Design and Manufacture of Testing Equipment for Switchgear

Testing of Circuit Breakers

Manufactured circuit breakers, due to their internal design, are capable of functioning under a range of conditions. These include switching loads up to the switching current as well as interrupting overloads or fault currents multiple times the rated current. Due to malfunction, the entire electric system along with the circuit breaker is prone to damage. Reliability in performance, especially in circuit breakers needs to be confident. Testing under conditions is the only simulative way of getting this confidence which comes with experience over years.

Compliance to a certain testing circuit bend region or world standard is what testing aims for. Some special tests are conducted by manufacturers on new designs for evaluation purpose. The common tests on almost all circuit breakers include:

Mechanical Operation

Sub-performance: Performance of the mechanism to open and close contacts

Sub-endurance: Endurance of the mechanism

Electrical Operation

Sub-safety and load: Ability to operate safely with rated loads

Sub-isolation ability: Ability to safely isolate overloads and short circuits

Note that the contact parting
time, as defined by ANSI, is the summation of the relay time plus the opening time. These relationships are illustrated in Fig. 1 below [2]

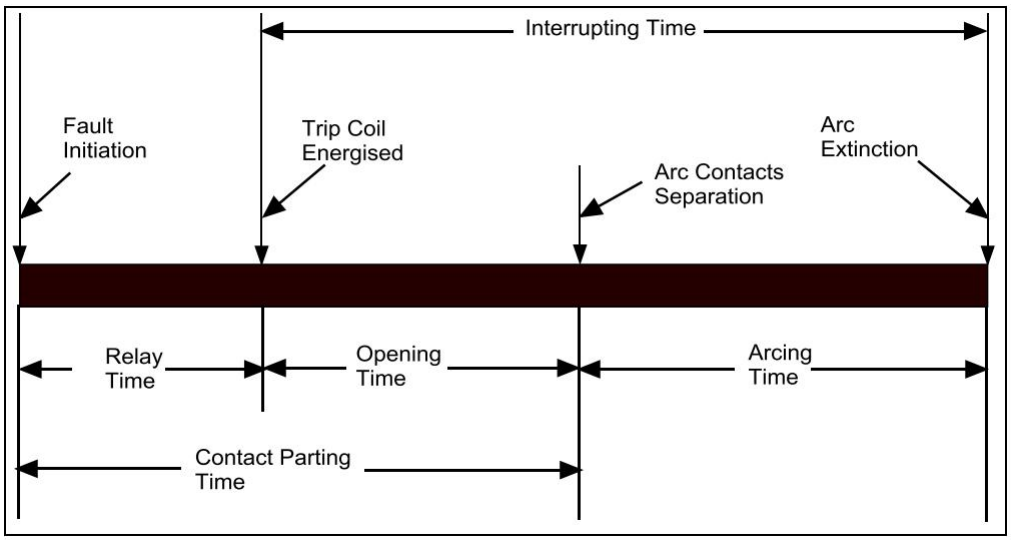


Fig 1: Interrupting Time Relationships

The most important operating characteristics of a circuit breaker are the opening and closing velocities and stroke, or travel distance. These features are mainly determined by the needs of the contacts.

Contact erosion and welding must always be avoided by closing and opening velocities for the contacts. Since contact stroke is the same as contact gap, circuit breaker stroke is mainly associated with how well the circuit breaker can endure the operating dielectric stresses.

The opening and closing motion curve of a circuit breaker is shown in Fig. 2 [3].

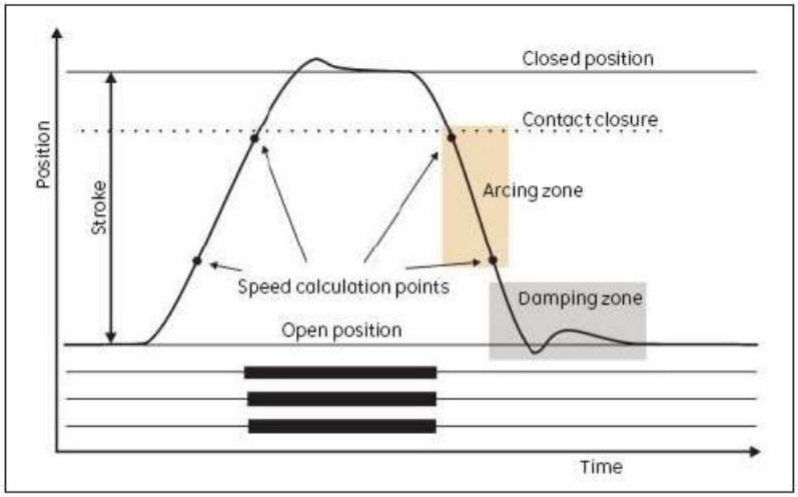


Fig. 2: Circuit Breaker Open and Closing Motion

Open / Close Speed Test

This test is performed to confirm the key mechanical parameters of the switchgear. This includes the open and close

speeds, travel distance and contact closing and parting times. Equipment for performing this test consists of:

- Computer equipment with application software for performing the test and analysing the results
- Displacement transducer for measuring the travel of the circuit breaker
- Continuity measurement for measuring the contact open and closing
- Control circuit and power supply for energising the trip and close coils
- Current clamps to measure trip and close coil currents

The equipment is shown below in Fig. 3.

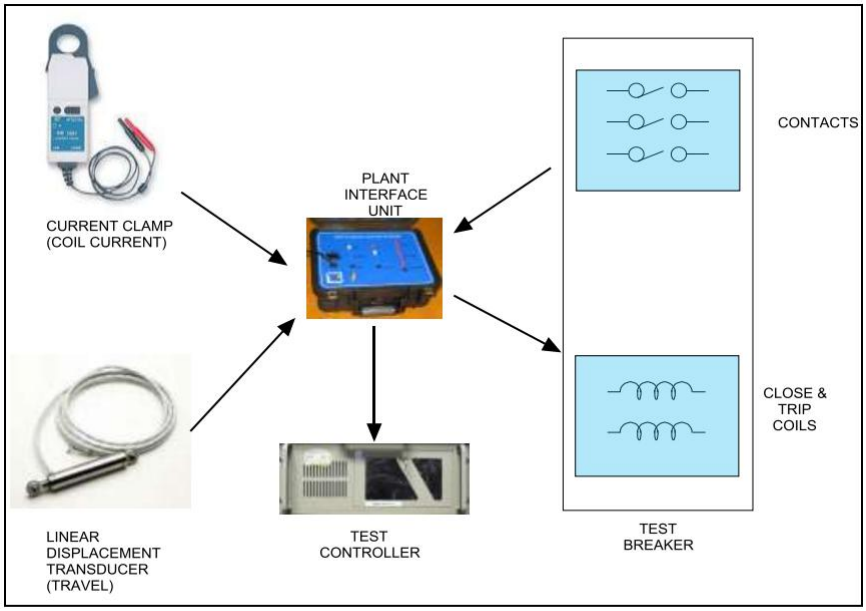


Fig. 3: Test Equipment for Open / Close Speed Test

The test system also requires a power supply to energise the close and trip coils as well as a supply for charging the
mechanism.

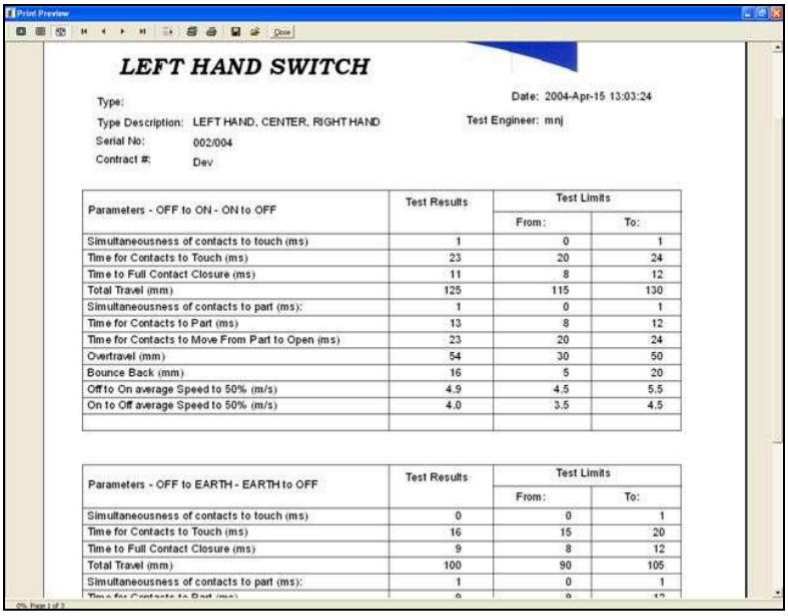
The travel measurement is obtained by connecting a linear displacement transducer to the contact mechanism. The
output of this transducer is then calibrated to correspond with the distance moved by the contacts.

A typical graphic display from the test is shown in Fig. 4.

Fig. 4: Open / Close Speed Trace

The upper trace is the travel. The centre three traces are the continuity of the contacts. This example shows severe
contact bounce when the contacts close. These results are then automatically analysed by the computer software and

a report is produced similar to the report in Fig. 5.



LEFT HAND SWITCH

Type:
Type Description: LEFT HAND, CENTER, RIGHT HAND
Serial No: 002/004
Contract #: Dev

Date: 2004-Apr-15 13:03:24
Test Engineer: mnj

Parameters - OFF to ON - ON to OFF	Test Results	Test Limits	
		From:	To:
Simultaneousness of contacts to touch (ms)	1	0	1
Time for Contacts to Touch (ms)	23	20	24
Time to Full Contact Closure (ms)	11	8	12
Total Travel (mm)	125	115	130
Simultaneousness of contacts to part (ms):	1	0	1
Time for Contacts to Part (ms)	13	8	12
Time for Contacts to Move From Part to Open (ms)	23	20	24
Overtravel (mm)	54	30	50
Bounce Back (mm)	16	5	20
Off to On average Speed to 50% (m/s)	4.9	4.5	5.5
On to Off average Speed to 50% (m/s)	4.0	3.5	4.5

Parameters - OFF to EARTH - EARTH to OFF	Test Results	Test Limits	
		From:	To:
Simultaneousness of contacts to touch (ms)	0	0	1
Time for Contacts to Touch (ms)	16	15	20
Time to Full Contact Closure (ms)	9	8	12
Total Travel (mm)	100	90	105
Simultaneousness of contacts to part (ms):	1	0	1

Fig. 5: Open / Close Speed Test Analysis Results

These results can be printed and are saved to a database for future reference.