CMU Polymer Class B (Power Class) Cutout Certified Test Report

Powering Business Worldwide

Design test for CMU Polymer Class B (power class) Cutouts per the following standards requirements:

1. IEEE standards:
    a. Std 4
    b. C37.41
    c. C37.41 - 2016/Cor 1 - 2017
    d. C37.42
2. ASTM D4476
3. Canadian standard CSA C310-09 reaffirmed 2014

Table 1 Products Certified with this Test Report

Product Number	Description
S4CMU Family	17kV CMU Polymer Cutout with Eaton CMU Class B (Power) Fuse
S9CMU Family	27kV CMU Polymer Cutout with Eaton CMU Class B (Power) Fuse

Table 2 Compatibility Tests covered with this Test Report

Product Number	Description
S4CMU Family	17kV CMU Polymer Cutout with Eaton 15.5kV Hinge Mount X-Limiter Fuse
S9CMU Family	27kV CMU Polymer Cutout with S&C SMU-20 Class B Fuse

CERTIFICATION

Statements made and data shown are, the best of our knowledge and belief, correct and within the usual limits of commercial testing practice.

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INTRODUCTION

Eaton's Cooper Power series CMU class B (power class) cutout has been developed to provide an industry standard interchangeable cutout.

The report details the testing conducted to verify performance and meet the listed IEEE standard requirements

Contents

INTERRUPTION TESTS

Object

Table 3 lists the maximum interrupting current rating (series 1) of each version of the class B cutout. The standard requires tests of only the minimum and maximum of the fuse series, thus only two current levels qualify the cutout for each fuse series.

Table 3 Series 1 interruption test

Product	Maximum Voltage Rating (kV)	Interruption Current	TRV Parameters		X/R ratio	Tested Fuse Ratings
		Symmetrical (kA)	Frequency (kHz)	Peak Factor		
17 kV CMU Cutout	17	14.0	3.2 +10%, -0%	1.4 +10%, -0%	Not less than 15	6K
						200K
						5E
						200E
27 kV CMU Cutout	27	12.5	2.1 +10%, -0%	1.4 +10%, -0%	Not less than 15	6K
						200K
						5E
						200E

Procedures

Cutouts listed in Table 3 were tested per IEEE C37.41-2016 / Cor 1 – 2017 Table 5 for class B fuses in series 1 interruption. One cutout was tested at three different close angles for each fuse rating and speed. Additional test criteria are determined by IEEE C37.41 – 2016 clauses 7 and 9. The 17 kV tests and the 27 kV tests with the 5E fuse were performed at CESI S.p.A. The 27 kV tests were performed at KEMA Laboratories DNV GL.

Test Results

All cutouts cleared interruption and the fuse dropped out as designed. There was no indication of damage to the insulator. After interruption, the fuse contacts were in good condition.

Conclusion

All cutouts passed Series 1 interruption.

INTERRUPTION AT TEMPERATURE EXTREME TESTS

Object

Table 4 lists the maximum voltage rating of the class B cutout tested. The standard test series requires tests of only the minimum of the fuse series, thus only one current level will qualify the cutout for all fuse series.

Table 4 Series 1 interruption at temperature extreme test

Maximum Voltage Rating (kV)	Interrupting Rating (kA)		Tested Fuse Ratings	Test Temperature,	
	Symmetrical	Asymmetrical		°C	°F
17	14.0	22.4	6K	-40	-40
				40	104
27	12.5	20.0	6K	-40	-40
				40	104

Procedures

Cutouts listed in Table 4 were tested per IEEE C37.41-2016 / Cor 1 – 2017 Table 5 for class B fuses in Series 1 interruption. Additional test criteria are determined by IEEE C37.41 – 2016 clauses 7, 9, and 18. This test applied cold or hot temperatures to the cutout frame only. The fuse is not subject to the temperature extremes. The 17 kV tests were performed at CESI S.p.A. The 27 kV tests were performed at KEMA Laboratories DNV GL.

Test Results

All cutouts cleared interruption and the fuse dropped out as designed. There was no indication of damage to the insulator. After interruption, the fuse contacts were in good condition. Dye penetration test of the insulator after interruption did not show any indication of fracture occurring in the core of the insulator.

Conclusion

All cutouts passed Series 1 interruption at temperature extremes.

DIELECTRIC TESTS

Object

Table 5 lists the maximum voltage rating of the class B cutout tested. The standard test series requires tests of only the maximum of the fuse series, thus only one current level will qualify the cutout.

Table 5 Dielectric test

Maximum Voltage Rating	Rated Lightning Impulse Withstand Voltage	Leakage Distance Nominal		60 Hz Dry Withstand Terminal to Ground	60 Hz Dry Withstand Terminal to Terminal	60 Hz Wet Withstand	60 Hz Wet Withstand Test Duration	Impulse Terminal to Ground	Impulse Terminal to Terminal
kV, rms	kV	Inch	(mm)	kV, rms	kV, rms	kV, rms	Seconds	kV	kV
17	150	24.5	(621)	70	77	60	10	150	165
27	150	27.4	(697)	70	77	60	60	150	165

Procedures

The 17 kV cutout with parallel groove conductor connectors listed in Table 5 was tested per IEEE C37.41 – 2008 clause 5, IEEE C37.42-2016 clause 8 and Table 8. In addition, the cutout was prepared per IEEE Std 4- 1995. This test was performed at Eaton's Thomas A. Edison Technical Center.

The 27 kV cutout with parallel groove conductor connectors listed in Table 5 was tested per IEEE C37.41 – 2016 clause 8, IEEE C37.42-2016 clause 8 and Table 8. In addition, the cutout was prepared per IEEE Std 4- 2013. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

There was no flashover or damage to the insulating material during the dry or wet withstand tests. The cutout passed the lightning impulse withstand test.

Conclusion

The cutout meets IEEE standards criteria for 150 kV BIL.

RADIO INFLUENCE TESTS

Object

Table 6 lists the maximum voltage rating of the class B cutouts tested. The standard test series requires tests of only the minimum of the fuse series, thus only one current level will qualify the cutout.

Table 6 Radio influence test

Maximum Voltage Rating (kV)	Interrupting Rating (kA)		Tested Fuse Ratings	Maximum allowable radio-influence voltage (µV at 1 MHz)
	Symmetrical	Asymmetrical		
17	14.0	22.4	3K	500
27	12.5	20.0	3K	650

Procedures

The cutouts listed in Table 6 were tested per IEEE C37.41 – 2016 clause 10, IEEE C37.42-2016 clause 6 and Table 12. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

All cutouts had a radio influence voltage less than the maximum value listed per Table 12 of IEEE C37.42-2016 and shown in Table 6.

Conclusion

The cutouts meet IEEE standards requirements for radio influence of class B fuses at rated maximum voltage of 17.2 kV and 27.0 kV.

HEAT RUN TESTS

Object

Table 7 lists maximum voltage rating of the class B cutout tested. The standard test series requires tests of only the maximum of the fuse series, thus only one current level will qualify the cutout.

Table 7 Heat run test

Maximum Voltage Rating (kV)	Interrupting Rating (kA)		Tested Fuse Rating	Maximum value of silver or nickel coated spring loaded contacts.	
	Symmetrical	Asymmetrical		Temperature (°C)	Temperature Rise (°K)
17	14.0	22.4	200E	105	65
27	12.5	20.0	200E	105	65

Procedures

A set of three cutouts with the maximum voltage rating listed in Table 7 were tested per IEEE C37.41-2016 clauses 5, 7, 11, and 18. The heat run is performed after the test unit experiences mechanical operation at temperature extremes per clause 18. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

All cutouts demonstrated thermal stability without thermal runaway. All silver coated contacts had a temperature rise and maximum temperature less than the values in IEEE C37.41-2016 Table 2 and shown above.

Conclusion

The cutout meets IEEE standards requirements for polymer insulator cutouts using silver coated contacts in air.

MECHANICAL ENDURANCE AT TEMPERATURE EXTREME TESTS

Object

Table 8 lists maximum voltage rating of the class B cutout tested. The standard test series requires tests of only the maximum of the fuse series, thus only one current level will qualify the cutout.

Table 8 Mechanical endurance at temperature extreme test

Maximum Voltage Rating (kV)	Interrupting Rating (kA)		Tested Fuse Rating	Number of cycles	Test Temperature	
	Symmetrical	Asymmetrical			°C	°F
17	14.0	22.4	200E	100	-40	-40
				100	40	104
27	12.5	20.0	200E	100	-40	-40
				100	40	104

Procedures

A set of three cutouts with the maximum voltage rating listed in Table 8 were tested per IEEE C37.41-2016 clause 18. This test includes 200 cycles of mechanical operation followed consecutively by: a heat run, a fuse element drop out, and a dye penetration test. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

After mechanical operation the cutouts had the same condition as the beginning of the test. There was no loose or deformed parts, cracks, or other obvious signs of visual deformation. The overall length of the fuse supports was measured to be in tolerance after endurance tests. The cutout allowed the fuse to drop out as designed. The dye penetration test did not show any signs of cracks or fracture in the core of the insulator.

Conclusion

The cutout meets IEEE standards requirements for polymer insulator cutouts in mechanical endurance.

THREE POINT BEND TESTS

Object

Table 9 lists the part number of the insulators tested.

Table 9 Three point bend test units

Part Number	Description	Quantity Tested
126116-24S	INSULATOR, 17KV, POLYMER CMU CUTOUT	3
4010474P01	INSULATOR, 27KV, POLYMER CMU CUTOUT	3

Procedures

This test utilizes specifics from ASTM D4476/D4476M-14, Standard Test Method for Flexural Properties of Fiber Reinforced Pultruded Plastic Rods to determine the crosshead loading rate. This test also uses the CSA C310-09 Rigidity standard by applying a 225-pound load and measuring the deflection. The test unit is positioned on a table with two of the end brackets down and one center mounting bracket up. The load is applied to the center mounting bracket. Three test units of each size are subject to this setup and loading. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

The 17 kV CMU cutout insulator has a deflection less than 0.03-inches when 225 pounds of force is applied. The load which causes the 17 kV cutout insulator to break is greater than 3,800 pounds with a crosshead rate of 0.42 in/min.

The 27 kV CMU cutout insulator has a deflection less than 0.06-in when 225 pounds of force is applied. The load which causes the 27 kV CMU cutout insulator to break is greater than 2,900 pounds with a crosshead rate of 0.60 in/min.

Conclusion

Each insulator break strength is greater than 2,900 lbs. The load application rate is significant to break strength and deflection.

HINGE MOUNT X-LIMITER FUSE COMPATIBILITY TESTS

Object

Table 10 lists the part numbers of the cutout, fuse and end fittings tested for mechanical compatibility and drop out operation.

Table 10 Compatibility test units

Description	Maximum Voltage Rating (kV)	Tested Catalog Number
Eaton 17kV CMU Cutout	15.5	S4CMUP1A
Eaton 15.5kV Hinge Mount X-Limiter Fuse		15F018HD1A

Procedures

Compatibility of the 17kV CMU Cutout and the 15.5kV Hinge Mount X-Limiter fuse was tested using Series 2 Interruption requirement defined in IEEE C37.41-2016 Clause 9.3. Thirty samples of fuse 15F018HD1A were tested. Each fuse was subject to mechanical operation of opening and closing the fuse, then tested for interruption. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

Hinge Mount X-Limiter fuses can physically be installed into the Eaton insulator and removed from the insulator. All units interrupted the circuit and the fuse dropped out as designed.

Conclusion

The Eaton CMU fuse insulator and fuse castings are compatible with Hinge Mount X-Limiter fuses.

S&C SMU-20 FUSE COMPATIBILITY TESTS

Object

Table 11 lists each catalog number of the class B cutout tested.

Table 11 Compatibility test units

Description	Maximum Voltage Rating (kV)	Tested Catalog Number
Eaton 27kV CMU Cutout	27	S9CMUP1A
S&C SMU-20 3K Fuse		703003
S&C SMU-20 140K Fuse		703140

Procedures

A set of two cutouts and three each of S&C SMU-20 fuses matching the catalog numbers listed in Table 11 were tested per IEEE C37.41-2016 Cor 1 – 2017 Table 5 class B fuses in Series 3. Each fuse is subject to mechanical operation of opening and closing the fuse, then tested for interruption. This test was performed at Eaton's Thomas A. Edison Technical Center.

Test Results

The S&C fuses can physically be installed into the Eaton insulator and removed from the insulator. All units interrupted the circuit and the fuse dropped out as designed.

Conclusion

The Eaton CMU fuse insulator and fuse castings are compatible with S&C SMU-20 fuses.

29 kV INTERRUPTION TESTS

Object

Table 12 lists the interrupting current (series 1), TRV parameters, and X/R ratio of each fuse rating and speed tested to 29 kV.

Table 12 Series 1 interruption test

Product	Nominal Voltage Input (kV)	Nominal Input Current	TRV Parameters		X/R ratio	Tested Fuse Ratings
		Symmetrical RMS (kA)	Frequency (kHz)	Peak Factor		
27 kV CMU Cutout	29.1	12.6	2.2	1.46	16.6	3K
						200K
						5E
						200E

Procedures

The product listed in Table 12 was tested per IEEE C37.41-2016 / Cor 1 – 2017 Table 5 for class B fuses in series 1 interruption. One cutout was tested at three different close angles for each fuse rating and speed. Additional test criteria are determined by IEEE C37.41 – 2016 clauses 7 and 9. The test was performed Powertech Labs.

Test Results

All cutouts cleared interruption and the fuse dropped out as designed. There was no indication of damage to the insulator. After interruption, the fuse contacts were in good condition.

Conclusion

All cutouts passed Series 1 interruption.

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REVISION TABLE

REVISION NO.	DATE	WHAT WAS ADDED/CHANGED
0	06/2019	New Report
1	10/2019	Added 29 kV test data. Add Revision table
2	12/2019	Added 15.5kV X-Limiter Compatibility, Renamed Compatibility Test to S&C SMU-20 Compatibility

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