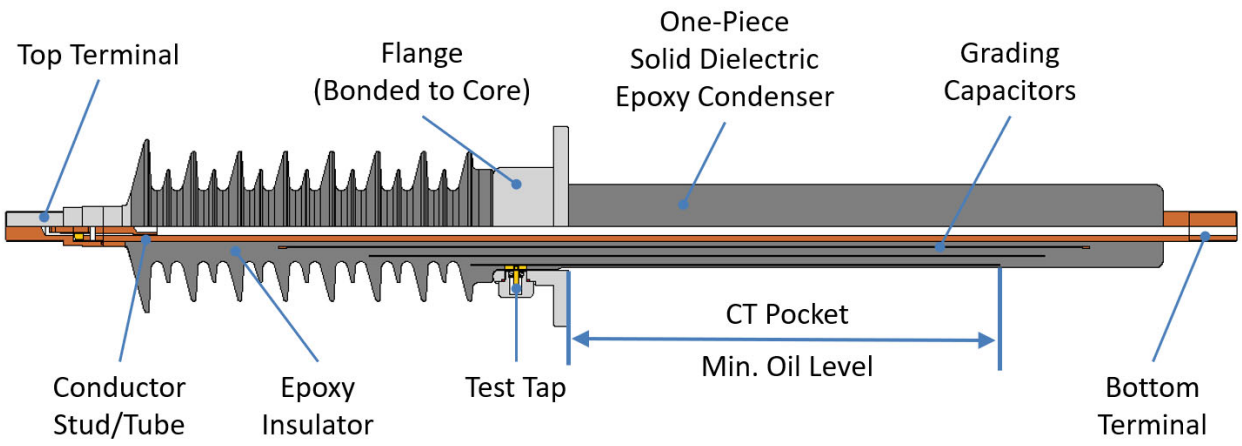
Electro Composites™
solid HV bushings solution

How an SDC™ Bushing Test Tap is Constructed

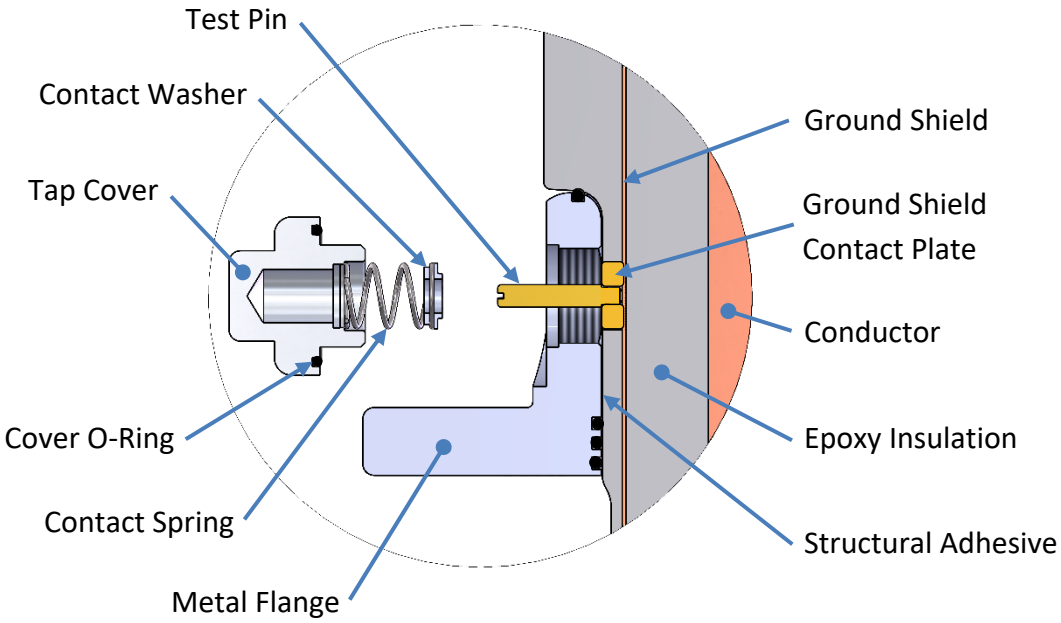
The typical construction of an Electro Composites SDC bushing is comprised of one-piece solid dielectric epoxy condenser core with encapsulated concentric grading capacitors and ground shield, and a central conductor stud or tube. The mounting flange is bonded to the exterior of the core using a high strength adhesive and typically includes a test tap. Depending on the rating and application of the bushing, the construction may vary (some bushings with a metal flanges or epoxy flanges do not have a test tap). This document applies solely to SDC bushings with a metal flange with a test tap and aims to address specifically the measurement of the bushing's tap insulation values, or C_2 power factor and capacitance. Measurement of the bushing's main insulation (C_1) power factor and capacitance is not covered in this document.

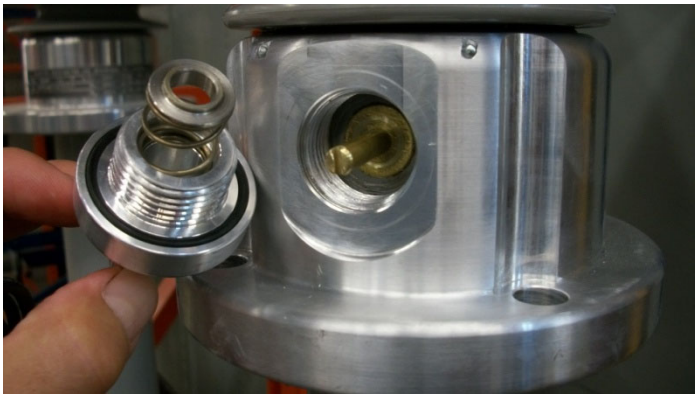
Cutaway View of a Typical SDC Bushing with a Test Tap



The test tap is comprised of a cover, spring, contact washer and sealing o-ring, and a connection pin threaded into the ground shield contact plate. When in place, the cover, spring, and contact washer are short-circuited to the ground shield contact plate to insure proper grounding during normal bushing operation. The bushing test tap must be screwed into the flange during normal operation of the bushing. Failure to fully screw the test tap in place when the bushing is in service will result in failure of the bushing.

Schematic View of a Typical SDC Test Tap



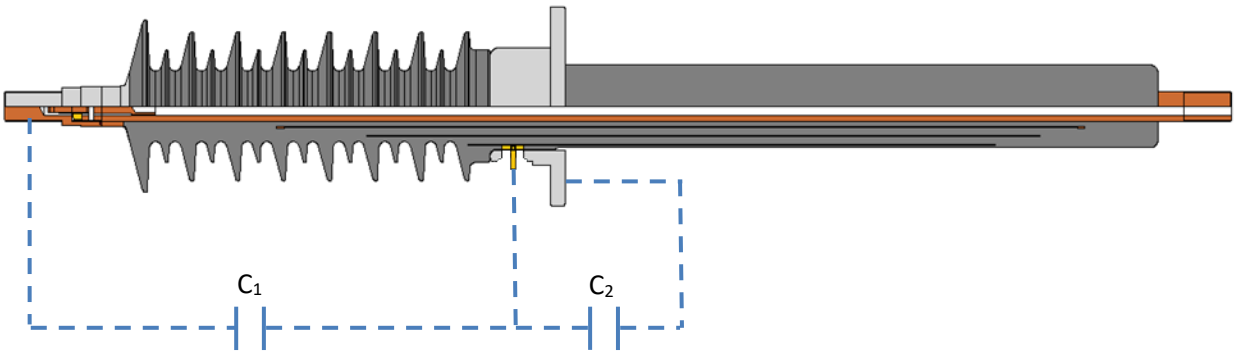


The tap cover, contact spring and washer are used to make electrical contact between the ground shield and flange. The spring and washer are press-fit into the cover and should not be disassembled. When the cover is screwed into the flange, the spring is compressed and insures proper contact with the ground shield contact plate. The tap pin is screwed into the ground shield contact plate and is only used to facilitate measurement of the bushing capacitance and power factor values. The cover o-ring seals the tap from moisture/water ingress.

Comments on Capacitance and Power Factor Measurements of the Tap Insulation on SDC Epoxy Bushings

An SDC bushing core can be broken down into two insulation/capacitive layers, each with a measurable capacitance and power factor, and both accessible through the test tap.

- The bushing's main capacitance, or C_1 capacitance, is the layer between the conductor and ground shield.
- The bushing's tap capacitance, or C_2 capacitance, is the layer between the ground shield and flange.



While the C_1 layer is completely comprised of the epoxy that makes up an SDC core, the C_2 layer is composed of a small layer of the core epoxy and a thin layer of structural adhesive (used to bond the flange onto the core). It is normal that the C_2 power factor differ from the C_1 power factor.

Both C_1 and C_2 values, as measured at the factory, are typically inscribed on the bushing nameplate for convenience. Most customers measure the C_2 values (tap capacitance and power factor) as part of their routine inspection. However, the C_2 tap insulation in an SDC bushing is not controlled as it is not intended for use as a voltage divider during normal bushing operation (see section 6.2 of the IEEE C57.19.00 – 2004 bushing standard), and in most situations, the C_2 values are not reproducible in the field, in particular when the bushing has been installed on the apparatus. Measurement of the C_2 values is highly susceptible to external factors during testing due to the way SDC bushings are designed (as explained above). We therefore do not recommend using the C_2 values as a diagnostic tool for the bushing's health. However, should you wish to measure and track C_2 values, please take the following points into consideration:

- The flange on an SDC bushing is bonded to the resin core using a very thin layer of high strength adhesive, where the thickness of the adhesive layer can vary from bushing to bushing and from model to model. When performing a C_2 measurement (tap insulation), the resulting values are the combined effect of the structural adhesive and a thin layer of epoxy insulation overlapping the ground shield. Therefore, the resulting power factor can vary greatly between bushings.

- During normal operation of an SDC bushing, the test tap and ground shield are grounded. As a result, the C_2 tap insulation is also grounded. Consequently, it is not subjected to any electrical stress and electrical deterioration.
- External factors such as stray leakage currents and capacitances, contamination, or moisture on the surface of the insulation or inside the test tap, differences in the ground plane (when bushings are installed on the apparatus vs testing at the factory), and other factors can disproportionally affect the C_2 capacitance and power factor. The structural adhesive is also more susceptible to moisture than the core insulation.
- Although the test tap is factory tested to a 2kV dry withstand test (for 1 minute), if the test tap is subjected to greater than 2kV, partial discharge within the tap can occur and negatively affect test measurements, as well as permanently damage the bushing.
- In order to measure the bushing C_2 values as closely as possible as at the factory, the bushing must be completely dry and clean, stabilized in temperature around 20°C, then suspended from the top terminal using an insulated sling or cable. The rest of the bushing should not be in contact with any grounded objects, other than the test equipment leads.

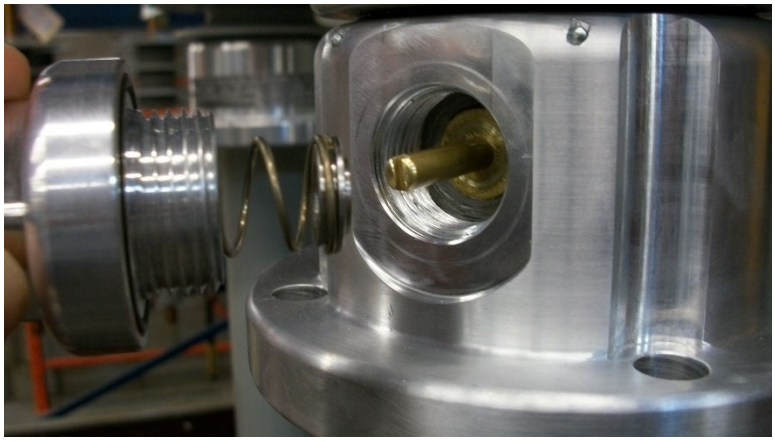
The C_2 values for an SDC bushing will generally vary between the values measured at the factory and those measured in the field. However, if C_2 testing is part of your operating procedures, the guidelines below should be followed when reviewing the test results of the bushing's C_2 tap insulation, provided the bushing has been thoroughly cleaned (see next section for test tap cleaning procedure) and all other potential testing issues have been eliminated:

- <5% - no action required
- between 5 to 10% - contact EC to troubleshoot
- >10% - contact EC before removing from service

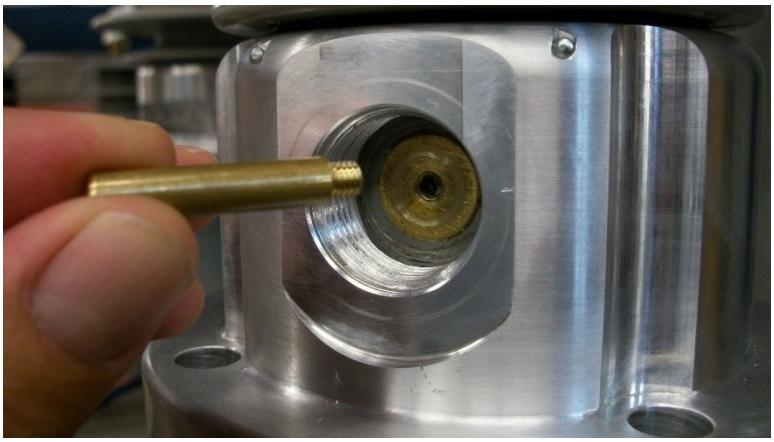
Recommended SDC Test Tap Cleaning Procedure

The following cleaning procedure is recommended if you are having C_2 testing issues and the test tap is deemed to require cleaning. **However, there is an inherent risk of damaging the test tap – please proceed with care.** These images are representative of Electro Composite test taps on SDC bushings with metal flanges, made in 2010 and later. Prior models do not have the contact washer at the end of the spring, the o-ring is not recessed, and the cover is round and knurled.

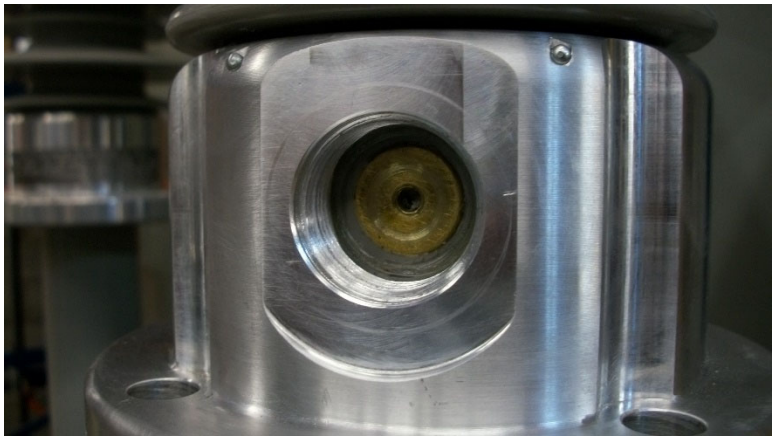
- Remove the test tap cover assembly by turning it counterclockwise.



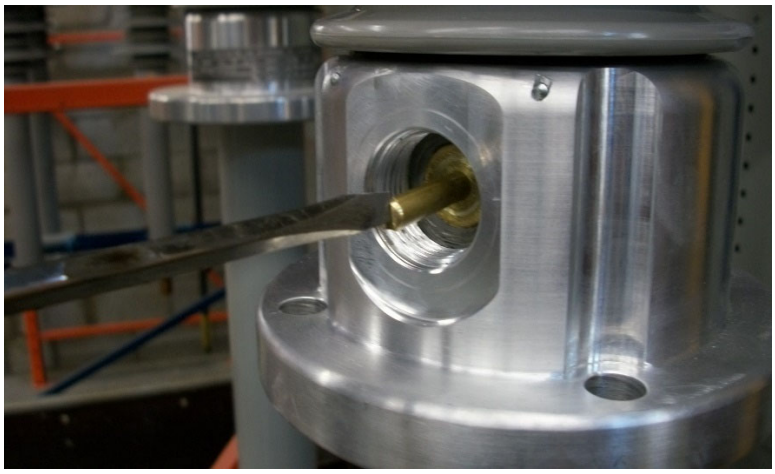
- Unscrew the test tap pin using a flat-head screwdriver.



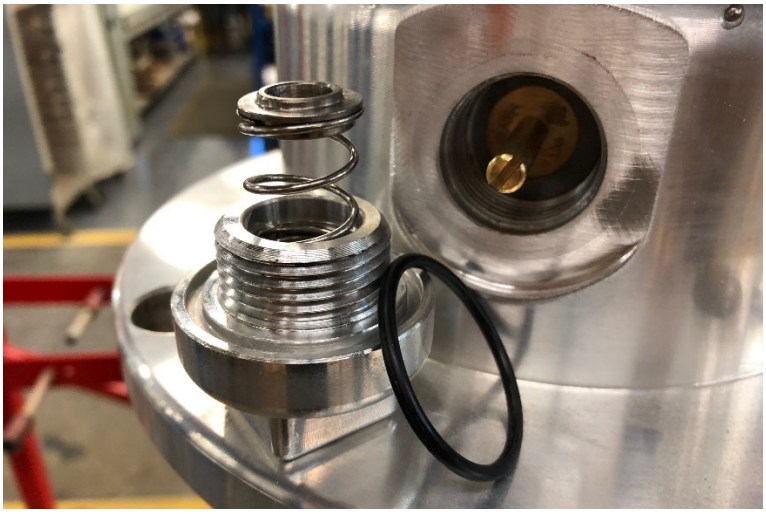
- Thoroughly clean the base of the test tap cavity with isopropyl alcohol or acetone using a clean lint-free towel, focusing on the circular band of grey insulation (tap insulation) surrounding the tap contact plate. A thin band of white material (flange adhesive) may also be seen surrounding the band of grey insulation.



- Thoroughly inspect the test tap visually using a bright light to make sure there are no metallic particles or any other contamination visible on the thin circular band of grey insulation surrounding the tap contact plate.
- Thoroughly dry the test tap. The presence of moisture will compromise the accuracy and validity of the C_2 readings. Use a hair dryer to assist with drying if necessary.
- Carefully screw the test tap pin back into the contact plate. Do not over-tighten or the pin thread may shear off. Check the base of the tap for any metal particles/filings and remove if present.



- To perform the bushing C_2 test, hook up the HV test lead to the tap pin, preferably using a lower weight wire equipped with alligator type jaws to prevent damaging the tap pin, and connect the LV test lead to the flange.
- Once the bushing has been tested, check the test tap cover o-ring for signs of aging (cracking, splitting, lack of elasticity) and replace as needed. Also check the flat face surface of the flange around the test tap for scratches or oxidation buildup and clean as needed. A small amount of petroleum jelly may be used to lubricate the o-ring when placing it into the tap cover. Do not fill the test tap with anything (leave dry).



- Thread the tap cover assembly clockwise ensuring that the spring and contact washer are securely in place inside the tap cover.
- Tighten the tap cover until it makes contact with the flange surface (metal to metal). Do not tighten the tap cover any further.

Please contact Electro Composites in case of any doubt or questions.

Email: Bushings@hubbell.com
Factory: 1-450-431-2777