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Category 6 Cable Designs Using Fillers or Separators

To make this discussion more meaningful a definition of terms is included below:

- Pair Lay – the distance required for the two conductors to make one 360-degree revolution of a twist and form the pair
- Twist Per Foot – the number of twists the pair of conductors makes in 12 inches
- Crosstalk isolation – the reduction of noise induced into an adjacent pair from a pair that is carrying a signal.
- NEXT – Near End Crosstalk is the noise measured at the near end of the cable by injecting a signal into the disturbing pair and measuring the amount of signal coupled into a disturbed pair.

Manufactures use separators in Category 6 designs to help mitigate crosstalk; however the first tool in the designer's toolbox is the Pair Lay. Each pair of any given 4 pair cable has its own unique Pair Lay. A pair's lay is selected so that noise contribution between the pairs, in conjunction with the other pair lays surrounding it, minimize crosstalk contribution between pairs. The rule of thumb is that the tighter the lay, the better the crosstalk isolation from one pair's lay to the others in the cable.

Unfortunately, tighter lays contribute to lowering a pair's impedance and raise the signal loss (attenuation) of the pair. Tighter lays reduce the center-to-center distance of the pair, which causes the impedance to become lower. Inherently tighter twist will also stretch the copper and deform the insulation more so than with longer pair lays.

The impedance can be corrected by increasing the diameter of the insulation. The loss can be corrected by increasing the copper diameter but there are limits as to how tight the pairs can be twisted.

Another way to minimize the crosstalk is to physically separate the pairs within the cable. The more physical separation both in distance and material, the less tightly the pairs have to be twisted. The limitation to this approach is keeping the cable from becoming too large and exceeding maximum OD requirements. Employing tighter pair lays along with adding a separator helps mitigate much of the crosstalk contribution within a cable.

Types of separators:

There are three types that are popular with designers. The first is a solid filament, either a rod or a square placed in the center of the cable, (see Figure 1). This type of filler tends to keep the pairs from moving closer to one another through the center of the cable core and aids in maintaining cable geometry. By allowing the cable to maintain the geometry it was designed for helps achieve the desired NEXT performance . A solid center filler relies mostly on the pair lay design to achieve NEXT performance.

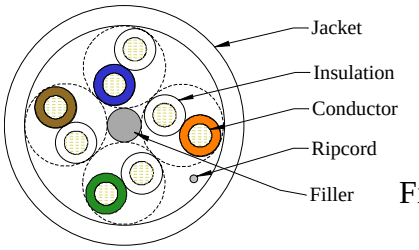

Figure 1

A second filler type is a flat tape, (see Figure 2). The tape is placed to enhance the NEXT of the "opposite" pairs. As previously mentioned 4 pair LAN cables have four unique pair lays. There are *generally* two pairs with longer lays and two pairs with shorter lays. These pairs are placed opposite each other to minimize crosstalk coupling. The tape provides a physical barrier between the like pair lays, isolating the two shorter pair lays and the two longer pair lays from each other; greatly improving crosstalk performance. In Figure 2, the Blue and Green pairs are considered opposite each other; likewise the Orange and Brown are also opposites. The designer has already taken advantage of the small separation between opposites but the tape adds additional separation and also stability to the cable geometry.

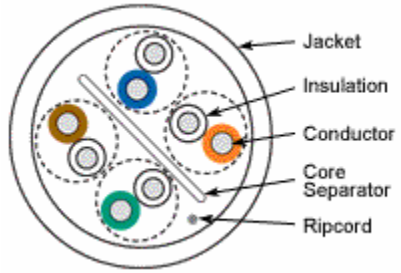

Figure 2

The third type of filler is a Cross Web or “X” shaped central filler as seen in Figure 3. This type of filler adds physical separation between all four pairs and as a result reduces the need for as tight a pair lay without giving up NEXT performance. This can allow for smaller conductor O.D.’s and a reduction of raw materials. A cross web provides the greatest amount of crosstalk isolation between all four pairs in the cable, short of shielding each pair.

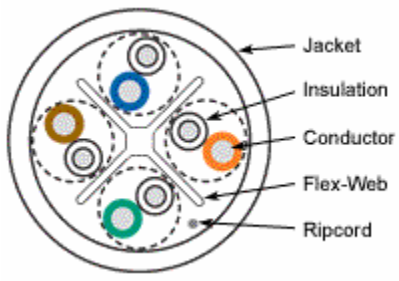

Figure 3

In summary, Category 6 cables without fillers rely solely on Pair Lay design to achieve the desired NEXT isolation. Various filler types allow the designer to achieve the desired NEXT performance without having to rely solely on tightening the pair lay. Employing cross web filler technology and properly designed pair lays provides the greatest NEXT isolation.