

Heat-Shrink Tubing: The Versatile Tools for Maintenance and Repair

Think of heat-shrink tubing as the duct tape for electrical wiring on the factory floor. Heat-shrink tubing is versatile, easy to use, and finds wide applicability in maintenance and repair. Heat-shrink tubing can be used for preventive maintenance to avoid problems, and it is a wonderful tool for making minor repairs to cables and connectors.

Insulate

A main use of tubing is to insulate wire terminations, connections, and entire printed circuit boards from electrical and environmental conditions. Heat-shrink tubing has excellent electrical properties.

Repair

Cable splices, insulation damage and cuts, cable jackets, and connections can be quickly repaired permanently or temporarily. Because heat-shrink tubing has insulating properties equivalent to wire insulation, it can be easily applied over cut or worn insulation. In some cases, such repairs are temporary until the cable can be replaced. In other cases, the repair is permanent.

Relieve strain

Tubing can be used on cables and connectors to prevent harmful flexing or bending. Flexing at the wire-to-terminal crimp can lead to reduced performance or failure. The conductor can become nicked or broken; insulation can be damaged. While many terminals and connector backshells have built-in strain relief, heat-shrink tubing can be used either as a supplement to the built-in strain relief or as a primary strain relief. Semirigid tubing is available to provide a stiffer strain relief.

Seal

Connections, backshells, and gaps can be sealed from moisture and other contaminants. The sealing function often coincides with other tubing uses, such as repairs or insulating when properly applied. Heat shrink tubing is available with a variety of inner adhesives for applications that require maximum sealing.

Bundle and organize

Wire harnesses, cables, tubing, and hose dressings can be grouped by function, length, or any other organizational need that makes application faster and easier.

Identify circuits

Heat shrink tubing is a handy way for identification of wires, cables, hoses, and so forth through color coding, grouping, and labeling. Some tubing can be printed on directly. Others accept labels, usually designed specifically for use with tubing. Markings can be permanent, with no smearing or fading before or after shrinking.

Protect

Substrates can be protected from moisture, UV light, corrosion, oxidation, dust, fungus, chemicals, abrasion, environmental conditions, solder joints, and encapsulation. Heat-shrink tubing is available in a range of materials to meet nearly any electrical, mechanical, or environmental need.

While heat-shrink tubing is widely used by OEMs in high-volume production, it is also an essential item in any toolkit.

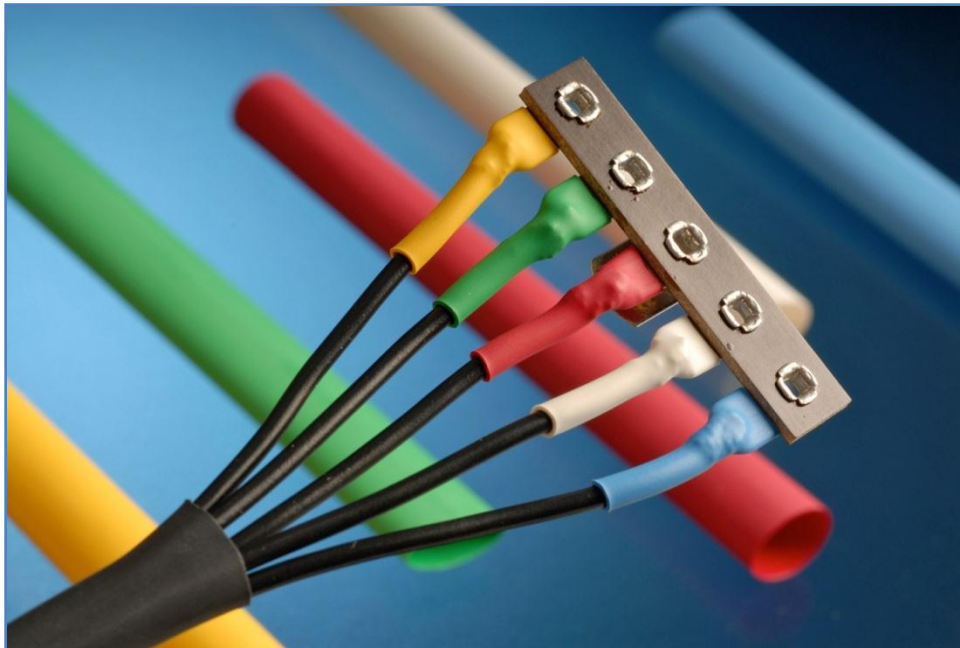


Figure 1. Heat-shrink tubing serves multiple purposes: here it protects the termination area from contamination, adds strain relief, and identifies circuits through color coding.

The name *heat-shrink tubing* pretty much sums up what it is and does: a plastic tube that shrinks permanently when heat is applied. How much it shrinks is determined by its shrink ratio, commonly ranging from 2:1 to 6:1. A 2:1 shrink ratio means that a tube will shrink to half its original diameter: a half-inch-diameter sleeve will shrink to one-quarter inch. The same half-inch sleeve with a 3:1 ratio will shrink to one-sixth of an inch.

Tubing is typically made by forming a tube and exposing it to intense radiation (irradiated), during which it is expanded to a larger size. The expanded tubing is what you buy. The expanded tubing has “memory,” so that when it is heated it will return to its original state.



Figure 2. Heat-shrink tubing can be used to repair worn and damaged wire and cable.

Picking the right heat-shrink tubing

Heat-shrink tubing is available in a seemingly bewildering array of materials and options. But for the plant floor, a few of the general-purpose materials will usually cover most needs. The most popular material is polyolefin, which can be used unless your requirements have special considerations. Here are some of the considerations in choosing the proper heat-shrink tubing:

Shrink ratio. A high shrink ratio will allow the sleeve to be fit over larger objects, such as connectors, and then shrunk down to the smaller diameter of a cable. Generally, though, don't use a higher ratio than your application requires. The common recommendation for choosing the tubing size is not to exceed 40% of the ratio. This allows for variation in the items it is being shrunk over. Please note that the tubing will also shrink

lengthwise by 5 to 7%, so adjust accordingly.

Sleeve diameter: The final shrink diameter should be smaller than the object that the sleeve is applied to. Put another way, you don't want to shrink the sleeve completely. The sleeve should shrink tightly against the object, which won't happen if the object is smaller than the final shrink diameter.

Wall thickness: Heat-shrink sleeves come in various thicknesses. A thicker wall provides more abrasion resistance, rigidity, and ability to withstand wear and tear. If you don't need such robustness, a thin-wall sleeve is fine.

Stiffness: Different sleeves have different degrees of flexibility. A more rigid sleeve is a good choice for achieving a strain relief on a connector or terminal, where reducing flexing is one goal of the heat-shrink tubing.

Sealing: Heat-shrink tubing, properly applied, will seal the interface between tubing and object. If sealing is important, choose a material that will withstand any unique contaminants. For the best coverage, try to limit the shrinking to 75% to 80% of maximum. For a 0.500 sleeve with a 2:1 shrink ratio, the object should not be less than 0.32 inch to ensure proper sealing.

Some heat-shrink tubing features an adhesive or meltable inner layer for applications that require maximum sealing. In most cases, standard tubing will provide adequate sealing, but adhesive lined tubing goes a step further.

Shrink temperature: Common polyolefin materials have a recommended shrink temperature of around 90°C, although other materials offer shrink temperatures, notably PTFE, as high as 250°C.

Shelf life: FIT Heat Shrink Tubing has a shelf life that ranges from 30 days to 25 years. This shelf life, which depends on material type, is dictated by the AMS-DTL-23053 standard. AMS allows for tubing to be retested and the shelf life to be extended to 50% of its original life. The tubing can be retested as many times as it meets specification. However, if the tubing is over 12 years old, the shelf life cannot be extended.

The usual considerations: You, of course, must consider the basic application requirements of voltage, operating temperature range, and other typical concerns in any application. You also need to consider special application needs, such as resistance to chemical and oils.

Application guidelines

Make sure you have the right tubing for your needs. It's a good idea to keep an assortment of tubing handy for maintenance and repair work. Vendors like Alpha Wire offer kits containing a variety of sizes and colors.

Use a tubing diameter that will not provide full shrinking.

If you are repairing a damaged jacket, make sure the cable is otherwise still in good shape. Make sure the insulation around separate conductors is not harmed and that there is no possibility of shorts or opens. Likewise, make sure that conductors are not nicked.

If you are sealing, consider a dual-wall tube that has an adhesive or meltable inner layer. While “standard” tubing proves good sealing in most case, use a dual-wall tubing to achieve optimum sealing.

Use a proper heat source. Heat guns especially designed for heat-shrink tubing are available. Their advantage is that they give you control both temperature and air flow.

Apply heat evenly, often moving the heat gun from one end of the tube to the other works well. You should also apply heat in a full 360° around the tubing. This may not always be possible, but cover as much of the tubing with heat as possible.



Figure 3. Heat-shrink tubing can be easily applied to irregular surfaces

Common heat-shrink materials and properties

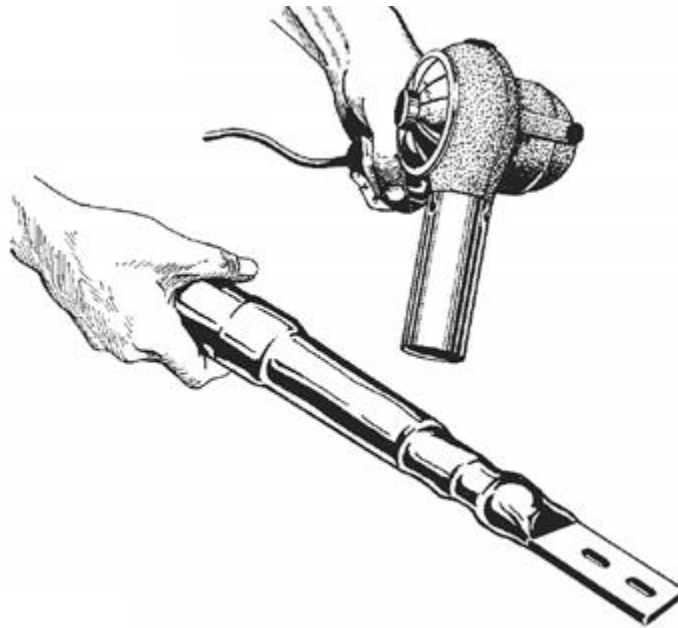
Figure 4 summarizes the range of heat-shrink tubing available from Alpha Wire. You can see that, while Irradiated polyolefin is the most common general-purpose material, a wide range of other materials meets special needs.

Material	Purpose	UL VW1	Resistance			Flex	Temp (°C)	Shrink Ratio	FIT Family
			Chemical	Heat	Abrasion				
Single-Wall Irradiated Polyolefin for General-Purpose Use									
Irradiated polyolefin	Variety of shrink ratios	✓					-55 to 125	2:1	FIT-221
							-55 to 125	4:1	FIT-421
Flame-retardant irradiated polyolefin	Low shrink temp	✓					-55 to 125	2:1	FIT-221V
								3:1	FIT-321V
Irradiated polyolefin	600V ground lead identification	✓					-55 to 125	2:1	FIT-260
Semi-rigid irradiated polyolefin	30% stronger 25% stiffer than standard polyolefin	✓		✓	✓		-55 to 125	2:1	FIT-295
Dual-Wall Polyolefin for Additional Sealing									
Surface irradiated, dual extruded	Meltable inner wall, no adhesive		✓				-55 to 125	2.5:1	FIT-300
Bonding, thermoplastic adhesive lined	Bonds to most materials; high voltage (2kV at 90°C continuous)						-55 to 110	3:1	FIT-700
Bonding, adhesive lined	Water and corrosion protection						-55 to 125	3:1	FIT-321
							-55 to 90	5.6:1	FIT-621
							-55 to 125	2:1	FIT-750
Special-Application Tubing									
Irradiated PVC	Low shrink temp; 30% stronger than standard polyolefin	✓					-20 to 105	2:1	FIT-105
Irradiated PVDF	High shrink temp; 3x tensile strength of standard polyolefin	✓	✓	✓	✓		-55 to 150	2:1	FIT-350
FEP	High shrink temp; thin wall thickness		✓				-75 to 200	1.2:1	FIT-400
PTFE	High shrink temp; thin wall thickness		✓				-75 to 260	1.5:1	FIT-500
Chlorinated polyolefin	Oil resistant	✓		✓	✓		-75 to 121	2:1	FIT-600
Flexible fluoroelastomer	High shrink temp		✓			✓	-40 to 200	2:1	FIT-650
Polyethylene/polyester	Resists harsh environments				✓	✓	-40 to 125	2:1	FIT-FABRIC
Irradiated silicone rubber	Pliable	✓		✓	✓	✓	-50 to 200	1.7:1	FIT-FLEX
Irradiated PVDF	Transparent after shrink; 2x tensile strength of standard polyolefin	✓	✓	✓			-55 to 150	2:1	FIT-CLEAR

Figure 4. Heat-shrink tubing is available in a wide range of materials to meet any MRO need.

Applying heat shrink tubing

Heat shrink tubing is versatile, protecting your cables against abrasion, chemicals, and weather. It is also great for bundling, color-coding and strain relief. Insulating your cables, terminations, and other devices with heat shrink tubing is easy—so long as you follow proper procedures as outlined below.



Step 1

Select the proper size of heat shrink tubing for your project. In order to get a secure fit, be sure that the tubing's recovered diameter (the diameter after shrinking) is smaller than the diameter of the area you're going to insulate. At the same time, the tubing's expanded diameter (the diameter before shrinking) needs to be large enough to easily fit over the area to be insulated, as well as any connectors attached to it.

Step 2

Cut the heat shrink tubing to a usable length, and be sure to allow for a minimum 1/4" overlap over any existing insulation or connectors. Keep in mind that tubing also shrinks lengthwise...typically 5-7% during the shrinking process.

Step 3

Slide the cut tubing over the object that you're covering; if you'll be splicing, slide the tubing over the center of the splice, and allow for equal overlap on both sides.

Step 4

Before shrinking, check your tubing's specifications for the recommended heating temperature. Any commercial heat gun or heat shrink oven can be used to shrink the tubing. Since uncontrolled heat can cause uneven shrinkage, physical damage and insulation failure, the use of open flame is not recommended.

Step 5

If you're covering a long length of cable with tubing, begin shrinking at one end, and gradually work your way down to the other. To ensure that the tubing shrinks evenly and without air bubbles, rotate the project as you're applying heat.

Step 6

Evenly apply heat over the length and around the diameter of the tubing, until it is uniformly shrunken and conforms to the shape of the cable, hose, or splice that it's covering. Immediately remove the heat source, and allow the tubing to cool slowly before you apply physical stress to it.

Important

Avoid overheating the heat shrink tubing, because it will become brittle or charred.

Tip!

Silicone lubricant spray can be applied to wires or cords to guide heat shrink over them without compromising the heat shrink material

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