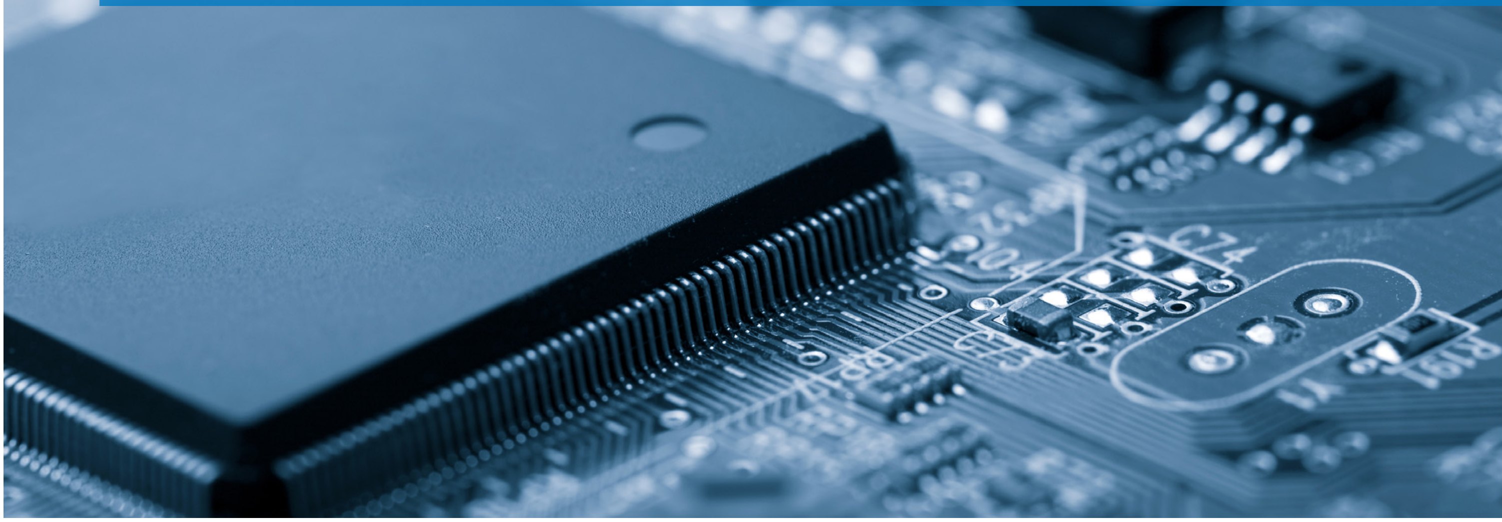

# How to apply fuse clips

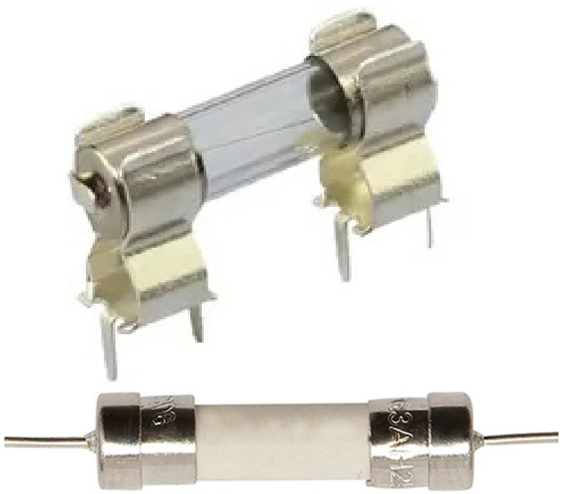

**Figure 1:** Fuses with axial leads can be leveraged for PCB installation. However, this prevents the user from easily replacing the fuse cartridge. Consequently, fuse holders are used for ease of fuse installation and replaceability.

### Employing fuse clips for cartridge fuses

Every electrical circuit has the potential for a damaging overcurrent or short circuit event. For this reason, many product standards are explicitly created to ensure product safety for the myriad of potential conditions it may be subjected to. The fuse is one of the most common devices to help protect electronic equipment and its users from the risk of electrical fire or shock due to these events, making it one of the most frequently employed solutions to obtain certification for these product and safety standards.

When it comes to electronic or printed circuit board (PCB) applications, cartridge fuses are a cost-effective option and typically have higher voltage and interrupting ratings when compared to other types of electronic or PCB fuses. Given these characteristics, they can help ease the fault current investigation required to meet safety standards. For example, a power supply design may include evaluating all possible ways a user may connect to a power source and the possible fault currents each of those sources may deliver.

When using cartridge fuses, a designer will need additional accessories to integrate this component on a PCB. Axial leads for thru-hole applications are one option (see **Figure 1**), but for designs requiring fuse replaceability or allowing the end-user to supply the fuses, fuse clips are a popular option. This document is intended to outline selection considerations, user guidelines, and considerations during assembly and fuse installation.

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### Fuse holder products

There is no one-size-fits-all fuse holder, and the suitability of the particular fuse clip depends heavily upon the end application. To best understand which fuse holder best meets the needs of an end application, see Eaton's guide on selecting a fuse holder. Eaton offers four different fuse holder products:

- Printed Circuit Board (PCB) fuse clips
- Printed Circuit Board (PCB) fuse holders
- Panel mount fuse holders
- In-line fuse holders

The fuse accessory selection guide offers assistance in selecting the correct fuse holders for a particular diameter fuse cartridge. The constructional differences between these types of fuse holders can be seen in **Figure 2**.

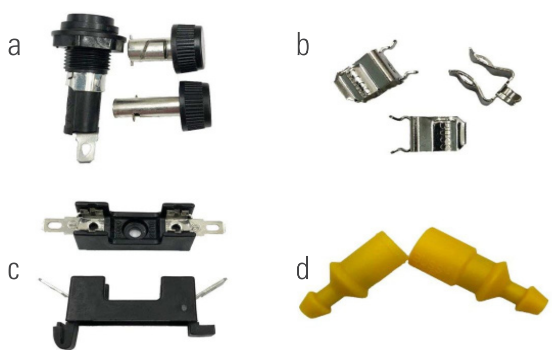


**Figure 2:** Four different fuse clips can be employed for cartridge fuses, including (a) panel mount fuse holders, (b) PCB fuse clips, (c) PCB fuse holders, and (d) in-line fuse holders.

### Fuse clip selection considerations

#### Choosing the right fuse clip for the cartridge fuse

Eaton offers a wide variety of PCB fuse clips for 5 mm, ¼" (6.3 mm), and 13/32" (10 mm) diameter cartridge fuses, as well as fuse clips for ATC/ATM auto blade fuses (see **Figure 3**). Much of fuse clip selection is due to preference; users may prefer a particular pin configuration or end stop variety for any number of reasons.

#### Fuse clip pin configurations

Eaton fuse clip circuit connections are all thru-hole. However, pin configurations can vary between straight, angled-out, angled-in, or the stand-off construction that keeps the bottom of the clip from hitting the board during the installation/removal process.

**Figure 4:** Fuse clips can come with straight, angled-out, angled-in, or stand-off configurations (left to right).

#### Constructional differences in fuse clips

Fuse clips can employ end stops (also referred to as "ears") to hold the fuse cartridge in place (see **Figure 5**). The choice between these two is mainly based upon the designer's preference. Both options provide an adequate fuse contact force while the end stops can help prevent connection issues due to fuses exiting the clips. As shown in **Figure 5**, these clips are of the same height (0.255") with the two fuse clip variations. Eaton offers 1/4" (6.3 mm) diameter fuse clips with straight, angled-in, and angled-out leads.

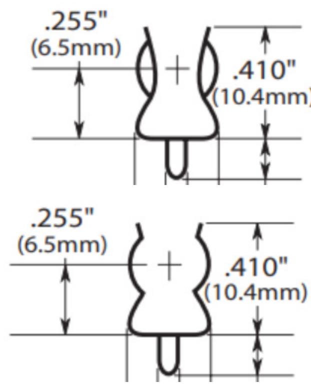


**Figure 5:** Fuse clips can either use end stops (top) or no end stops (bottom).

Some variations of ears (or end stops) will also include metal tabs as stoppers for the cartridge fuse.

**Figure 6:** Fuse clip with metal tabs to prevent slippage from horizontal motions or vibrations.

## Fuse clips

| Family | Max current rating | Fuses accepted | Circuit connections | 3rd party certifications |
|---|---|---|---|---|
| 1Axxxx | 40 A | 10 mm | Thru-hole | cURus |
| | 30 A | 1/4" (6.3 mm) | Thru-hole | cURus |
| | 10 A | 5 mm | Thru-hole | |
| | 15 A | ATC/ATM auto blade fuses | Thru-hole | |
| HTC-2xx | 6.3 A | 5 mm | Thru-hole | |

**Figure 3:** Specifications for fuse clips can be found in Eaton's circuit protection devices & applications catalog.

### Horizontal fuse height

The horizontal fuse height from the board varies per fuse family (see **Table 2**). This range in fuse heights from the board is most apparent in the various fuse clip families made for 5 mm cartridge fuses. The two fuse clips in **Figure 7** support the same 5 mm diameter cartridge fuse and have straight leads with standoffs. However, they have different fuse heights of 3.2 mm and 11.2 mm. The choice between fuse heights depends upon the access a user may need to the fuse clips and the profile of the PCB. Employing a shorter fuse clip for high integration, lower-profile PCBs may be more optimal.

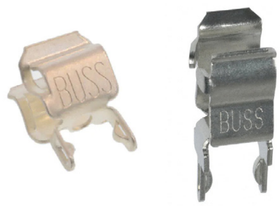


**Figure 7:** 1A3399 fuse clip with a 3.2 mm fuse height from the board and the 1A5018 fuse clip with an 11.2 mm fuse height from the board. Both options support 5 mm cartridge fuses.

### Body material

The fuse clip's body material and plating composition may vary as well (see **Tables 1 and 2**). Fuse clips must exhibit a high degree of strength and a resistance to permanent deformation to withstand the strain of fuse installation and replacement. For this reason, the body of the fuse clip must have a high yield strength and modulus of elasticity to provide adequate contact forces while also preventing any material deformations during handling (see **Table 1**). Additionally, the body materials contribute to the overall circuit resistance. Thus, selecting a reasonably conductive alloy to carry the operational current is another condition to consider. Generally speaking, more conductive alloys are recommended for higher current applications.

For each material, there are heat treating or additional manufacturing processes that help properly utilize the material properties of each alloy and ensure suitability for virtually all electronic applications, including the current carry capability.

### Plating composition

The plating composition of fuse clips is typically either bright tin or pure silver (see **Table 2**). The primary purpose of plating layers of fuse clips is to support solderability in the application. While both are good options for solderability, given the alloy markets, tin plating is a more economical option. Since there are differences in conductivity between these two plating alloys, silver plating does offer slightly improved conductivity for the overall clip. However, the thickness of plating doesn't provide significant improvements in current carrying capability. Each application and operational conditions are different though. Lastly, if there are concerns around tin whiskers of bright tin plating, silver plating does provide an option to avoid costly and time consuming testing to help speed to market.

**Table 1: Body Materials of Fuse Clips**

| Body Material | Yield strength | Modulus of Elasticity |
|---|---|---|
| Spring Bronze | 634 to 745 MPa | 100 GPa |
| Spring Brass | ~ 620 MPa | 97 to 110 GPa |
| Cartridge Brass | 76 to 448 MPa | 97 to 110 GPa |
| Beryllium Cu | 965 to 1205 MPa | 125 to 130 GPa |
| Cu Clad Steel | 441 to 1517 MPa | 173 GPa |

## Properly installing a fuse clip

### Fuse clip assembly

Two fuse clips must be horizontally aligned and orthogonal to the fuse cylinder to properly install fuse clips. Naturally, the centers of the fuse clips should be centered with the contacts of the fuse cylinder (**Figure 8**). This need for proper orientation and alignment of the fuse clips necessitates the use of fuse clips with identical fuse heights from the PCB. In this case, one fuse clip might contain end stops while the other might not for the ability to slide the fuse in and out. To mitigate the risk of an unusable fuse clip installation, employ two identical fuse clips. While the fuse clips have an inherent resistance to deformation, it is essential not to deform them due to improper installation, which includes not pressing the fuse past where it is intended to be held by the clip. This requires careful insertion/removal of any fuse cartridge. The through-hole fuse clips must be soldered straight to ensure proper heat rise. This way, the fuse clips and fuse assembly can carry current safely without issues.

**Figure 8:** Fuse clips must be in plane with each other and orthogonal to the fuse cylinder. It is crucial to get the orientation and alignment correct to install a fuse.

Per the UL4248, the UL standard for fuse holders, a dummy fuse is for testing and has a 30°C limit in order to have a consistent and standardized resistance. However, many fuses in the relevant fuse diameters have varying current handling capabilities and DC resistances (DCRs) than a dummy fuse. The DCR of the fuses will inevitably be higher than that of a dummy fuse, which will contribute significantly to a different heat rise vs the standard laboratory testing. For this reason, the standard approaches may not be sufficient for ensuring sufficient heat rise. Additional testing should be carried out under worst-case (or similar) conditions that the equipment may experience to ensure the suitability of the installation in harsh electrical and environmental conditions. This testing could include testing the board within higher ambient temperatures, higher currents, with the potential use of higher resistance fuses by end-users.

**Table 2: Fuse Clip Specifications for Cartridge-type Fuses**

| Diameter of Fuse | Fuse Family | End Stop Configuration | Pin Configuration | Fuse Height from Board | Fuse Clip Body Material | Plating Composition |
|---|---|---|---|---|---|---|
| 1/4" | 1A1119 | end stops | angled-in | 6.35 mm (0.25") | multiple | silver, bright tin |
| | 1A1907 | end stops | straight | 6.5 mm (0.255") | multiple | silver, bright tin, bright dipped |
| | 1A4534 | end stops | angled-out | 6.5 mm (0.255") | multiple | bright tin |
| | 1A1120 | no end stops | angled-in | 6.35 mm (0.25") | multiple | silver, bright tin |
| | 1A3398 | no end stops | straight | 6.5 mm (0.255") | catridge brass | bright tin |
| | 1A4533 | no end stops | angled-out | 6.5 mm (0.255") | multiple | bright tin |
| 5 mm | 1A5601 | end stops | straight, stand-offs | 4.73 mm (0.186") | multiple | bright tin |
| | 1A5602 | end stops | straight | 6.35 mm (0.25") | catridge brass | bright tin |
| | 1A3399 | end stops | stand-offs | 3.2 mm (0.125") | multiple | bright tin, silver |
| | 1A5018 | end stops | stand-offs | 11.2 mm (0.44") | spring bronze | bright tin, silver |
| 13/32" | 1A3400 | end stops | straight | 18.5 mm (0.73") | catridge brass | bright tin |

Other worst-case scenarios may consist of the experimental use of thinner PCB traces or wires with no ambient airflow. Larger PCB trace weight can help thermally conduct and dissipate additional heat. Natural or forced convective cooling would also reduce heat rise; however, suitability is up to the end application. Eaton and authorized distributors provide the expertise and required samples to assist engineers in designing and installing fuses.

Dimensions

| | A | | | | | | ATC | ATM | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Catalog number | 7/8" (22.2mm) | 1" (25.4mm) | 1¼" (31.8mm) | 1⅜" (34.93mm) | 1½" (38.10mm) | 20mm | — | — | B Tabs | C (4 holes) | Board thickness |
| 1A5778- | — | — | | | — | — | — | 0.464" (11.79) | 0.144" (3.66) | 0.065"±0.002" (1.65±0.05) | 0.062" (1.57) |
| 1A5779- | — | — | | | — | — | — | 0.464" (11.79) | 0.144" (3.66) | 0.065"±.002" (1.65±.05) | 0.062" (1.57) |
| 1A5780- | — | — | | | — | — | 0.560 (14.22) | — | 0.200" (5.08) | 0.100"±0.002" (2.54±0.05) | 0.062" (1.57) |
| 1A3398-<br>1A1907- | 1.00" (25.40) | 1.125" (28.58) | 1.375" (34.920) | — | — | — | — | — | 0.295"-0.305" (7.49-7.75) | 0.067"-.070" (1.70-1.78) | 0.093" (2.36) |
| 1A1119- | 1.00" (25.40) | 1.125" (28.58) | 1.375" (34.92) | — | — | — | — | — | 0.295"-0.305" (7.49-7.75) | 0.093"±0.002" (2.36±0.05) | 0.062" to 0.125" (1.57to3.18) |
| 1A1120- | 1.00" (25.40) | 1.125" (28.58) | 1.375" (34.920) | — | — | — | — | — | 0.295"-0.305" (7.49-7.75) | 0.093"±0.002" (2.36±0.05) | 0.062" to 0.125" (1.57 to 3.18) |
| 1A3399- | — | — | | | — | 0.875" (22.23) | — | — | 0.200" (5.08) | 0.067"-.070" (1.70-1.78) | 093" (2.36) |
| 1A3400- | — | — | | 1.50" (38.10) | 1.625"— (41.28) | | — | — | 0.405" (10.29) | 0.091"-.095" (2.31-2.41) | 0.125" (3.18) |
| 1A4533- | 1.00" (25.40) | 1.125" (28.58) | 1.375" (34.920) | — | — | — | — | — | 0.300" (7.62) | 0.067"-.070" (1.70-1.78) | 0.062" (1.57) |
| 1A4534- | 1.00" (25.40) | 1.125" (28.58) | 1.375" (34.920) | — | — | — | — | — | 0.300" (7.62) | 0.067"-.070" (1.70-1.78) | 0.062" (1.57) |
| 1A5018- | — | — | | | — | 0.820"±0.015" (20.80±0.38) | — | — | 0.180" (4.6) | 0.053"-.002" (1.35-0.05) | 0.093" (2.36) |
| 1A5600- | — | — | | | — | — | — | — | 0.200" (5.08) | 0.062"±0.003" (1.57±0.077) | 0.125"max. (3.18) |
| 1A5601- | — | — | | | — | 0.820"±0.015" (20.80±0.38) | — | — | 0.266" (6.76) | 0.067"±0.003" (1.70±0.074) | 0.062" (1.57) |
| 1A5602- | — | — | | | — | — | — | — | 0.220" (5.588) | | 0.125"max. (3.175) |

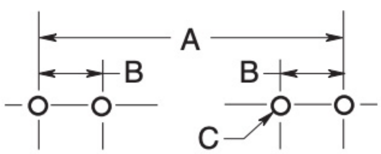


**Table 3:** PCB layout from the 1Axxxx datasheet.

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