

Choosing Conductors

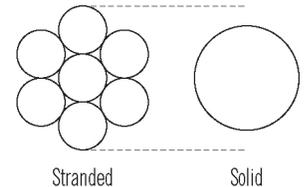
Conductors are the metallic components of a wire or cable through which electrical power or an signal travels. Choosing the best conductor for an application requires an understanding of the circuit's electrical parameters and the environment in which the wire will be installed.

Wire Size and Stranding

By defining many different conductor configurations, industry standards ensure the correct wire size and stranding for a circuit. The North American standard for conductor size is the American Wire Gauge (AWG). Stranding configuration requirements are spelled out in a number of ASTM International standards such as ASTM B3, B8, B33, etc. Additional information on stranding types and conductor properties are available in the "Conductors" section of Anixter's *Wire & Cable Technical Information Handbook*¹ and *Wire Wisdom C-1*, "Conductors – The Electron Superhighway."²

Diameter of Stranded vs. Solid Conductors

With the exception of a few specialty strand types, solid conductors are usually drawn with a circular die, which of course results in a round cross-section. Conversely, stranded conductors are composed of multiple strands of circular conductors—each one much smaller than final gauge size. Because these smaller wires are round, small triangular air spaces (interstices) exist between them. The resulting diameter of a stranded conductor is therefore larger than the diameter of a solid conductor of the same gauge size. The interstices and their impact on overall conductor diameter is illustrated in Figure 1. Whether solid or stranded, the total cross-sectional area of copper is the same for a given AWG size.



Stranding adds Flexibility and Durability

Solid conductors are relatively rigid, and in larger sizes, they can be difficult to install. They are also more likely to break when flexed repeatedly. A stranded conductor can improve a wire's flexibility and ease of installation. Stranding also improves wire longevity for applications with moderate to high vibration. Modern wire production methods often mean that a finely-stranded conductor will add minimal cost to the overall wiring system even if it has a significant impact on the cost-per-foot of the wire. The same cross-section of a stranded conductor gives it essentially the same resistance characteristics as a solid conductor, but with added flexibility. Increasing the number of strands increases the flexibility and flex-life of the wire while maintaining important electrical characteristics.

¹<http://www.anixter.com/AXECOM/US.NSF/Technology/ReferenceGuides>

²[http://www.anixter.com/./AXECOM/AXEDocLib.nsf/\(UnID\)/340A46A10946569080256F24006F4F92/\\$file/C-1_8.pdf](http://www.anixter.com/./AXECOM/AXEDocLib.nsf/(UnID)/340A46A10946569080256F24006F4F92/$file/C-1_8.pdf)

Stranded on an Island of Bad Connections

Even though stranded conductors offer a host of benefits, they can dictate changes in the design of the cable as well as the raceways and connectors used. Loose strands, i.e., individual strands that separate (stray) from the rest of the conductor and do not make contact with the connection point, are a common termination problem. They increase the likelihood of inadvertent short circuits to adjacent contacts, and they increase the resistance at the termination point. Increased resistance causes heating, electrical loss (lower efficiency) and a higher probability of circuit failure. Such connections can be detected with the use of automatic crimp-force monitors in automated applications but require proper training and a quality program for manually performed crimps.

As mentioned earlier, finely stranded conductors are more likely to have strands left dangling out of the barrel of a connector. Some lugs, spade, ring and pin terminal connectors have specific design features to accommodate the larger diameter and potentially disorderly wires of a stranded conductor. These include funnel or bell shaped openings to help channel *all* the fine wires into the connector.

Suggestions for Better Connections

When installing power connectors or terminals, consider choosing a connector with an increased barrel length, a slightly larger barrel diameter to accommodate the larger diameter of finely-stranded conductors, and a connector with a "belled" end that funnels the strands into it. These methods improve the termination quality on finely stranded conductors by providing higher levels of grip and less damage to the stranding.

For power connections, the use of a manufacturer-approved combination of 1) crimping tool; 2) crimping die; 3) connector; 4) conductor size; and 5) conductor stranding will provide the user with the peace of mind that the *system* has been tested and approved by a third-party agency, such as Underwriters Laboratory (UL). Remember, successful wire termination requires the correct connector, the proper application, suitable test methods and a thorough understanding of the impact that conductor size and stranding have on wire selection for a given application.