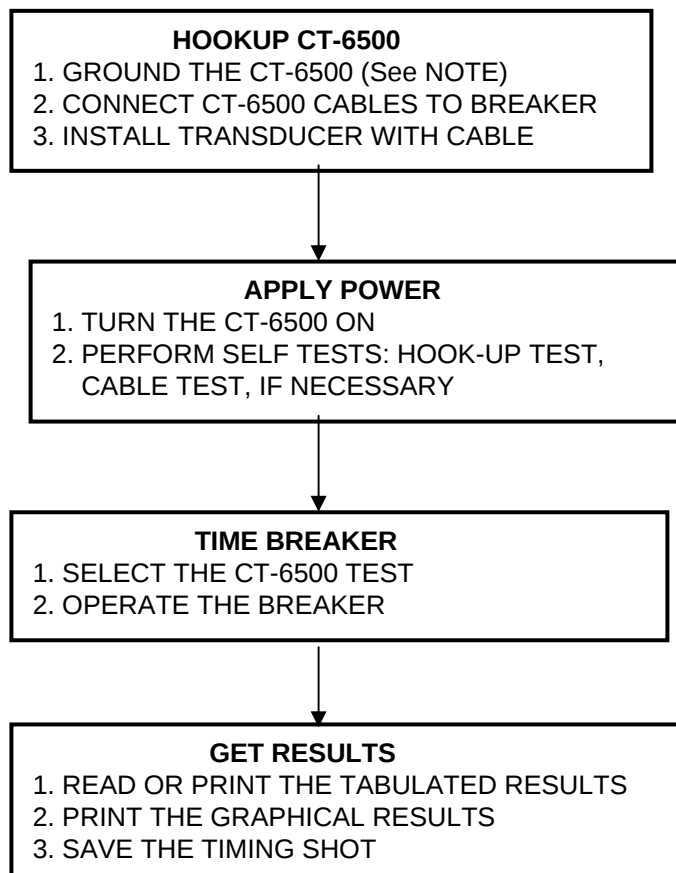


Figure 10.0 CT-6500 Operating Steps

NOTE

To reduce the possibility of damaging the CT-6500 contact channels due to static discharge in high voltage substations, it is recommend to ground one side of the breaker's bushings.

Always connect the CT-6500 ground stud to the substation ground before connecting any cables to the unit.

CT-6500 Series 2 Operating Instructions

9.1 Timing a Circuit Breaker

The CT-6500 will initiate the breaker operation and do a timing test on the following operations:

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

NOTE

1. The CT-6500 can start the OPEN-CLOSE operations without a delay or by using a programmable delay between the OPEN and CLOSE commands.
2. The CLOSE-OPEN operation can be started by the CT-6500, using several options.
 - Contact #1 Close
The CT-6500 can initiate a CLOSE command and then an OPEN command after detecting the breaker's contact was closed. The CT-6500 detects that the breaker's contact was closed through contact channel #1. The selection is recommended for the CLOSE-OPEN operation since it truly represents when the circuit breaker closed and then opened.
 - Set DELAY
The CT-6500 can initiate a CLOSE command and then an OPEN command after a programmable delay that can be set in milliseconds.
 - No DELAY
The CT-6500 can initiate a CLOSE command and then an OPEN command without any delay. Since the circuit breaker is in the open state, the circuit 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 closed state, the 52A contact will close allowing the breaker to initiate the open command.
3. The OPEN-CLOSE-OPEN operation can be initiated by the CT-6500, by using a programmable delay between each of the operations, where the delays can be set between the OPEN to CLOSE and between the CLOSE to OPEN commands.

CT-6500 Series 2 Operating Instructions

9.1.1 Timing an OPEN Operation (With No Insertion Resistors)

The following example shows the steps for performing an Open Test on a circuit breaker.

Table 3.0 Open Operation With No Insertion Resistors

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION..	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT NO INSERTION RESISTOR.	PRESS #1 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SEC 2.WINDOW = 10 SEC 3. WINDOW = 20 SEC
3	SELECT 1-SECOND TIMING WINDOW.	PRESS #1 KEY.	TRIGGER MODE: 1. INTERNAL TRIGGER 2. EXTERNAL TRIGGER
4	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-O 5. O-C-O
5	SELECT OPEN OPERATION.	PRESS #1 KEY.	OPEN TIMING Hold "ARM" Switch, Then "START". "STOP" to ABORT
6	INITIATE OPEN COMMAND.	HOLD THE "ARM" SWITCH AND PRESS THE "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 25 seconds)
7	OBSERVE BREAKER OPERATED. ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.RUN TEST 06/12/07 2.GET RSLT 19:20:01 3.SET-UP 4.DIAGNOSTIC

Go to section 9.2 to print a test report.

NOTE

One-second timing windows are used for breaker timing. The 10 and 20 second timing windows are used for long timing events (i.e. timing circuit-switchers).

The user can set the CT-6500 to print tabulated and graphical reports automatically after it completes a test. See Paragraph 9.17 for the automatic print setting.

CT-6500 Series 2 Operating Instructions

9.1.2 Timing an OPEN Operation with Insertion Resistors

The CT-6500 can time breakers with insertion resistors. The insertion resistor can range from 10 to 7,000 Ohms. Any insertion resistor more 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.

Table 4.0 Open Operation With Insertion Resistor

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION.	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT INSERTION RESISTOR.	PRESS #2 KEY.	RESISTOR VALUE: 1.LESS THAN 1000 OHM 2.1000 to 2000 OHM 3.MORE THAN 2000 OHM
3	SELECT LESS THAN 1000 OHM RESISTOR RANGE.	PRESS #1 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SEC 2.WINDOW = 10 SEC 3.WINDOW = 20 SEC
4	SELECT 1-SECOND WINDOW.	PRESS #1 KEY.	TRIGGER MODE: 1. Internal Trigger 2. External Trigger
5	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-O 5. O-C-O
6	SELECT OPEN OPERATION.	PRESS #1 KEY.	OPEN TIMING Hold "ARM" Switch, Then "START". "STOP" to ABORT
7	INITIATE OPEN COMMAND.	HOLD THE "ARM" SWITCH AND PRESS THE "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 25 seconds)
8	ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.RUN TEST 06/12/07 2.GET RSLT 19:20:01 3.SET-UP 4.DIAGNOSTIC

Go to section 9.2 to print a test report.

CT-6500 Series 2 Operating Instructions

NOTE

One-second timing windows are used for breaker timing. The 10 and 20 second timing windows are used for slower timing events (i.e. timing circuit-switchers).

The user can set the CT-6500 to print tabulated and graphical reports automatically after it completes a test. See Paragraph 9.17 for the automatic print setting.

9.1.3 Timing CLOSE-OPEN Operation Using Contact Channel #1

The CLOSE-OPEN operation of the breaker simulates a condition where a breaker is closed on a fault. There are 3 choices for the user to setup the CLOSE-OPEN operation:

1. Contact #1 CLOSE

The CT-6500 will initiate a CLOSE operation. The Open operation is then initiated after contact channel # 1 is closed.

2. Set DELAY

The user can set a delay from 10 to 500 ms between a CLOSE command to the OPEN command. The CT-6500 will initiate the CLOSE operation and start the delay counter. The OPEN operation will be initiated when the delay time completes.

3. No DELAY

Both the CLOSE and OPEN commands are initiated by the CT-6500 simultaneously. The OPEN coil is energized when the Open auxiliary switch makes.

NOTE

The CLOSE-OPEN command option "Contact #1 CLOSE" closely simulates the breaker closing on a fault condition in the field.

CT-6500 Series 2 Operating Instructions

Table 5.0 Close-Open Operation Using Contact Channel #1

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION.	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT NO INSERTION RESISTOR.	PRESS #1 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SEC 2.WINDOW = 10 SEC 3.WINDOW = 20 SEC
3	SELECT 1-SECOND WINDOW.	PRESS #1 KEY.	TRIGGER MODE: 1.INTERNAL TRIGGER 2.EXTERNAL TRIGGER
4	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-O 5. O-C-O
5	SELECT CLOSE-OPEN OPERATION.	PRESS #4 KEY.	C-O Second Trigger: 1. Contact #1 CLOSE 2. Set DELAY 3. No DELAY
6	SELECT CONTACT #1 CLOSE.	PRESS #1 KEY.	CLOSE-OPEN TIMING Hold "ARM" Switch Then "START" "STOP" to ABORT
7	INITIATE OPEN COMMAND.	HOLD THE "ARM" SWITCH AND PRESS THE "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 25 seconds)
8	ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.RUN TEST 06/12/07 2.GET RSLT 19:20:01 3.SET-UP 4.DIAGNOSTIC

NOTE

1. Users can program a delay from 10 to 500 ms between the CLOSE and OPEN commands. When a delay is used in the operation, it may not represent a true breaker operating condition.
2. Users can also program in no delay for the operation in which case, the CLOSE and OPEN commands are initiated at the same time by the CT-6500.

CT-6500 Series 2 Operating Instructions

9.1.4 Timing OPEN-CLOSE-OPEN Operation

The OPEN-CLOSE-OPEN operation requires the user to enter two time-delays between the circuit breaker operations. The time delays are in millisecond intervals. The first delay is from the first OPEN command to the CLOSE command. The second delay is from the CLOSE command to the second OPEN command. Refer to Table 6.0 for setting up the OPEN-CLOSE-OPEN operation.

Table 6.0 Open-Close-Open Operation Using Delay

STEP	OPERATION	ACTION	DISPLAY
1	READY TIMER FOR BREAKER OPERATION.	PRESS #1 KEY.	INSERTION RESISTOR? 1.NO 2.YES
2	SELECT NO INSERTION RESISTOR.	PRESS #1 KEY.	TIMING WINDOWS: 1.WINDOW = 1 SEC 2.WINDOW = 10 SEC 3.WINDOW = 20 SEC
3	SELECT 1-SECOND WINDOW.	PRESS #1 KEY.	TRIGGER MODE: 1.INTERNAL TRIGGER 2.EXTERNAL TRIGGER
4	SELECT INTERNAL TRIGGER.	PRESS #1 KEY.	TIMING MODE: 1. OPEN 2. CLOSE 3. O-C 4. C-O 5. O-C-O
5	SELECT OPEN-CLOSE-OPEN OPERATION.	PRESS #5 KEY.	O-C Delay in mS: (10 – 350) mSec ENTER when done
6	SELECT DELAY BETWEEN OPEN-CLOSE OPERATION.	ENTER DELAY USING 0-9 KEYS, PRESS THE "ENTER" KEY TO CONFIRM.	C-O Delay in mS: (10 – 350) mSec ENTER when done
7	SELECT DELAY BETWEEN CLOSE-OPEN OPERATION.	ENTER DELAY USING 0-9 KEYS, PRESS THE "ENTER" KEY TO CONFIRM.	OPEN-CLOSE-OPEN TIMING Hold "ARM" Switch, Then "START". "STOP" to ABORT
8	INITIATE O-C-O COMMAND.	HOLD THE "ARM" SWITCH AND PRESS THE "START" KEY.	TEST IN PROGRESS Hold "ARM" Until Test complete. (Up to 25 seconds)
9	ANALYZER IS READY TO OUTPUT RESULTS.	NONE.	1.RUN TEST 06/12/07 2.GET RSLT 19:20:01 3.SET-UP 4.DIAGNOSTIC

CT-6500 Series 2 Operating Instructions

9.2 Printing Tabulated Timing Results Using the Thermal Printer

The circuit breaker timing results can be printed on the thermal printer by using the steps listed in Table 7.0.

A typical circuit breaker timing result printed on thermal printer is shown in Figure 11.0.

Table 7.0 Printing Tabulated Results

STEP	OPERATION	ACTION	DISPLAY
1	GET TIMING RESULTS.	PRESS #2 KEY.	1.PRINT TEST RESULTS 2.PLOT FULL CHART 3.PLOT EXPANSION 4.PLOT 0-200 MS
2	PRINT TABULATED RESULTS.	PRESS #1 KEY.	SELECT PRINTER 1.THERMAL PRINTER 2.DISPLAY RESULTS
3	OUTPUT TABULATED RESULTS ON THERMAL PRINTER.	PRESS #1 KEY.	BUSY PRINTING

CT-6500 Series 2 Operating Instructions

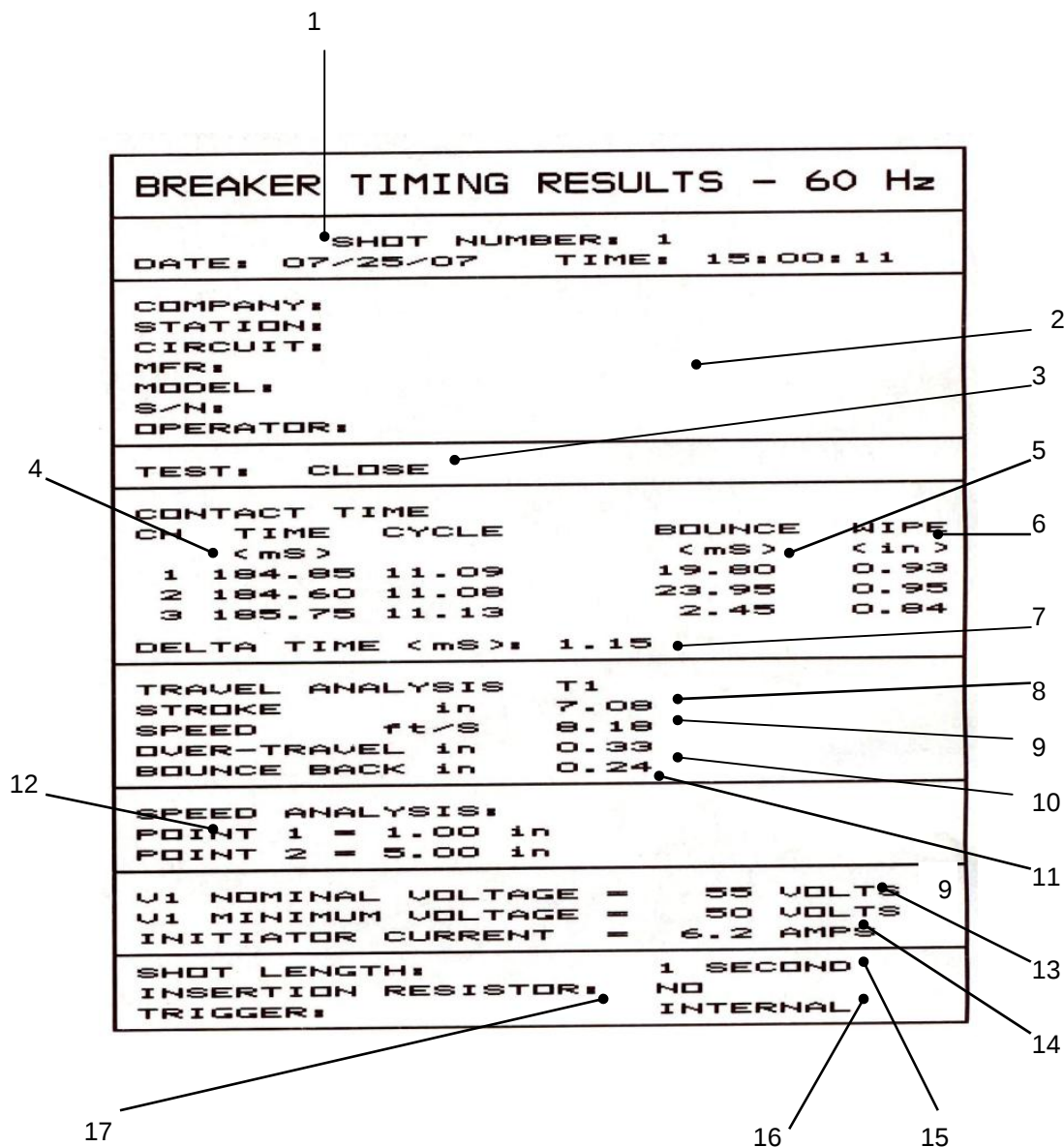


Figure 11.0 Typical Tabulated Printout of an Open Operation From the Thermal Printer

9.2.1 Tabulated Results Interpretation

1. Timing Record is time and date stamped by the CT-6500.
2. Timing record header information (Company, Substation name, Circuit, etc) is also saved with test record.
3. Timing test type (OPEN, CLOSE, O-C, C-O, O-C-O) is identified. A CLOSE timing shot is shown in Figure 12.0.
4. Contact channel #1 time is shown in both milliseconds and cycles. From Figure 12.0, contact channel #1 time was 184.85 ms or 11.09 cycles.
5. Contact channel #1 bounce duration was 19.80 ms.
6. Contact channel #1 wipe was measured as 0.93 inches.
7. The slowest contact and fastest contact differential time is shown as contact delta, 1.15 ms.
8. Breaker contact stroke was measured as 7.08 inches.
9. Contact velocity calculation was 8.18 feet per second.
10. Contact over-travel distance was measured as 0.33 inches.
11. Contact bounce-back distance was measured 0.24 inches.
12. Contact velocity calculation was from the two analysis points:
Analysis point # 1 was 1.00 inch from the fully closed position.
Analysis point # 2 was 2.00 inches from the fully closed position.
13. The DC power supply was monitored during the test. The nominal voltage was 55 Volts and the minimum voltage was 50 Volts.
14. Initiate current was 6.2 Amperes.
15. Timing shot duration was one second.
16. Trigger mode was internal therefore the timing window starts at the same time when the CT-6500 energized the circuit breaker.
17. There was no insertion resistor in the test, thus no insertion resistor time was measured.

9.3 Get Graphic Timing Results Using the Thermal Printer

Selecting the "PLOT FULL CHART" command will plot the timing chart as follows:

- Timing chart from 0 to 1000 ms with one second window and 50 ms time markers.
- Timing chart from 0 to 10 seconds with 10 second window and 500 ms time markers.
- Timing chart from 0 to 20 seconds with 20 second window and one second time markers.

Table 8.0 Plot Timing Chart

STEP	OPERATION	ACTION	DISPLAY
1	GET TIMING RESULTS.	PRESS #2 KEY.	1.PRINT TEST RESULTS 2.PLOT FULL CHART 3.PLOT EXPANSION 4.PLOT 0-200 MS
2	PLOT FULL CHART.	PRESS #2 KEY.	SELECT PRINTER 1.INTERNAL THERMAL 2.EXTERNAL INK JET
3	SELECT THERMAL PRINTER.	PRESS #1 KEY.	PLEASE WAIT PLOTING GRAPH
4	RETURN TO MAIN MENU AFTER PRINT CHART.	NO ACTION.	1.RUN TEST 06/12/07 2.GET RSLT 19:20:01 3.SET-UP 4.DIAGNOSTIC

NOTE

1. Plot Expansion, which is Selection #3, in Step 1, allows the user to expand the graphic results in 100 ms increments.
2. Selecting "PLOT 0-200 MS" will automatically plot the timing chart from 0 to 200 milliseconds in the expansion mode with 10 ms timing markers.
3. Typical graphic results are shown in Figure 12.0 and 13.0.
4. Graphical result interpretations are shown in Figures 14.0, 15.0 and 16.0.

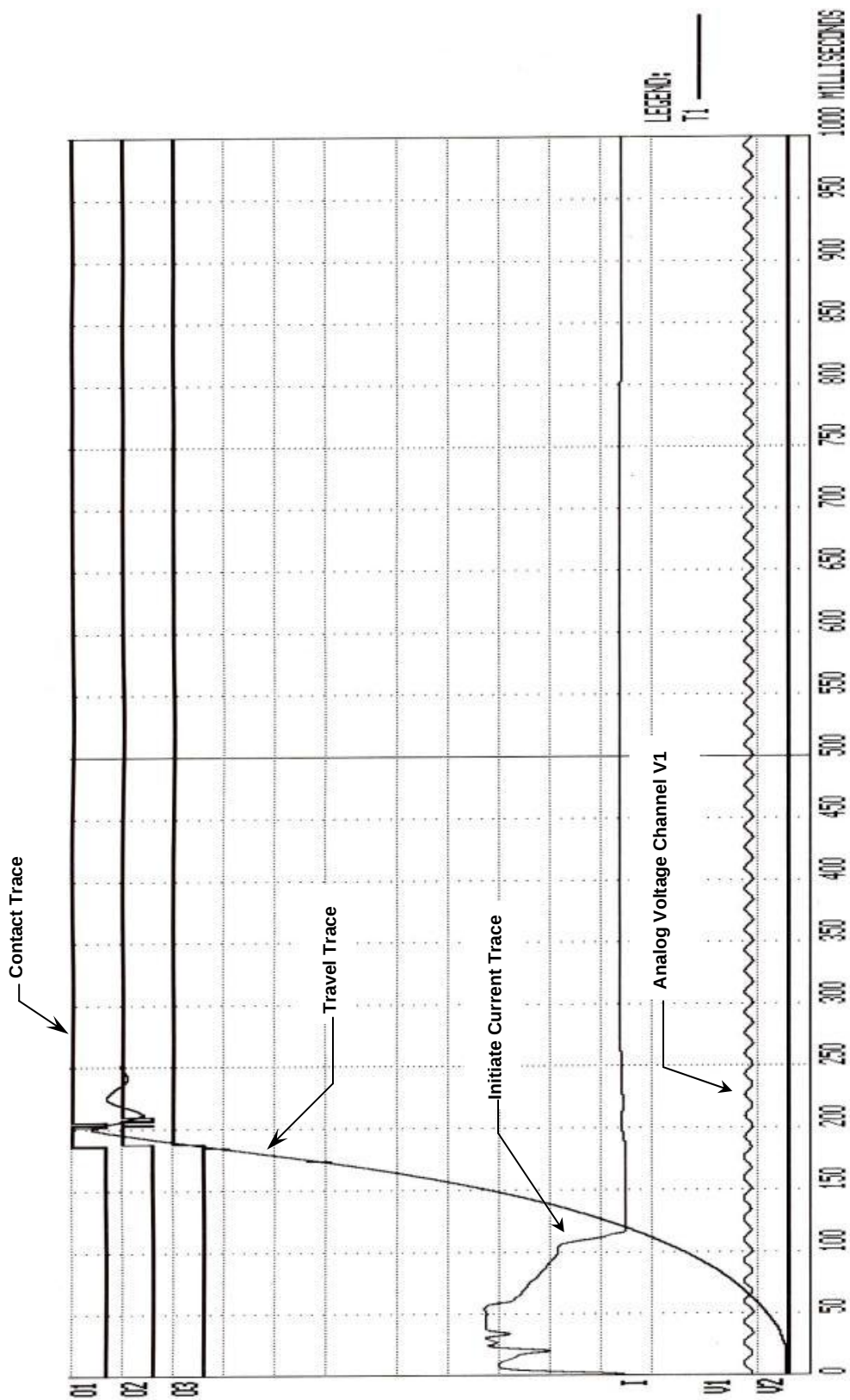


Figure 12.0 Typical Graphic Result Printed on Thermal Printer

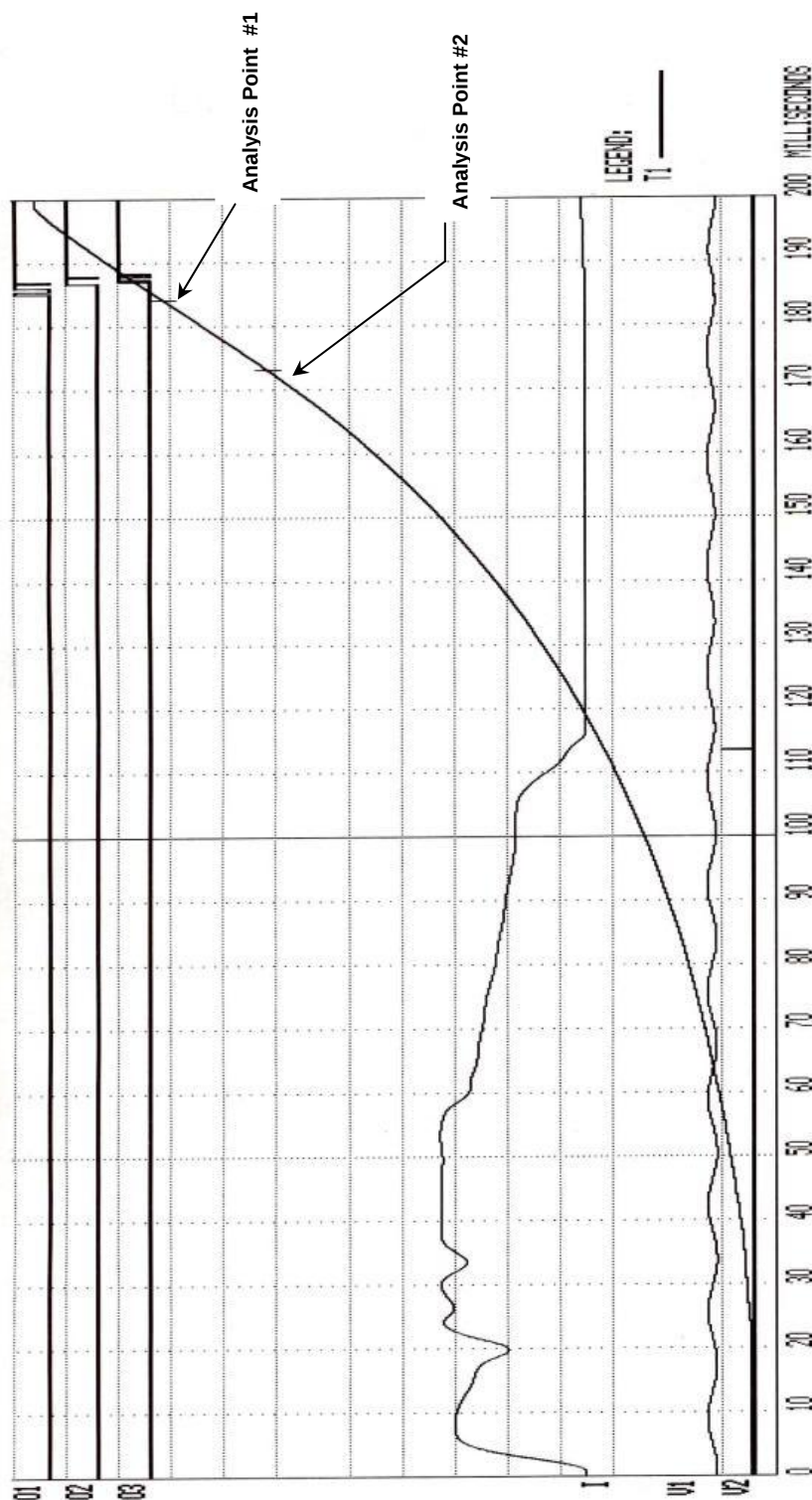
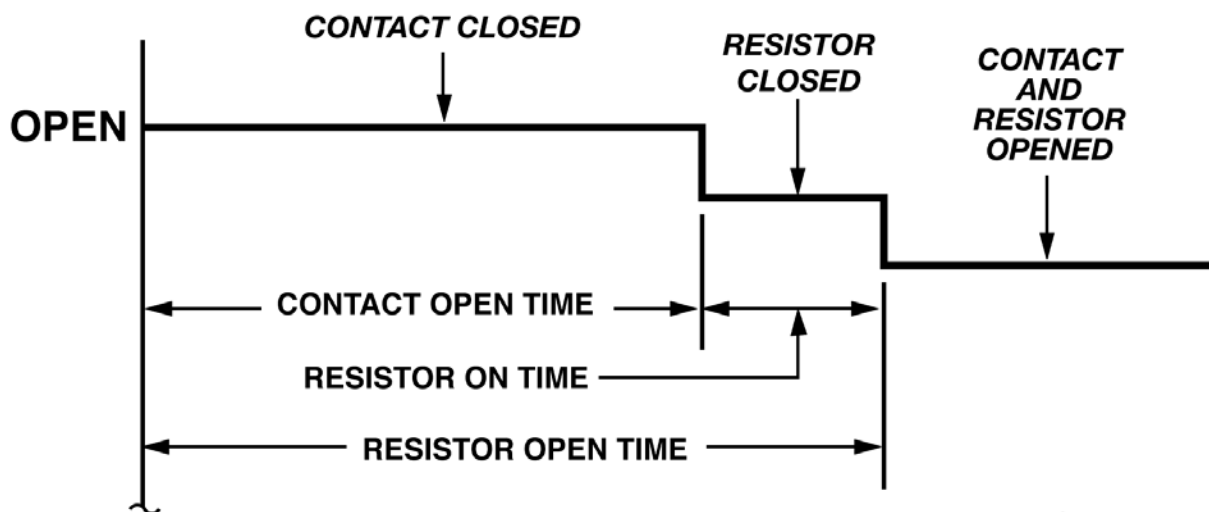


Figure 13.0 Expansion Graph From 0 to 300ms Printed on Thermal Printer

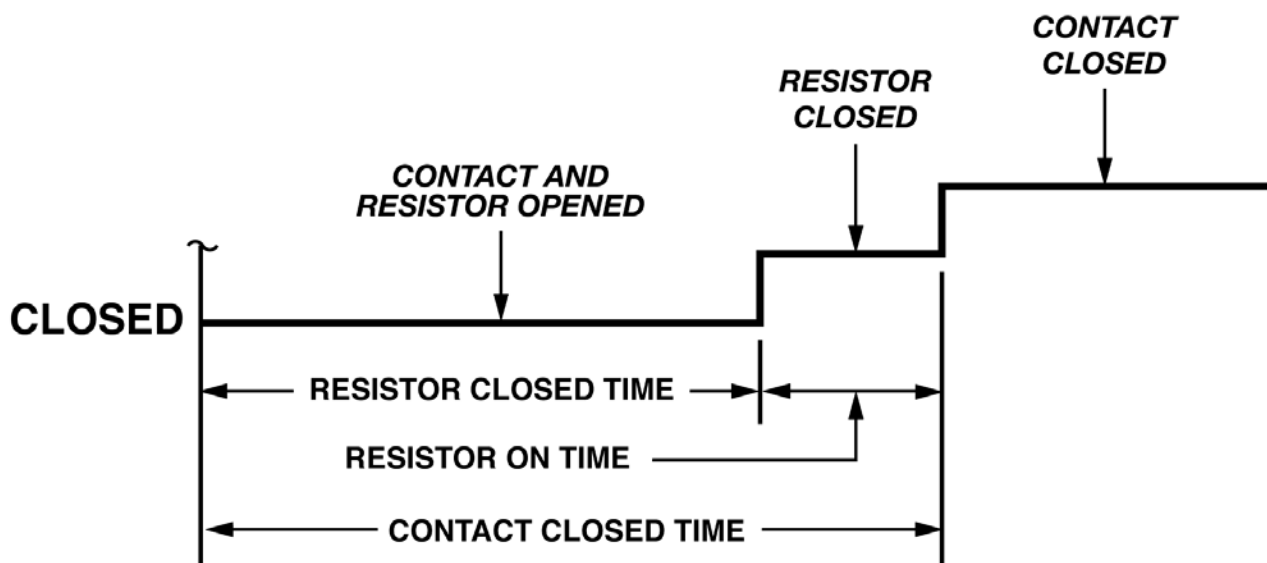
NOTE

Analysis point # 1 and point #2 are shown on chart.



CT65K13.030902

Figure 14.0 Graphical Interpretation of an Open Timing Shot



CT65K14.030902

Figure 15.0 Graphical Interpretation of a Close Timing Shot

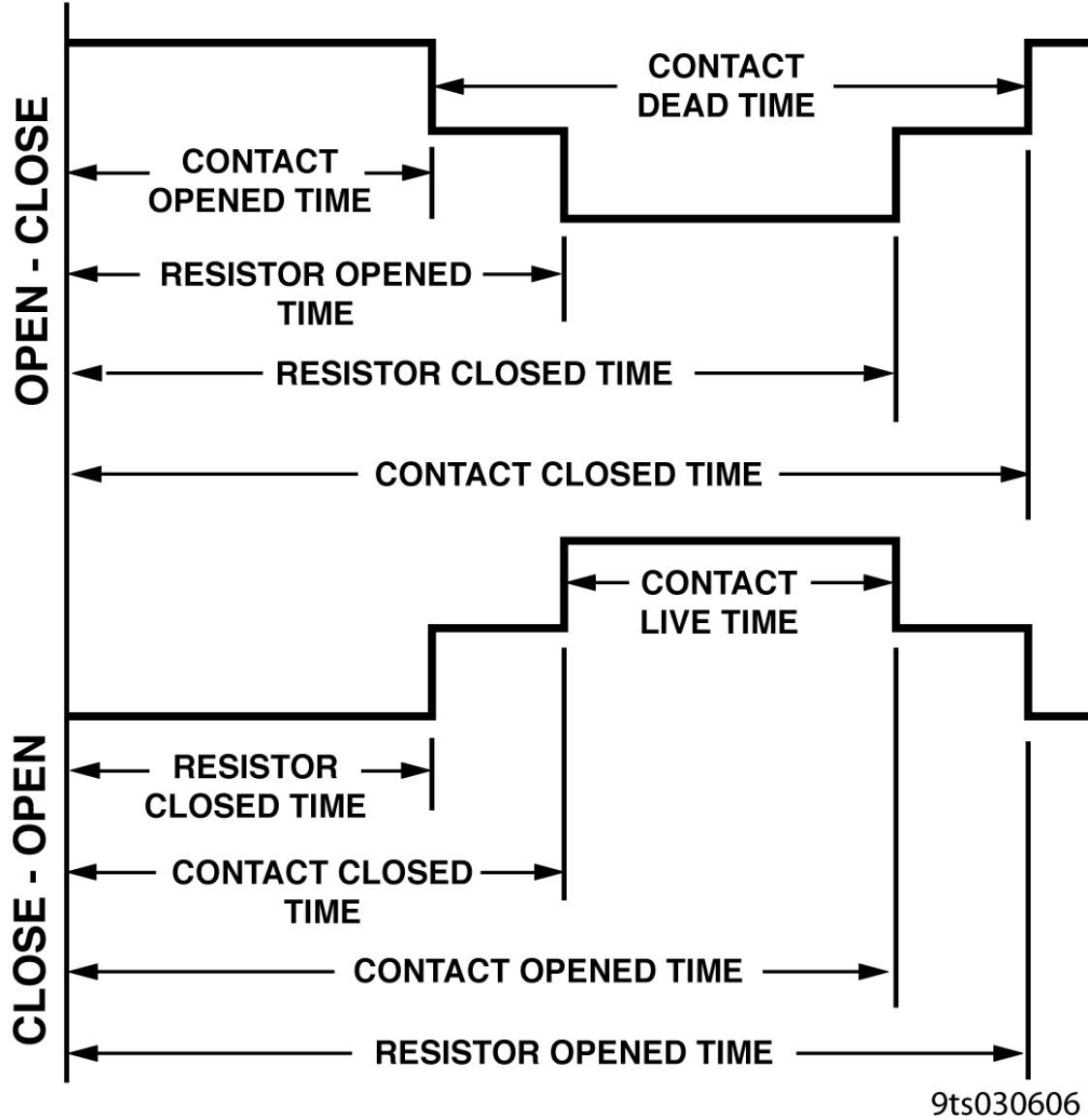


Figure 16.0 Graphical Interpretations of an Open-Close and a Close-Open Timing Shot

CT-6500 Series 2 Operating Instructions

9.4 Save Timing Test Records in the EEPROM

Use the steps in Table 9.0 to save a timing test record in the FLASH EEPROM.

Table 9.0 Save Timing Test Record In EEPROM

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SETUP MENU.	PRESS #3 KEY.	1.ANALYSIS POINTS 2.MEASUREMENT UNITS 3.SAVE / RESTORE 4.NEXT PAGE
2	SELECT SAVE MENU.	PRESS #3 KEY.	1.SAVE SHOT 2.RECALL SHOT 3.SHOT DIRECTORY 4.ERASE SHOT
3	SELECT SAVE SHOT.	PRESS #1 KEY.	SAVE SHOT # 002 TEST: CLOSE DATE: 05/23/07 12:36 "ENTER" TO PROCEED
4	CONFIRM SAVING SHOT.	PRESS THE "ENTER" KEY.	SAVE IN PROCESS PLEASE WAIT
5	OBSERVE SHOT BEING SAVED.	NONE.	SHOT SAVE
6	RETURN TO MAIN MENU.	PRESS ANY KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTE

Timing test record storage capability varies, depending upon the size of the records. The CT-6500 will assign an identification number for each of the records stored in the EEPROM.

Shot ID #2 was assigned in the example above.

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9.5 Printing Timing Test Record Directory Stored in the EEPROM

The user can obtain a timing-record directory that was stored in the CT-6500's FLASH EEPROM by using the steps in Table 10.0.

Table 10.0 Print Timing Test Record Directory

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SETUP MENU.	PRESS #3 KEY.	1.ANALYSIS POINT 2.MEASUREMENT UNITS 3.SAVE / RESTORE 4.NEXT PAGE
2	SELECT SAVE/RESTORE MENU.	PRESS #3 KEY.	1.SAVE SHOT 2.RESTORE SHOT 3.SHOT DIRECTORY 4.ERASE SHOT
3	SELECT SHORT DIRECTORY.	PRESS # 3 KEY.	1.SHORT DIRECTORY 2.FULL DIRECTORY "STOP" TO QUIT
4	SELECT SHORT DIRECTORY.	PRESS #1 KEY.	PRINTING ABBREVIATED DIRECTORY "STOP" TO QUIT
5	RETURN TO MAIN MENU.	NO ACTION.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTE

1. If the "Short Directory" was selected, the CT-6500 will print out the shot identifications of the last ten timing shots stored in the EEPROM.
2. If the "Full Directory" was selected, the CT-6500 will print out the shot identifications of all the timing shots stored in the EEPROM.
3. A typical shot directory printout is shown on in Figure 17.0.

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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 D-C-D
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

Figure 17.0 Printout of the Timing Shot Directory From the Thermal Printer

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9.6 Recalling a Timing Test Record

The following steps in Table 11.0 are used to recall a timing test record stored in the EEPROM to the working memory. Once a test record is recalled, the user can get a printout of the test results from the thermal printer.

Table 11.0 Recalling a Timing Test Record

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SETUP MENU.	PRESS #3 KEY.	1.ANALYSIS POINT 2.MEASUREMENT UNITS 3.SAVE / RESTORE 4.NEXT PAGE
2	SELECT SAVE/RESTORE SHOT.	PRESS # 3 KEY.	1.SAVE SHOT 2.RESTORE SHOT 3.SHOT DIRECTORY 4.ERASE SHOT
3	SELECT RESTORE SHOT.	PRESS #2 KEY.	ENTER SHOT NUMBER TO BE RESTORED XXXX "ENTER" TO CONFIRM
4	ENTER SHOT NUMBER "1" TO BE RESTORED.	PRESS KEYS 0-9 FOR SHOT ID THEN PRESS THE "ENTER" KEY.	ENTER SHOT NUMBER TO BE RESTORED 0001 "ENTER" TO CONFIRM
5	CONFIRM SHOT TO BE RESTORED.	PRESS THE "ENTER" KEY.	RESTORING SHOT # 0001 TEST: OPEN DATE: 06\12\07 09:12 "ENTER" TO CONFIRM
6	CONFIRM TEST RESTORED.	NONE.	RESTORE COMPLETE
7	RETURN TO MAIN MENU.	PRESS ANY KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

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9.7 Deleting a Timing Test Record

Users can delete a specific timing test record or all of the timing test records from the CT-6500's EEPROM by using the steps in Table 12.0.

Table 12.0 Deleting a Timing Record

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1.ANALYSIS POINTS 2.MEASUREMENT UNITS 3.SAVE / RESTORE 4.NEXT PAGE
2	SELECT SAVE / RESTORE MENU.	PRESS # 3 KEY.	1.SAVE SHOT 2.RESTORE SHOT 3.SHOT DIRECTORY 4.ERASE SHOT
3	SELECT ERASE SHOT.	PRESS # 4 KEY.	1.ERASE SHOT 2.ERASE ALL SHOTS!
4	SELECT ERASE SHOT.	PRESS # 1 KEY.	ENTER SHOT NUMBER TO BE ERASED XXXX "ENTER" TO CONFIRM
5	ENTER SHOT NUMBER "1" TO BE ERASED.	PRESS KEYS 0-9 TO SELECT SHOT NUMBER, PRESS THE "ENTER" KEY TO CONFIRM.	ERASE SHOT # 0001 TEST: OPEN DATE: 03/12/07 09:12 "ENTER" TO CONFIRM
6	CONFIRM TO ERASE SHOT.	PRESS THE "ENTER" KEY.	ERASE IN PROCESS PLEASE WAIT
7	WAIT FOR SHOT BEING ERASED.	NO ACTION.	ERASE COMPLETE
8	RETURN TO MAIN MENU.	PRESS ANY KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

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9.8 Test Record Description

The CT-6500 has the capability for users to enter the breaker and other identification information. The data usually consists of the name of the company, station, circuit and manufacturer. Other information could be the breaker's model, serial number and the operator's name. The identification data will print out in the header section of the tabulated report.

If the user saves the timing shot, the identification data will also be saved with the timing shot, along with the time and date.

The user can input letters of the alphabet by utilizing the alphanumeric keys. To select the letter "A," the user will need to press key numbered "2," twice. To select the letter "C," the user will need to press the key numbered "2," four times and so on.

To move the cursor forward, press the "UP ARROW" key. To move the cursor backwards, use the "DOWN ARROW" key. Use the "CLEAR" key to enter a space.

Table 13.0 Entering Test Record Identification Header

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS #3 KEY.	1.ANALYSIS POINTS 2.MEASUREMENT UNIT 3.SAVE / RESTORE 4.NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1.SHOT DESCRIPTION 2.NUMBER OF CHANNELS 3.SET DATE & TIME 4.SET PRINT MODE
3	SELECT SHOT DESCRIPTION.	PRESS # 1 KEY.	COMPANY: XXXXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT
4	ENTER COMPANY NAME.	PRESS KEYS 0-9 AND PRESS "ENTER" KEY.	STATION XXXXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT
5	ENTER STATION NAME.	PRESS KEYS 0-9 AND PRESS "ENTER" KEY.	CIRCUIT XXXXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT
6	ENTER CIRCUIT NAME.	PRESS KEYS 0-9 AND PRESS "ENTER" KEY.	MANUFACTURER XXXXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT
7	ENTER MANUFACTURER NAME.	PRESS KEYS 0-9 AND PRESS "ENTER" KEY.	BREAKER XXXXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT

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Table 13.0 Entering Test Record Identification Header (Continued)

STEP	OPERATION	ACTION	DISPLAY
8	ENTER BREAKER MODEL.	PRESS KEYS 0-9 AND PRESS "ENTER" KEY.	SERIAL XXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT
9	ENTER SERIAL NUMBER.	PRESS KEYS 0-9 AND PRESS "ENTER" KEY.	OPERATOR XXXX ↑/↓ TO POSITION "ENTER" TO ACCEPT
10	RETURN TO MAIN MENU.	NO ACTION.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

9.9 Computer Interface

Each CT-6500 has one RS-232C and one USB port, where the Circuit Breaker Analyzer Software Series 2 package provided with each CT-6500, enables an IBM-compatible personal computer to communicate with the unit. The software operating under Windows XP environments allows the user to transfer timing records stored in the EEPROM into the computer. From the user's computer, the user can now reanalyze the breaker's timing shots and then print the timing reports through an office printer. Since timing shots are stored in the office computer, users can create a database of a breaker's timing history.

This PC program allows the user to generate and transfer circuit breaker test plans to the CT-6500 EEPROM. Up to 99 circuit breaker test plans can be stored in the CT-6500 EEPROM.

Using the PC program, the user can control the CT-6500 to time circuit breakers.

Note

1. There is no requirement to place the CT-6500 under computer control to access the RS-232C or USB port.
2. An interconnect cable must be run between the CT-6500's RS-232C port or USB port to the user's PC.
3. The CT-6500's RS-232 connector pin layout is shown in the table below.

Table 14.0 RS-232C Connector Pin Definition

Pin No.	Signal Name
2	Tx
3	Rx
5	Gnd

9.10 Breaker Travel Analysis

The CT-6500's travel analysis includes the breaker's stroke, over-travel, bounce-back, contact-wipe distances and contact velocity calculations.

9.10.1 Breaker Stroke

The CT-6500 uses a digital transducer to measure a breaker's contact stroke, over-travel and bounce-back. The digital transducer output is 200 counts per linear inch of travel, therefore the resolution is accurate to about 1/200 inch. The output resolution is ± 0.01 inch on the test result report.

Unlike slide-wire transducers, the CT-6500's digital transducer needs no calibration or setup. A user verifies the transducer's functionality by selecting a diagnostic test for the transducer, which is further explained in Paragraph 9.14.

9.10.2 Breaker Over-Travel Distance

Over-travel is the distance the contact moves beyond the resting position. Over-travel is typically found in the close operation. (See Appendix A for more details).

9.10.3 Breaker Bounce-Back Distance

Bounce-back is the distance the breaker contact moves before the resting position after the over-travel. Again, bounce-back is typically found in the close operation. (See appendix A for more details).

9.10.4 Contact Wipe

Contact wipe is the distance measured from the close position to the contacts touching or parting positions. In the close operation, contact wipe is measured from the contacts touching position to the final close position.

In the open operation, the contact wipe is measured from the close position to the contact break or parting position.

NOTE

Contact wipe is measured during an operation. The measurement may not be as accurate as the measurement done using the Slow-Close Mode. It is recommended that the user use the Slow-Close Test to verify the contact wipe measurement, if required. Please refer to Paragraph 9.13 for further information on the Slow-Close Mode.

9.10.5 Breaker Velocity

When used with a travel transducer, the CT-6500 can calculate the breaker contact velocity through the arc zone. Users will need to program the calculation points or analysis points on the travel curve for the unit to calculate the contact velocity. Analysis point selections and setup are discussed in the following paragraphs.

9.10.6 Analysis Point Selections

Analysis points are used to calculate the average contact speed through the contact's arc zone. The analysis points are usually specified by the breaker's manufacturers. The analysis points can be programmed into the CT-6500 by the user. The CT-6500 will store the two setup points for calculating velocity one set each for the open and another set for the close operations. These setups remain in the CT-6500's memory until it is changed by the user.

9.10.7 Analysis Point No.1 (AP1)

Three selections are available to the user for setting analysis point No. 1:

1. PERCENTAGE OF STRK
2. DISTANCE FROM CLOSE
3. CONTACT #1

a. Percentage of Stroke

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.*** See appendix A for more detail.

b. Distance From Close

Distance from Close range is selectable from 00.0 inch to 99.99 inches or from 0.0 centimeter to 99.90 centimeters. ***Again, the distance is referenced from the contact's closed position.*** See Appendix A for more detail.

c. Contact Point #1

Contact point 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. ***Contact channel #1 will be used for the selection.***

9.10.8 Analysis Point No. 2 (AP2)

There are three selections for analysis point 2:

1. PERCENTAGE OF STRK
2. DISTANCE FROM CLOSE
3. CONTACT +/- TIME

a. See Paragraph 9.10.7.a for "PERCENTAGE OF STROKE" description.

b. See Paragraph 9.10.7.b for "DISTANCE FROM CLOSE" description.

c. "CONTACT +/- TIME", is available for both OPEN and CLOSE operation under analysis point #2 only. For "CONTACT + TIME", the user enters the millisecond time after the contact channel #1 made the transition from OPEN to CLOSE or CLOSE to OPEN to define the Analysis Point No. 2.

For "CONTACT – TIME", the user enters the millisecond time before the contact channel #1 makes the transition from OPEN to CLOSE or CLOSE to OPEN to define the Analysis Point No. 2.

NOTES

1. Average velocity through the arc zone is calculated by using the following formula:

$$V_{avg} = \text{Distance} \div \text{Time}$$

2. The breaker contact velocity can be recalculated based upon the data stored inside the memory after any new analysis points were 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 is then calculated from the travel data stored in memory from the last operation.

3. For complex velocity calculations, the user can create a test plan using the CT-6500 Breaker Analysis Software from a PC. The test plan then can be downloaded to the CT-6500. The complex breaker velocity calculation can now be executed easily by recalling the test plan before running the timing test.

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9.10.9 Set-Up Open Analysis Points

The following procedure allows the user to set the analysis points to calculate velocity of the circuit breaker in the open operation. The open analysis point #1 is 1.00 inch from the fully closed position of the circuit breaker. The open analysis point #2 is 2.00 inches from the fully closed position.

Table 15.0 Setting Up "OPEN" Analysis Points Using Distance

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1.ANALYSIS POINT 2.MEASUREMENT UNITS 3.SAVE / RESTORE 4.NEXT PAGE
2	SELECT ANALYSIS POINT.	PRESS # 1 KEY.	1.OPEN TIMING 2.CLOSE TIMING 3.PRINT SETTING 4.TEST PLAN
3	SELECT OPEN TIMING.	PRESS # 1 KEY.	OPEN ANALYSIS PT 1 1.PERCENT OF STROKE 2.DISTANCE FROM CLOSE 3.CONTACT #1
4	SELECT DISTANCE FROM CLOSE.	PRESS # 2 KEY.	OPEN ANALYSIS PT 1 DISTANCE FROM CLOSE VALUE: XX.XX in "ENTER" TO CONFIRM
5	ENTER 1 INCH.	PRESS KEYS 0-9 TO SET 1.00. USE THE "ENTER" KEY TO CONFIRM.	OPEN ANALYSIS PT 1 DISTANCE FROM CLOSE VALUE: 01.00 in "ENTER" TO CONFIRM
6	CONFIRM ENTRY.	PRESS THE "ENTER" KEY.	OPEN ANALYSIS PT 2 1.PERCENTAGE OF STROKE 2.DISTANCE FROM CLOSE 3.CONTACT +/- TIME
7	SELECT DISTANCE FROM CLOSE.	PRESS # 2 KEY.	OPEN ANALYSIS PT 2 DISTANCE FROM CLOSE VALUE: XX.XX in "ENTER" TO CONFIRM
8	ENTER 2 INCHES.	PRESS KEYS 0-9 TO SET 2.00 INCHES.	OPEN ANALYSIS PT 2 DISTANCE FROM CLOSE VALUE: 02.00 in "ENTER" TO CONFIRM
9	RETURN TO MAIN MENU.	PRESS THE "ENTER" KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

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NOTES

1. If an entry is not correct, re-enter the digits until the screen shows the desired numbers, then press the "ENTER" key.
2. Analysis Point #1 is 1.00 inch from the fully closed position.
3. Analysis Point #2 is 2.00 inches from the fully closed position.

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9.11 Select English or Metric Measurement Unit.

The CT-6500 supports and displays both English and Metric calculations from the breaker's travel parameters such as the stroke, velocity and other parameters. The user can switch from one system to the other by following the steps in Table 16.0.

Table 16.0 Select English or Metric Procedure

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1.ANALYSIS POINT 2.MEASUREMENT UNITS 3.SAVE / RESTORE 4.NEXT PAGE
2	MEASUREMENT UNITS.	PRESS # 2 KEY.	SELECT UNITS 1.ENGLISH 2.METRIC 3.ROT ENC 4.RES ENC
3	SELECT METRIC UNIT	PRESS # 2 KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

9.12 Digital Rotary Transducer Selection

A rotary transducer requires the user to enter the defined linear distance in millimeters or inches, per one degree of rotary motion as seen in Table 17.0.

Table 17.0 Select Rotary Transducer

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT MEASUREMENT UNITS.	PRESS # 2 KEY.	SELECT UNITS 1. ENGLISH 2. METRIC 3. ROT ENC 4. RES ENC
3	SELECT ROTARY TRANSDUCER.	PRESS # 3 KEY.	ROTARY ENCODER: 1. ENGLISH (In./deg) 2. METRIC (MM/deg)
4	SELECT INCH PER DEGREE.	PRESS #1 KEY.	INCHES/DEGREE 0.014 in/deg
5	ENTER 0.50 INCH PER DEGREE.	ENTER 0.50 USING 0-9 KEYS.	INCHES/DEGREE 0.500 in/deg
6	RETURN TO MAIN MENU.	PRESS THE "ENTER" KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

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9.13 Slow-Close Test

The CT-6500 offers a unique feature called a "Slow-Close" test. The test permits users to measure 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 channel 1, 2, 3 and transducer channel 1 will be used for "Slow-Close" testing. The CT-6500 will measure the contact touch and contact wipe for each contact channel.

Contact touch is the distance measured from the contact 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.

Table 18.0 Performing a Slow-Close Test

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC MENU.	PRESS # 4 KEY.	1. SLOW CLOSE TEST 2. CHECK HOOKUP 3. TEST TRANSDUCER 4. NEXT PAGE
2	SELECT SLOW CLOSE TEST.	PRESS # 1 KEY.	BREAKER SLOW CLOSE TEST RMV CB GND (1 SIDE) "ENTER" TO BEGIN
3	START SLOW CLOSE TEST.	PRESS THE "ENTER" KEY.	CONTACT 1:OPEN CONTACT 2:OPEN CONTACT 3:OPEN LIFT TO CLS BREAKER NOW
4	CONTINUE TO CLOSE BREAKER.	NO ACTION.	LIFT BRKR TO CLS POS THEN PRESS "ENTER" TO FIND CONTACT WIPE
5	RETURN TO MAIN MENU.	NO ACTION.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTE

The user can also save a Slow-Close test report in the EEPROM. A typical report of a Slow-Close test is shown on in Figure 18.0.

BREAKER TIMING RESULTS - 50 Hz		
SHOT NUMBER: 0006		
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

Figure 18.0 Typical Slow-Close Test Report

NOTE

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

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9.14 Transducer Self-Test

The operator can check the transducer electronics by connecting the transducer to the CT-6500 (D1 or D2 or D3) and running a "Test Transducer" diagnostics.

Table 19.0 Performing a Transducer Self Test

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. CHECK HOOKUP 3. TEST TRANSDUCER 4. NEXT PAGE
2	SELECT TRANSDUCER.	PRESS # 3 KEY.	TRANSDUCER TEST 1= 0.00 IN / 000.0° 2= 0.00 IN / 000.0° 3= 0.00 IN / 000.0°
3	MOVE TRANSDUCER SLIDER TO A KNOWN DISTANCE & OBSERVE DISPLAY	MOVE TRANSDUCER SLIDER	TRANSDUCER TEST 1= 5.00 IN / 360.0° 2= 0.00 IN / 000.0° 3= 0.00 IN / 000.0°
2	RETURN O MAIN MENU	PRESS # STOP KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTES

1. After selecting the transducer test mode, move the transducer slider and observe the display on the CT-6500 LCD.
2. If the slider is moved 1.00 inch, the CT-6500 LCD should display 1.00 inch.
3. Press the "STOP" key to return back to the main menu.

9.15 Check Cable Hookup

The following steps allow the user to check the CT-6500 contact cable connections to the circuit breaker.

Table 20.0 Checking the Cable Hookup

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. CHECK HOOKUP 3. TEST TRANSDUCER 4. NEXT PAGE
2	SELECT CHECK HOOK UP.	PRESS # 2 KEY.	MAKE SURE BREAKER IS IN CLOSE POSITION, THEN PRESS "START"
3	INITIATE TEST.	PRESS THE "START" KEY.	1 2 3 C - - - "START" to RETEST "STOP" to EXIT
4	RETURN TO MAIN MENU.	PRESS THE "STOP" KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTES

1. The CT-6500 will also print a test report with the thermal printer.
2. A contact closure is shown as "C" on the LCD and printout.
3. An open contact is shown as "-" on the LCD and printout.

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9.16 Set CT-6500 Time and Date

The CT-6500 has an internal clock with a lithium battery. The clock's time and date is displayed on the LCD screen. When a timing record is stored in the EEPROM, the time and date are also stored along with the record. To set the clock, follow the steps in Table 21.0.

Table 21.0 Set CT-6500 Time and Date

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. SET DATE & TIME 4.SET PRINT MODE
3	SELECT SET DATE & TIME.	PRESS # 3 KEY.	ENTER MM-DD-YY HH:MM:SS
4	ENTER MONTH DATE & YEAR.	PRESS KEYS 0-9.	ENTER MM-DD-YY HH:MM:SS 06/10/07
5	ENTER HOUR MINUTES & SECONDS.	PRESS KEYS 0-9.	ENTER MM-DD-YY HH:MM:SS 06/10/07 20:10:00
6	RETURN TO MAIN MENU.	NO ACTION.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTE

1. The clock battery is good for three years.
2. Loosing the clock battery will not affect the CT-6500's performance.

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9.17 Automatic Print Setting

The CT-6500 can be set to print graphs and tabulated results automatically after each timing shot. To turn on the “Auto Print Results” mode, follow the steps in Table 22.0.

Table 22.0 Automatic Print Setting

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. SET DATE & TIME 4. NEXT PAGE
3	SELECT NEXT PAGE.	PRESS #4 KEY.	1. SET PRINT MODE 2. SET 50/60 Hz
3	SELECT SET PRINT MODE.	PRESS # 1 KEY.	SET PRINT MODE 1. AUTOMATIC PRINT 2. BY REQUEST ONLY
4	SELECT “AUTOMATIC PRINT”.	PRESS # 1 KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

NOTE

Select print “BY REQUEST ONLY” to disable the “Automatic Print” mode.

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9.18 Selecting 50 Hz or 60 Hz for Contact Time Reading

Tabulated contact time is printed in both milli-seconds and cycles. The cycle readings can be in 50 Hz or 60 Hz. The example below shows the steps to set for 60 Hz readings.

Table 23.0 Selecting 50Hz or 60 Hz for Contact Time Reading

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. SET DATE & TIME 4. NEXT PAGE
3	SELECT NEXT PAGE.	PRESS #4 KEY.	1. SET PRINT MODE 2. SET 50/60 Hz
4	SELECT 50 / 60 Hz MODE.	PRESS # 2 KEY.	1. SET 50 Hz 2. SET 60 Hz
5	SELECT "60 Hz".	PRESS # 2 KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

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BREAKER TIMING RESULTS - 50 Hz					
SHOT NUMBER: 3					
DATE: 10/19/07 TIME: 07:21:07					
COMPANY: UIC					
STATION: SHOP					
CIRCUIT: 123					
MFR:					
MODEL:					
S/N:					
OPERATOR:					
TEST: OPEN					
CONTACT TIME					
CH	TIME	CYCLE	BOUNCE	WIPE	
	<ms>		<ms>	<in>	
1	21.05	1.05	0.10	0.00	
2	22.05	1.10	0.10	0.00	
3	23.05	1.15	0.05	0.00	
DELTA TIME <ms>: 2.00					
CT CHANNEL ANALYSIS					
TIME	CYCLE				
<ms>					
0.00	0.00				
TRAVEL ANALYSIS T1					
STROKE	in	0.00			
SPEED	ft/s	0.00			
OVER-TRAVEL	in	0.00			
BOUNCE BACK	in	0.00			
SPEED ANALYSIS:					
POINT 1 = 1.00 in					
POINT 2 = 5.00 in					
V1 NOMINAL VOLTAGE = 1 VOLTS					
V1 MINIMUM VOLTAGE = 0 VOLTS					
INITIATOR CURRENT = 4.8 AMPS					
SHOT LENGTH: 1 SECOND					
INSERTION RESISTOR: NO					
TRIGGER: INTERNAL					

Cycle Reading at 50

Figure 19.0 Typical 50 Hz Tabulated Report

BREAKER TIMING RESULTS - 60 Hz					
SHOT NUMBER: 3					
DATE: 10/19/07 TIME: 07:21:07					
COMPANY: UIC					
STATION: SHOP					
CIRCUIT: 123					
MFR:					
MODEL:					
S/N:					
OPERATOR:					
TEST: OPEN					
CONTACT TIME					
CH	TIME	CYCLE	BOUNCE	WIPE	
	<ms>		<ms>	<in>	
1	21.05	1.26	0.10	0.00	
2	22.05	1.32	0.10	0.00	
3	23.05	1.38	0.05	0.00	
DELTA TIME <ms>: 2.00					
CT CHANNEL ANALYSIS					
TIME	CYCLE				
<ms>					
0.00	0.00				
TRAVEL ANALYSIS T1					
STROKE	in	0.00			
SPEED	ft/s	0.00			
OVER-TRAVEL	in	0.00			
BOUNCE BACK	in	0.00			
SPEED ANALYSIS:					
POINT 1 = 1.00 in					
POINT 2 = 5.00 in					
V1 NOMINAL VOLTAGE = 1 VOLTS					
V1 MINIMUM VOLTAGE = 0 VOLTS					
INITIATOR CURRENT = 4.8 AMPS					
SHOT LENGTH: 1 SECOND					
INSERTION RESISTOR: NO					
TRIGGER: INTERNAL					

Cycle Time at 60 Hz

Figure 20.0 Typical 60 Hz Tabulated Report

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9.19 CT-6500 Channel Configuration

The CT-6500 is available with 3 or 6 or 12 contact inputs. Most common timing conditions require the user to use only 3 contact timing channels and one travel transducer channel. There is no need to print more than 3 timing channels and one transducer channel on the graphic and tabulated report. The CT-6500 will always default to 3 contact channels (channel 1, 2 and 3) and one transducer channel (transducer channel #1) when the user first turns on the unit. The user can always turn on the rest of the timing channels and transducer channels by following the steps in the table below:

Table 24.0 Channel Configuration

STEP	OPERATION	ACTION	DISPLAY
1	SELECT SET UP MENU.	PRESS # 3 KEY.	1. ANALYSIS POINT 2. MEASUREMENT UNITS 3. SAVE / RESTORE 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. SHOT DESCRIPTION 2. NUMBER OF CHANNELS 3. SET DATE & TIME 4. NEXT PAGE
3	SELECT NUMBER OF CHANNELS.	PRESS # 2 KEY.	NUMBER OF CHANNELS 1. 3 CONTACT 2. 6 CONTACT 3. 12 CONTACT
4	SELECT 3 CHANNELS OR 6 CHANNELS OR 12 CHANNELS.	PRESS # 1, OR 2 OR 3 KEY.	1. TRANSDUCER 1 2. TRANSDUCER 1 , 2 3. TRANSDUCER 1 , 2 , 3
5	SELECT 1 TRANSDUCER, OR 2, OR 3.	PRESS #1, OR #2, OR #3.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

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9.20 Print Test Record Data

Print data command allows the user to print the hexadecimal timing data collected by the CT-6500. This feature is mainly for factory testing. The CT-6500 collects 20,000 data points in the one-second timing window. As a results, each data sample is 0.05 ms apart. By looking at the time marker and the data point, the user can actually find the channel activities vs time in the timing record.

The following steps allow the user to print CT-6500 timing data from memory.

Table 25.0 Print Test Record Data

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. CHECK HOOKUP 3. TEST TRANSDUCER 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. PRINT DATA 2. ENCODER FILTER 3. CONTACT FILTER
3	SELCT PRINT DATA.	PRESS # 1 KEY.	STARTING ADDRESS?:
4	ENTER ADDRESS BOUNDARY (See note below)	PRESS KEY # 1 to 9	1. EVERY POINT 2. EVERY 5 POINTS
5	CT-6500 PRINTS DATA.	NONE.	1. EVERY POINT 2. EVERY 5 POINTS
6	RETURN TO MAIN MENU.	PRESS THE "STOP" KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

As sample of the CT-6500 timing data print out is shown in Figure 21.0.

Note

Pressing key #0 will start printing the data at address location 0 (or the first data point)

Pressing key #1 will start printing the data at address location .10000 second.

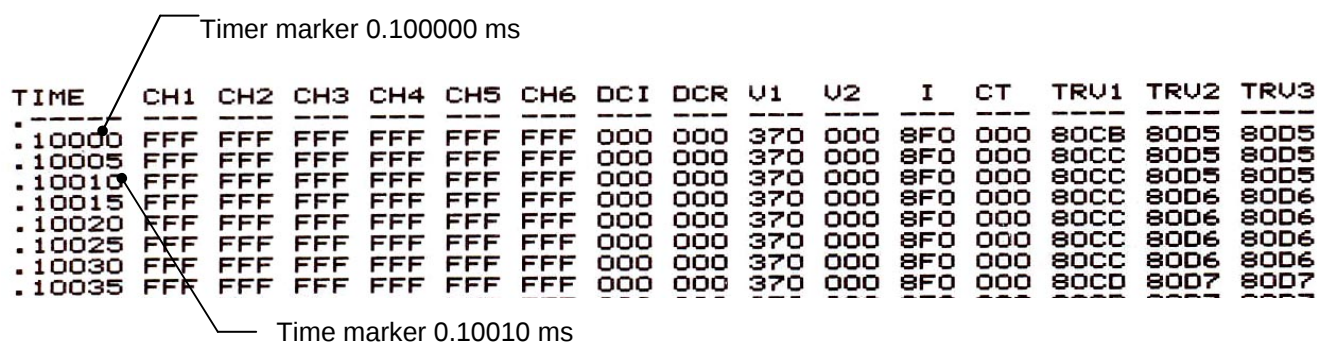


Figure 21.0 CT-6500 Timing Data

9.21 Transducer Encoder Filter Setting

In a typical 1 second timing record, the CT-6500 records 20,000 data points for each of the Contact channels (C1-C6), Digital transducer channels (D1-D3), Voltage input channels (V1 & V2), CT channel, DCR channel, Resistor transducer channel and Initiate current channel.

In most circuit breaker timing application, the breaker activities end after 200 ms. A common problem found in the field was the CT-6500 recorded erroneous data on the transducer channels (after breaker activities ended) due to vibration. The erroneous data is probably due to the transducer not being secured to the mounting plate properly or a poor linkage problem between the transducer and the circuit breaker mechanism.

The Transducer Encoder Filter setting allows the user to stop recording the transducer channel data after a specific window. This feature allows the user to filter out the unwanted motion picked up by the transducer after the breaker activities have ended.

The following procedure allows the user to stop recording transducer data after 200ms.

Table 26.0 Set Transducer Filter

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. CHECK HOOKUP 3. TEST TRANSDUCER 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. PRINT DATA 2. ENCODER FILTER 3. CONTACT FILTER
3	SELCT ENCODER FILTER.	PRESS # 2 KEY.	ENTER FILTER TIME (010 - 999)
4	END RECORDING DATA AFTER 200MS.	ENTER "2, 0, 0".	ENTER FILTER TIME (010 - 999) 200
5	SELECT FILTER SETTING.	PRESS "ENTER" KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

Note

The Transducer Encoder Filter setting is default to "No Filter" when the CT-6500 is powered on.

The filter setting is available from 10 ms to 999 ms.

A setting of 200 ms requires the user to enter 200 in the "FILTER TIME". This setting makes the CT-6500 not to record any Transducer Encoder data after 200 ms.

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9.22 Contact Filter Setting

The contact filter setting is ***applicable for timing shots with insertion resistors only***. The CT-6500 automatically detects the contact time using its own algorithm. However, manual setting for contact time calculation is made available to the user.

The filter setting of 1 allows the CT-6500 to pick up the first contact transition time after the resistor contact activity is detected. The filter setting of 300 allows the CT-6500 to pick up the last contact transition time after the resistor contact activity is detected. Use the steps below to set contact filtering.

Table 27.0 Set Contact Filter

STEP	OPERATION	ACTION	DISPLAY
1	SELECT DIAGNOSTIC.	PRESS # 4 KEY.	1. SLOW-CLOSE TEST 2. CHECK HOOKUP 3. TEST TRANSDUCER 4. NEXT PAGE
2	SELECT NEXT PAGE.	PRESS # 4 KEY.	1. PRINT DATA 2. ENCODER FILTER 3. CONTACT FILTER
3	SELCT CONTACT FILTER.	PRESS # 3 KEY.	ENTER FILTER SETTING (1 – 300) CURRENT SETTING: 1 NEW SETTING?
4	ENTER NEW FILTER SETTING. SELECT 5 SAMPLES.	PRESSSS KEY # 5	ENTER FILTER SETTING (1 – 300) CURRENT SETTING: 1 NEW SETTING? 5
5	SELECT FILTER SETTING	PRESS “ENTER” KEY.	1.RUN TEST 06/10/07 2.GET RESULTS 20:10:01 3.SETUP 4.DIAGNOSTIC

Note

The CT-6500 will return to automatic filter setting after power is cycled.

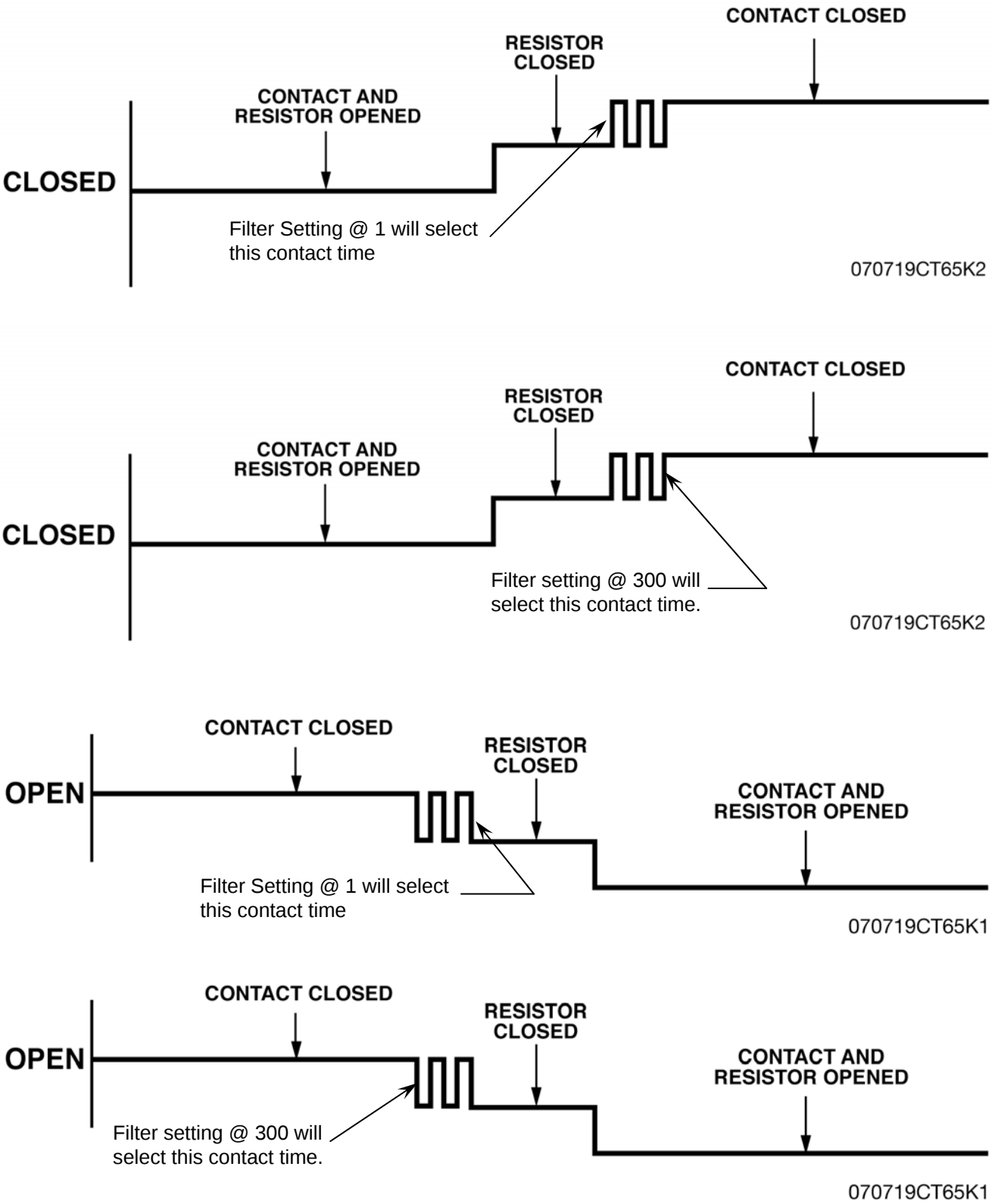


Figure 22.0 Contact Filter Setting Illustration

9.23 Running CT-6500s in Tandem

For timing application requiring more than 6 timing contact channels, the user can use two or more CT-6500s to time a circuit breaker. A typical application is to use one CT-6500-6 and one CT-6500-3 to create a 9 contact timing application. To time this circuit breaker, the user can use the following steps:

- Connect the CT-6500-6 to phase A and B of the circuit breaker.
- Connect the CT-6500-3 to phase C of the circuit breaker.
- Connect the CT-6500-6 initiate cable to the breaker control circuit. This CT-6500-6 will operate the circuit breaker.
- Connect the CT-6500-3 external trigger cable to the OPEN coil for the OPEN test and CLOSE coil for the CLOSE test. This CT-6500-3 will operate as a slave device.
- Set the CT-6500-3 to start a test using "EXTERNAL TRIGGER".
- Set the CT-6500-6 to start a test using "INTERNAL TRIGGER".
- Hold the "ARM" switch on the first CT-6500-6 to operate the circuit breaker.

The CT-6500-6 will operate the circuit breaker and start the timing sequence. The CT-6500-3 will start its timing sequence as soon as it senses the voltage applied to the breaker coil.

The timing report of the CT-6500-6 will show the contact time of phase A and B. The timing report of the CT-6500-3 shows contact time for phase C.

If the user downloads the test results of both the CT-6500s to the PC, the user then can combine the 2 test reports to generate a 9-channel test report. This report now can be printed on the PC printer.

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10.0 CT-6500 Trouble Shooting Guide

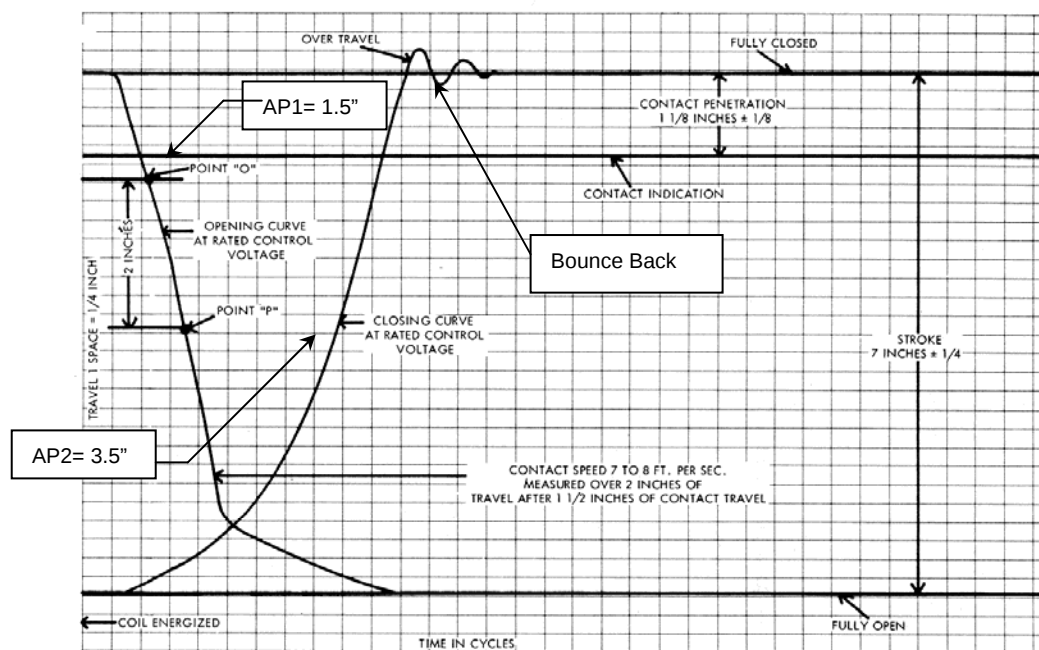
Problems	Suggestion
1. CT-6500 will not trip nor close the breaker.	- Make sure you hold the "ARM" switch down during each test. - Check the OPEN or CLOSE fuses. - Check the initiate leads. For a "Positive Trip" circuit, one Close lead and one Open lead should be connected to the Positive side of the power supply. - Check the initiate leads. For a "Negative Trip" circuit, one Close lead and one Open lead should be connected to the Negative side of the power supply.
2. Getting message "TRIGGER FAULT" "No Trigger" When using external trigger.	- Trigger voltage was not detected by the CT-6500. - Check the external trigger input to the CT-6500. - Make sure the external trigger signal is presented when the CT-6500 displays "AWAITING TRIGGER."
3. Missing timing or transducer channels on report and graphic output.	- Timing or transducer channels were not turned on. Turn on channels by going to "SETUP", "NEXT PAGE", "NUMBER OF CHANNELS".
4. No contact time (0 ms) in Trip or Close test.	- Make sure one side of the breaker is not grounded. - Make sure the breaker operates on the Open or Close test only. A dual operation OPEN-CLOSE or CLOSE-OPEN will result in 0 ms reading. - Damaged CT-6500 contact channels or bad cables. Try the "CHECK HOOK-UP" test.
5. No contact time (0 ms) in Close-Open.	- Make sure the breaker contacts complete the transition from the Open (initial state) to the Close, 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 10 ms. The CT-6500 has a 10ms de-bounce time, any contact state less than or equal to 10ms is invalid, thus the delay time is probably too slow. - Try the Close-Open using contact channel #1 option.
6. Select Open-Close test. The breaker opens and will not close.	- Delay between Open to Close is probably too small. Increase delay time.
7. No data or erratic reading on travel transducer.	- Bad transducer. Try "TEST TRANSDUCER" diagnostics. - Transducer slider is not secured to timing rod. - Transducer is not secured properly.
8. No activity on "V2" voltage input channel.	- The "V2" voltage input channel requires a voltage change from 0 V to above 30 V, to see activities on the timing chart.

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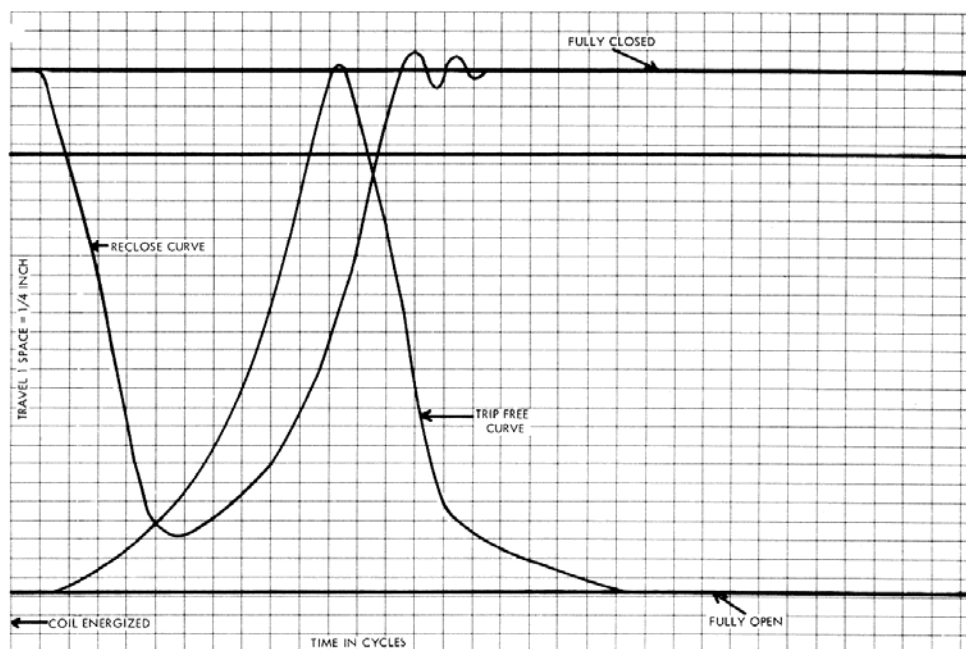
Problems	Suggestion
9. How does one review the current analysis setting?	- Go to SETUP (Press key #3). - Select Analysis (Press key #1). - Select PRINT SETTING (Press key #3). The CT-6500 will print out the current AP1 & AP2 settings.
10. The CT-6500 will not communicate with the PC.	- Make sure your PC communication port is selected correctly. - Make sure your serial or USB cable is connected properly.
11. Turn on Automatic Print Results mode.	- See section 9.17.
12. Where can one get some thermal paper?	- Call the factory at 909-923-9390 or BG Instruments at 509-893-9881. The CT-6500 uses TP-4 thermal paper. - In case of an emergency, thermal paper can be purchased at Radio Shack. Radio Shack carries 4.25 inch wide thermal paper. It is not the right size but it will work.
13. How does one darken or lighten the LCD?	- Press and hold the “↑ PAPER LCD” key will darken the LCD. - Press and hold the “↓ PAPER LCD” key will lighten the LCD.
14. How does one move thermal paper forward or backward?	- Press and release the “↑ PAPER LCD” key, the thermal paper will advance. - Press and release the “↓ PAPER LCD” key, the thermal paper will retract.

CT-6500 Series 2 Operating Instructions

APPENDIX A ITE Circuit Breaker model 14.4K Timing Chart

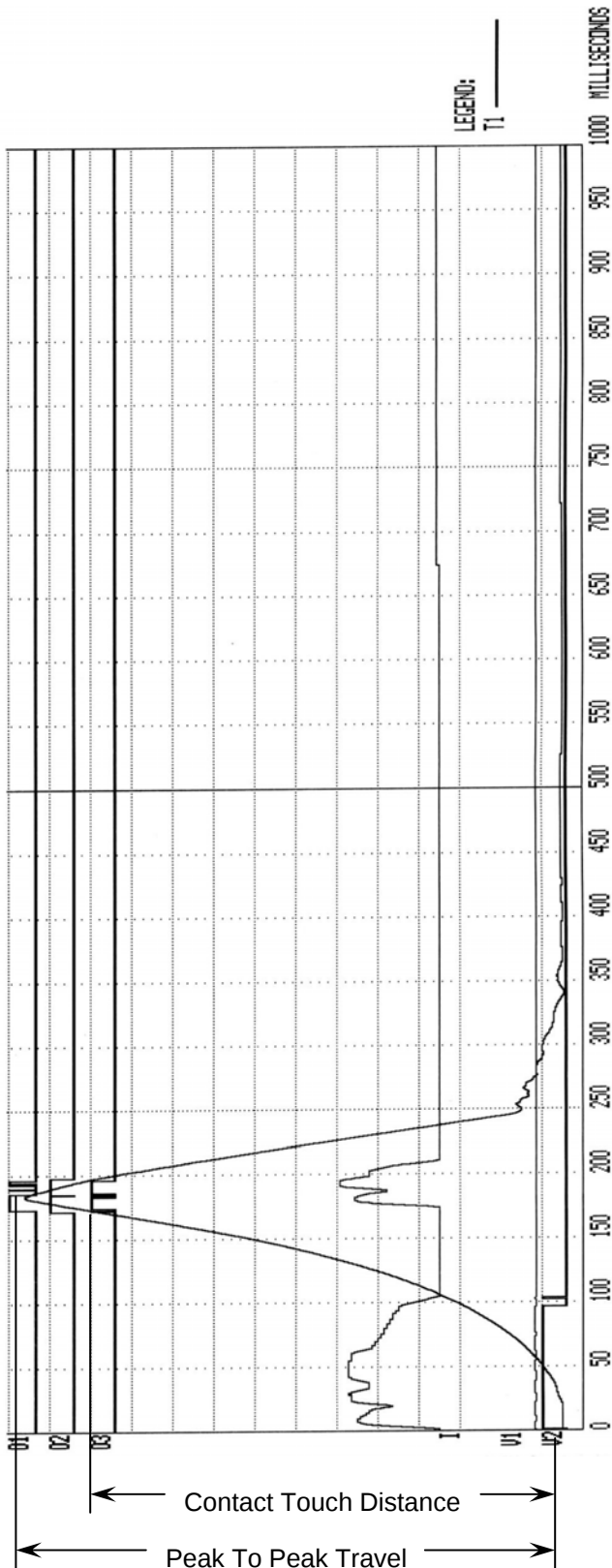


TYPICAL NO LOAD TRAVEL CURVES FOR OPENING AND CLOSING OPERATIONS
AT RATED CONTROL VOLTAGE



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

APPENDIX B CLOSE-OPEN Timing Chart for ITE Circuit Breaker Model 14.4K

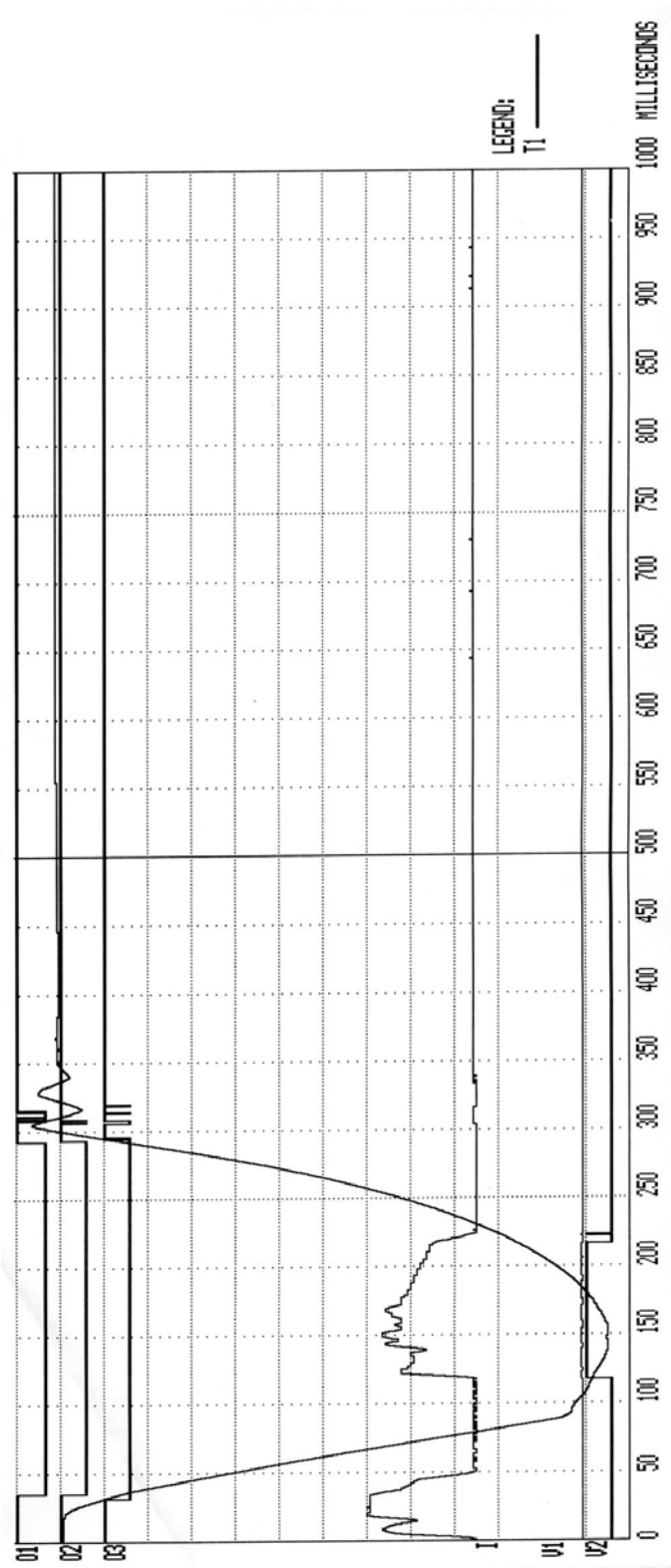


CT-6500 Series 2 Operating Instructions

APPENDIX C CLOSE-OPEN Tabulated Report for ITE Circuit Breaker Model 14.4K

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	000.30
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			
U1 NOMINAL VOLTAGE = 48 VOLTS			
U1 MINIMUM VOLTAGE = 45 VOLTS			
INITIATOR CURRENT = 05.6 AMPS			
SHOT LENGTH: 1 SECOND			
INSERTION RESISTOR: NO			
TRIGGER: INTERNAL			
DELAY: CLOSE CH #1			

APPENDIX D OPEN-CLOSE Timing Chart for ITE Circuit Breaker Model 14.4K



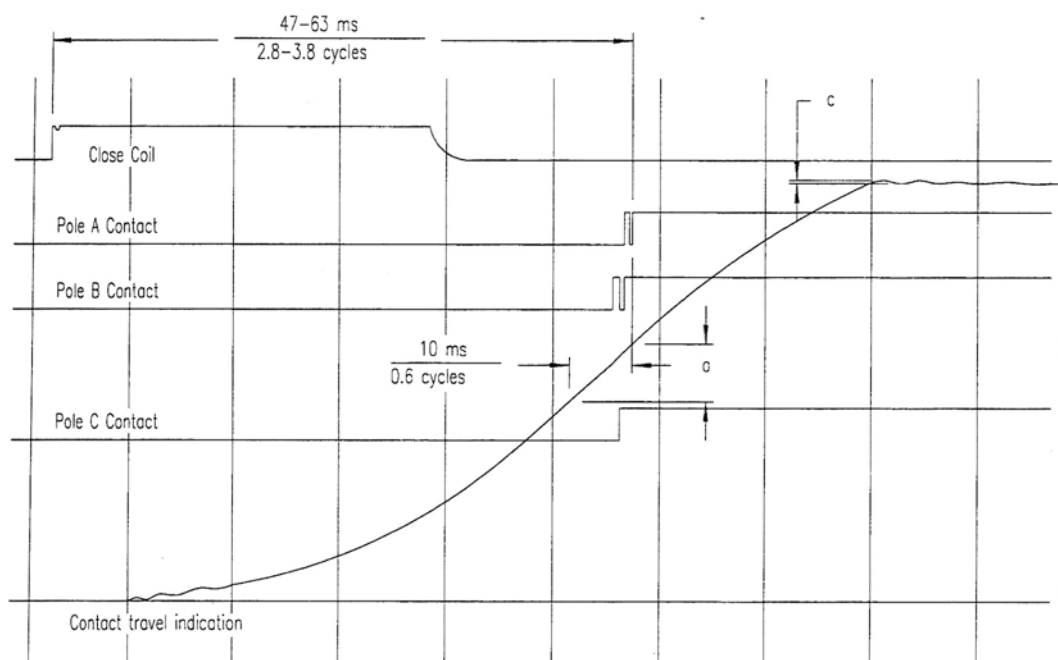
CT-6500 Series 2 Operating Instructions

APPENDIX E OPEN-CLOSE Tabulated Report for ITE Circuit Breaker Model 14.4K

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	001.00
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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APPENDIX F SIEMENS TCP Breaker Velocity Calculation



Example of Close Operation Record

Calculation For Contact Closing Velocity

$$V = 12.0a/b \text{ meters/second}$$

Calculation For Overtravel/rebound

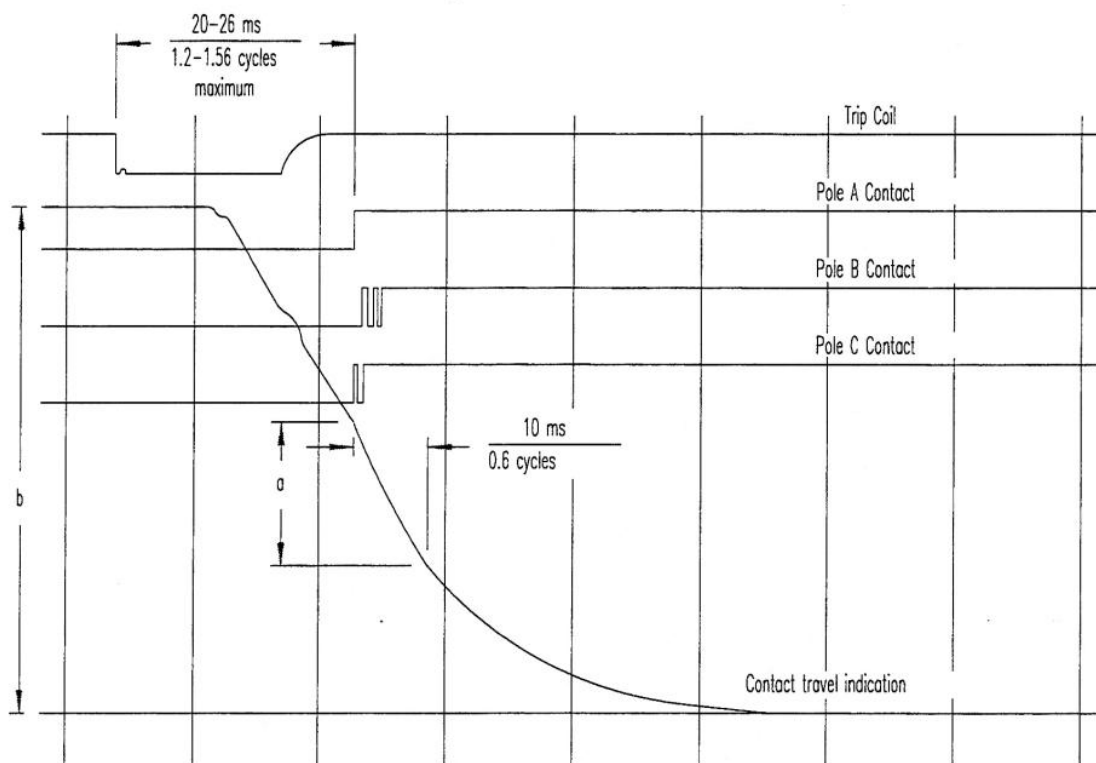
$$S = 120.0c/b \text{ millimeters}$$

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

Contact Stroke = 120 mm
Transducer Stroke = 80 mm

CT-6500 Series 2 Operating Instructions

APPENDIX G SIEMENS SPS2 Breaker Velocity Calculation



Example of Opening Operation Record

Calculation For Contact Opening Velocity

$$V=12.0a/b \text{ meter/second}$$

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

Contact Stroke = 120mm
Transducer Stroke = 80 mm

CT-6500 Series 2 Operating Instructions

APPENDIX H CT-6500 SIEMENS SPS2 Test Plan

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	VEL	O-TUL	BNC-BK	
	mm	M/S	mm	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 LD	074.9	03.50	000.0	000.0	
VEL = Cx[OIST(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					

CT-6500 Series 2 Operating Instructions

APPENDIX I CT-6500 Transducer Illustration



Linear Transducer on an OCB



Rotary Transducer on Alstom HE 1014 Circuit Breaker



Rotary Transducer on ABB HMB Mechanism



Rotary transducer on Federal Pacific Circuit Breaker



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