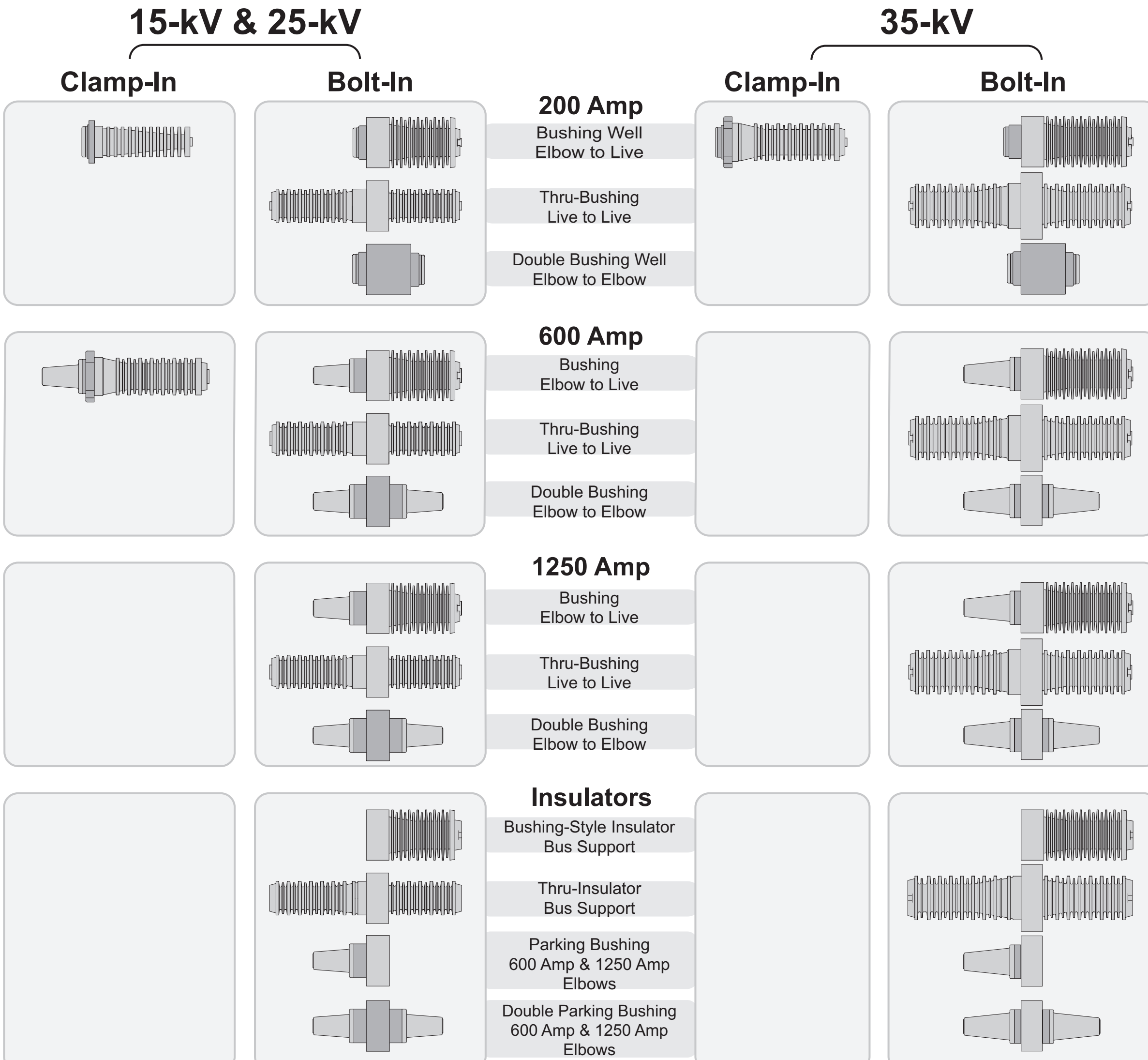
ELRIM Cycloaliphatic Epoxy Bushings

Elliott Apparatus Bushings are components used to construct Air-Insulated Switchgear, Metering Stations, Capacitor Stations, Dry-Type Transformers, Transformer Stations and other electrical distribution products. Elliott Apparatus Bushings are constructed of ELRIM cycloaliphatic epoxy with metal inserts and solid metal conductors for long life and cool operation.



A wide choice of Bushings and Accessories

We provide a wide choice of Elliott Apparatus Bushings for Air-Insulated Switchgear, as well as Apparatus Insulators, fuse clips, tools and special components. These bushings come in two mounting styles: Clamp-In and Bolt-In.

Clamp-In Bushings

Elliott "A" Series clamp-in Apparatus Bushings are designed to fit older-style equipment and used to upgrade or replace other manufacturer's failed bushings on existing equipment in the field. Each clamp-in bushing uses a different mounting configuration.

Bolt-In Bushings

For new designs, we recommend our higher performance "B" Series (bolt-in) bushings, which offer superior electrical performance, much higher cantilever strength and numerous design advantages. The "B" Series includes bushing wells, bushings, thru-bushings, double bushing wells, double bushings, parking bushings, double parking bushings and insulators that fit the same mounting provisions.

Elliott Molding and Components
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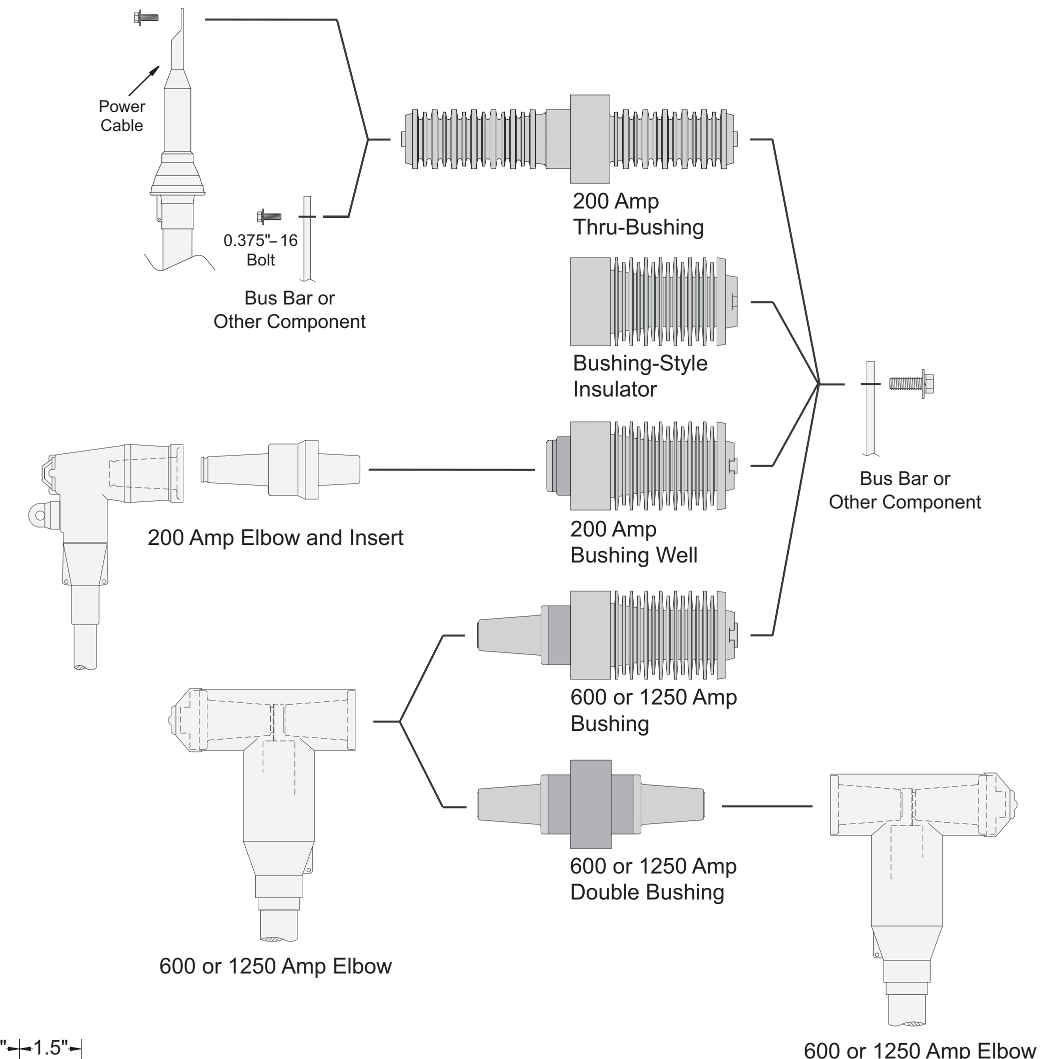
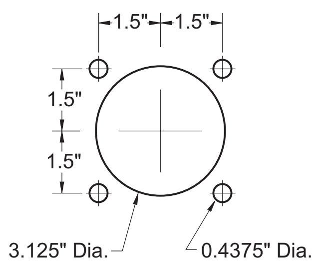
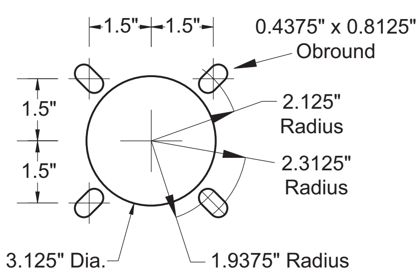




Standard Mounting Holes for Elliott "B" and "C" Series Bushings



Uni-Mount Mounting Holes Accepts Elliott and S&C Bushings

Universal Mounting System

Punch a Standard Mounting hole pattern or a Universal Mounting (Uni-Mount) hole pattern in your equipment mounting plate and you can install a wide variety of Elliott bushings, insulators and other components. Connect 200, 600 or 1250 Amp Elbows on the front side and connect to your live terminal equipment on the back. If you need to connect to stress-cone-terminated cable or bus bars on both sides, install a Thru-Bushing. If you need to connect to an elbow on the front and back, install a Double Bushing Well or Double Bushing. The Uni-Mount permits the installation of Elliott “B” and “C” Series bushings, as well as S&C bushings. Bushing-Style Insulators fit the Standard Mount and the Uni-Mount and can be installed in place of a Bushing. This allows the end-user to upgrade the equipment in the field. The Elliott system allows you to:

- Build live-terminal equipment with Thru-Bushings and replace them with Bushing Wells in the future to convert the equipment to deadfront.
- Field upgrade equipment by changing the 200 Amp Bushing Wells and bus to 600 Amp Bushings and bus as the load increases.
- Add an additional terminal in the field by removing a Bushing-Style Insulator and replacing it with a Bushing.

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History

Elbow-terminated, air-insulated pad-mounted switchgear was constructed with clamp-in bushings until both Elliott and S&C offered bolt-in ("B" Series) air-insulated bushings in 1981. Failures of the early clamp-in bushings included flashover due to partial discharge at the mounting hole, cracking due to thermal stress, interface voids and other design deficiencies. Determined to eliminate these problems, in 1975 Elliott Industries began offering bushings and insulators molded from cycloaliphatic epoxy. Advances in electrical shielding, manufacturing technology, material technology and design have elevated the performance to a superior level and eliminated the earlier problems.

Limitations of the Clamp-In design

An ideal bushing has plenty of cantilever strength, leakage distance and a standard mounting hole. To increase cantilever strength, a larger diameter shank is needed. If you keep the same length skirts, your mounting hole must increase in size. To keep the same mounting hole, you are forced to use shorter skirts, resulting in less leakage distance. Less leakage distance means less resistance to contamination, resulting in more field failures.

If you want to increase leakage distance, the designer can use more and longer skirts. Longer skirts mean a larger mounting hole unless you use a smaller shank. A smaller shank lowers cantilever and thermal shock strength. If the designer uses thinner skirts and uses more of them, leakage can be increased while holding the same cantilever strength. But thin skirts are fragile. If a thin skirt catches the edge of the mounting hole as the bushing is being installed, it will snap off. Our solution has been to increase the size of the hole to allow for adequate strength and leakage. This is why different model clamp-in bushings use different mounting holes and clamp rings.

The Elliott Solution

Elliott bolt-in bushings do not suffer from the design constraints of clamp-in bushings. Since the bushing installs from the back, only the interface must pass through the mounting hole. The shank and skirts can be of any diameter. This allows the bushing designer to use a large diameter shank for higher cantilever strength, while using lots of high leakage skirts for increased resistance to contamination. The design also provides for better electrical performance, a universal mounting hole and less chance of damage at installation.

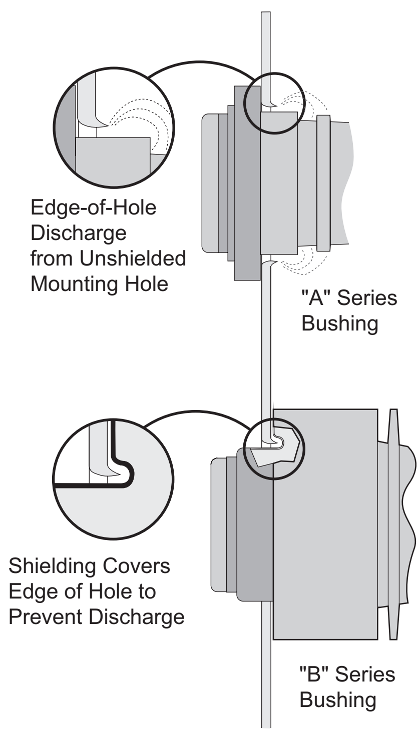
The first Elliott bolt-in bushing was our #1202-635B. We needed a 600 Amp 35 kV bushing. It was clear that the bushing needed a larger shank than any of our previous clamp-in designs, but the shank would be too large to fit through a hole without damaging the skirts. The obvious solution was to forget the clamp-in design and move the mounting flange to the back. We developed the #1202-635B bolt-in bushing and were very pleased with the resulting high electrical performance and mechanical strength. Over time, we developed an entire line of "B" Series products, including bushings, bushing wells, thru-bushings, double bushings, thru-insulators and bushing-style insulators. To the switchgear manufacturer, the Elliott bolt-in design is a huge advantage. Instead of having different equipment plate designs (depending on what combination of bushings a customer wants) the manufacturer can use a single design and install any combination of Elliott bolt-in devices the customer desires. Plus, the Elliott system and Uni-Mount makes it easier to upgrade equipment in the field.

Corona, moisture and tracking

The existence of corona in switchgear is very serious business. Corona (partial discharge) in air generates ozone, an unstable triatomic molecule of oxygen. Ozone is highly corrosive, second only to fluorine in its oxidizing power. Ozone can combine with water to create an extremely corrosive atmosphere. This water/ozone solution is one of the most corrosive substances known. The combination of corona, moisture and time will cause rapid decay of the equipment. We have seen poorly designed and built equipment suffer a very short life due to these problems.

Edge-of-hole discharge

When you punch a hole in sheet metal, you get a sharp edge where the punch passed through the sheet. When a conductor passes through the hole, large electrical stresses occur at the sharp edge, which can result in corona (partial discharge). If an unshielded bushing is installed, corona will slowly eat away at the insulation until failure occurs. If the bushing is mounted off-center in the hole, a higher stress is created where the air-gap is smallest, increasing corona activity.



The best clamp-in bushings add shielding to the shank, which greatly improves the situation. The bushing can still "see" the sharp edge, but its effects are minimized. Some manufacturers don't add this type of shielding to keep the price down. We believe this is false economy.

The Elliott bolt-in bushing completely shields the hole. The conductor cannot "see" the edge of the hole and is completely unaffected.

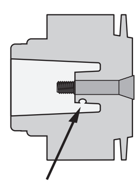
Sharp threads

In early bushing designs, live parts were mounted on a threaded stud on the shank. The stud was easily broken and its length limited the thickness of live parts. It also caused the flow of current to pass from the conductor, through a nut, flat washer and then to the bus bar. That's a lot of current flowing through a lot of small connections. In such a connection, it is extremely important to achieve proper clamping pressure – difficult to achieve on a fragile copper stud. Worse, the exposed sharp threads can cause corona.

We prevent those problems with a simple solution – female threads on a large diameter conductor. This design allows direct bus-to-conductor contact, eliminates all the extra fasteners and eliminates the corona-causing sharp threads. The installer can easily break a copper stud but is unlikely to break a bolt.

Interface voids

Due to the nature of the molding process, it is quite normal for a small percentage of production to have some imperfections. Often, the imperfections cause no performance problems. Usually, when such a flaw exists on the interface, the part is visually rejected before final electrical testing. Sometimes a void exists where it is nearly impossible to see. Proper electrical testing is needed to find these voids.



Hidden Void Detected only by Proper Testing with Interface Plug

Some vendors cut their testing costs by using a non-solid insulation in the interface (like oil). While quicker and cheaper, the electrical stresses are different; and we have found that oil can fill hidden voids and allow a defective bushing to pass testing. To insure our testing is meaningful, we use solid rubber interface plugs (or caps) that fit just like an elbow or insert. This accurately simulates operating conditions and allows an interface void to fail the test, just like it should.

Contamination

No matter how good a bushing is, excessive contamination can cause it to fail. However, there are a number of design features that can extend its life, even under severe duty. A design with greater leakage distance, no corona and lower electrical stress will serve considerably longer. Elliott bushings are designed with a generous amount of leakage (creep) distance. Our skirt design features a vertical-to-horizontal ratio of over 3:1. Our low stress designs operate corona-free and perform well even with significant contamination.

Elliott ELRIM Cycloaliphatic Epoxy

Elliott's experience with cycloaliphatic epoxy dates back to 1975 when cycloaliphatic epoxy bushing wells and insulators were utilized in 35 kV elbow-terminated pad-mounted switchgear. Successful field operating experience soon led to greatly expanded use of cycloaliphatic epoxy components.

Elliott bushings are manufactured with a liquid resin cycloaliphatic epoxy compound, which includes silica. This compound is pressure injected into a preheated, controlled temperature, precision shaped mold. Low viscosity and pressure injection allow the manufacture of bushings with multiple square-edge skirts and greater leakage distance for superior performance in contaminated environments.

Cast-in-place threaded and knurled brass inserts in the heavy-duty flange provides exceptionally high cantilever strength. Elliott "B" Series (bolt-in) bushings can be used to provide physical support for energized parts.

Elliott ELRIM cycloaliphatic epoxy bushings are homogeneous. If chipped by rough handling or vandalism, the exposed surface will provide the same performance characteristics of the unchipped surface.

Electrical Characteristics

Nontracking, self-scouring and nonweathering performance is characteristic of Elliott ELRIM cycloaliphatic epoxy bushings. Pyrolysis of cycloaliphatic epoxy bushings produces gaseous by-products such as water vapor and carbon dioxide that leave a virtually residue-free nontracking surface. A high temperature arc decomposes minute amounts of cycloaliphatic epoxy liberating water as steam that scours the surface of the bushing in the path of the arc. The bushings are resistant to ultraviolet radiation and do not react with water or contaminants due to the nonweathering qualities.

Test and Field Experience

Elliott ELRIM cycloaliphatic epoxy bushings have been tested to confirm impulse withstand ratings, corona extinction voltage, low frequency withstand dry and low frequency withstand wet. Mechanical testing confirms cantilever strength, tensile strength, torsion strength and compression strength. Thermal cycling withstand tests from +200°F to -200°F assure trouble-free field service for cycling loads in the most severe climatic conditions. In addition to the in-house testing, various utilities have tested bushings, apparatus insulators and line post insulators in their most severe outdoor test facilities to substantiate the superior performance of ELRIM cycloaliphatic epoxy.

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