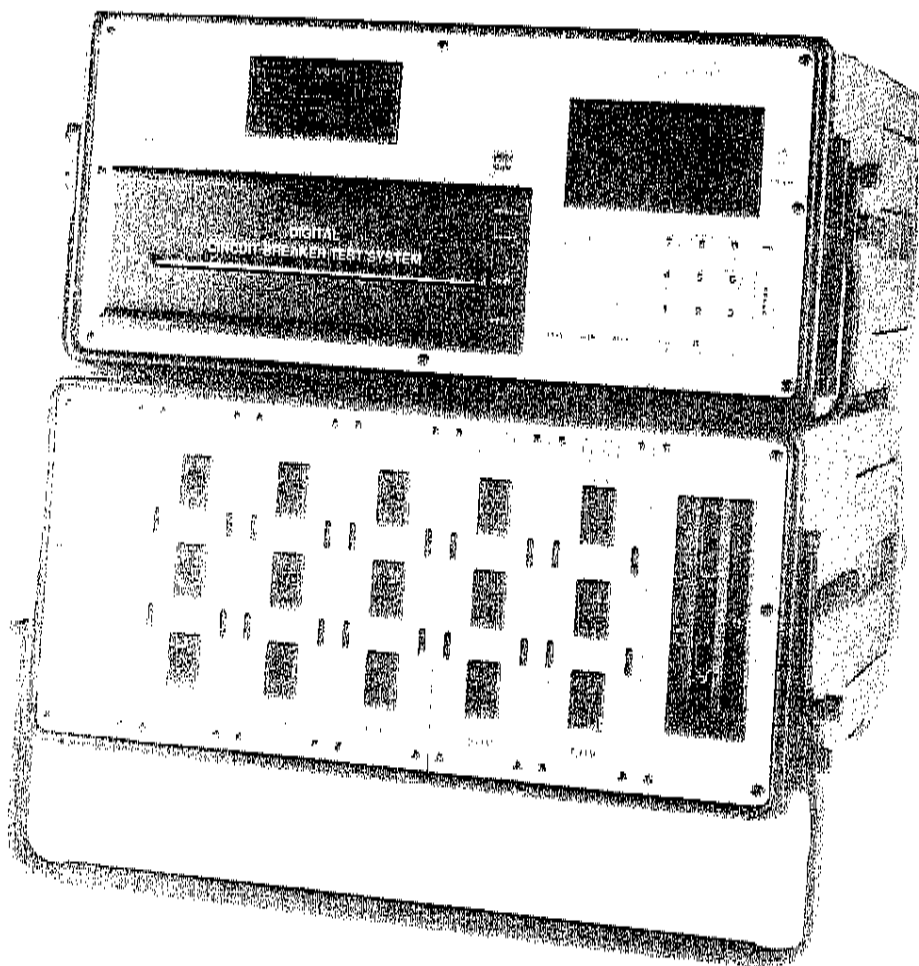


doyle

TR-3000

DIGITAL CIRCUIT BREAKER TEST SYSTEM



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The TR3000 Digital Circuit Breaker Test System is modular and includes two Instruments — the TR3100 Master and the TR3300 Slave. The TR3100 is a stand-alone Instrument specifically designed for testing dead-tank circuit breakers. For testing multi-module live tank breakers, a TR3300 Slave is interfaced to the TR3100 Master using a high speed optical modem via the RS422 fiber-optic Communications Interface. Complete, automated breaker testing, and test data archiving is possible by adding the TR3200 Automation Option to any TR System.

Operate the System manually, or automate operation by adding the TR3200 Automation Option. You'll save time, test to specifications, and develop a breaker performance data base automatically.

TEST FUNCTIONS

- Timing
 - main contacts
 - resistor switches
 - wet/dry auxiliary contacts
- Travel and velocity measurements
 - rotary and linear motion —
- Measuring insertion resistor values
- Measuring grading capacitor values
- Waveforms
 - main contact operation/bounces
 - resistor switch operation/bounces
 - trip/close command currents
 - auxiliary contact operation
 - auxiliary currents
 - auxiliary voltages

The TR3000 System is menu-driven for both manual and automated operation. A hierarchical array of menus is organized for:

- **Defining** breaker command parameters and all tests.
- **Entering Specifications** against which actual performance is compared, and **Pass/Fail qualification** determined.
- **Specifying Breaker Description**, location, and identifying which channels are used to ensure a complete test record.
- **Running a Test**; printing tabulated results.
- **Controlling the Plotter** for **zoom graphics**.
- **Controlling** all TR3200 **automated** functions.

MANUAL OPERATION

When testing manually, each test is defined and run individually.

- **Operate** the breaker *once* for each test
 - Test results are automatically stored in the internal microcomputer
- **Preview** the test results on the L.C.D. screen to verify proper breaker operation
- **Print** tabular results
- **Zoom Plot** the dynamic performance of contact operation, mechanical motion and velocity, auxiliary contacts/currents/voltages

AUTOMATION

When using automation, the complete breaker Test Plan is stored on a floppy disk. This includes command parameters for all tests, performance specifications, breaker identification, plus all test results insuring a complete record of a field test session.

- **Select** a test from the Test Plan
- **Operate** the breaker *once*
- **Preview** the test results on the L.C.D. display
- **Print** the tabulation including **PASS/FAIL qualification** for all tests

Test results are automatically stored on the floppy disk, and compared against specifications for all mechanical measurements and contact performance tests providing immediate **Pass/Fail qualification**. This important feature minimizes the level of expertise to properly test breakers, since "expert" analysis of graphical results is eliminated. Zoom Graphic plots are always available for analyzing performance when breaker operation is abnormal.

The Breaker Library and Test Data Base are additional TR3200 Automation Option functions. The "Library" concept evolves from the principle that each breaker "type" has a unique set of command parameters and functional specifications. Since one breaker "type" may be used in many locations, standardizing the test procedure and result analysis for each "type" insures testing compatibility throughout the power system and a dependable breaker Test Data Base.

Using the TRX™, MS DOS computer program, a Test Plan for every generic "type" of breaker may be generated and stored for later use on a "Breaker Library" disk. Test Plans include all command parameters, tests, and specifications specific to *one breaker type/model* produced by a manufacturer. Approximately 100 breaker Test Plans may be stored on one Breaker Library disk. To run tests in the field, plug the Library disk into one disk drive; scroll through the Breaker Library main menu and select the breaker. Then, by entering Breaker Identification Information from the nameplate and substation drawing and running the tests, the test results become uniquely identified with *that particular* circuit breaker. Test results for *that particular* breaker are automatically stored on a floppy disk in the second disk drive. For easy retrieval, test results are stored on one floppy disk for each breaker.

The test results are processed immediately after each test is run, and are then available for printing the test result tabulation, and plotting graphics.

TEST RESULT TABULATION

Electrical measurement results and specifications:

Main contact: opening/closing <i>time</i>	Trip/Close: command currents
Δ <i>time</i> within each module	Trip/Close/Delay: command duration
Δ <i>time</i> for each phase	Insertion resistor value (ohms)
Δ <i>time</i> for the breaker	Grading capacitor value (pF)
Resistor Switch: opening/closing <i>time</i>	Auxiliary contact opening/closing time
Δ <i>time</i> within each module	Auxiliary current peak amplitudes
Δ <i>time</i> for each phase	
Δ <i>time</i> for the breaker	

Mechanical measurement results and specifications:

Total travel	Instantaneous Velocity
Overtravel	Average Velocity, Zone 1; Trip/Close
Rebound	Average Velocity, Zone 2; Trip/Close
Contact wipe	

USING TR3000 AUTOMATION YOU'LL ACHIEVE:

- Consistent performance analysis with standardized test plans.
- PASS/FAIL Qualification by comparison to specification.
- Comprehensive data base with automatic test storage.
- Faster setup and testing for shorter breaker outages.

ZOOM GRAPHICS

After a test is RUN, a full 1600 mS graphic plot displaying all channels is available for review. Using **Zoom Graphics** for more detailed analysis, select any portion of the plot by identifying the beginning and ending time, and Zoom Resolution. Then select the channels of interest. The TR will calculate plot length for you. The high resolution thermal plotter clearly displays up to 100 μ S intervals, and identifies all channels for a clear picture of breaker dynamic performance.

SPECIFICATIONS

TR3100 MASTER INSTRUMENT

The TR3100 includes Doble's field-proven 80186 microcomputer and 256K R.A.M., and a full alphanumeric membrane keyboard. A 256 x 128 dot supertwist L.C.D. display with adjustable backlighting is included for high visibility in direct sunlight or office environments. Multi-level menus define Instrument operation including all tests and trip/close test parameters. A high resolution plotter prints tabulations, and Zoom Graphic plots with all measurement channels identified for a complete test record on 8" thermal paper. No external computer is required so the TR3000 is safe for use in noisy electrical environments up to 765 kV.

The Master Instrument includes solid-state trip/close control for accurate timing and reliable operation. Trip and close currents are measured and their waveforms plotted so the relationships between breaker control currents and breaker timing can be determined. An RS232 port is available for connection with an external Modem for communicating test results to your office data base. The Instrument may be used manually, or with the optional Automation Package which includes dual floppy disk drives for automating Instrument operation, and storing test results.

Used as a stand-alone Instrument, the TR3100 is designed to test dead-tank/O.C.B. breakers, when equipped with suitable measurement options. For testing multi-module live tank/E.H.V. breakers, a TR3300 Slave is interfaced to the MASTER using a high speed optical modem via the RS422 fiber-optic communications interface. Dead tank/O.C.B. measuring options are not required in the MASTER for the TR3100/TR3300 configuration.

The TR3100 Master may optionally be equipped with:	Analog and Digital Channels
1 — TR3200 Automation Option	
1 — TR3110/3120 Three Phase Contact Measurement Module	3
1 — TR3130 Auxiliary Contact Monitor	6
1 — TR3140 Auxiliary Current Monitor	3
1 — TR3145 Auxiliary Voltage Monitor	3
1 — TR3150 Motion Transducer Receiver, interfacing one, two or three TR3160 Digital Transducers	6
Breaker Trip and Close Commands and Command Current waveforms are graphically plotted	<u>4</u>
	Total 25 Channels

TR3100 COMMAND/CONTROL

COMMAND SEQUENCES:

TRIP
CLOSE
TRIP FREE; Contact #1 make
TRIP FREE & Delay
TRIP FREE - Standing
RECLOSE & DELAY
RECLOSE - STANDING
O-C-O; Contact #1 make
O-C-O & Delay
O-C-O - Standing

COMMANDS

TRIP/CLOSE: 10 μ s 1600 mS/10 μ s 96 cycles
Resolution: 0.1 mS/0.1 cycle
DELAY: 0 μ s 1600 mS/0 μ s 96 cycles
Resolution: 0.1mS/0.1 cycle

TRIP COMMAND CURRENT MEASUREMENT:

Ranges: 0 to 1/5/20/100 A
Accuracy: $\pm 1\%$ full scale
Response: dc to 5 kHz, minimum
Sample Rate: 100 μ S/10 kHz

CLOSE COMMAND CURRENT MEASUREMENT

Ranges: 0 to 0.2/1/5/20 A
Accuracy: $\pm 1\%$ full scale
Response: dc to 5 kHz, minimum
Sample Rate: 100 μ S/10 kHz

COMMAND MODULE RATINGS:

Voltage: 500 V dc/ac peak, - maximum; polarity insensitive
Current: TRIP: 100-A, dc, maximum
CLOSE: 20-A, dc, maximum
Duty Cycle: 100%

One fifty foot/1.5 meter Trip/Close Command Cable is included with the TR 3100 Master

TR3100 OPTIONS

TR3200 AUTOMATION PACKAGE

Includes dual 3 1/2" floppy disk drives using both 720K/1.4mB disks, instrument firmware and TRX™ Automation Software for generating and reviewing test disks on your MS DOS computer, printing and plotting test results. The TR3200 **automates** instrument operation; compares actual test results to user-defined breaker specifications and \pm tolerances for **PASS/FAIL qualification**; stores the test results for building a breaker performance data-base.

Create a breaker TEST PLAN disk in the field directly via the keyboard and L.C.D. display using the multi-level menus. Or create the disk in advance by using your MS-DOS p.c. in the office with Doble's TRX™ Automation software package.

Test results are automatically stored on the floppy disk; test results may also be transmitted to other locations using an external modem — or test results can be printed and plotted immediately in the field.

TR3110 O.C.B. THREE PHASE CONTACT MEASUREMENT

Times the open and closed states of main contacts and resistor switches with 100 μ S resolution — and **detects** bounces of 30 μ S or greater duration.

TR3120 O.C.B. THREE PHASE CONTACT AND RESISTOR MEASUREMENT

Times the open and closed states of main contacts and resistor switches with 100 μ S resolution — and **detects** bounces of 30 μ S or greater duration; **measures** the resistance value in ohms of insertion resistors from 10 Ω to 7K.

Resistor measuring Accuracy: $\pm 10\%$ of value, maximum

Measurement time: 1.6 mS - minimum

One TR3110/3120 may optionally be included in the Master Instrument.

One 60/18 meter Contact Monitoring Cable is included for the TR3110/3120.

TR3400 REMOTE DATA ACQUISITION INSTRUMENT

Used only with the TR3100 Master Instrument to expand measuring capability for tri-state contact, voltage and current monitoring options.

The TR3400 includes Doble's field proven 80186 microcomputer with 256K R.A.M.; an optically isolated D232 serial interface and fifty foot cable are included for communication and synchronization with the TR3100 MASTER Instrument. Monitor measurement results are graphically presented and tabulated. Packaged in a high impact molded ABS case, the TR3400 accepts the TR3130, TR3140, and TR3145 modular, plug-in monitoring options.

TR3130 TRI-STATE CONTACT MONITOR

Times the states and transitions of up to six energized (**wet**) contacts up to 500 V dc **and** unenergized (**dry**) contacts. *Tri-State Measurement* determines the open, closed wet, and closed dry contact states and transitions in any sequence with 100 μ s resolution. Inputs meet E.S.D. and S.W.C. specifications and are automatically protected against damage from reverse polarity.

One TR3130 may optionally be plugged into the TR3400 Remote Instrument.

TR3140 CURRENT MONITOR

Three full differential, isolated inputs **measure** breaker control current waveforms and **determine** amplitude. Three ranges are provided for use with measurement shunts or clip-on current probes. Inputs meet E.S.D. and S.W.C. specifications.

One TR3140 may optionally be plugged into the TR3400 Remote Instrument.

SHUNT MEASUREMENTS

Requires optional external shunts

Input Range: 0—1/2/2.5 V
Frequency Response: d.c. to 5 kHz
Accuracy: $\pm 1\%$ of full scale

CURRENT PROBE MEASUREMENTS

Requires optional current probes

Input Range: 0—1/2/2.5 V
Current Range: 2—20/20—200 A, using recommended
Fluke Y8-100 clip on, Hall effect probe.
1—10/10—100 A, using recommended
E. W. Bell CG-100A clip on Hall effect probe.
Frequency Response: d.c. to 1 kHz

To allow convenient probe offset adjustment, a zero indicator is included on the front panel.

TR3145 VOLTAGE MONITOR

Measures up to three voltage waveforms and determines amplitude. Inputs meet E.S.D. and S.W.C. specifications.
Input Ranges: 20—200/40—400 V
Frequency Response: dc to 5 kHz
Accuracy: $\pm 1\%$ of full scale.

One TR3145 may optionally be plugged into the TR3400 Remote Instrument.

TR3150 MOTION TRANSDUCER RECEIVER

Provides power and digital interfaces for one, two or three TR3160 Digital, Rotary/Linear Motion Transducers.
One TR3150 may optionally be included in the Master Instrument.

TR3160 DIGITAL, ROTARY/LINEAR TRANSDUCER

Measures rotary, and linear motion.

The digital transducer signal is processed to graphically display both displacement and instantaneous velocity. Average velocity between two specific sets of displacement points is calculated and printed in the Test Results tabulations. Up to 3 transducers may be used simultaneously with one TR3150 Motion Transducer Receiver.

	Linear Motion	Rotary Motion
Range:	0.0 to 40.0"	0.0 to 2800°
Accuracy:	$\pm 0.1\%$ of measured value; $\pm 0.1"$ maximum error	$\pm 0.1\%$ of measured value; $\pm 0.1^\circ$ maximum error
Resolution:	0.002"	0.1°
Velocity:	50 ft/second, maximum	120 revolutions/second, maximum
Acceleration:	400g for 50 μ S, maximum	7×10^6 degrees/second ² , maximum

Requires a TR3150 Motion Transducer Receiver in the Master Instrument.

One 50' Interconnecting cable is supplied with each TR3160.

TR3300 SLAVE INSTRUMENT

Used only with the TR3100 Master Instrument to expand measuring capability for multi-module live tank breakers.

The TR3300 includes Doble's field proven 80186 microcomputer with 256K R.A.M., and a Synch Receiver providing the control and communications interface with the MASTER instrument. High speed optical modems and rugged fifty foot optical cable interconnect MASTER and SLAVE to ensure noise immunity even in 765 kV environments. **The TR3300 Slave** may optionally be equipped with from one to five (maximum) TR3310/3320 Three Phase E.H.V./Live Tank Contact Measurement Modules for measuring the operation of two, seriesed main contacts and two resistor switches (four contacts per phase). Test results from each three phase module are individually tabulated as twelve measurements. Using five, three phase modules, sixty individual measurements are tabulated; the graphic plot displays *each main contact and resistor switch pair* independently.

Grading Capacitor measurements may optionally be added to each contact measuring module.

A 50'/15 meter rugged optical communications Cable and two High Speed Optical Modems are included with the TR3300.

TR3300 OPTIONS

TR3310 THREE PHASE LIVE TANK/E.H.V. CONTACT MEASUREMENT MODULE

Times the operation of two, seriesed main contacts plus two resistor switch contacts per phase with 100 μ S resolution, and detects bounces in accordance with the Digital Discriminator setting.

TR3320 THREE PHASE E.H.V. CONTACT AND RESISTOR MEASUREMENT MODULE

Times the operation of two-seriesed main contacts plus two resistor switch contacts per phase with 100 μ S resolution. Measures the resistance value in ohms of insertion resistors from 10 Ω to 500 Ω

Resistor Measuring Accuracy: $\pm 10\%$ of value, maximum; Measurement Time: 1.6 mS, minimum.

The Programmable Digital Discriminator is automatically set to optimize **bounce detection** measurements based on the number of E.H.V. breaker modules being tested, and the cable length.

Bounce Detection — TR3310/TR3320 Contact Measurement Module

# Modules	60' Cable	110' Cable
1-2-3	30 μ S	40 μ S
4	40 μ S	60 μ S
5	60 μ S	70 μ S

The Programmable Discriminator may be set to detect transitions from 5 μ S to 500 μ S for special, analytical tests.

*Up to 5 TR3310/3320 may optionally be included in the Slave Instrument.
One 60'/18 meter Contact Monitoring Cable is supplied with each TR3310/20.
Optional 50'/15 meter Extension Cables are available.*

TR3330 CAPACITANCE MEASUREMENT

Sequentially measures the capacitance value in pF, of grading capacitors in each breaker module.

Range: 300 to 10,000 pF Accuracy: $\pm 5\%$ of value Frequency: 1kHz

Requires one TR3335 Capacitor Interface for each TR3310/3320 module.

One TR3330 may optionally be included in the Slave Instrument.

TR3335 CAPACITOR INTERFACE

Sequentially connects each contact measurement input to the TR3330 Capacitance Measurement option.

One TR3335 is required for each TR3310/20.

PHYSICAL

Weight:	TR3100: 23 Kg / 50 lbs TR3300: 30 Kg / 66 lbs, when equipped with five TR3310/20 TR3400: 15 Kg / 35 lbs.
Dimensions:	TR3100/3300: 24 x 50 x 55.8 cm / 9.5 x 19.75 x 22 inches TR3400: 16.5 x 50 x 19 cm / 6.5 x 19.75 x 7.5 inches
Mains Voltage:	117V/240 AC $\pm 10\%$; 50/60 Hz.
Current:	3A (117V) / 1.5A (240V)

Power Mains Cable is included for TR3100/3300/3400

A Safety Ground Cable is included for TR3100/3300

ENVIRONMENTAL

Operating temperature:	0° — 50°C
Storage temperature:	-30° — 70°C, 95%, non-condensing.
Optional Heater:	for low temperature operation to -20°C
TRANSPORT SHOCK	Designed and tested to ASTM D 999.75.
E.S.D.	TR3000 Instruments meet I.E.C. 801 - 2 20 kV — no Instrument damage 12 kV — no Instrument damage or loss of data.
S.W.C.	TR3000 Instruments meet ANSI C37.90 / 1978.