Reel Time

How It's Made: Twisted Pair Cables

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Q. THERE IS A TELEVISION SHOW THAT STARTED ON THE DISCOVERY CHANNEL THAT SHOWS HOW SIMPLE PRODUCTS ARE MADE. I'VE ALWAYS WONDERED HOW TWISTED PAIR CABLES ARE MANUFACTURED SINCE THE "REEL TIME" COLUMN CREDITS THE CABLE'S ELECTRICAL CHARACTERISTICS TO THE MANUFACTURING PROCESS. HOW CAN SOMETHING AS SIMPLE AS COMBINING COPPER AND PLASTIC BE MADE AS A CRITICAL COMPONENT FOR TRANSPORTING SENSITIVE DATA, VOICE, VIDEO AND POWER?

A. The basic steps to making twisted pair cables are similar in each manufacturing facility. However, for leading cable suppliers, such as Berk-Tek, cable manufacturing is an engineered science, which includes intricate quality control measures during every step. These detailed measurements assure that each cable lot is consistently being monitored and manufactured to be able to provide maximum electrical characteristics that meet or exceed performance standards set by ANSI/TIA/EIA, ISO/IEC and Ethernet applications defined by IEEE. If ever given the opportunity for a cable plant tour (either fiber or copper), make the time as it is worthy of an interesting television episode. But, here are the basics – in other words, this is how we do it.

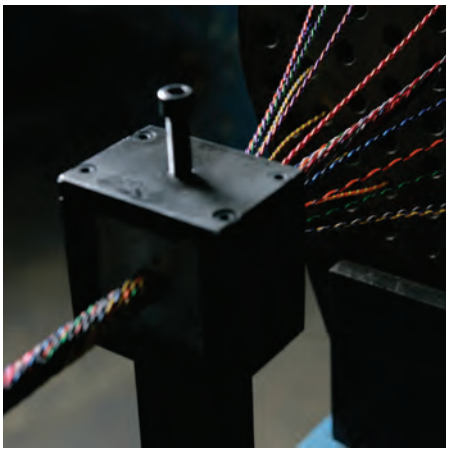
DRAWING

Raw copper rods are delivered to the plant in huge coils. At this point the rod has a diameter of about .3 inches. The thick copper rod is drawn down to a more manageable 11 AWG. 11 AWG has a diameter of .09 inches. In the drawing process the copper rod is pulled through a series of dies, each a little smaller than the next and the conductor is stretched to the required diameter. The 11 AWG copper conductor is then drawn down again to the precise final diameter required for that particular cable. This is a very exacting process the difference in diameter is miniscule (23 AWG = 0.0226", 24 AWG = 0.0201"), but performance differences can be huge. The smaller the gauge number, the thicker the conductor, which can make a difference in electrical characteristics, especially the insertion loss. The wire is then annealed to give it the right amount of stretch and strength for the application.

EXTRUSION

Although the term "extrusion" sounds like something that is pulled out, actually the extrusion process is insulating or coating the copper conductor with a thin layer of plastic. The purpose is to protect the conductor and provide separation from one conductor to another to control the transmission characteristics. The insulation materials are either fluorinated ethylene propylene (FEP) or polyethylene (PE). These materials are chosen for their electrical characteristics and flame retardancy. Therefore FEP is specified for plenum (air handling, ducts) and PE is installed in less threatening non-plenum (or riser) installations.

The plastics for the insulation is supplied in pellet form and small amounts of colorant are added to the raw material before the material reaches the extruder. The extrusion machines melt the plastic,



coats the copper and then are immediately cooled (in water).

An extruder is essentially a heated barrel with an auger inside. The auger or screw is designed to move the compound so it is heated, completely mixed and delivered to the crosshead at the correct pressure. The crosshead holds the die and allows the wire to pass through. The extrusion line is equipped with laser micrometers and other pieces of equipment that allow the quality of the product to be monitors on a continuous basis. One of the key parameters for quality cable manufacturing is concentricity – keeping the copper wire perfectly in the middle of the insulation.

BANDING

Because one pair in the twisted pair is made up of a solid-color insulated conductor and the other is white with a band of the matching color, the white insulated conductor needs to get banded with a color (either blue, brown, orange or green). This is procedure is an automatic "spray painter," but precisely timed and measured so that the installers can easily differentiate the solid from the striped conductor.

TWISTED

After all the different colored conductors have been produced and are reeled they are arranged in a staging area. Now it's time to combine the solid and the banded conductors to create a pair on twinning machines. Each twinning machine is set to precisely twist the pairs at different lay lengths. The purpose of different lay lengths is to alleviate crosstalk (or interference) between the pairs.

CABLING

Once the pairs have been combined together and wound on reels, it is time to combine all four pairs, with the center spline, if needed.

The pairs are threaded through a round die cast metal guide and combined in a cabling machine. This guide assures proper placement of the pairs and center spline, as it is critical to control the crosstalk, not only between the pairs, but also for alien crosstalk between cables, which can occur in higher bandwidth applications.

The cabled pairs are put on a take-up reel and jacketed as a separate process. The cabling machines are very sophisticated and the most recent designs have the ability to dynamically change the rate of twist improving the electrical characteristics of the cable.

JACKETING

Cable jacketing material is either PVC (for riser) PVC alloy (for plenum) or PE (for outdoors or harsh environments). The process is very similar to the one described in the extrusion operation except that the machines are much larger and have the ability to push lots of compound. The jacketed cable is pulled through a trough of water to cool the hot material. Precise measurements of the jacket thickness are critical to determine compliance to the manufacturer's procedures. If too much or too little material is extruded over the cable core the cable may no longer meet the required flammability requirements.

PACKAGING

The cable can be packaged in a number of ways, boxes, reels, and reel-in-a-box. Most reels and boxes usually contain cables of 1,000-feet lengths, but it is also possible to package longer lengths on large reels. The most popular packaging is the box. The automated machines that make the boxes are very interesting to watch. In one operation the cable is printed with the countdown numbering, wound in that very specific manner that allows the cable be pulled form the inside. At the same time the box is formed into shape. The cable is place into the box and finally it is sealed.

FINAL INSPECTION

Before a manufacturered lot of cable leaves the facility, the last step, but most important is a quality assurance lab to assure that it meets or exceeds the electrical characteristics set by the standards. It is not feasible to test every foot of cable so often manufacturers use statistics to determine compliance to industry and often stricter internal standards. The use of statistics is an important part of the process because it not only allows the manufacturer to determine if the cable passes or fails, but also allows them to look at trends that help to head off problems before they really become problems. If you specify and install cable, make sure that you ask for any testing reports and proof that the cable meets the specified UL-listing. If not, the life of a critical network and safety of people and equipment around it is at risk. ■

"Reel Time" addresses cable topics including both copper and fiber constructions, applications, installation practices and standards updates. If you have a particular cable issue, please send an E-mail to: carol.oliver@nexans.com and we will feature the solution in an upcoming issue.

Photos by Bob Pollett