It's All About Skew

By Carol Everett Oliver, RCDD, Berk-Tek, a Nexans Company

Berk-Tek's MDP (Micro Data center Plenum) is a loose-tube fiber optic cable designed for high-speed/high-bandwidth data center applications.

Q. I HEAR A LOT ABOUT "SKEW" AS A CONCERN IN FIBER OPTIC CABLE. IS THIS LIKE DELAY SKEW IN COPPER? CAN YOU DEFINE SKEW AS IT RELATES TO FIBER CABLE AND TELL ME WHAT IT MEANS TO CABLE PERFORMANCE AND WHAT I SHOULD LOOK FOR WHEN PURCHASING AND INSTALLING FIBER OPTIC CABLE?

A. The skew effect in fiber is very similar to that of copper. However, up until now, skew concerns were more with copper than with fiber because of the cable construction, transmission properties, application and speed differences. In its simplest terms, skew is the time difference between two transmission conductors (copper or fiber), within the same jacket traveling simultaneously, reaching the same end point. The difference between the slowest and fastest is called the "skew" rate.

For copper, the four pairs each incorporate a different twist ratio, affecting the length (As mentioned in previous articles, the purpose of different lengths of copper pairs is for improved crosstalk performance between pairs). So, the skew is the difference in time, measured in nanoseconds (ns), from the shortest (fastest) pair to the longest (slowest) reaching the termination point.

TIA/EIA-568-A-1 requires a test procedure when testing copper channels. Known as "delay skew" this provides the ratio between the fastest and slowest pairs. The lower the number, the better. The ideal skew rate is between 25 and 45 nanoseconds (ns) over a 100-meter cable run. According to the TIA standards, 45 ns delay skew per 100 meters of Category 5e cable has been identified as a required maximum. Any more could result in latency and slowdowns of the network, which is, obviously, not good.

The main difference between copper and fiber is that fiber basically operates over a one-to-one ratio – one fiber to transmit and one to receive simultaneously. This is called "simplex transmission" because there is one single transmission path in each direction. Most fiber protocols, up to 10 gigabit, are simplex transmissions, therefore skew is not relevant.

To better understand this concept, let's use a runner analogy. A race with many runners is like a signal traveling down a copper cable running from a starting block to the finish line. Skew would be the time difference between the winner and the loser. Or, better yet, if they are running around a track at the same speed, the runner on the inside lane has the shortest distance and therefore will get to the finish line first. So, skew would be the difference between the runner on the inside and the one on the outermost lane.

Fiber is a different race. With a fiber cable, it would be consist of one runner at a time. The race is more like a time trial – trying to beat his own record, or his competitors. One fiber, one end point, one path. However, the race is about to change.

RACE TO THE FINISH

The race is about to become more challenging and include some hurdles as technology pushes fiber to the limit. As bandwidth requirements are being defined in the 40 gigabit and 100 gigabit range, primarily in the data center arena, higher fiber-count cables with multiple fibers transmitting in the same direction will be needed.

Today a typical 12-fiber cable can handle six channels of 10 gigabit (patch panels are usually grouped by six ports in a patch panel). With 12 fibers, six are simultaneously transmitting in one direction while the other six are receiving. Each fiber has its own signal path.

IEEE 802.3ba, which is defining the next generation channel and system requirements for 40 and 100 gigabit systems are calling for multiple parallel paths within a fiber optic cable. Because the fibers will be running tandem in the same paths, skew will become an important factor in the fiber optic cable to perform these multiple point-to-point speeds.

Currently, since one fiber can transmit 10 gigabits in one direction, while another fiber simultaneously performs the same on the receiving end, it will take four fibers (in each direction) to transmit 10 gigabits at a time for a 40-gigabit transmission. This means that it will take a minimum of eight fibers in one cable for one channel. Now, setting up a typical six-port scenario will require a 48-fiber cable (eight fibers for one channel x 6 channels = 48 fibers)

Pushing it further to 100 gigabits will equate to 20 fibers per channel (10 simultaneous fibers running in each direction). For a six-port scenario, this would require a cable with 120 fibers.

As you can imagine, it is imperative

that all of these fibers reach their destination at the same time or there will be skew. And the higher the bandwidth requirements, the tighter the allowable skew rate. Imagine what would happen in a data center, such as for a financial institution where preciseness in transactions counts down to the penny. If packets of information were dropped or latency occurred, the outcome could be an economic disaster.

CABLES FOR SKEW

Since IEEE defines the channel and not the components, the race is on for cable manufacturers to offer the best cabling solution for 40 and 100 gigabit. In the data center environment, a small-diameter round cable will allow better airflow and provide a better bend radius for high-density switches and servers. However, not all round cables are alike and will suffice. Make sure to specify a cable that has been designed and built to withstand these strict required tolerances, to be assured that the fiber transmission is in perfect cadence. Alternatively, ribbon cable lines up the fibers in a row. However, a ribbon cable, with its side-by-side fibers and "flat construction" takes up more space and requires a larger bend radius than a round cable. Where cooling is a primary concern, this could be an issue around heat producing active equipment and within enclosed cabinets.

A relay race scenario will not suffice as all the fibers need to reach their end point at the same time. Two factors that impact skew is the fiber length and the optical properties of each of those fibers. Once the IEEE work is complete, the specification will be available to make sure that the signals traveling along the multiple fiber paths meet the allowable skew rate. So when deciding upon a cable that will provide you with future proofing for tomorrow's applications, remember what you've learned in "Skew U." ■

"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.