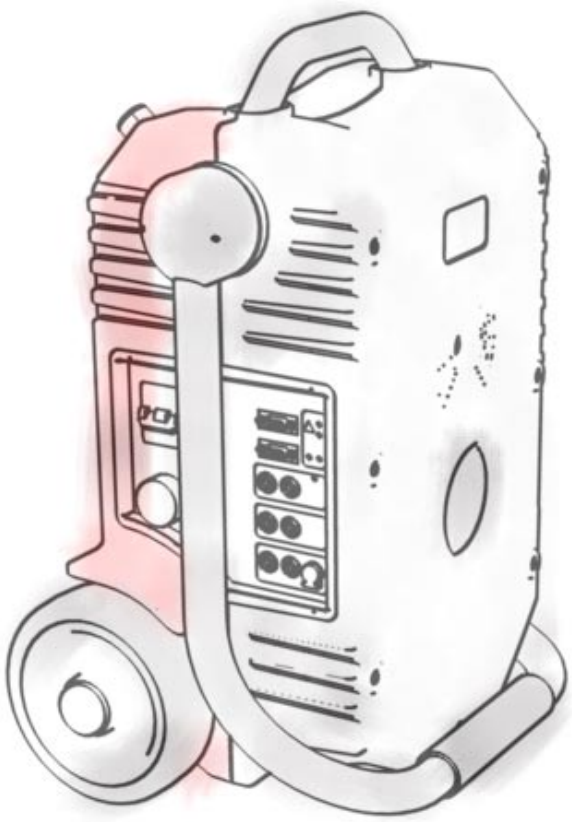
Primary Overcurrent Trip Test

December, 19th, 2012



A Sample Practice for Raptor Users

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Introduction

The best way to quickly become familiar with a new tool is by conducting a simple job while you learn key aspects and features that will make your life safer, easier and more efficient.

This document shows how to take advantage from the innovative solutions that you will find in your new Raptor Primary Injection System while you perform a typical overcurrent testing on a distribution circuit breaker.

WARNING

Before proceeding, we strongly recommend you to read the Raptor User's Manual, especially the sections dedicated to safety considerations and equipment care.

Job description

Operation times must be verified on a circuit breaker, using primary quantities for overcurrent fault simulation. Contact resistance should also be verified during this job.

Tested object

Elements intervening in the protective function include (see figure 1):

- A 23kV three-phase vacuum circuit breaker
- An overcurrent trip and reclosing relay with IDMT inverse (overload) and fixed time (short-circuit) operation characteristics
- Three-phase busbar connections at both sides of the CB
- Three phase protection current transformers and one homopolar protection toroid transformer
- Associated switchgear, control, communications, monitoring, and and local operation elements
- 110 Vdc auxiliary power
- Wiring

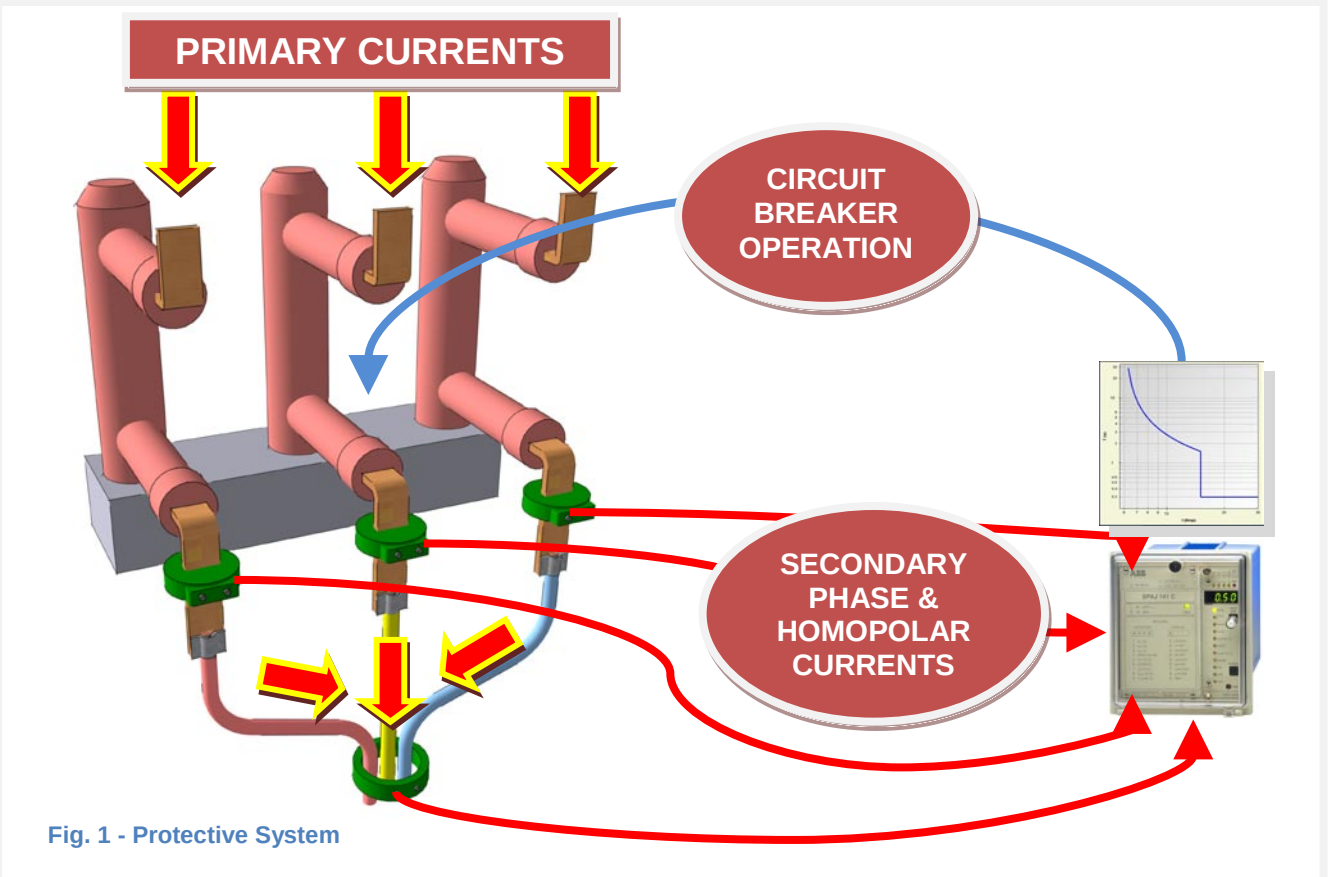


Fig. 1 - Protective System

Related data

The test protocol should specify the current values that must be injected and the corresponding (theoretical) operation times. The test results must be documented as a comparison between the expected and the measured trip times. Assessment of 'correct' and 'incorrect' results must be based upon pre-defined tolerance ranges. Optionally, the results can be plotted on the relay's characteristic curve for quick visual evaluation.

Other data like date, time, location, equipment identification and actual DC auxiliary voltage should complement the test report (see Fig. 2).

CIRCUIT BREAKER TRIP TEST REPORT

Test Date: _____

Location: _____

Operator's name & company: _____ (_____)

Cell ID: _____

Aux DC voltage: _____

Test equipment used

Type	Make	Serial No.	Calibrated on

Fault type: Overcurrent (50/51) Phase-ground and homopolar.

Nominal phase current: 500 A Nominal homopolar current: 1 A

Overload timer start value

Phase: I >= Io + 10% Homopolar: I >= Io + 10%

Short circuit settings

Phase: I >= 4.5 x Io

Test points

Phase overload

Phase	Io Current Multiplier	Expected time (s)	Measured time (s)	Deviation (s)	Tolerance (s)	Result (PASS/FAIL)
A overload	1	no trip			0	
	1.1	40			14	
	1.5	18			6	
	2	10			3	
	2.5	8			2	
	4	1			0.2	
A s. circuit.	4.5	0.3			0.2	
	5	0.3			0.05	
... B, ..., C						

Fig. 2 – Test Report

Test data

- DC voltage must be measured at the tested assembly's auxiliary power input and recorded in the test report.
- Circuit breaker trip time must be assessed against expected values for a series of overcurrent faults specified in the test report.
- Reclosing behavior must be tested against programmed sequences as also specified in the test report.
- Contact resistance values must be measured for the three main contacts in the closed circuit breaker.

Job execution

Conducting this type of test with the Raptor should represent only a fraction of the overall job's time, as preparation, especially setting the mandatory safety precautions into place, should take significantly longer.

Safety precautions

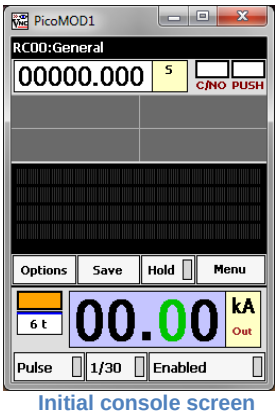
Apart from the general and site-specific safety rules common at any high voltage facility, you must make sure that the complete cell containing the tested circuit breaker is fully isolated from the power grid.

SAFETY WARNING

Before proceeding, make sure and double-check that the complete cell containing the tested circuit breaker is fully isolated from the power grid.

Preparation

1. Fill-out the test report header with all the known data (e.g. date/time, identification of equipment and yourself, etc.)
2. Place the Raptor as close as possible to the cell and locate a suitable AC supply (110/230 VAC ±10%, 50/60 Hz, 50 A). If you are forced to use a fuel generator, make sure that power oscillations will not exceed the Raptor's supply tolerances during the test.
3. Connect the Control unit to the Raptor using the supplied RS-485 cable.
4. Switch the Raptor ON and wait until the power-on cycle finishes and the initial screen is displayed by the console.



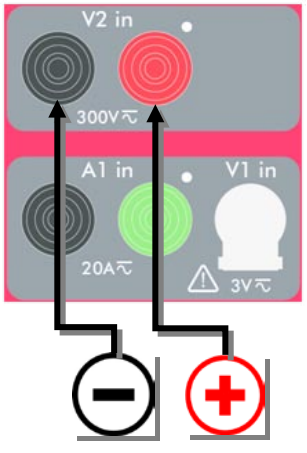
Initial console screen

Measuring Auxiliary DC voltage

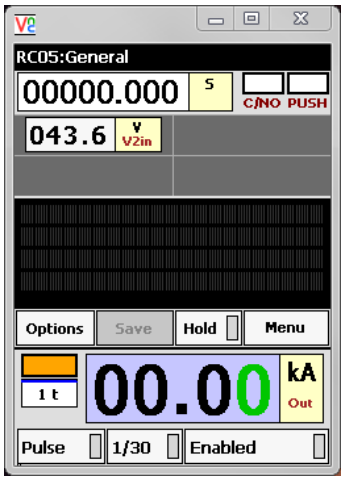
1. Connect the measurement leads to the Raptor's voltage measurement input V2.
2. Locate the Auxiliary Power input circuit inside the circuit breaker's control cabin and connect the measurement terminals to it using the correct polarity.
3. In the Raptor console, touch MEASUREMENT and note the displayed voltage value into the corresponding place of the report.
4. Disconnect the measurement leads from the cabin first, then from the Raptor.

SAFETY WARNING

Auxiliary power voltage can be lethal if handled improperly. Use isolated tools and safety clothing, including footwear and gloves.



Measuring auxiliary DC voltage



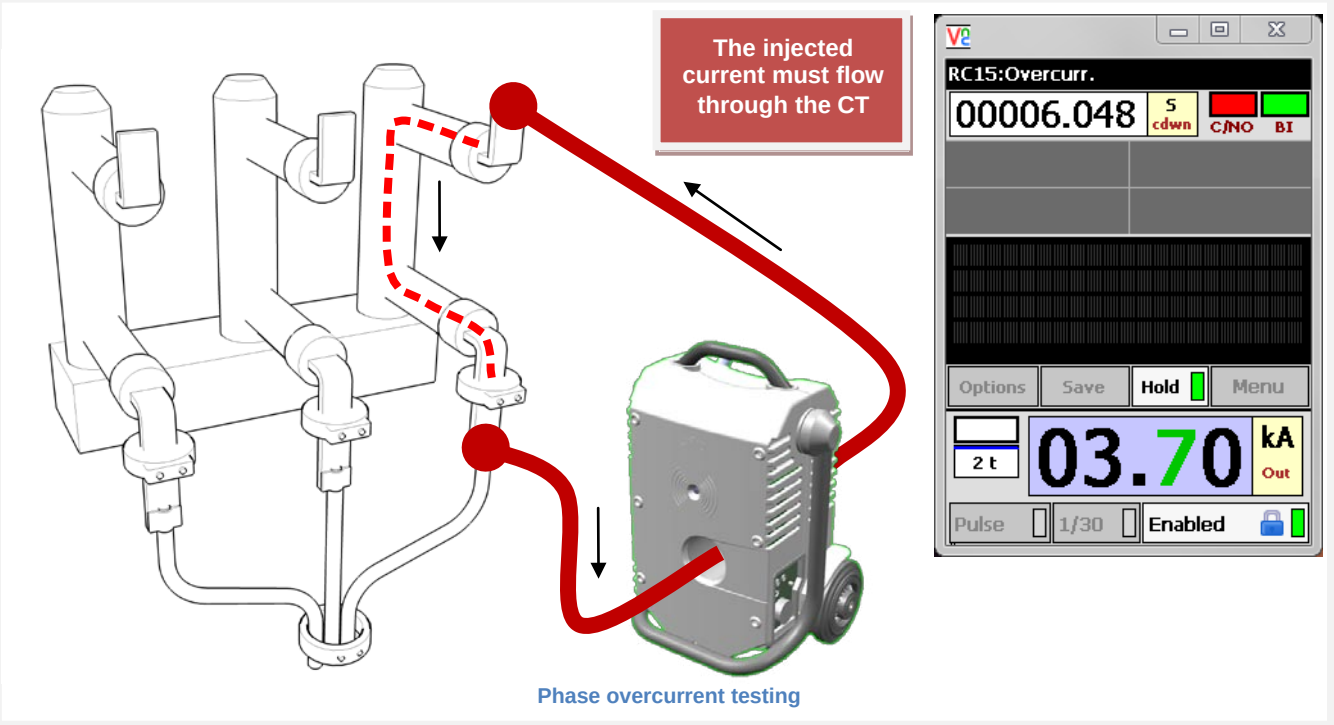
Phase overcurrent testing (50/51)

1. Attach one end of your high current cable to a good contact spot on the busbar connection of phase A at the upstream side of the circuit breaker.
2. Pass the free end of the current cable through the Raptor's power tunnel and attach it to the busbar at the downstream side of the circuit breaker.

PERFORMANCE HINT

Use tape to maintain cable legs at both sides of the Raptor together and avoid looping in order to keep inductive impedance to the minimum.

3. In the TEST tab, adjust the current to the first current value and reset the chronometer.
4. Set the test time to a value slightly greater than the expected trip time for this fault, according to the settings specified in the test report.



Phase overcurrent testing

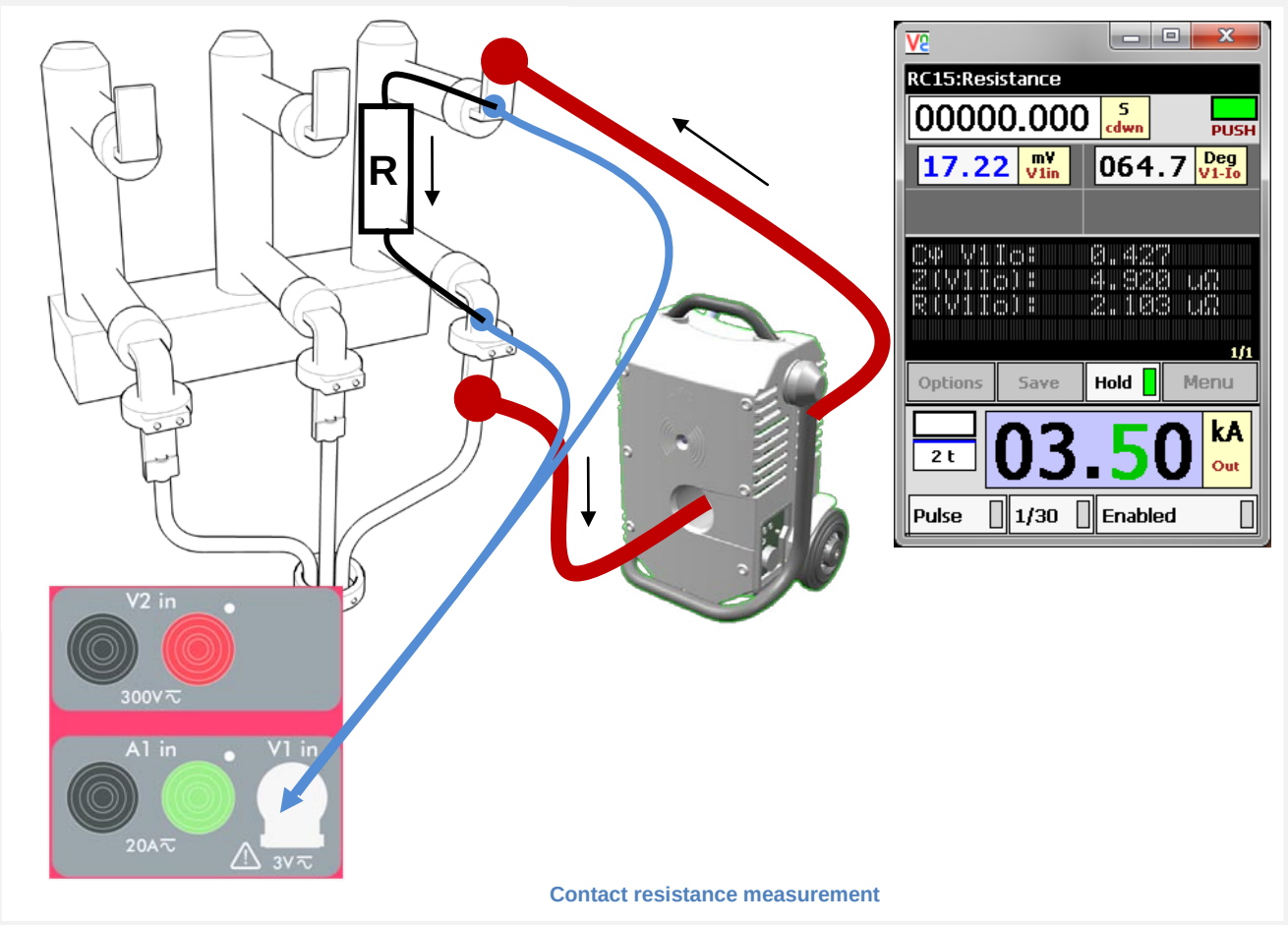
5. Manually set the circuit breaker to CLOSE position if necessary.
6. Touch TEST in the console and wait until it returns to stand by (green) state, indicating that the test has finished.
7. Note the displayed trip time or 'no trip' for this test point in the report.
8. Repeat steps 3 – 7 for all the test points in phase A. If you also need to measure the contact resistance in this pole, follow the procedure described at the end of this section and then resume with step 9.
9. Move the current cable terminals to phase B, then C, in the circuit breaker and repeat steps 3 – 7 for all the test points.

Contact resistance measurement (μΩ)

Before disconnecting the current injection cable after step 8 above, add two measurement leads from the Raptor's voltage input to each side of the breaker's pole and you will get an accurate resistance value measured with the four-wire (Kelvin) method.

You must make sure that the voltage probes are attached onto the busbar plates *inside* the injection circuit.

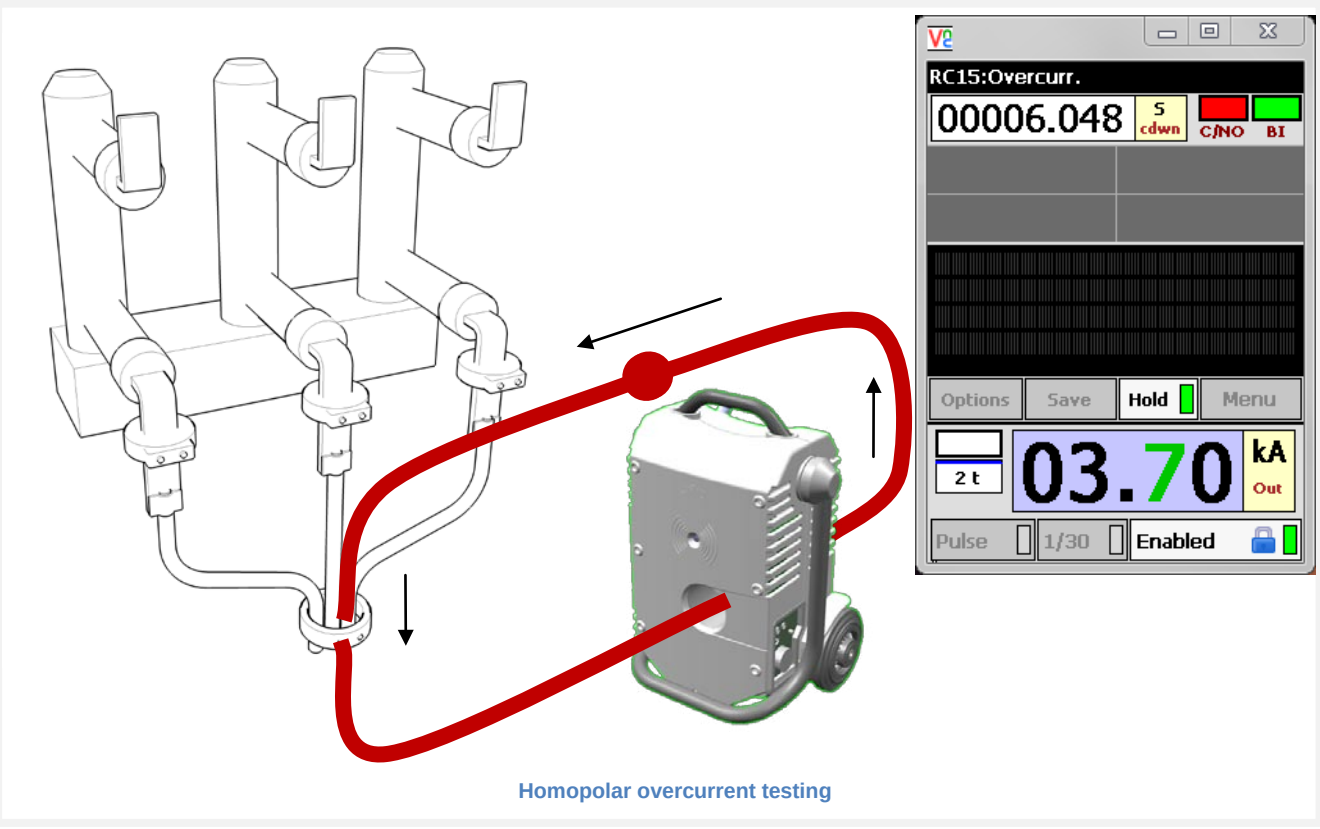
The resistance measurement function will take three seconds to display the value in microohms.



Contact resistance measurement

Homopolar overcurrent testing (50n)

1. Detach both sides of the current lead from the circuit breaker's busbar sections.
2. Locate the toroidal transformer used to measure homopolar (residual) current for the neutral overcurrent element in the protection.
3. Make some room among the three phase cables and pass one of the free ends of the current lead through the toroidal transformer.
4. Attach both ends of the current cable firmly to each other for the best contact quality possible. If necessary, add some tape to bring the remaining loose sections together in order to eliminate loops that create inductive power loss.
5. Select LOW range in the console's SETTINGS tab.
6. In the TEST tab, adjust the current to the first test value and reset the chronometer.
7. Set the test time to a value slightly greater than the expected trip time for this fault, according to the settings specified in the test report.
8. Manually set the circuit breaker to OPEN position if necessary.
9. Touch TEST in the console and wait until the button returns to standby (green) state, indicating that the test has finished.
10. Note the displayed trip time or 'no trip' for this test point in the report.
11. Repeat steps 6 – 10 for all the homopolar overcurrent test points.



Homopolar overcurrent testing

Finishing the Job

After you have completely filled out the test report with trip times, evaluate each result against the specified tolerance values and write the assessment word ('PASS' or 'FAIL') next to it.

Then, sign and keep your report in a safe place.

Remove the current lead from the circuit breaker and switch the Raptor off.

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