

APPLICATION NOTE

Using Riedon™ UL Class T and ANL Fuse Blocks by Bourns to Streamline Modular, Safe, Easy-to-Use Fuse Designs



Riedon™ FB Series Fuse Blocks by Bourns



Riedon™ NFB Series Fuse Blocks by Bourns

Introduction

Modular. Safe. Easy-to-use. These are terms used throughout the electronics industry to describe component attributes that are sought after for any design. For fuse devices, fuse blocks are the epitome of these terms, allowing fuses to be designed into a system that requires users or technicians to test and replace fuses in a safe and reliable manner, while also minimizing downtime. For these reasons, fuse blocks are an essential design tool enabling developers to easily achieve a modular, safe, and easy-to-use design.

Subsequent text provides: 1) a brief introduction to fuses, specifically Class T and ANL type fuses; 2) a discussion of the features and benefits designed into Riedon™ fuse blocks by Bourns; and 3) descriptions of applications that benefit from fuse blocks.

Fuses: A Brief Overview

Fuses are a necessary component for power safety in all designs. Fuse origins began as a piece of copper patented by Thomas Edison in 1890 for “Improvement in Lightning-Arresters” in telegraphy applications.^[1] In today’s modern age, fuses remain a highly passive device used for overcurrent protection. As with any technology, the fuse has greatly improved performance over the original Edison design by incorporating quartz sand, multiple “bridges” with various geometries, differing materials for the outer casing, and with a wide variety of metal element alloys. These design changes all have one common goal: to “open” the circuit in a desired fashion and contain an arc in the event of a short-circuit or overcurrent situation.

Edison, at the time, designed his fuses on a whim and they were based solely on his specific application. Today, engineers and designers for low-voltage fuses must meet strict standards dictated by Underwriters Laboratories (UL), predominately for North American markets. The UL 248 standard, applicable to “Low-Voltage Fuses,” includes classes of fuses (UL’s naming convention is “Class XX” where typical classes are CC, J, and T, among others), each having their own function. They are delineated by their current ratings in the UL 248 standard, with each segmentation defined by peak let-through currents and I^2t values at specified fault currents ranging from 50 kA to 200 kA in the case of Class T fuses. There is also a constraint put forth by the UL 248 standard on the construction of the fuse, where each current rating range has specific body styles and dimensions. For your convenience, Table 2 at the end of this paper simplifies this description for UL 248 Class T fuses.

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Fuses: A Brief Overview (Continued)

The Class T fuse is available in only two styles: the ferrule and the knife blade. These designs lend themselves to needing a fuse block for a sustainable, non-complicated design that is both modular and safe.

ANL fuses are categorized as “special purpose” fuses per the UL 248 standard. Fuses in this category are different from the previously described Class T fuses. For context, special purpose fuses can cover several types of fuses, such as forklift, cable protection, telecommunication, and capacitor fuses. Instead of being put into classes, special purpose fuses will typically be “UL Recognized” and are intended to be incorporated into larger systems. Practically, special purpose fuses are tested by UL to the specifications published in the manufacturer’s data sheets. If UL deems the testing results as passing, then the fuses will be given UL recognition. Therefore, while still tested by UL, ANL fuses do not have a standardized dimensional requirement. However, this caveat pertains only to special purpose type fuses where UL does not require a specific “look”. For example, Figure 1 shows special purpose fuses with differing appearances. For this reason, Bourns recommends checking dimensions with a data sheet to ensure proper fitting.



Figure 1. | Special purpose fuses of differing styles ^[2]

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Why Fuse Blocks Matter

One of the side effects from having a standardized design, as described previously, is that each current rating has dimensional constraints driven by the physics of power and fusing needs. This is a key reason fuse blocks have taken a modular approach in the design cycle. Tables 2 and 3 at the end of this paper, describe this effect within certain ranges of current ratings, where the dimensions of the fuse do not change. Taking from Table 4, a fuse block that is designed with the dimensions described in the 101-200 A range for Class T fuses can be used for all fuses rated 101-200 A. Similarly, ANL fuses are the same dimensions from current ratings ranging from 35 A to 750 A. Thus, the same fuse block can be used for a variety of current ranges. This modularity can prove useful in designs that have designated space for a fuse block, but load currents vary per design. Modularity is not the only benefit that proves a fuse block to be a worthwhile investment. An additional consideration is that fuses must be properly mounted to ensure safety.

For any design involved with fuses, the fuse must be positioned correctly within the circuit. As an example, some may think that simply having the fuse “free-floating” in the air using the attached cables and connections between two wires is sufficient. However, by doing this, a design becomes at risk for possibly shorting to other parts of the circuit, or worse, to humans by contact. Fuses have considerable mass, as they contain sand and copper as part of their safety system. If not properly secured by chassis mount via a fuse block, over time, an unsecured fuse in constant movement or motion can cause connections of wire to slip or degrade and create a short-circuit or human-shock hazard.

By adding a fuse block, the weight of the fuse becomes null as the fuse block is mounted to a stable point in the design. This aids in reducing strain on wire connections and eliminates the possibility of the fuse moving.

Another benefit of fuse blocks is ease of use. By using a fuse block, replacing a fuse in the event of an overcurrent situation is made trivial. In the case of a knife blade fuse design, the fuse is bolted to the fuse block allowing a simple nut driver to loosen the fuse free. With “free-floating” fuses, especially in the case of a soldered connection of a “free-floating” fuse, the process of removing the fuse can be laborious if it is in a small space.

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Selecting and Installing a Riedon™ UL Class T or ANL Fuse Block by Bourns®

Because fuse blocks can help enhance designs involving fuses, there are four different UL Class T fuse block model series offered. Made of fiberglass reinforced polycarbonate, these are designed for 300 VAC rated UL Class T fuses with current ratings of 110–200 A and 250–400 A. Along with the two current rating ranges, Bourns also offers multiple wire termination styles that include bare wire or ring/spade terminations.

Described below in Table 1, designers can select the correct fuse block for a given application.

Table 1. | Selecting the Correct Fuse Block

Wire Connection Type	Rated Current of Class T Fuse (A)	Voltage Rating of Class T Fuse (V _{AC})	Model Series
Bare	110 - 200	300	CFB1
Bare	250 - 400	300	CFB2
Ring/Spade	110 - 200	300	FB1
Ring/Spade	250 - 400	300	FB2

Hardware is included (for the fuse bolt downs and terminals; mounting hardware is not) with all Riedon™ fuse blocks by Bourns, as well as a snap-on acrylic cover for added safety. All parts are rated to 750 VDC dielectric strength from terminal block to base.

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Selecting and Installing a Riedon™ UL Class T or ANL Fuse Block by Bourns (Continued)

A description of installing a fuse block for the ring/spade wire connection option is given below.

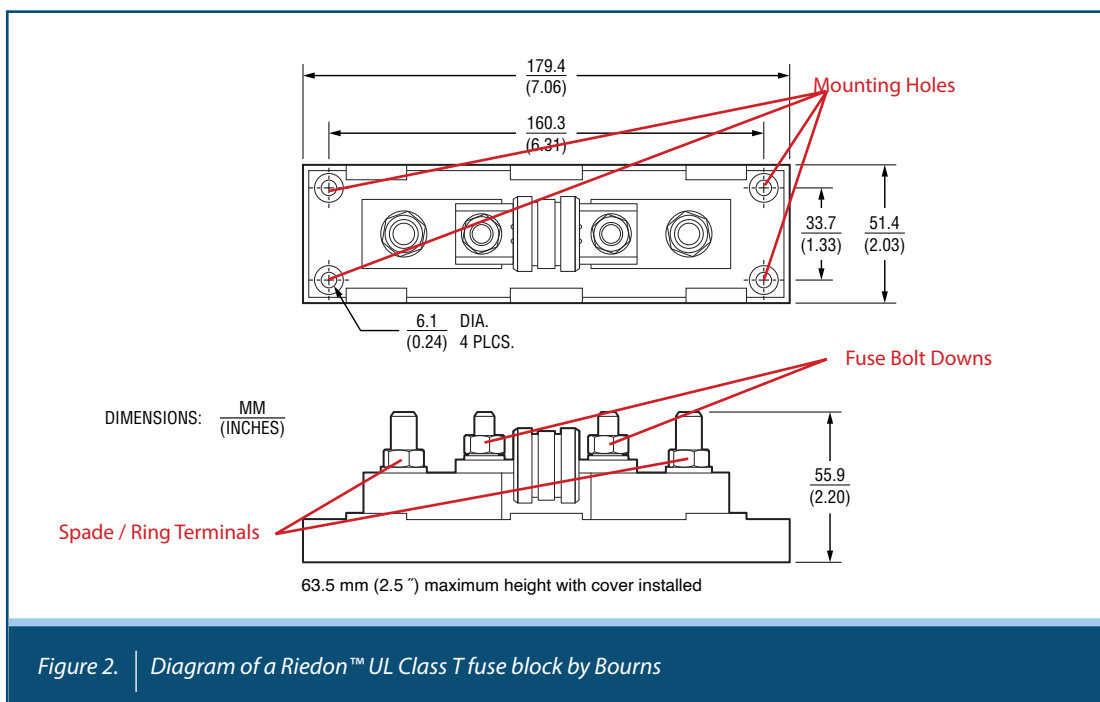


Figure 2. | Diagram of a Riedon™ UL Class T fuse block by Bourns

When reviewing Figure 2, and considering the previous discussion regarding fuse block criticality, mounting holes are provided as part of the fuse block structure to connect the fuse block to a rigid body or chassis. This will ensure that the fuse block remains in place (given that it is tightened correctly in the design). Bourns recommends using all four mounting holes for securing the fuse block while taking care that the material being bonded to the fuse block is a strong material. It is important to note that bonding to metal may need extra care (a reminder that the dielectric strength is 750 VDC from terminal to base).

The fuse should be of the correct current and voltage rating for the specified fuse block (shown in Table 1). The right placement of the fuse is between the fuse bolt-down terminals. These connections are secured with the provided lock washer and nut. The fuse should be firmly mated to the fuse terminal blocks, making sure there is no slack.

The spade/ring terminals are for wires with spade/ring terminations only. Again, the connections should be secured using the provided hardware and firmly mated to the terminal block. Once the steps above are successfully completed, the designer can then snap-in the provided acrylic shield for added security during the operation of the fuse. These same steps apply for a bare wire connection.

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Selecting and Installing a Riedon™ UL Class T or ANL Fuse Block by Bourns (Continued)

Riedon™ ANL fuse blocks by Bourns are much the same. Figures 3 and 4 show the two styles offered: Model NFB and Model NFB2 Series, respectively.

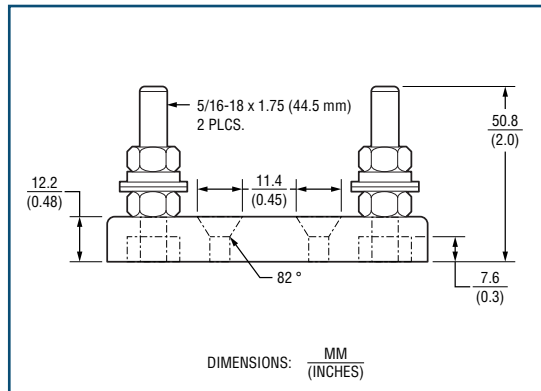


Figure 3. Riedon™ Model NFB Series fuse block by Bourns

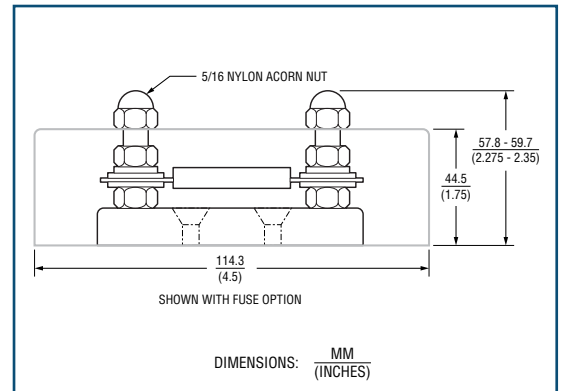


Figure 4. Riedon™ Model NFB2 Series fuse block by Bourns

These two styles differ in the base material, where the Model NFB Series is a heavy duty phenolic and the Model NFB2 Series is a Glass-filled Polycarbonate. Both series' dielectric strengths from terminal to base are 750 VDC. Both include hardware with purchase (not including mounting hardware) and a clear polycarbonate shield for increased safety. Note that the included shield for the Model NFB and Model NFB2 Series differ in dimensions with the shield for Model NFB2 Series being larger. Both fuse holders also accept ANL fuses. Please refer to the respective Bourns data sheets for more information.

Installation of these Model NFB fuse blocks is different from installation of UL Class T fuse blocks. Like UL Class T fuse holders, Model NFB fuse holders still require proper mounting as prescribed. However, borrowing from Figure 3, the fuse and wire must be sandwiched between the included washers for correct installation. The wire requires the use of a spade/ring termination, and the installer must not use bare wire. The included nut and split washer should be used to tighten the fuse and wire to the fuse holder. Overall, it is important that the fuse and wire are flush and firmly connected to the fuse holder.

In order to fasten the polycarbonate shielding to the fuse holder, installers should use the included acorn nut after installing the fuse.

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Common Applications for Fuse Blocks

Fuse blocks are typically not visible. In most applications, they will never be seen. They tend to be placed behind panels or doors that are rarely opened, and when they are, it is usually by qualified professionals. However, this does not discredit the benefits that a fuse block offers.

A common application of a Riedon™ fuse block by Bourns is the protection of inverters in various applications. Namely, solar inverters are a large market for this product. With the allowance from UL Class T and ANL fuses, applications that have high load currents will need a proper fuse block as shown in Figure 5.

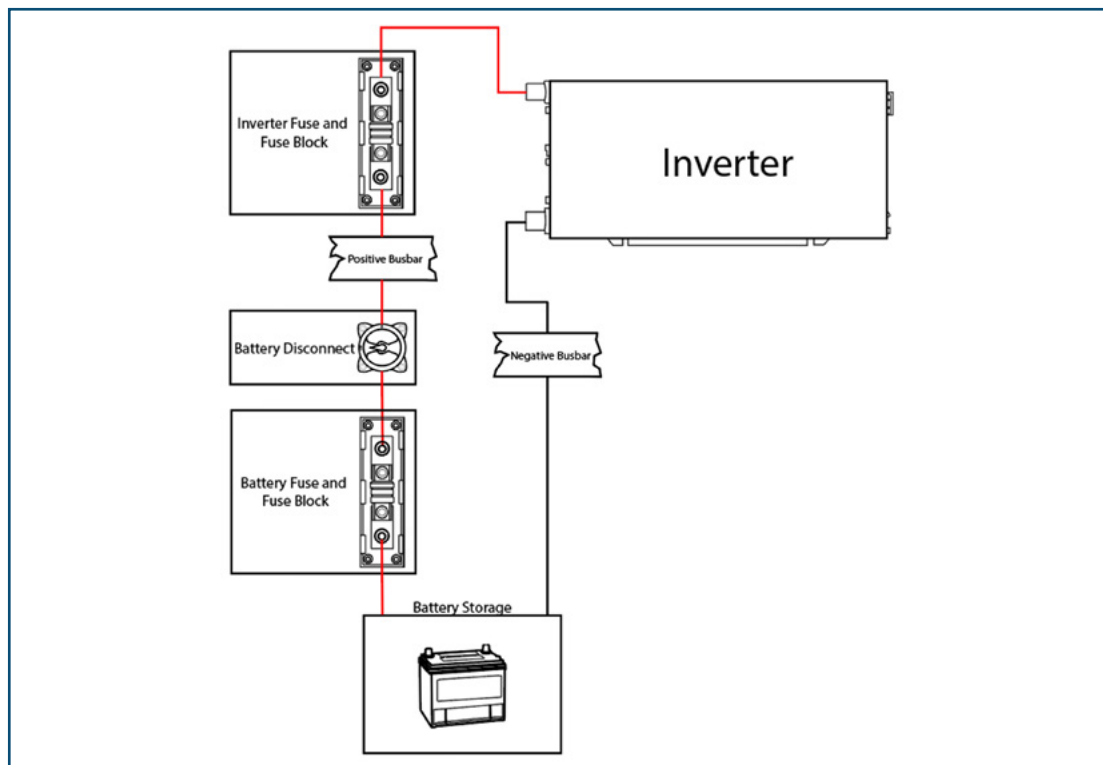


Figure 5. | Common inverter set-up diagram on a simplified circuit
(Note: this set-up does not include modules such as the battery charger and solar array)

Due to the inherent current draw from an inverter, typically these circuits will require a fuse with a high current rating. It is important to fuse both the inverter and battery for maximum protection. The batteries provide a low DC voltage well in the voltage range of 300 VAC UL Class T and ANL fuses, and many manufacturers will recommend this fusing arrangement. Once a current rating is decided, it is important for the designer to revisit Table 1 (unless ANL fuse holders are used) to properly select the correct Riedon™ fuse block by Bourns for their application. For example, in the case for a UL Class T fuse, if the fuse chosen is 200 A and the wire terminations are spade/ring, then a Riedon™ Model FB1 Series fuse block by Bourns would be the correct choice.

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Common Applications for Fuse Blocks (Continued)

Another application that can benefit from using a Riedon™ fuse holder by Bourns is an industrial application. These types of applications are housed in cabinets and electrical boxes seen in outdoor and factory type settings. Again, not visible to most, but within the cabinets are a host of electrical components. Each housing will have some form of overcurrent protection, with a main choice being fuses. With each fuse, there will be a fuse holder providing stable mounting.



Figure 6. | Image of a typical cathodic protection rectifier

One such application is a cathodic protection rectifier. These rectifiers step down voltage from AC mains into a lower AC voltage on the secondary side of a transformer. Adjustable voltages can be selected via taps on the transformer. The voltage is then rectified into a DC voltage used to prevent corrosion on metal pipes and tanks. The DC current can be in the range of 110-400 A and of 100 VDC, making a UL Class T fuse an ideal candidate for overcurrent protection. Figure 7 illustrates the system and where a fuse block is necessary.

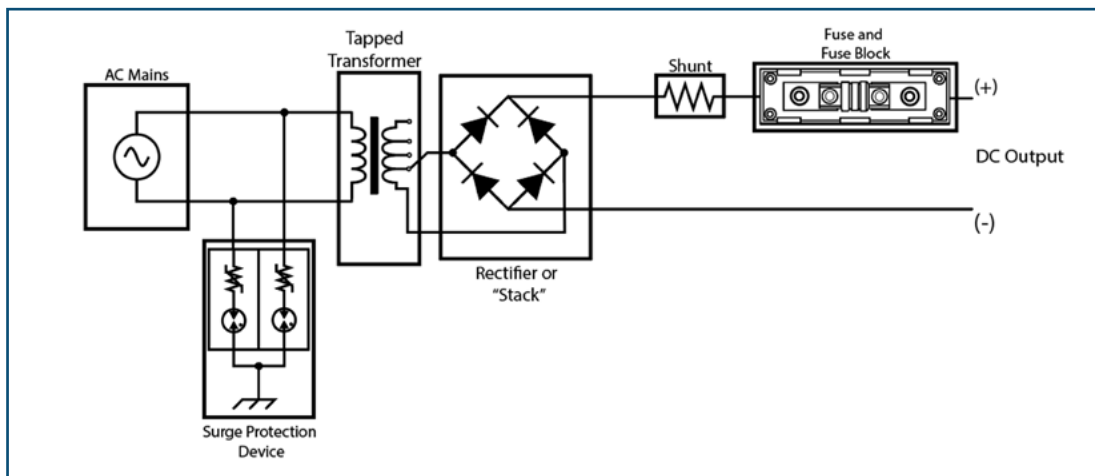


Figure 7. | Typical cathodic protection rectifier circuit^[3]

With the panels open, Figure 6 shows the complexity that an unassuming electrical box can contain. Within it, the tapped transformer and rectifier or "stack" mentioned previously are contained. This is coupled with controls, surge protective devices (SPDs), and shunts. The fuses and associated fuse blocks will also be found within this container. Again, without implementing a fuse block within this application, regardless of conditions to help ensure its reliable operation, the design would not have the ruggedness and performance that it is required to achieve.

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Fuse Characteristics

Table 2. | A simplified table excerpt from UL 248-15 Low-Voltage Fuses – Part 15: Class T Fuses ^[4]

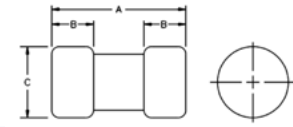
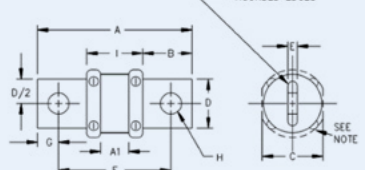
UL 248 Class T Fuse Requirements				
Fuse Rating (A)	Rated Voltage (V _{AC})	Peak Let-Through Current at 200 kA (A)	I ² t at 200 kA (A ² s)	Image of design
1–30	300	9000	3500	
61–100	300	20000	150000	

Table 2 describes a condensed version of the UL 248 standard for Class T fuses. This table omits overload current testing, temperature rise, 50 kA/100 kA fault currents, and much more because each current rating specified by UL 248 will have different requirements on these tests.

The objective of this table is to show the vast difference in the physical design of a Class T fuse between fuse current ratings. As shown, Class T fuses of 1–30 A current ratings are required to be of ferrule design, while the 61–100 A are knife blade designs. More wholly, 1–60 A current ratings will be of ferrule design, while 61–1200 A will have the knife blade design. Although one may question why 1–30 A is specified when current ratings of 1–60 A are of the same construction, this is due to the difference in the dimensions between certain current ranges (as specified by UL 248). Tables 3 and 4 show these current ranges and differences in dimensions.

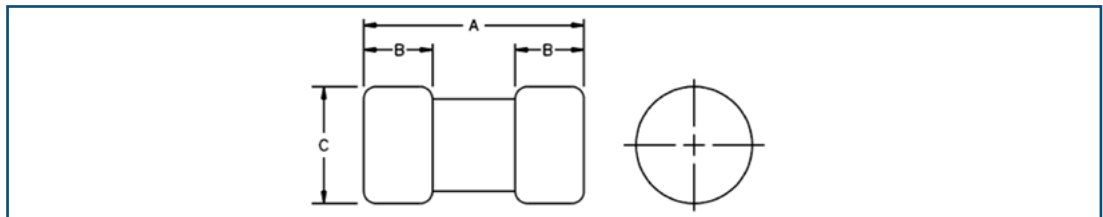


Table 3. | Dimensional requirements for ferrule fuses from UL 248-15 Low-Voltage Fuses – Part 15: Class T Fuses ^[4]

Rating		Overall Length of Fuse	Length of Ferrule	Outside Diameter of Ferrule
Volts (V _{AC})	Current (A)	A (mm)	B (mm)	C (mm)
300	0 – 30	22.35	7.11	10.31
	31 – 60	22.35	7.11	14.30

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Fuse Characteristics (Continued)

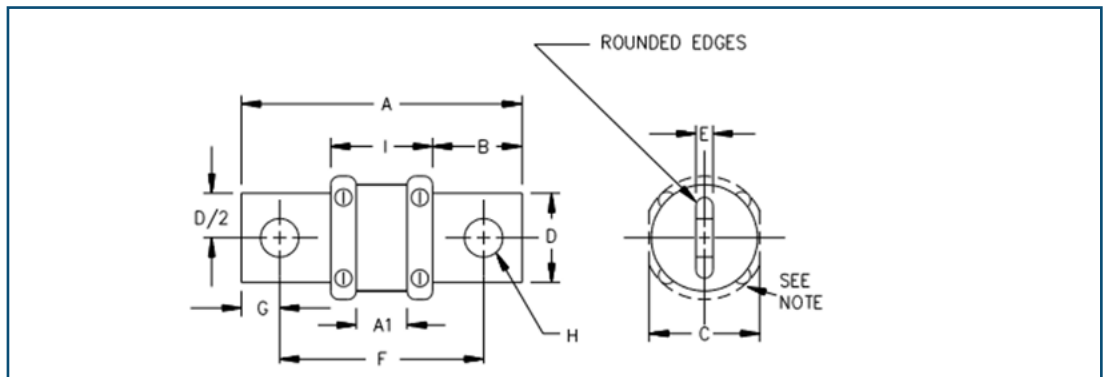


Table 4. Dimensional requirements for knife blade fuses from UL 248-15 Low-Voltage Fuses – Part 15: Class T Fuses ^[4]

	Current Rating (A)					
	300 V					
	61–100	101–200	201–400	401–600	601–800	801–1200
Overall length of fuse, A (mm)	54.76	61.93	69.85	77.80	85.73	101.6
Minimum length of insulated body, A1 (mm)	6.35	6.35	6.35	6.35	6.35	6.35
Minimum length of blade, B (mm)	16.4	19.99	23.52	27.28	31.04	36.60
Maximum diameter of fuses, C (mm)	21.03	27.38	34.14	41.28	52.78	63.90
Width of blade, D (mm)	19.05	22.22	25.40	31.75	44.45	50.80
Thickness of blade, E (mm)	3.18	4.78	6.35	7.92	9.53	11.11
Distance between mounting centers, F (mm)	39.52	43.05	46.84	51.59	55.36	64.29
Distance of mounting hole from end, G (mm)	7.62	9.45	11.51	13.11	14.68	18.67
Diameter of mounting holes, H (mm)	7.14	8.74	10.31	12.29	13.89	15.48
Maximum length of body, I (mm)	21.59	21.59	21.84	22.35	22.63	27.38

From Table 3 and 4, one can see the vast array of dimensional differences available for Class T fuses. In total, there are eight different body sizes available for the 300 VAC Class T fuses. These allow engineers and designers to size their fuse designs appropriately to allow for current ratings as described. Without these standards in place, fuse sizes could vary between manufacturers, making drop-in replacements a difficult task. Note the difference in ferrule versus knife blade designs break at 60 A. The highlighted portion of Table 4 are the design constraints for the Riedon™ Class T fuse block by Bourns.

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Conclusion

A design that is modular, safe, and easy-to-use is something to strive for in any electrical design. Riedon™ UL Class T and ANL fuse blocks by Bourns are no exception and achieve these goals. This application note has provided helpful information on how the Riedon™ fuse block by Bourns is modular through both fuse styles, while also explaining the safety and simplicity of their installation. With the range of fuse blocks available from Bourns, designers are able to select the right one for their specific application further helping it to be: Modular. Safe. Easy-to-use.

References

- [1] <https://patentimages.storage.googleapis.com/7d/09/64/6ef40435c3d1f5/US438305.pdf>
- [2] <https://www.fusesunlimited.com/products/specialpurposefuse#:~:text=Special%20Purpose%20Fuses%20are%20designed,protection%20for%20fluorescent%20lighting%20fixtures.>
- [3] <https://www.jaelectronics.com/cathodic-protection-rectifiers/air-cooled-rectifiers/>
- [4] UL 248-15 Low-Voltage Fuses – Part 15: Class T Fuses

www.bourns.com

Americas: Tel +1-951 781-5500
Email americus@bourns.com

EMEA: Tel +36 88 520 390
Email eurocus@bourns.com

BOURNS®

Asia-Pacific: Tel +886-2 256 241 17
Email asiacus@bourns.com

Mexico: Tel +52 614 478 0400
Email mexicus@bourns.com

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