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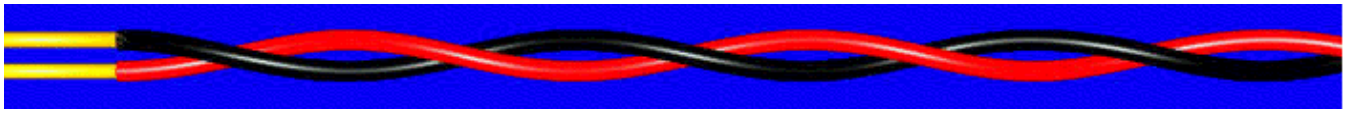
Teflon Wire Trivia



Wonderful Stuff

Teflon insulated wire is wonderful stuff. If you are accustomed to fighting insulation melt-back with ordinary PVC hook-up wire, you are in for a treat when you try Teflon (you cannot hurt it with a soldering iron). Teflon wire has been used in downhole logging tools almost exclusively since the 1960s because of its excellent high temperature performance. Some manufacturers have also used it in logging surface electronics. *AnaLog Services, Inc.* uses Teflon wire for all well logging electronics applications.

Teflon insulated wire is made using several techniques, including extrusion and wrapping. The extruded type is most commonly used in logging tools and surface electronics, usually in stranded sizes 22 and 24 AWG. Smaller sizes are found in the smaller diameter production logging tools where space is at a premium, and as inductor leads (high voltage transformers and the like). Miniature Teflon coaxial cable is also commonly found in well logging electronics; it often has the wrapped and fused type Teflon as the outer jacket insulation. A variety of multi-conductor Teflon insulated cables are made, but are not often used in the well logging industry (Teflon insulated plenum cable is an example). Teflon insulated logging cable is used for high temperature work.

Specs

Extruded Teflon (polytetrafluoroethylene or PTFE) insulated hook-up wire comes in three main flavors: the more commonly encountered Type E, rated for 600 volts (historically M16878/4), the slightly thicker Teflon jacketed Type EE, rated for 1000 volts (historically M16878/5), and the rarely seen very thin insulation Type ET, rated for 250 volts (historically M16878/6). All three types are silver plated and rated for use up to 200℃. Other specs cover the 200℃ wrapped Teflon insulated wires, and the 260℃ extruded and wrapped nickel plated wires. To minimize rambling, the balance of this effort is limited to extruded Teflon single conductor wire, often referred to as Teflon "hook-up" wire.

MIL-W-16878 is the historical mil spec for Teflon insulated wire. The full part identifying number (PIN) consists of M16878/x, where x is the specification sheet number for a given wire type, followed by three letters and a final color number as shown in the table below. 125℃ and above wire types, including Teflon, are no longer covered by MIL-DTL-16878G, the current incarnation (the last revision to cover Teflon wire was MIL-W-16878F, a large pdf file). In late 1999, the Department of Defense (DoD) adopted the NEMA standard NEMA HP 3 covering Type E, Type EE, and Type ET Teflon insulated wire. However certain specific MIL-W-16878 Type E and Type EE wire sizes and constructions were covered by MIL-W-22759 (a large pdf file) prior to the adoption of NEMA HP 3 (see MIL-W-16878 /4C and /5C supersession Table III). MIL-W-22759 appears to still be active (there is no explaining the military). Because MIL-W-16878 is still widely cited, and because so much older surplus wire is available, the tables below have been prepared

for reference purposes.

TEFLON INSULATED WIRE - Part Identifying Number (PIN)					
M16878	/4	B	C	B	2
Mil Spec	Spec Sheet	Conductor Material	Conductor Size	Stranding	Color
MIL-W-16878F MIL-DTL-16878 Replacement: NEMA HP 3. See also: MIL-W-22759E, spec sheets: /9, /11, /20, /22.	/4B E 600v /4C E 600v /5B EE 1kv /5C EE 1kv /6B ET 250v /6C ET 250v All M16878/ Teflon sheets now canceled.	B = Coated Copper C = Coated Copper-Clad Steel (CC Steel) D = Coated High-Strength Copper Alloy (HSCA) E = Coated Copper / Overall Metallic Coating	A = 32 M = 10 B = 30 N = 8 C = 28 P = 6 D = 26 R = 4 E = 24 S = 2 F = 22 T = 1 G = 20 U = 0 H = 18 W = 00 J = 16 Y = 000 K = 14 Z = 0000 L = 12	A = 1 B = 7 C = 10 D = 16 E = 19 F = 26 G = 37 H = 41 J = 65 K = 105 L = 133	0 = Black 1 = Brown 2 = Red 3 = Orange 4 = Yellow 5 = Green 6 = Blue 7 = Violet 8 = Gray 9 = White

MIL-W-16878 / MIL-W-22759 Supersession Data

Type E Former PIN	600 Volt Replacement
M16878/4-BCB	M22759/11-28
M16878/4-DCB	M22759/22-28
M16878/4-BDE	M22759/11-26
M16878/4-DDE	M22759/22-26
M16878/4-BEE	M22759/11-24
M16878/4-DEE	M22759/22-24
M16878/4-BFE	M22759/11-22
M16878/4-DFE	M22759/22-22
M16878/4-BGE	M22759/11-20
M16878/4-DGE	M22759/22-20
M16878/4-BHE	M22759/11-18
M16878/4-BJE	M22759/11-16
M16878/4-BKE	M22759/11-14
M16878/4-BLE	M22759/11-12
M16878/4-BMG	M22759/11-10

Type EE Former PIN	1000 Volt Replacement
M16878/5-BCB	M22759/09-28
M16878/5-DCB	M22759/20-28
M16878/5-BDE	M22759/09-26
M16878/5-DDE	M22759/20-26
M16878/5-BEE	M22759/09-24
M16878/5-DEE	M22759/20-24
M16878/5-BFE	M22759/09-22
M16878/5-DFE	M22759/20-22
M16878/5-BGE	M22759/09-20
M16878/5-DGE	M22759/20-20
M16878/5-BHE	M22759/09-18
M16878/5-BJE	M22759/09-16
M16878/5-BKE	M22759/09-14
M16878/5-BLE	M22759/09-12
M16878/5-BMG	M22759/09-10
M16878/5-BNL	M22759/09-8

Pretty Colors

Teflon wire is available in a wide variety of colors. For the most part, the well logging industry has adopted the color code scheme used by the military. Said scheme uses the same numbering as resistor color codes, with black = 0, brown = 1, red = 2, orange = 3, yellow = 4, green = 5, blue = 6, violet (purple) = 7, gray (slate) = 8, and white = 9. There has been less agreement historically within the logging industry over the numbering scheme for the multi-colored striped wires. Unfortunately, the wire manufacturing industry has never established standards for color shades; actual wire colors vary over a wide range. Some of the Teflon wire insulation colors can be very pretty, almost with a glowing or neon quality. See also Surface Wiring Color Codes and Downhole Wiring Color Codes and Tool Connector Pinouts.

Why Silver Plating?

Teflon wire is usually silver plated, as is most wire rated for use at over 125℃. At high temperatures, and over time, tin plating or solder tinning can dissolve into the underlying copper wire, leaving a surface that is difficult to solder. Silver plating can withstand higher temperatures for longer periods of time than can conventional tinning. Further, at the temperatures Teflon insulation is extruded and cured, individually tinned strands would be effectively soldered together to make a solid wire. Freshly stripped Teflon wire is truly beautiful with its white silver luster. But silver plated wire tarnishes (just like silverware); it should not be stored near sources of sulfur fumes such as cardboard, paper, rubber bands, etc. Teflon insulated silver plated copper wire is fairly immune to tarnish, but sometimes it is necessary to cut off and discard an inch or two if discoloration is seen at the end. Nickel plating is used for temperatures exceeding 200℃, but nickel is more difficult to solder due to surface oxidation. Interestingly, because of the difficulty in extruding long runs of Teflon insulation, the mil spec allows a large spool of Teflon insulated wire to be made up of several spliced pieces (the hydraulic extrusion rams can only hold so much Teflon material, thus limiting the maximum uninterrupted producible length).

Stripping Woes

Only stranded wire should be used in well logging electronics. Long experience has shown that solid hook-up wire fails long before stranded wire, probably because of vibration during transport more than anything else. However, improperly stripped (nicked) stranded Teflon wire often fails at the connection point. (An alternative theory holds that these failures are related to solder wicking up the silver plated wire strands, but proper stripping seems to eliminate most of the failures.) A common complaint heard about Teflon wire is that it is hard to strip. Most authorities recommend expensive automatic stripping tools with special Teflon insulation cutting dies installed. These gizmos cost a small fortune, we hate their cumbersome action, and they do not always do such a great job.

One relatively inexpensive simple stripper is as good as or better than any of the high priced models. The Milbar Model 7E hand stripper is great with Teflon wire; it works with AWG sizes 22 down to 30. (Milbar was absorbed by Stride Tool which also owns the Imperial line of tools, so the Milbar 7E is now also branded as the Imperial IE180.) The geometry of the die notches may be the reason this stripper works so well with Teflon, and the Ideal, Klein, etc. non-automatics work so poorly. A well broken-in pair works even better than a brand new pair. Some vendors claim the Milbar 7E / Imperial IE180 is for *solid* wire, but we use the stripping notches as size-labeled for *stranded* E or EE Teflon insulated wire. Several vendors sell the Milbar 7E / Imperial IE180 with their own house branding imprinted on the handles; Snap-On sold this wire stripper for years marked Model PWC7 as part of their Blue Point line, but recently dropped it from their catalog. McMaster-Carr currently has the 7E for around ten bucks as their part number 7294K59. Use of garden variety (Ideal, Klein, etc.) manual strippers with Teflon wire is a recipe for disaster.

We also use several types of thermal strippers, but we like HOTweezers by Meisei Corporation best (Contact Meisei at (805) 497-2626). Thermal strippers are helpful for very small gauge Teflon insulated transformer, trimpot, etc. leads.

Expensive and Worth It

Teflon insulated wire is expensive, several times more expensive than ordinary PVC insulated wire. One manufacturer's published literature states the cost is eight to ten times as great. Fortunately, there are reputable vendors with good quality Teflon wire at half or less the cost of the big boys (Belden, et al.). Further, Teflon wire is available in the surplus marketplace, though not all wire gauges, stranding options, or insulation colors may be available at any given time. Unfortunately, in recent years, the audiophile community has driven surplus Teflon wire prices up

considerably. These folks believe they can actually hear an improvement when audio equipment is constructed with Teflon wire. This is of course utter nonsense, but they sure buy a bunch of Teflon wire, thus driving up the surplus prices.

Contact us if you need information on where to buy bulk Teflon wire at bargain prices, or drop us an e-mail at Teflon@logwell.com. Try eBay for small quantities at decent prices.

A small part of *AnaLog's* collection of Teflon insulated wire.

See also Teflon Tubing Trivia.

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