



Standard Terminology Relating to Uninsulated Metallic Electrical Conductors¹

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INTRODUCTION

These terminologies relate only to interpretations as applied to uninsulated metallic electrical conductors in specifications under the jurisdiction of ASTM Committee B01 on Electrical Conductors, and do not necessarily correspond to the definitions used in other fields.

1. Scope

1.1 This terminology standard defines abbreviations and terms specific to uninsulated electrical conductors. For terms relating to superconductors, see Terminology B713.

2. Referenced Documents

2.1 *ASTM Standards*:²

B193 Test Method for Resistivity of Electrical Conductor Materials

B713 Terminology Relating to Superconductors (Withdrawn 2001)³

E8/E8M Test Methods for Tension Testing of Metallic Materials

3. Abbreviations

AAAC—all aluminum alloy conductor

AAC—aluminum conductor

AACSR—aluminum alloy conductor, steel reinforced

ACAR—aluminum conductor, aluminum alloy reinforced

ACSR—aluminum conductor, steel reinforced

ACSS—aluminum conductor steel supported

AMC—aluminum matrix composite

AW—old designation for what is now termed AW2

AW2—aluminum-clad steel core wire, normal strength

AW3—aluminum-clad steel core wire, high strength

AZ—old designation (aluminized)

CCA—copper-clad aluminum

¹ This terminology is under the jurisdiction of ASTM Committee B01 on Electrical Conductors and is the direct responsibility of Subcommittee B01.01 on Editorial and Records.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

CCS—copper-clad steel

COMP—compact construction

EHS—extra high strength

GA—old designation for what is now termed GA2

GA2—zinc coated (galvanized) steel wire, coating class A

GA3—zinc coated (galvanized) high strength steel wire, coating class A

GA4—zinc coated (galvanized) extra high strength steel wire, coating class A

GA5—zinc coated (galvanized) ultra high strength steel wire, coating class A

GB—obsolete designation, class B galvanizing is no longer offered

GC—old designation for what is now termed GC2

GC2—zinc coated (galvanized) steel wire, coating class C

HS—high strength

IACS—international annealed copper standard, which is 1/58 Ohm-mm²/m at 20°C for 100 % conductivity

LSE—low stress elongation

MA—old designation for what is now termed MA2

MA2—zinc-5 % aluminum-mischmetal alloy coated steel wire, coating class A

MA3—zinc-5 % aluminum-mischmetal alloy coated high strength steel wire, coating class A

MA4—zinc-5 % aluminum-mischmetal alloy coated extra high steel wire, coating class A

MA5—zinc-5 % aluminum-mischmetal alloy coated ultra high steel wire, coating class A

MB—obsolete designation, class B galvanizing is no longer offered

MC—old designation for what is now termed MC2

MC2—zinc-5 % aluminum-mischmetal alloy coated steel wire, coating class C

MS—old designation for what is now termed MA3

MM—mischmetal

NS—non-specular

SD—self dampening construction

SIW—single input wire construction

TP—twisted pair
TW—trapezoidal shaped wire
UHS—ultra high strength
UNS—unified numbering system
Zn-5Al-MM—zinc-5 % aluminum-mischmetal alloy coating

ing

4. Terminology

4.1 Definitions:

aeolian vibration—resonant vibration of a conductor caused by the alternate shedding of wind-induced vortices from opposite sides of the conductor. (Frequency is usually less than 200 Hz and amplitude rarely exceeds one conductor diameter.)

anneal (annealing), *n*—a thermal treatment to change the properties or grain structure of the product. When applied to a cold-worked product having a single phase: to produce softening by recrystallization or recrystallization and grain growth with the accompanying changes in properties. When applied to a product having two or more phases: to produce softening by changes in the phase relationship that may include recrystallization and grain growth.

annealed wire—see **soft wire**.

area density—mass per unit area.

bare conductor—a conductor having no nonmetallic covering.

brazing—the joining of ends of two wires, rods, or groups of wires with a nonferrous filler metal at temperatures above 800°F (427°C).

breaking strength—the maximum load that a conductor attains when tested in tension to rupture.

bunch-stranded conductor—a conductor composed of wires twisted together with a given length and direction of lay in such manner that the respective wires at successive cross sections along the length of the conductor do not necessarily form a symmetrical geometric pattern, nor necessarily occupy the same positions relative to each other.

casting, continuous, *n*—a casting produced by the continuous pouring and solidification of molten metal through a water-cooled mold which determines the cross-sectional shape. The length of the product is not restricted by mold dimensions.

circular mil (cmil)—a unit of area equal to the area of a circle one mil (0.001 in., 0.0254 mm) in diameter. The area of a circle in circular mils is equal to the square of the diameter in mils (area(cmils) = diameter(mils)²), 1 cmil = 7.854 × 10⁻⁷ in.² (5.067 × 10⁻¹⁰ m²).

clad wire—wire comprised of a given metal covered with a relatively thick application of a different metal. The bonding process is normally a combination of heat and pressure and results in a metallurgical bond.

coated wire—wire comprised of a given metal covered with a relatively thin application of a different metal. The coating process is normally electroplating or dip coating.

coil, *n*—a length of the product wound into a series of connected turns. The unqualified term “coil” as applied to tube usually refers to a bunched coil.

cold-drawing—reducing the cross section by pulling through a die or dies, at a temperature lower than the recrystallization temperature.

cold work, *n*—controlled mechanical operations for changing the form or cross section of a product and for producing a strain-hardened product at temperatures below the recrystallization temperature.

combination stranded conductor—a conductor constructed with wires of different diameters with such differences occurring either within a single layer or from layer to layer.

compact stranded conductor—a unidirectional or unilay or conventional concentric conductor, constructed with a central core surrounded by one or more layers of helically laid wires and formed into final shape by rolling, drawing, or other means; and manufactured to a specified nominal diameter, approximately 8 to 10 % below the nominal diameter of a conventional non-compact conductor of the same cross-sectional area.

compressed stranded conductor—a unidirectional or unilay or conventional concentric conductor manufactured to a specified nominal diameter 3 % less than the calculated diameter of non-compressed conductor of the same construction and cross-sectional area.

composite conductor—a conductor consisting of two or more types of wire, each type of wire being plain, clad, or coated; stranded together to operate mechanically and electrically as a single conductor.

concentric-lay conductor—conductor constructed with a central core surrounded by one or more layers of helically laid wires. Several types are as follows:

compact round conductor—see **compact stranded conductor**.

conventional concentric conductor—conductor constructed with a round central core surrounded by one or more layers of helically laid round wires. The direction of lay is reversed in successive layers, and generally with an increase in length of lay for successive layers.

equilay conductor—conductor constructed with a central core surrounded by more than one layer of helically laid wires, all layers having a common length of lay, direction of lay being reversed in successive layers.

parallel core conductor—conductor constructed with a central core of parallel-laid wires surrounded by one layer of helically laid wires.

rope-lay conductor—conductor constructed of a bunch-stranded or a concentric-stranded member or members, as a central core, around which are laid one or more helical layers of such members.

unidirectional conductor—conductor constructed with a central core surrounded by more than one layer of helically laid

wires, all layers having a common direction of lay, with increase in length of lay for each successive layer.

unilay conductor—conductor constructed with a central core surrounded by more than one layer of helically laid wires. All layers having a common direction of lay and essentially similar length of lay, which is a multiple of the outer diameter of the finished conductor, for each successive layer. The lay length of the inner layers shall not vary by more than $\pm 10\%$ of the lay length of the outer layer.

conductivity—the measure of a material’s ability to conduct an electric current between two points. Conductivity is inversely related to resistivity and typically expressed as % IACS. Annealed copper is defined as 100 % IACS and other conductivity values are reported relative to annealed copper.

conductor—a wire or combination of wires not insulated from one another, suitable for carrying an electric current.

conductor core—the center strand or member about which one or more layers of wires or members are laid helically to form a concentric-lay.

continuous cast drawing stock—the as-rolled section, normally round, produced by a continuous casting and rolling process.

core—see **conductor core**.

cored, annular, conductor—a conductor in which one or more layers of wires are laid helically around a central core of metallic or nonmetallic material. The core is used as a mandrel for the application of subsequent layers of wire to maintain consistent spacing of these members around the conductor axis.

direction of lay—the lateral direction, designated as left-hand or right-hand, in which the wires of a member or units of a conductor run over the top of the member or conductor as they recede from an observer looking along the axis of the member or conductor.

drawing stock—the as-rolled or extruded section, normally round, made from any of a variety of manufacturing processes, intended as feed stock for subsequent drawing operations.

drawn wire, *n*—wire stock brought to final dimensions by cold drawing through a die, regardless of temper or prior operations.

electric-butt, cold-upset weld—a weld between two prepared ends of adjacent lengths of work-hardenable material that is pressed together in a resistance welding apparatus which melts the abutting ends to unite them and form the weld. In turn, the resulting weld zone is forced out in the form of flash by a cold-upsetting operation which, through cold-working, restores the material substantially to its original tensile strength.

equilay conductor—see **concentric-lay conductor**.

fill factor—the ratio of the weight of a given length of a stranded conductor to the weight of the solid conductor of the same diameter, length, and material. It may also be

expressed by the ratio of the nominal area of the conductor times (1 plus the stranding factor) and the area of the circle that encloses the strands of the conductor.

flat wire, *n*—a product up to and including 0.188 in. (4.78 mm) in thickness and up to and including 1¼ in. (31.8 mm) in width.

galvanized steel wire—steel wire coated with zinc.

half-hard wire—as applied to aluminum, wire that has been processed so as to produce a strength approximately midway between that of soft wire and that of hard-drawn wire.

hard-drawn wire—as applied to aluminum and copper, wire that has been cold drawn to final size so as to approach the maximum tensile strength obtainable.

hot-rolled drawing stock—the as-rolled section, normally round, produced by hot rolling in a rod mill from a billet or wire bar.

intermediate temper—as applied to aluminum, any temper between soft and hard drawn.

joint—that portion of the conductor where the ends of two wires, rods, or groups of wires are joined by brazing, soldering, welding, or by mechanical means.

lay, *n*⁴—one turn of the helix of a wire or member of a standard conductor. See also **direction of lay** and **length of lay**.

lay, *v*—to arrange the wires or members of a conductor either by twisting them or by forming them into one or more layers helically applied.

lay factor—the ratio of the length of lay to the external diameter of the corresponding layer of wires or members in the stranded conductor.

length of lay—the axial length of one turn of the helix of a wire or member.

lengths, *n*—straight pieces of the product.

linear density—mass per unit length.

liquor-finished wire—wire, usually of ferrous material, drawn through a wet solution of metallic salts, that is, tin or copper, to facilitate drawing and to enhance the appearance and surface characteristics of the finished wire, and not to provide the properties of a coated wire.

magnet wire, *n*—a nonferrous electrical core conductor containing an insulating film or dielectric that creates a magnetic field for converting electrical energy into useful mechanical work.

medium-hard drawn wire—as applied to copper wire, having tensile strength less than the minimum for hard-drawn wire, but greater than the maximum for soft wire.

⁴ From or adapted from American National Standard Definitions of Electrical Terms (ANSI C42.35—1957) published by the Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., P.O. Box 1331, Piscataway, NJ 08854-1331.

member—a group of wires stranded together for combination with other stranded groups into a multiple-membered conductor.

messenger wire—a metallic supporting member either solid or stranded which may also perform the function of a conductor.

mil—a unit of length equal to $\frac{1}{1000}$ of an inch [0.0254 mm].

nominal, *adj*—name or identifying value of a measurable property by which a conductor or component or property of a conductor is identified, and to which tolerances are applied.

non-specular (NS)—nonreflective matte grey surface finish for aluminum conductors.

oxygen free copper, *n*—a highly conductivity copper that has been produced in such manner as to contain no oxide or residual deoxidants. It has very high resistance to hydrogen embrittlement (Copper Nos. C10200, C10300)

parallel-core conductor—see **concentric-lay conductor**.

percent conductivity—the ratio of the resistivity of the International Annealed Copper Standard (IACS) at 20°C to the resistivity of a material at 20°C, expressed in percent. Results are calculated on a weight basis or volume basis and so specified.

plain conductor—a conductor made up of one or more plain wires of the same metal.

plain wire—wire consisting of one metal only.

rated strength—the strength in tension of a stranded conductor calculated in accordance with specification requirements.

redraw rod, *n*—rod stock within a limited range of sizes for further drawing or rolling.

redraw wire, *n*—wire stock within a limited range of sizes for further drawing or rolling.

reel, *n*—a device on which wire, flat wire, and narrow strip are wound to facilitate handling and shipping. See also **spool**.

resistance⁴—the scalar property of an electric circuit or of any body that may be used as part of an electric circuit which determines for a given current the rate at which electric energy is converted into heat or radiant energy and which has a value such that the product of the resistance and the square of the current gives the rate of conversion of energy. In a dc circuit:

$$P = I^2 R$$

where:

P = power, W,

I = current, A, and

R = resistance, Ω .

resistivity—the electrical resistance of a body of unit length, and unit cross-sectional area or unit weight. **B193**

rod, *n*—a round, regular hexagonal or regular octagonal solid section furnished in straight lengths. A regular hexagonal or a regular octagonal rod is a solid section having equal sides and equal angles.

rope-lay conductor—see **concentric-lay conductor**.

sample, *n*—the final form of a material submitted for chemical analysis (drillings, millings, and so forth) or a prepared test specimen to be used for mechanical testing.

shape, *n*—a solid section other than rectangular, square, or standard rod and wire sections, furnished in straight lengths.

self-damping conductor—a conductor with internal vibration damping properties which will protect itself from damaging strains caused by aeolian vibration.

single input wire construction—a stranded conductor design which varies the number of wires within a range of conductor sizes in order to permit that range of conductor sizes to be constructed from wires of a single diameter.

soft wire—wire that has been drawn or rolled to final size and then heated to remove the effects of cold working.

solderability, *n*—the capability of a metal to be wetted by solder.

soldering, *n*—joining metals by fusion of the alloys that have relatively low melting points, most commonly, lead-base or tin-base alloys, which are the soft solders. Hard solders are alloys that have silver, copper, or nickel bases. Use of these alloys with melting points higher than 800°F (427°C) is properly called “brazing.”

solid conductor—a conductor consisting of one wire.

solution heat treatment, *n*—a thermal treatment of a product to put alloying elements into solution in the base metal by heating into the temperature range of solid solubility, followed by cooling at a sufficient rate to retain them in a supersaturated solid solution.

spool, *n*—a small reel.

splice—see **joint**.

stiffness (as applied to copper)—the property of a conductor that causes it to resist permanent deformation by bending.

strain hardening⁵—an increase in hardness and strength caused by plastic deformation at temperatures lower than the recrystallization range.

strand, *n*⁴—one of the wires of any stranded conductor.

stranded conductor—a conductor composed of a group of wires, usually twisted, or of any combination of such groups of wires.

stranding factor—the ratio of the mass or electrical resistance of a unit length of stranded conductor to that of a solid conductor of the same cross-sectional area. The stranding factor *m* for the completed stranded conductor is the numerical average of the stranding factors for each of the individual wires in the conductor, including the straight core wire, if

⁵ Adapted from *ASM Metals Handbook*, Vol 1, “Properties and Selection of Metals,” Am. Soc. Metals, 1961.

any (for which the stranding factor is unity). The stranding factor (m_{ind}) for any given wire in a concentric-lay-stranded conductor is:

$$m_{ind} = \sqrt{1 + (9.8696/n^2)}$$

where:

$$n = \frac{\text{length of lay}}{\text{diameter of helical path of the wire}}$$

temper, n —the metallurgical structure and properties of a product resulting from thermal or mechanical processing treatments.

tensile strength—the maximum load per unit of original cross-sectional area that a conductor attains when tested in tension to rupture.

test, tension, n —a test to determine one or more of the following: tensile strength, yield strength, elongation, and contraction reduction of area. See Test Methods **E8/E8M**.

thermal treatment, n —a controlled heating: time at maximum temperature-cooling cycle as needed to satisfy the property and grain structure requirements of the temper.

three-quarter-hard wire—as applied to aluminum, wire that has been processed to produce a strength approximately midway between that of half-hard wire and that of hard-drawn wire.

tinned wire—see **coated wire**.

tough pitch copper, n —copper of any origin cast in the form of refinery shapes, containing a controlled amount of oxygen in the form of cuprous oxide. By extension the term is also applicable to fabricators' products made therefrom.

tow—a bundle, containing multiple fibers.

trapezoidal wire—a wire with a keystone-shaped (wedge) cross section with two circular parallel sides (see **Fig. 1**).



FIG. 1 Typical Cross Section of Trapezoidal Wire

trolley wire—a round or shaped, solid bare, hard conductor ordinarily used to supply current to motors through traveling current collectors.

unaided eye, n —visual inspection, without the use of special equipment or enhancement excepting the use of corrective lenses.

unidirectional conductor—see **concentric-lay conductor**.

volume resistivity—the resistance in ohms of a body of unit length and unit cross-sectional area.

weight resistivity—the resistance in ohms at a specified temperature of a body of uniform cross section and of unit weight and unit length.

welding—joining the ends of two wires, rods, metal whose length is great in comparison with the major axis of its cross section, or groups of wires (I) by fusing, using the application of heat or pressure or both, by means of a flame torch, electric arc, or electric current or (2) by cold pressure.

wire⁴—a rod or filament of drawn or rolled metal whose length is great in comparison with the major axis of its cross section.

wire bar, n —refinery shape used for rolling into rod or flat product for subsequent processing into wire, strip, or shape. Approximately 3.5 to 5 in. (89 to 127 mm) square in cross section, usually 54 in. (1.37 m) in length, and ranging in weight from 200 to 420 lb (91 to 191 kg). Usually tapered on both ends.

5. Keywords

5.1 definitions; terminology

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