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Electrical Conductivity of Materials

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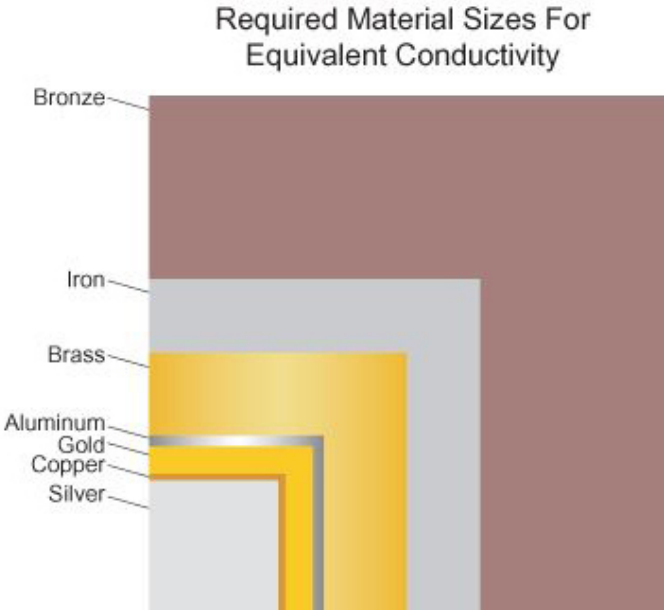
The differences in electrical conductivity of various materials used in marine electrical products are often not well understood. Making assumptions about the electrical conductivity of a material because it looks similar to another conductive material of known ampacity can lead to disastrous results.

Perhaps the most common form of this error is the substitution of brass or bronze for copper in electrical applications. Brass is only 28% as conductive as copper. Some bronzes are as low as 7% as conductive as copper!

Copper is the standard by which electrical materials are rated and conductivity ratings are expressed as a relative measurement to copper. These ratings will frequently be expressed as "28 IACS". IACS is the abbreviation for International Annealed Copper Standard and the number preceding "IACS" is the percentage of conductivity a material has relative to copper, which is considered to be 100% conductive. This does not mean that copper has no resistance (is 100% conductive in an absolute sense), but rather that it is the standard by which other materials are measured. The higher the % IACS, the more conductive the material is. This standard refers to a pure, "standard" copper having a resistivity of 1.7241 microhm-cm at 20°C (68°F).

Armed with this knowledge it is interesting to examine the IACS conductivity values of some common materials.

Material IACS	% Conductivity
Silver	105
Copper	100
Gold	70
Aluminum	61
Nickel	22
Zinc	27
Brass	28
Iron	17
Tin	15
Phosphor Bronze	15
Lead	7
Nickel Aluminum Bronze	7
Steel	3 to 15



Perhaps the most interesting fact revealed by this chart is how low most copper alloy materials rank in relative conductivity. One might easily assume that alloys such as the brasses and bronzes, because they are mainly copper, are nearly as conductive as copper. This is not the case. The small percentages of tin, aluminum, nickel, zinc and phosphorus that make up these alloys degrade the electrical performance of the resulting alloy to a far greater percentage than their compositional percentage in the alloy.

One should not conclude from this, however, that brass should never be used in electrical applications. There are instances where the superior tensile and machining characteristics of brass make it a better choice than copper as long as the sectional areas are increased proportionately to achieve the conductivity that a copper part would have in the application. Size for size, however, copper is exceeded only by silver among the materials commonly used for electrical applications.