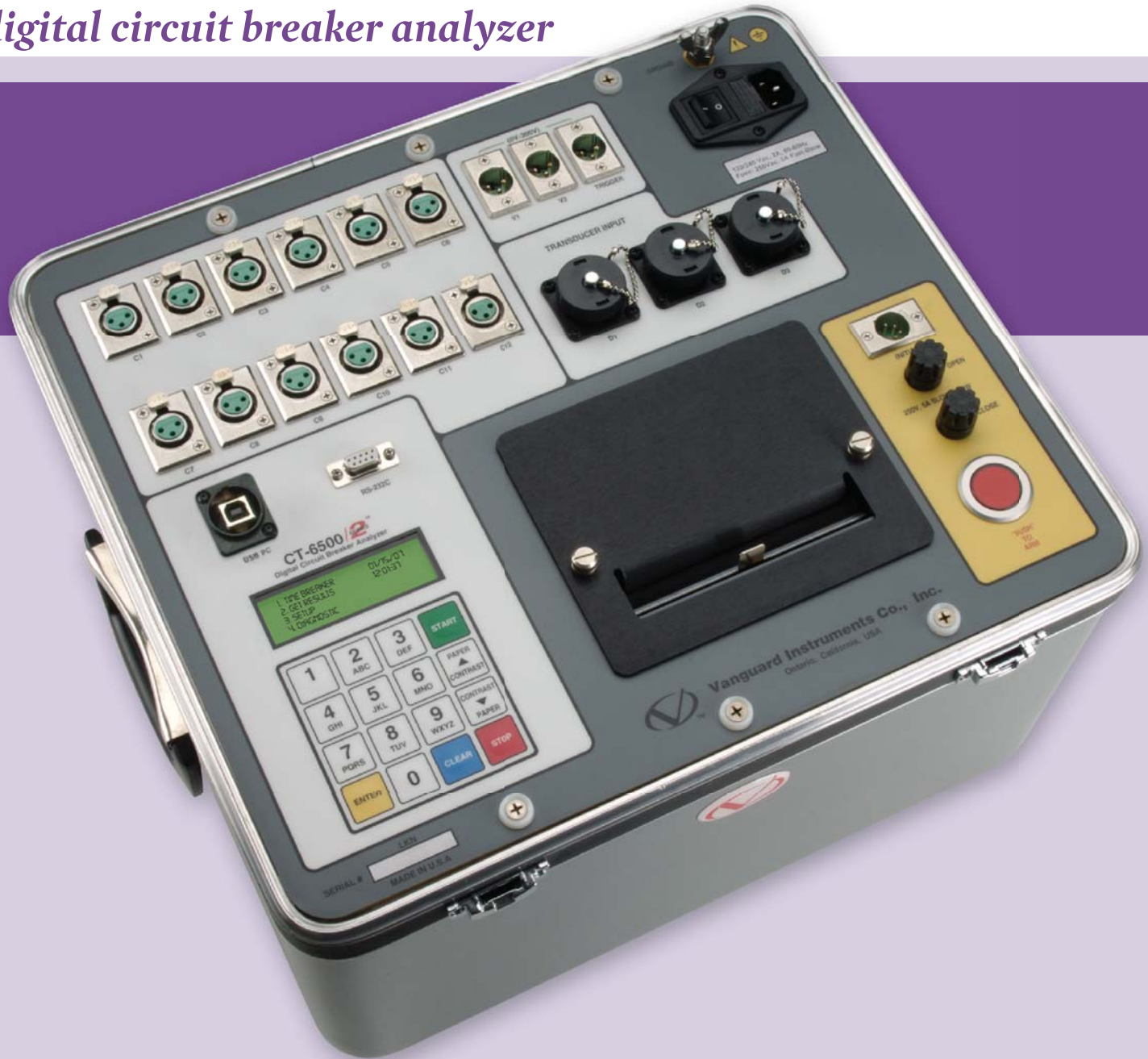


# CT-6500 S2

*digital circuit breaker analyzer*



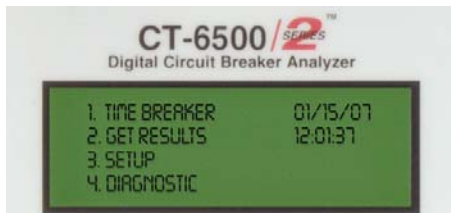
**Vanguard Instruments Company, Inc.**  
[www.vanguard-instruments.com](http://www.vanguard-instruments.com)



# CT-6500 S2

## digital circuit breaker analyzer

The CT-6500 S2 is an inexpensive, easy to use, stand-alone, microprocessor-driven EHV circuit-breaker analyzer. The CT-6500 S2 is available in models with either 3 (CT-6500-3 S2), 6 (CT-6500-6 S2), or 12 (CT-6500-12 S2) dry-contact inputs. The CT-6500 S2 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 circuit breaker operations (Open, Close, Open - Close, Close - Open, and Open - Close - Open). The CT-6500 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.



### outstanding features

- Prints breaker analysis results in both tabular and graphic formats
- Built-in 4.5" wide thermal printer
- Initiate breaker operation
- Digital travel transducer requires no setup or calibration
- Detects main contact and insertion contact on the same input channel
- Stores up to 200 test records
- RS-232C and USB computer interfaces
- Diagnostic capabilities

### 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.

### "Slow-Close" Test

The "slow-close" test feature is a very useful tool for accurately measuring contact-travel during circuit maintenance, especially when the circuit-breaker contact motion is slowly jacked through the stroke by manual operation. A table of the "slow-close" test results can be printed on the built-in thermal printer.

### Internal Test Record and Test Plan Storage

The CT-6500 S2 can store up to 200 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.

### Diagnostic Capabilities

The CT-6500 S2 can perform diagnostics on its internal electronics. Diagnostics can be performed to verify contact cable connections and to test the travel transducer's electronics.

## ordering information

Part number **CT-6500-3 S2**  
 Part number **CT-6500-6 S2**  
 Part number **CT-6500-12 S2**  
 Part number **CT-6500-CASE**  
 Part number **Paper-TP4**

CT-6500 S2 with 3 contact channels, cables, and PC software  
 CT-6500 S2 with 6 contact channels, cables, and PC software  
 CT-6500 S2 with 12 contact channels, cables, and PC software  
 CT-6500 S2 shipping case  
 Thermal printer paper

# CT-6500 S2 Controls & Indicators



## 1 Conventional Time Travel Analysis Mode

The CT-6500 S2 is available in models with either 3 (CT-6500-3 S2), 6 (CT-6500-6 S2), or 12 (CT-6500-12 S2) dry-contact inputs. Each contact input channel can detect main contact and insertion-resistor contact times in milli-seconds and cycles.

## 2 Voltage Monitoring Inputs

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

## 3 Built-in Thermal Printer

The CT-6500 S2's built-in 4.5-inch wide thermal printer can print the breaker contact analysis results in both tabular and graphic formats.

## 4 Breaker Stroke and Velocity

Three digital travel transducer channels are available on the CT-6500 S2 for measuring circuit-breaker velocity, stroke, over-travel, and bounceback. Unlike other transducer types, the digital transducer requires neither calibration nor setup.

## 5 User Interface

The CT-6500 S2 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.

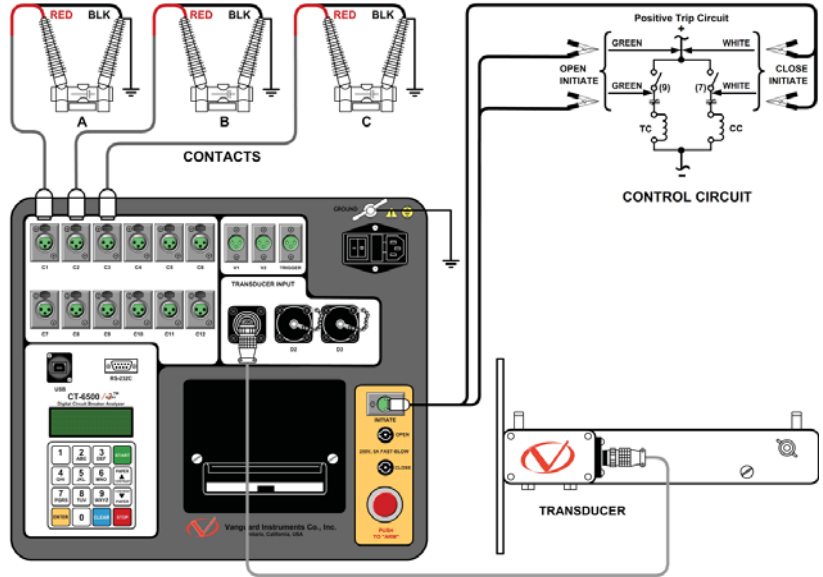
## 6 Computer Interface

The CT-6500 S2 can be computer-controlled via its RS-232C or USB interface. A Windows® XP/Vista/7-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-6500 S2 and then stored on the PC for future analysis and report generation. Additionally, test records can be exported in Excel, PDF, and XML formats for further analysis.

## 7 Breaker Initiate Features

A built-in solid-state initiate device is used to operate a breaker from the CT-6500 S2. 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.

# CT-6500 S2 connections



# CT-6500 S2 desktop printer output

Desktop printout of tabulated test results



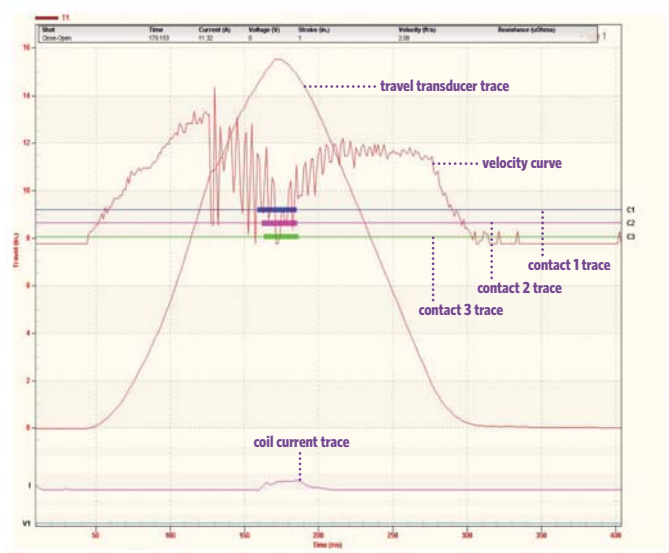
Filename: Close-Open.dat      Date/Time: 01/10/12 15:31:43  
 Company: ITC Midwest      Manufacturer: General Electric  
 Station: Orlutwa Generation      SN: 0138A7230-203  
 Circuit: BKR 878      Operator: John Van Wardhuizen  
 Model: GE FK 169 31500 5      Test: CLOSE-OPEN

CONTACT (CLOSE)				CONTACT (OPEN)			
CHA	PfF Time(ms)	Cycle	Bounce(ms)	CHA	PfF Time(ms)	Cycle	Bounce(ms)
1	158.750	9.52	2.70	1	185.150	11.11	1.05
2	161.950	9.72	2.20	2	185.500	11.13	0.25
3	163.050	9.78	2.45	3	186.450	11.19	0.10
4	0.000	0.00	0.00	4	0.000	0.00	0.00
5	0.000	0.00	0.00	5	0.000	0.00	0.00
6	0.000	0.00	0.00	6	0.000	0.00	0.00

Delta Time(ms): 4.300      Delta Time(ms): 1.300

Travel Analysis	T1	T2	T3
Peak To Peak (in.)	15.565	0.000	0.000
Initiator Current: 11.644 A		V1 Nominal: 1V	V1 Min: 0V
Shot Length: 1 SEC			
Insertion Resistor: None			
Delay: CONTACT #1			
Trigger: Internal			

Desktop printout of graphic test results



# CT-6500 S2 thermal printer output

Thermal printout of tabulated test results

BREAKER TIMING RESULTS - 60 Hz

SHOT NUMBER: 5  
 DATE: 04/03/12      TIME: 09:28:49

COMPANY: VANGUARD INSTRUMENTS  
 STATION: MIRA  
 CIRCUIT: 220KV  
 RFR: HITSUBISHI  
 MODEL: 200 SFRT 63F  
 S-14 OPERATOR: SPK

TEST: CLOSE - OPEN

CONTACT CLOSE TIME			
CH	TIME <ms>	CYCLES	BOUNCE <ms>
1	69.65	5.32	2.10
2	69.05	5.32	1.50
3	69.00	5.34	1.95

CONTACT OPEN TIME			
CH	TIME <ms>	CYCLES	BOUNCE <ms>
1	125.30	7.52	0.05
2	125.48	7.51	0.05
3	125.40	7.52	0.05

CONTACT LIVE TIME	
CH	TIME CYCLES
1	36.68 2.18
2	36.40 2.18
3	36.40 2.18

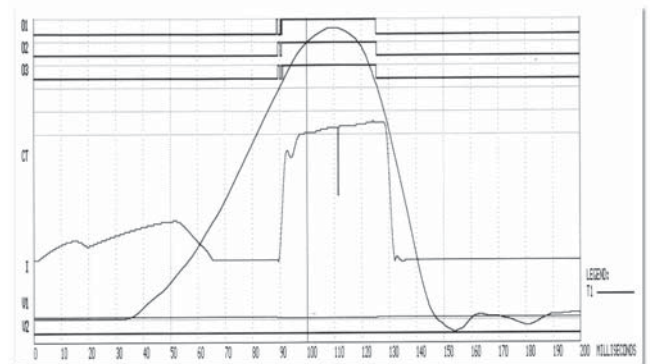
PEAK TO PEAK TRAVEL <mm>  
 T1 215.6

CH1 TOUCH DISTANCE <mm>  
 159.0

U1 NOMINAL VOLTAGE = 1 VOLTS  
 U1 MINIMUM VOLTAGE = 0 VOLTS  
 INITIATOR CURRENT = 13.3 AMP

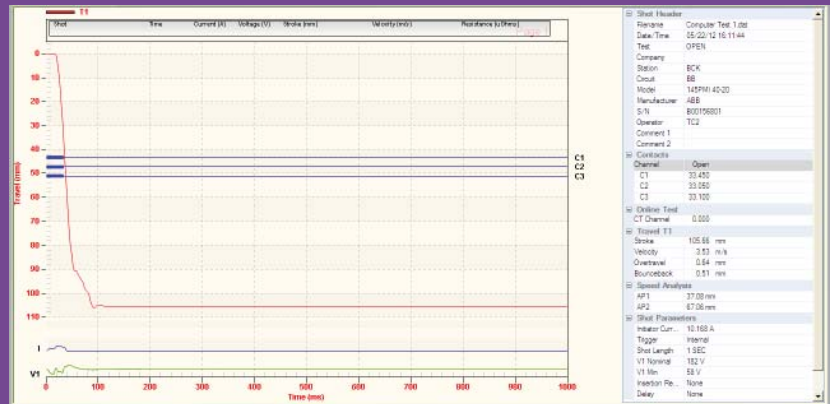
SHOT LENGTH: 1 SECOND  
 INSERTION RESISTOR: NO  
 TRIGGER: INTERNAL  
 DELAY: CLOSE CH #1

Thermal printout of graphic test results



# Computer control and analysis with included VCBA S2 Software

The CT-6500 S2 comes with the Vanguard Circuit Breaker Analysis Series 2 (VCBA S2) PC software. The VCBA S2 software can be used to retrieve timing records from the CT-6500 S2, analyze retrieved records, view test results in graphic format, generate timing reports, and control the CT-6500 S2 from the PC to perform timing tests. The software can also be used to print test results to a desktop printer.



## CT-6500 S2 specifications

<b>type</b>	portable digital circuit-breaker analyzer
<b>physical specifications</b>	16"W x 11"H x 14" D (40.6 cm x 29.9 cm x 35.6 cm); Weight: less than 25 lbs (11.3 kg)
<b>input power</b>	100 – 240 Vac, 50/60 Hz
<b>dry-contact inputs</b>	3, 6, or 12 dry-input channels (depending on model). Each channel detects main and insertion resistor contacts
<b>timing windows</b>	1 second, 10 seconds, or 20 seconds
<b>timing resolutions</b>	±50 micro-seconds @ 1 sec. duration, ±500 micro-seconds @ 10 sec. duration, ±1.0 milli-seconds @ 20 sec. duration
<b>timing accuracy</b>	0.05% of reading ±0.05 ms @ 1 second duration
<b>dry-contact channel protection</b>	all contact inputs are grounded until test; input channels are protected against static discharge
<b>dry-contact detection range</b>	closed: less than 20 ohms; open: greater than 5,000 ohms
<b>resistor detection range</b>	50 – 5,000 ohms
<b>ct current sensor</b>	one, non-contact, 0 – 100 amperes
<b>trigger input voltage</b>	open/close: 30 – 300 V, DC or peak AC
<b>voltage sensing input range</b>	V1: analog input; 0 – 255 V DC or peak AC; sensitivity ±1 V V2: voltage presence/absence detector input; 30 – 300 V DC or peak AC
<b>breaker operations</b>	Initiate Open, Close, Open-Close, Close-Open, Open-Close-Open
<b>breaker initiate capacity</b>	30A, 250 Vac/dc max
<b>initiate current reading range</b>	one, non-contact, Hall-effect sensor, 0 – 20 amp range, dc to 5 KHz
<b>digital travel transducer inputs</b>	3 digital travel transducer channels; linear range: 0.0 – 60.0 in (±0.01 in) rotary range: 0 – 360 degrees (±0.36 degrees)
<b>contact travel point difference</b>	measures "slow-close" contact-point distances; results can be printed
<b>display</b>	back-lit LCD screen (20 characters by 4 lines); viewable in bright sunlight and low light
<b>printer</b>	built-in 4½" wide thermal printer that can print both graphic contact travel waveforms and tabulated test results
<b>internal test record storage</b>	stores up to 200 test records
<b>computer interfaces</b>	one RS-232C port, one USB port
<b>pc software</b>	Windows® based Breaker Analysis software included with purchase price
<b>safety</b>	designed to meet UL 6101A-1 and CAN/CSA C22.2 No 1010.1-92 standards
<b>environment</b>	Operating: -10°C to +50°C (+15°F to +122°F); Storage: -30°C to +70°C (-22°F to +158°F)
<b>humidity</b>	90% RH @ 40°C (104°F) non-condensing
<b>altitude</b>	2,000 m (6,562 ft) to full safety specifications
<b>options</b>	transportation case (available for the CT-7500 S2 and travel transducers)
<b>warranty</b>	one year on parts and labor

**NOTE :** the above specifications are valid at nominal voltage and ambient temperature of +25°C (+77°F). Specifications are subject to change without notice.

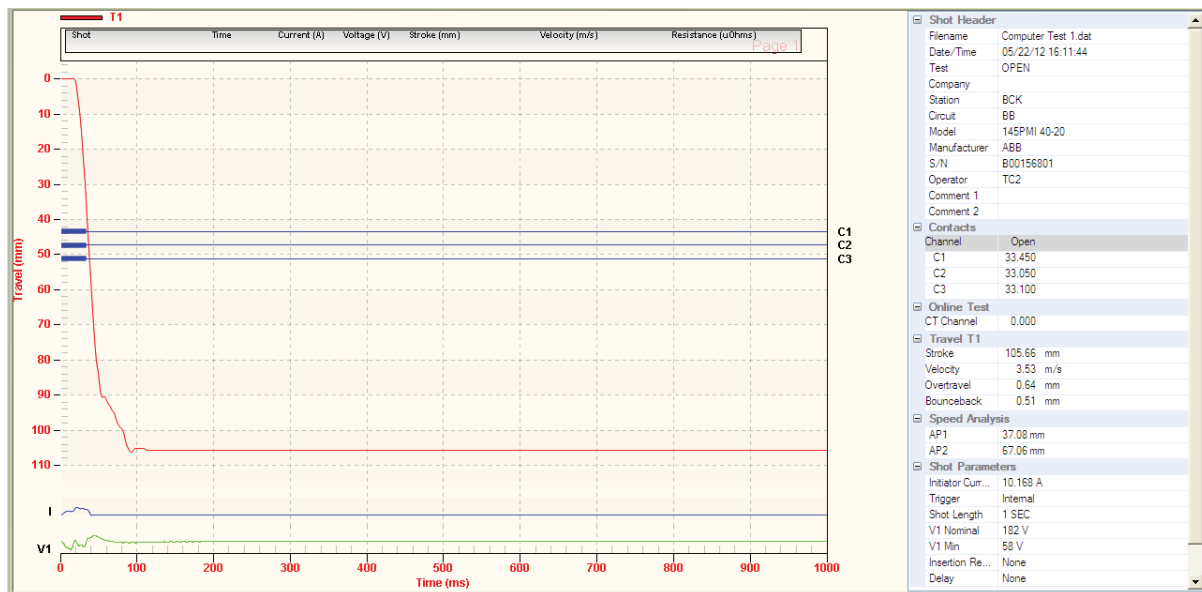
# VCBA S2

## Vanguard circuit breaker analyzer software

The Vanguard Circuit Breaker Analyzer Series 2 (VCBA S2) Windows®-based software is included with all compatible Vanguard Circuit Breaker Analyzers (CT-6500 S2, CT-7000 S2, CT-7500 S2, CT-8000, DigiTMR S2, DigiTMR S2 PC) at no additional cost. This robust application can be used to control the circuit breaker analyzer from a PC to perform CB timing tests. It can also be used to retrieve test records from the circuit breaker analyzer, analyze timing records, and view test results in tabulated and graphical format. Circuit breaker test plans can also be created and transferred to the circuit breaker analyzer.

### Retrieving and Analyzing Test Records

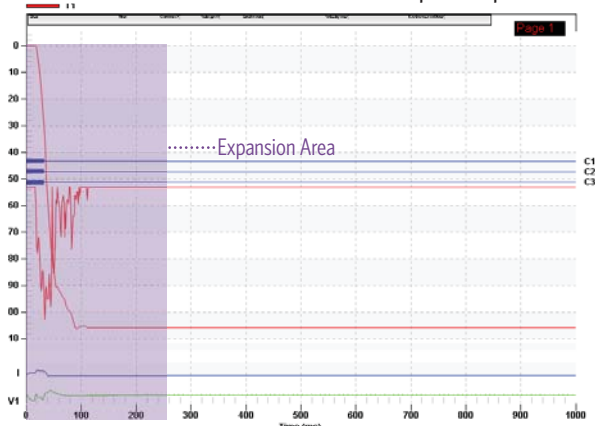
The VCBA S2 software can be used to quickly retrieve test records from a compatible Vanguard circuit breaker analyzer. Test results can be viewed in tabular and graphical format and can be saved on the PC hard drive. Test record header information, such as the company name, station, circuit, operator name, manufacturer, model, and serial number can also be edited.



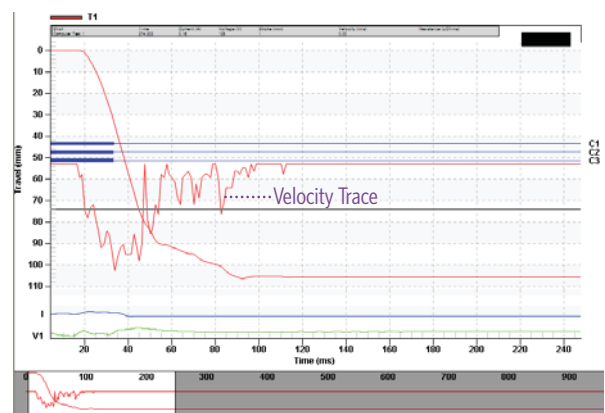
Sample Test Results (OPEN Test)

### Getting a Closer View with Graph Expansions

The VCBA S2 software can be used to expand a portion of the graphical test results for more accurate analysis.



Graphical Test Results



Graphical Test Results Expansion (from 0 to 200ms)

## Timing a Circuit Breaker with the VCBA S2 Software

The VCBA-S2 software can be used to control a CB analyzer and run circuit breaker timing tests. The following tests are supported: OPEN, CLOSE, OPEN-CLOSE, CLOSE-OPEN, OPEN-CLOSE-OPEN, and STATIC RESISTANCE. Also, a test plan for a specific breaker can be used with the test. If a test plan is used, the Pass/Fail indicator will be displayed based on the settings in the test plan.

The screenshot shows the 'Time Breaker' software window. It is divided into several sections:

- File Information:** Test Plan: c:\Vanguard\VCBA-S2\TestPlan\default.set; Save To: C:\Vanguard\VCBA-S2\Shots for Catalog; Filename: Shot. There are checkboxes for 'Add Date' and 'Add '001' to ensure uniqueness'.
- Shot Type:** Radio buttons for 'Open', 'Close', 'Open - Close', 'Close - Open', 'Open - Close - Open', and 'Static Resistance'. A dropdown menu for 'Close - Open' is set to 'Contact #1 Closed'. There are input fields for 'Delay between Open-Close' and 'Delay between Close-Open', both set to 10.
- Timing Window:** Radio buttons for '1 Second', '10 Second', and '20 Second'. '1 Second' is selected.
- Trigger Type:** Radio buttons for 'Internal' and 'External'. 'Internal' is selected.
- Insertion Resistor:** Radio buttons for 'None', '< 1000 ohms', '1000 - 2000 ohms', and '> 2000 ohms'. 'None' is selected. There is a checkbox for 'Dynamic Resistance' which is unchecked.

Buttons at the bottom include 'Resend Shot', 'OK', and 'Cancel'.

Breaker Testing Parameters

## Creating Test Plans for Faster Testing

A circuit breaker test plan is comprised of all circuit-breaker performance specifications (stroke, velocity, and contact time). A test plan can be used to test a circuit breaker. When used with a test record, a Pass/Fail report is generated by comparing the actual performance of the breaker with the specifications in the stored test plan. Test plans can be easily created with the VCBA-S2 software and can be stored on the hard drive or transferred to a CB analyzer.

The screenshot shows the 'Shot Information' and 'Contact Analysis' sections of the software:

- Shot Information:** Fields for Company, Station, Circuit, Manufacturer, Model, Serial Number, Operator, Comment #1, and Comment #2.
- File Information:** A section for file details.
- Contact Analysis:** A table of timing parameters in milliseconds (ms):

	Open (ms)	Close (ms)	C-O (LIVE) (ms)	Q-C (DEAD) (ms)
Contact Low:	0.0	0.0	0.0	0.0
Contact High:	0.0	0.0	0.0	0.0
Contact Delta:	0.0	0.0		
Resistor On Low:	0.0	0.0	0.0	0.0
Resistor On High:	0.0	0.0	0.0	0.0
Resistor On Delta:	0.0	0.0		
- Travel Analysis:** Fields for 'Open' and 'Close' analysis points (Stroke Low/High, Velocity Low/High, Overtravel Low/High, Bounce Back Low/High) in inches (in.) and feet per second (ft/s). It also includes 'Open Analysis Point' and 'Close Analysis Point' settings for Point #1 and Point #2, both set to '% of Stroke' with values of 25% and 50% respectively. A 'Measure Unit' dropdown is set to 'English' and 'Manual Override' is set to 'Disabled'. There is a checkbox for 'Enable Rotary Encoder' and a field for '0.000 in./deg'.

Creating a Test Plan



## Instruments designed and developed by the hearts and minds of utility electricians around the world

Vanguard Instruments Company, (VIC), was founded in 1991. Currently, our 28,000 square-foot facility houses Administration, Design & Engineering, and Manufacturing operations. From its inception, VIC's vision was, and is to develop and manufacture innovative test equipment for use in testing substation EHV circuit breakers and other electrical apparatus.

The first VIC product was a computerized circuitbreaker analyzer, which was a resounding success. It became the forerunner of an entire series of circuitbreaker test equipment. Since its beginning, VIC's product line has expanded to include microcomputer-based, precision micro-ohmmeters, single and three phase transformer winding turns-ratio testers, transformer winding-resistance meters, mega-ohm resistance meters, and a variety of other electrical utility maintenance support products.

VIC's performance-oriented products are well suited for the utility industry. They are rugged, reliable, accurate, user friendly, and most are computer controlled. Computer control, with innovative programming, provides many automated testing functions. VIC's instruments eliminate tedious and time-consuming operations, while providing fast, complex, test-result calculations. Errors are reduced and the need to memorize long sequences of procedural steps is eliminated. Every VIC instrument is competitively priced and is covered by a liberal warranty.



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