

Routine Production Testing of Voltage Regulators

Tests Performed in Accordance with the IEEE Std C57.15™ / IEC 60076-21™ Standards

This document describes the routine production tests performed on Eaton's Cooper Power series voltage regulators. These tests are performed as part of normal production activities and may be witnessed by the customer. Two weeks notice prior to the tests will be given if Eaton is informed of the test witness requirement at time of order. These tests are performed in accordance with the routine tests described in the IEEE Std C57.15™ / IEC 60076-21™ standards.

1. Ratio Tests on All Tap Connections

The verification of proper ratios is performed prior to placing the internal regulator assembly into the tank. The values are recorded and saved for a period of time but are not reported. Certification that this test was performed and passed is indicated by the words "All regulators listed have received and passed the following tests: ...Ratio" in the certified test report.

2. External Voltage Run-in Test

This test verifies the proper operation of the tap changer and position indicator limit switches. The test is performed after the tank has been filled with oil under vacuum. The test consists of 1000 operations of the tap changer with the position indicator limit switches set at 12 Raise and 12 Lower. An application of 120 volts is applied to the motor circuit via the control cable connection under the junction box. Certification that this test was performed and passed is indicated by the words "Units have received and passed a 1,000 operations run-in test" in the certified test report.

3. Leak Test

A leak test is performed to confirm that the regulator tank is free from leaks and that all seals are performing as designed. After the voltage regulator is filled with fluid under vacuum, it is pressurized to 10 PSI or 7 PSI for round or rectangular tanks, respectively. After a minimum of 1 hour has elapsed, the unit is inspected for signs of oil on tank surfaces and

a loss of pressure. Certification that this test was performed and passed is indicated by the words "All regulators listed have received and passed the following tests: ...Leak" in the certified test report.

4. Rated Voltage Operational Test

This test verifies the proper operation of the tap changer and the position indicator limit switches using applied rated voltage. During the test, voltage is applied between the S and SL bushings. There are two parts to the test. During the first part, the limit switches are placed at 8 Raise and 8 Lower. The tap changer is raised and lowered checking for proper operation of the tap changer, tap changer indexing, mechanical position indicator limit switches and percentage regulation of voltage. In the second part, the limit switches are moved to 16 Raise and 16 Lower and the test is repeated.

5. Polarity Test

The polarity test is used to confirm that the current and voltage transformers are installed with the correct polarity. The test verifies the phase shift of the current in the CT in relation to the control voltage when 30% of rated current is circulated in the series windings. A phase shift of less than 90° is acceptable. Certification that this test was performed and passed is indicated by the wording "All regulators listed have received and passed the following tests: ...Polarity and Phase Relation" in the certified test report.

6. Resistance Measurements of All Windings

The resistance of the shunt winding and series windings at taps 16 Raise, 15 Raise, 15 Lower, and 16 Lower is measured during the load loss test. The results are compared to design values for consistency. The results are entered into the test data system and upon request, are listed in the certified test report.

7. Insulation Power Factor Test

The power factor is measured using a capacitance dissipation bridge (30 VAC). In this test, all three bushings are tied together and energized while the tank is grounded. This value is reported in the certified test report.



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8. Insulation Resistance Test (Megger)

During the insulation resistance test, the bushing terminals are tied together while the tank is grounded. 5 kV DC is applied between the bushing terminals and ground for one minute. The final value is read and recorded in meg ohms (M Ω). This data is shown in the certified test report.

9. Applied Potential Test (AC Hi-Pot)

The applied voltage test is performed with all three bushings tied together and energized at the level specified per IEEE Std C57.15™ standard while the tank is grounded. Certification that this test is performed and passed is indicated by the statement "All regulators listed have received and passed the following tests: ...Applied Voltage" in the certified test report.

10. Routine Impulse Test

During the routine impulse test, all bushing terminals are tested at rated BIL. The line terminals, S and L, are tied together through a resistor of 450 Ω \pm 10% to limit induced voltage. A Type A voltage regulator has the test applied to the source (S) terminal while set in the maximum buck position. A Type B voltage regulator has the test applied to the load (L) terminal while set in the maximum boost position. In addition, voltage regulators have impulse voltage applied to the SL line terminal. Two shots are given per test, a reduced full wave shot at 50-70% of BIL impulse levels and a full wave shot at 100% of BIL impulse levels. The wave shapes are displayed on a memory oscilloscope and compared for similarities. The detection system is such that a fault as small as a turn-to-turn short can be detected. Certification that this test is performed and passed is indicated by the statement "All regulators listed have received and passed the following tests: ...Routine Impulse" in the certified test report.

11. Induced Potential Test (Over Excitation)

This test is performed with 200% of rated voltage applied to the windings. The duration of the test is 7200 cycles (400 Hz for 18 seconds). Certification that this test was performed and passed is indicated by the statement "All regulators listed have received and passed the following tests: ...Induced Voltage" in the certified test report.

12. No Load (Excitation) Loss at Rated Voltage and Frequency

No load (core) loss is measured and recorded at taps Neutral and 1 Raise for Type A and B regulators with rated voltage applied across the shunt (excitation) windings. A regulator with a series transformer is tested at Neutral, 15 Raise and 16 Raise. This data is shown in the certified test report.

13. Excitation Current at Rated Voltage and Frequency

This test is performed in conjunction with the No Load (Excitation) Loss test. Exciting current (in amperes) is measured and recorded at taps Neutral and 1 Raise for Type A and B regulators with rated voltage applied across the shunt (excitation) winding. A regulator with a series transformer is tested at Neutral, 15 Raise and 16 Raise. The percentage values for this test are calculated and printed on the report. This data is shown in the certified test report.

14. Impedance and Load Loss at Rated Current and Frequency

Load (winding) losses and impedance (in volts) are measured and recorded at taps 16 Raise, 15 Raise, 15 Lower, and 16 Lower at rated current. Impedance percentage is calculated and printed on the certified test report.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Eaton.com/cooperpowerseries

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Publication No. TD225010EN

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