138 kV, Type O Plus C II Condenser Bushings
Technical Guide
1 Introduction

The 138 kV, Type O Plus C II condenser bushing replaces the Type AB, 138 kV, condenser bushing. Both the electrical characteristics and physical dimensions are unchanged in the transition from Type AB to Type O Plus C II bushing. The change does two things: 1) the Type O Plus C II bushing uses much simpler style numbers (very similar to the standard Type O Plus C bushing) and 2) the Type O Plus C II bushing is not reconfigurable in the field except to change from 800 A draw-lead to 1200 A bottom connected with appropriate conversion kit.

1.1 Style Number

The style number for the 138 kV, Type O Plus C II condenser bushing will be written as: 138ZnnnnAA where nnnn is the current rating in amperes except in the case of TBI (transformer breaker interchangeable). In the TBI bushing these characters are written to show the current rating when applied to a transformer and when applied to an oil circuit breaker. The final two characters eg, AA, are used by ABB to describe the other characteristics of the bushing. Note that the fourth character “Z” becomes “Y” for brown porcelain.

1.1.1 Style Number Examples

<table>
<thead>
<tr>
<th>Type O Plus C II Style Number</th>
<th>Replaces</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>138Z0800AA</td>
<td>1ZUA138012-AAASEEABCG Through CK</td>
<td>Standard 138 kV bushing 800 A, draw-lead</td>
</tr>
<tr>
<td>138Z1216AK</td>
<td>1ZUA138012-AAASEWCXX</td>
<td>Standard 138 kV bushing 1200 A, bottom connect transformer and 1600 A for circuit breaker application</td>
</tr>
<tr>
<td>138Z1200AJ</td>
<td>1ZUA138012-AAASEDAXX</td>
<td>Standard 138 kV bushing 1200 A, draw rod</td>
</tr>
<tr>
<td>138Z1620AC</td>
<td>1ZUA138020-AAASMWCXX</td>
<td>Standard 138 kV bushing 1600 A, bottom connect transformer and 2000 A for circuit breaker application</td>
</tr>
<tr>
<td>138Z0800XA</td>
<td>1ZUA138012-AACSEEABBCG Through CK</td>
<td>Extended creep 800 A, draw-lead</td>
</tr>
<tr>
<td>138Z1620XC</td>
<td>1ZUA138020-AACSMWCXX</td>
<td>Extended creep, 1600 A, bottom connect transformer and 2000 A for circuit breaker application</td>
</tr>
<tr>
<td>138Z1216XK</td>
<td>1ZUA138012-AACSEWCXX</td>
<td>Extended creep 1200 A, bottom connect transformer and 1600 A for circuit breaker application</td>
</tr>
<tr>
<td>138Z3000XW</td>
<td>1ZUA138030-AACSMWCXX</td>
<td>Extended creep 3000 A, bottom connect</td>
</tr>
</tbody>
</table>
2 Basic Characteristics

2.1 Standards

The 138 kV Type O Plus C II condenser bushing meets all requirements of the IEEE bushing standards, i.e., C57.19.00, C57.19.01, C57.19.100 C57 and IEEE Seismic standard 693 (qualified at HIGH level). These bushings will also meet the thermal requirements of the CSA bushing standard and the electrical requirements of IEC 137.

2.2 Ratings

The standard ratings for this family of bushings are as follows:

Nominal system voltage = 138 kV
Maximum line-to-ground voltage = 88 kV
Lightning impulse voltage withstand (BIL) = 650 kV BIL
Current rating = see outline drawing
Creep distance = min 44 mm/kV L-G & see outline drawing
Seismic (IEEE 693) = High

2.3 Features

The 138 kV Type O Plus C II bushing is designed to operate under "Usual Service Conditions" as defined in IEEE C57.19.00, *IEEE Standard General Requirements and Test Procedures for Power Apparatus Bushings*.

The 138 kV Type O Plus C II bushing is of center-clamped construction, i.e., the bushing is held together by the action of clamping springs which act on the bushing conductor tube and hold the entire bushing assembly under a compressive load. The bushing is built around the central conductor tube on which the condenser body is wound. The upper and lower insulators, mounting flange, flange extension, spring assembly, sight bowl, lower support and clamping nut form an oil tight shell to contain the condenser and insulating oil. O-rings in grooves and/or flat fiber reinforced gaskets create the seals between components. High grade transformer oil fills the space between the shell and the condenser. This oil is part of the insulating and cooling systems of the bushing. Above the oil, there is a gas space to provide for thermal expansion of the oil. The gas space is filled with dehydrated nitrogen gas.

The bushing oil level is easily visible in the sight bowl. The sight bowl is prismatic to enhance observation of the oil level. See Figure 1.

The mounting flange and flange extension are high strength corrosion-resistant aluminum.
The upper (air-side) insulator is a one-piece, high quality porcelain with a shed configuration designed for maximum performance. The insulator meets the IEEE requirement for “Heavy Creep” which is 44 mm/ kV_L-G. Note that higher creep versions are also available.

2.4 Mounting
The 138 kV Type O Plus C II bushing is suitable for use at angles of up to 60 degrees from the vertical position.

2.5 Voltage Tap
The bushing is provided with a Type A (normally grounded) voltage tap as described in Figure 1 of the IEEE Standard C57.19.01. This tap is connected to one of the inner foil electrodes of the condenser. ABB tests the voltage tap at 20 kV, 50/60 Hz for 1 minute.

This tap is grounded under normal operation. If the voltage tap is used in conjunction with a potential/monitoring device, the voltage between the tap and ground should be limited to 6 kV.

3 Testing
As part of the manufacturing process, the bushing is subject to a number of routine tests.

3.1 Pressure/Vacuum Tests
Vacuum tightness is performed at nearly a full vacuum and a test is made with an oil over pressure of 41 psig for 8 hours at ambient temperature. No evidence of a leak is permitted.

3.2 Electrical Tests
Each bushing is subject to final electrical tests at ambient temperature with the lower end of the bushing submerged in transformer oil. The power-factor and capacitance are measured and the bushing is subjected to a one-minute power frequency test at a level of one-half the BIL rating. During power frequency testing the level of partial discharge is carefully monitored. The power-factor and capacitance are also confirmed after the one-minute test.

4 Bushing Loading

4.1 Current Rating & Over Load
The current rating of the 138 kV Type O Plus C II bushing indicates the maximum continuous rating of the device without abnormal loss of life. ABB designs these bushings for overloading according to IEEE Standard C57.19.100 with loss of life not to exceed the calculations included in that standard.

4.2 Short Circuit Current Rating
The bushing will withstand a short circuit of 25 times rated current for 2 seconds or the i²t equivalent with the following exceptions:

Draw-lead bushings: short circuit rating is defined by the draw-lead cable
Draw-rod applications have contacts with short circuit ratings of 20 times the continuous rating for not more than 2 seconds and a dynamic peak not to exceed 2.5 times the rms value of the fault.

For short circuit loss of life data relative to the bushing condenser insulation, contact ABB.

4.3 Draw-Lead Application

The sizing of the draw-lead cable is the responsibility of the transformer designer. The maximum rated current for the bushing in the draw-lead application is 800 amperes. The transformer designer must note the inside diameter of the bushing conductor tube because this will limit the choice of cable size. As a service to our transformer customers, we make the following suggestions relative to draw-lead cable size.

<table>
<thead>
<tr>
<th>Cable Size (MCM)</th>
<th>Cable Size (mm²)</th>
<th>Maximum Continuous Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>450</td>
<td>228</td>
<td>440</td>
</tr>
<tr>
<td>800</td>
<td>405</td>
<td>670</td>
</tr>
<tr>
<td>900</td>
<td>456</td>
<td>750</td>
</tr>
<tr>
<td>1000</td>
<td>507</td>
<td>800</td>
</tr>
</tbody>
</table>
5 Recommended Positioning

The maximum stresses in the oil at the lower end of the bushing must be limited to those values normal for uninsulated conductors of similar components in the same transformer. The lower insulator must be totally under oil for all operating conditions.

The following recommendations are intended as guidelines only. ABB recommends that specific design calculations be made to verify the proper clearances.

5.1 Distance of Grounded Edge from Live Parts
Within the angle of 0°- 45° from the end of the ground sleeve, the “Radius A” shall be a minimum of 0.125" (3.175 mm).

Within the angle of 45°- 60° from the end of the ground sleeve, the “Radius B” shall be a minimum of 0.25" (6.35 mm).

5.2 Distance of Grounded Flat Surface from Live Parts
“S” is the minimum distance from bushing live parts to a large surface such as a tank wall or core clamp.

5.3 Shielding of Exposed Threads
When applying these recommendations, all exposed threads must be shielded using a static shield assembly, bolting collar assembly or other appropriate shielding method.

Minimum Electrical Clearances

<table>
<thead>
<tr>
<th>Dimension “S” (inches)</th>
<th>6.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension “S” (mm)</td>
<td>165</td>
</tr>
</tbody>
</table>

6 Ordering Details
When ordering please specify the following:

- Bushing type and style number
- Current Rating
- Voltage Class and BIL
- Special requirements
• Special Requirements: Any nonstandard requirement, such as impulse tests or high temperature application, must be specified at the time of quotation.

6.1 Draw-lead Connected
If a draw-lead bushing is ordered, it will be shipped with the standard draw-lead connector as shown in Figure 3. In many cases, ABB has other draw-lead connectors. If you cannot use the standard draw-lead connector, please contact ABB for connectors.

6.2 Bottom Connected
The 138 kV Type O Plus C II bushing generally has the IEEE Std C57.19.01-2000 lower end configuration. Connection is made directly to the lower support of the bushing. Figure 4 shows the various lower support configurations for this line of bushings.

6.3 Draw-rod Connected
Draw-rod configurations of 138 kV Type O Plus C II bushings are available. Figure 6 shows a typical draw-rod configuration. Bushings that are suitable for draw-rod applications have an opening through the main axis of the bushing conductor. The draw-rod is pulled through this opening and secured at the top of the bushing. This makes it possible to remove/install bushings without draining the apparatus on which it is applied. With this application the current is not carried by the rod but is transferred to the bushing conductor at the lower end of the bushing. Therefore, the draw-rod rating of the bushing is the same as for bottom connected. However, the rating of the bushing does not affect the rating of the draw-rod. The rating of the bushing/draw-rod combination is never greater than the maximum rating of the lower rated component.

6.4 Top Terminal Connections
The Type AB bushings in this Technical Guide generally have IEEE Std C57.19.01 top terminals (see Figure 4). The purchaser can order bushings with other terminals if desired. The choice of terminals may affect price and/or delivery.
Figure 4
Epoxy Coated Shield Ring

8 - 0.500 - 13 UN Through on a 6.75 BC spaced at 45°

8 - 0.375 - 16 UN 0.750 deep on a 3.75 BC spaced at 45°

800 A, Draw Lead 1200 A Bottom Connect

Bolting Collar

Figure 5

Bolting Collar

7 - 0.500 - 13 UN Through on a 6.75 BC spaced at 45°

8 - 0.375 - 16 UN 0.750 deep on a 3.75 BC spaced at 45°

3000 A, Bottom Connect
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