LOCOMOTIVE CIRCUIT BREAKER MAINTENANCE TEST SETUP

- For testing single and double interrupter 25 kV overhead vacuum circuit breakers (VCBs) used in AC locomotives
- Setup consists of the following
  - CBScan Analyser
  - 0-150 V DC Power Supply
  - Transducers and Fixtures
  - MVT 100 Contact Resistance Meter
Benefits from this Test Setup

The solution offered by us benefits you in the following ways:

- A complete solution comprising of an Analyser, Contact Resistance Meter, Power Supply, Transducers, and Fixture that is beneficial for performing a wide range of tests
- Compact and portable design allows easy movement in yards and shop-floors
- Significant time savings by quick-fit connections and wear resistant test leads
- Simple and easy-to-use system that allows even an untrained operator to perform tests and understand pass/fail results effortlessly
- System performs calculations automatically within no time and generates tamper-proof test reports
- Windows-based software with an easy-to-use interface for programming test sequences, viewing test results, and analyzing and handling graphical test data
- Test results are stored on a hard disk for future retrieval and comparison to understand wear and tear of the breaker during periodic maintenance

*Figure 1: Testing of VCB of an electric locomotive in loco shed*
Introduction

Electrification as a form of traction for railways emerged towards the end of the 19th century. 25 kV, 50 Hz AC has become an international standard for railway electrification. Medium voltage switchgear is used for protection and interrupting short-circuits in the overhead catenary system that are frequent and transient in nature. The short circuits appearing in railway traction application are much more than those occurring in electrical power transmission and distribution.

Hence, a circuit breaker having a short breaking time with minimum contact gap and arcing is required for this purpose on electric locomotives. Vacuum circuit breakers are ideal for traction applications as they can quench the arc much quickly. Vacuum circuit breakers are, especially, preferred as they are reliable, long lasting, require less maintenance and can withstand multiple tripping operations. Sometimes, air blast circuit breakers are also used in railway traction, especially, in older systems as they can operate quickly and are suitable for repeated duty. However, they require a lot of maintenance and hence are being replaced with vacuum circuit breakers.

Functioning of VCBs

VCBs use vacuum as an arc-quenching medium when the current carrying contacts of the circuit breaker separate. The fixed and moving contacts are permanently sealed in a vacuum chamber called as a vacuum interrupter. Vacuum has a high dielectric strength and causes the arc to quench quickly. Due to a lack of any ionizing material, except the breaker contacts, VCBs have very minimal arcing.

Need for Testing

Proper shop-floor and on-site periodic testing of vacuum circuit breakers is important to ensure that the circuit breaker operates when required, as a failure to do so may lead to the destruction of the circuit breaker and all equipment connected to it. To ensure a reliable operation and a long service life, periodic testing of VCBs is done in a similar manner as other types of circuit breakers. VCB testing involves various measurements, such as speed and contact travel, contact timings and bounce, coil current characteristics, contact resistance, endurance test, etc.
CBScan Locomotive Circuit Breaker Test System

CBScan Locomotive Circuit Breaker Analyser is a compact and portable analyser used for testing 25 kV medium voltage circuit breakers that are used in electric locomotives. To ensure portability, an external laptop is required to run the test software. The analyser is ideal for railway yards for performing periodic maintenance checks. It is also suitable for manufacturers on their shop-floors for testing newly manufactured circuit breakers to ensure reliable operational life and minimize on-site failures.

CBScan is used for performing routine tests on vacuum circuit breakers that are commonly used for railway traction applications as per suitable standards. Some older locomotives may consist of air blast circuit breakers, which can also be tested using CBScan.

Tests Performed/Parameters Derived from Testing

- Endurance test
- Contact timings
- Contact bounce
- Total piston stroke
- Distance between new contact
- Non-simultaneity of contacts (in case of double bottle)
- Auxiliary contacts timings
- Travel characteristics of contact for speed, insertion, contact gap, over-travel and rebound
- Close and Holding coil current characteristics
- Pre-stress
- Contact resistance (using MVT 100)
Accessories

- Power supply for operating the coils

![Power Supply](image)

*Figure 4: 0 to 150 V DC Power Supply*

- Transducers and fixtures for acquiring travel/speed characteristics

![Transducer Fixture](image)

*Figure 5: Linear Travel Transducer with Fixture*

- MVT 100 Contact Resistance Meter for measuring the contact resistance of the breaker contacts
MVT 100 Contact Resistance Meter

MVT 100 is a powerful digital millivolt drop-cum-contact resistance meter to measure accurate contact resistances of vacuum circuit breakers (VCBs) used in railway traction applications. It consists of a 20x4 line LCD and a built-in continuous DC source of up to 100 A.

Features

- Continuous current injection of up to 100 A DC and direct display of micro-ohm value
- Selectable continuous current injection of 20, 50, and 100 A DC for testing wide range of objects with lower current ratings and higher resistances and vice versa
- Single LCD to display current and resistance/millivolt-drop value
- Resistance ranges of 10 micro-ohm to 20 milli-ohm @100A and from 10 milli-ohm to 100 milli-ohm @20A
- Resistance Auto-Ranging facility for certain models
- No need for lead resistance compensation as Kelvin's four-wire measurement method is used
- Easy to operate instrument supplied in DIN standard enclosure or in a carrying case. A movable trolley can also be provided as an option
- Supplied with 15 meter long, factory-calibrated test lead set with specially designed Ck/Crocodile clamp suitable for EHV class test objects

Figure 6: MVT 100 Contact Resistance Meter
Software Screenshots and Test Report of Autometer Alliance Breaker

Figure 7: Close Operation

Figure 8: Open Operation
Circuit Breaker Characteristics

Breaker Sr. No.: BVAC0102155  Date: 28/06/2017
Breaker Rating: Autometers Alliance  Breaker Make: Autometer Alliance Ltd
Coil Voltage: 110 VDC

CLOSE

X - Scale in mSec.

OPEN

Test Results

<table>
<thead>
<tr>
<th></th>
<th>Close</th>
<th>Limits</th>
<th>Open</th>
<th>Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Time (ms)</td>
<td>40.80</td>
<td>&lt; 60 ms</td>
<td>61.20</td>
<td>30 - 60 ms</td>
</tr>
<tr>
<td>Contact Bounce (ms)</td>
<td>1.80</td>
<td>&lt; 2 ms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Of Bounces</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Travel (mm)</td>
<td>19.46</td>
<td>19.0 - 2.5 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact Gap (mm)</td>
<td>15.53</td>
<td>14.75 - 17 mm</td>
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</table>
Software Screenshots and Test Report of Alstom Double Bottle Breaker

Figure 9: Close Operation

Figure 10: Open Operation
**Locomotive Circuit Breaker Maintenance Test Setup**

**Circuit Breaker Characteristics**

<table>
<thead>
<tr>
<th>Breaker Sr. No.</th>
<th>Date</th>
<th>Breaker Type</th>
<th>Coil Voltage</th>
<th>Breaker make</th>
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</thead>
<tbody>
<tr>
<td>0023</td>
<td>28/06/2017</td>
<td>Alstom Double Bottle</td>
<td>110 VDC</td>
<td>Alstom</td>
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</table>

**CLOSE**

- **X - Scale in mSec.**

**OPEN1**

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**Test Results**

<table>
<thead>
<tr>
<th>Left Side Bottle</th>
<th>Right Side Bottle</th>
<th>Close Limits</th>
<th>Open Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Time (ms)</td>
<td>135.20</td>
<td>57.10</td>
<td>137.10</td>
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<tr>
<td>Semultaneity (ms)</td>
<td>1.90</td>
<td>0.20</td>
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</tr>
<tr>
<td>Contact Bounce (ms)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>No of Bounces</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Travel (mm)</td>
<td>11.67</td>
<td>10.93</td>
<td></td>
</tr>
<tr>
<td>Contact Gap (mm)</td>
<td>11.07</td>
<td>10.40</td>
<td></td>
</tr>
<tr>
<td>Speed (m/s)</td>
<td>0.17</td>
<td>0.70</td>
<td>0.13</td>
</tr>
<tr>
<td>Prestress/OT(mm)</td>
<td>0.60</td>
<td>0.53</td>
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<tr>
<td>Prestress/OT Time(ms)</td>
<td>96.60</td>
<td>-4.30</td>
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<tr>
<td>Over Travel(mm)</td>
<td>0.67</td>
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<tr>
<td>Bounce Back(mm)</td>
<td>0.59</td>
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</table>
Crest Test Systems is a pioneering company in the field of Test & Measurement. The Crest core team has an experience of 30 years in the field of Switchgear Testing. Our test systems are used everyday to test switchgear on the shop-floors of all leading switchgear manufacturers and also in government test and certification labs. Apart from the Power Sector, Crest also designs and manufactures customized test systems for Metros & Railways, Motor Manufacturing, Battery Industry, and Test & Certification Labs.

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