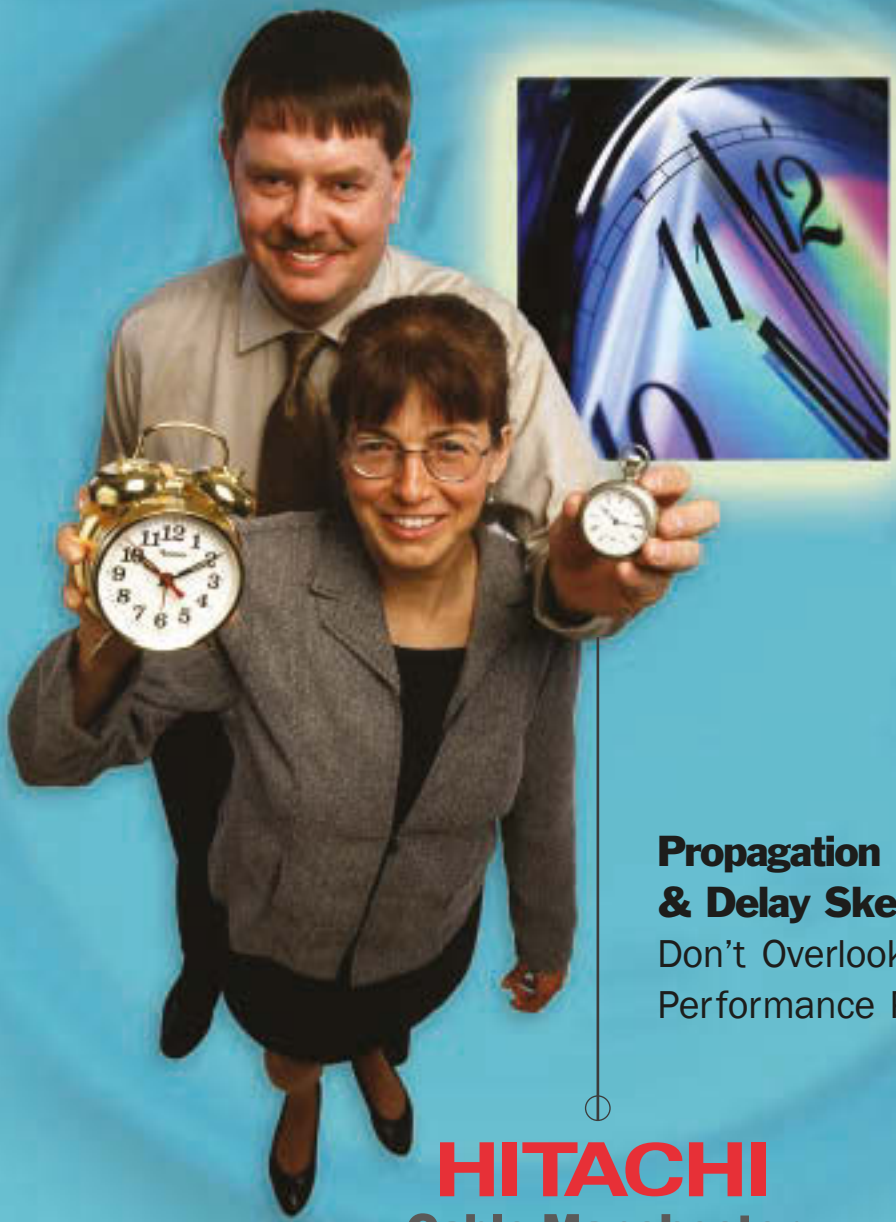
CABLEMania™

"Our engineers have carefully investigated the role of signal timing in data transmission..."

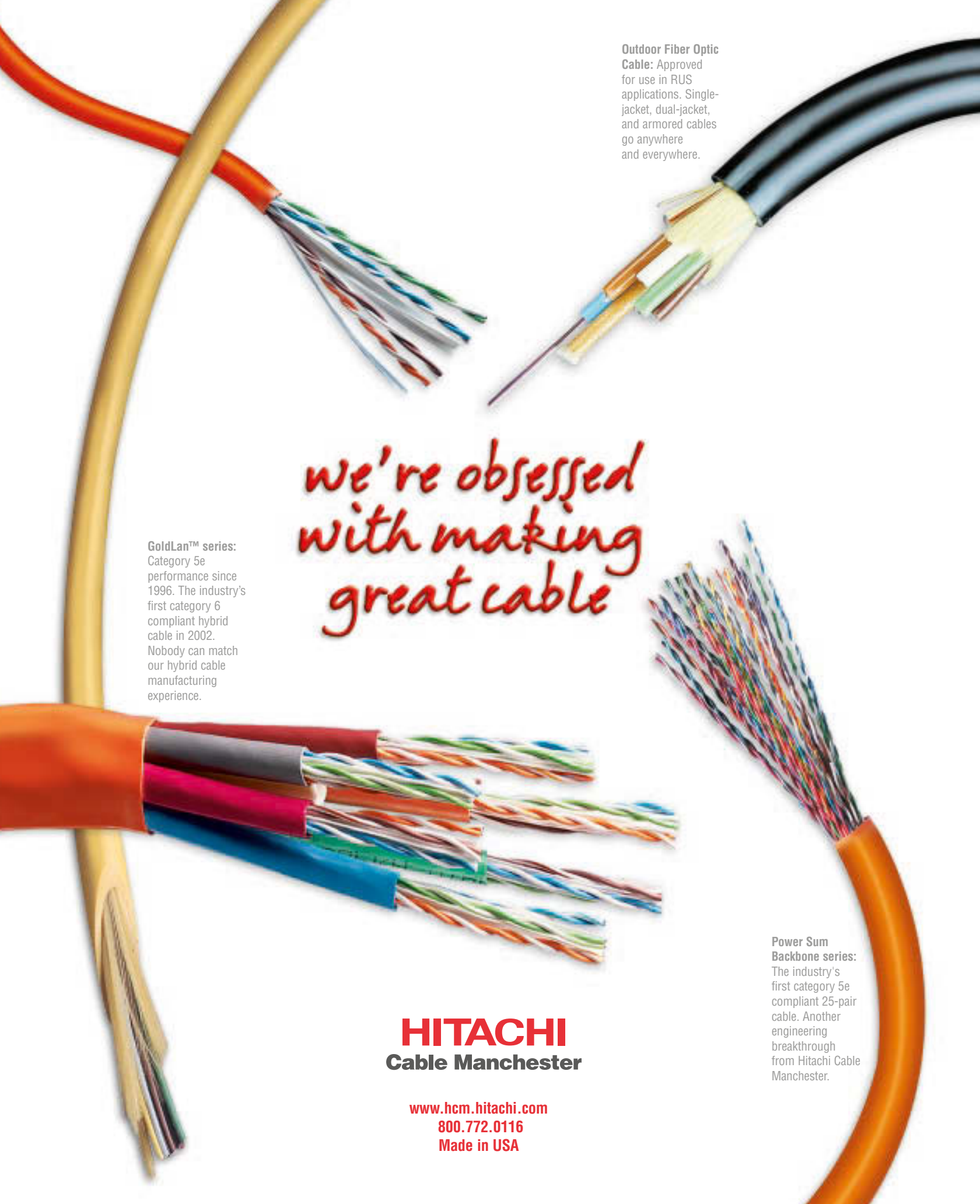
issue 2



Propagation Delay & Delay Skew
Don't Overlook these Critical Performance Parameters

HITACHI
Cable Manchester

we're obsessed with making great cable



Outdoor Fiber Optic Cable: Approved for use in RUS applications. Single-jacket, dual-jacket, and armored cables go anywhere and everywhere.

GoldLan™ series: Category 5e performance since 1996. The industry's first category 6 compliant hybrid cable in 2002. Nobody can match our hybrid cable manufacturing experience.

Power Sum Backbone series: The industry's first category 5e compliant 25-pair cable. Another engineering breakthrough from Hitachi Cable Manchester.

HITACHI
Cable Manchester

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Welcome to CableMania™

issue 1

It's been said that necessity is the mother of invention. If this is so, then we wonder if obsession is its father?

In the HCM engineering department, our obsession drives us to continuous product innovation, performance enhancement, and process improvement. If an end-user needs a custom cable design for their application, there is always a creative person here to invent it!

These days, as customers specify category 6 cabling for their building infrastructures, there is hardly a thought given to the history, creation, or imagination of the engineers who first had the initiative to develop fiber-optic and twisted-pair technology. Doing without many of today's cable inventions would certainly eliminate our ability to access the Internet, take advantage of computer-controlled applications, and communicate on a global basis. Other enhancements, such as the development of category 4 cabling, are so insignificant today that we wouldn't miss them if we never saw them again. But no matter what the invention, one thing is true...they originated in a creative mind!

We are continuously pushing the performance envelope of our cables. In this issue of CableMania, we focus on the transmission parameter of delay skew. This simple calculation describing the difference in signal speed between cable pairs is fundamental to network operation, but the need for its accurate specification is often overlooked. As early as 1995, when HCM voted to hold-up the publication of TIA/EIA-568-A until the parameters of propagation delay and delay skew were added to the standard, we have studied the relationship between jacket compounds, conductor properties, and signal propagation. Application needs have changed dramatically since 1995 and controlling signal arrival times is more important now than ever. Our findings may surprise you.

For those who need to get warmed up before jumping into our technical feature, check out our Jumble puzzle on the back cover. It's the easiest way to get in the mood for CableMania. Who knows, you might even win a FREE "CableManiac" t-shirt!

Sincerely,
The HCM Engineering Team

PS . Drop a line to our Editor at: CableMania@hcm.hitachi.com with any thoughts that you'd like to share.

New Product Releases

CableMania

StratusClear™ 50/125 µm Multimode Fiber Supports 10 Gb/s Applications

Hitachi Cable Manchester, Inc.'s new StratusClear™ 50/125 µm multimode fiber cables are the preferred solution for emerging, laser-based applications such as 10 Gb/s Ethernet. StratusClear 50/125 µm fiber cables are fully compliant with the requirements of the TIA/EIA-568-B.3-1 standard and are guaranteed to support 10 Gb/s transmission up to 300 m (984 ft) using 850 nm wavelength laser light sources. These premium fiber optic cables also provide Gigabit Ethernet applications support over extended distance and significantly extend the transmission operation distances (up to 2,000 meters) for less demanding protocols such as Fast Ethernet, FDDI, and 155 Mbps FDDI.

StratusClear 50/125 µm cables are available for indoor, indoor/outdoor, and outside plant use in a variety of interconnect, SingleUnit and MultiUnit distribution, and central tube cable designs. All HCM outside plant fiber optic cable designs are available with corrugated steel armoring upon request.

Category 5e Cable Supports Outdoor Applications

HCM has developed a rugged category 5e, 4-pair cable that is suitable for use in direct burial, duct, or aerial outdoor applications. The heavy-duty construction features a black UV- and abrasion-resistant polyolefin jacket and a gel-filled cable core that is impervious to water penetration. The special water-blocking gel is non-conductive and has superior dielectric properties for optimum transmission performance. This cable is perfectly suited for providing telecommunications services to satellite locations such as portable classrooms and trailers in a campus environment.

HCM is not only known for our performance-driven telecommunications cables, but also for our quality Electronics products.

Our Electronics division has just released a comprehensive, 72-page catalog highlighting HCM's line of electronic cables for industrial, medical, and high technology computer applications. Contact HCM's Customer Support Team at 603.669.4347 for your free copy.

THE CABLE ENQUIRER

EXTRA EXTRA

Hitachi first again!!!

Exclusive photos prove space aliens behind Hitachi engineering feats.

Befuddled competitors exclaim: *"We don't know how they do it!"*

Sources monitoring breakthroughs at telecommunications cabling plants throughout the world are keeping a close eye on the Hitachi Cable Manchester, Inc. manufacturing facility in Manchester, NH. In particular, the unprecedented number of new products released within the last few months has industry experts speculating that the engineering capability at HCM exceeds that of all other cable manufacturers combined. Hitachi engineers have been relentless in their mission to continuously raise the cable performance bar. Amazingly, within the course of a few weeks time, HCM released both the industry's first category 6 hybrid and the industry's first category 5e multipair backbone cables. Reporters are on the scene to deliver late-breaking stories as they unfold.

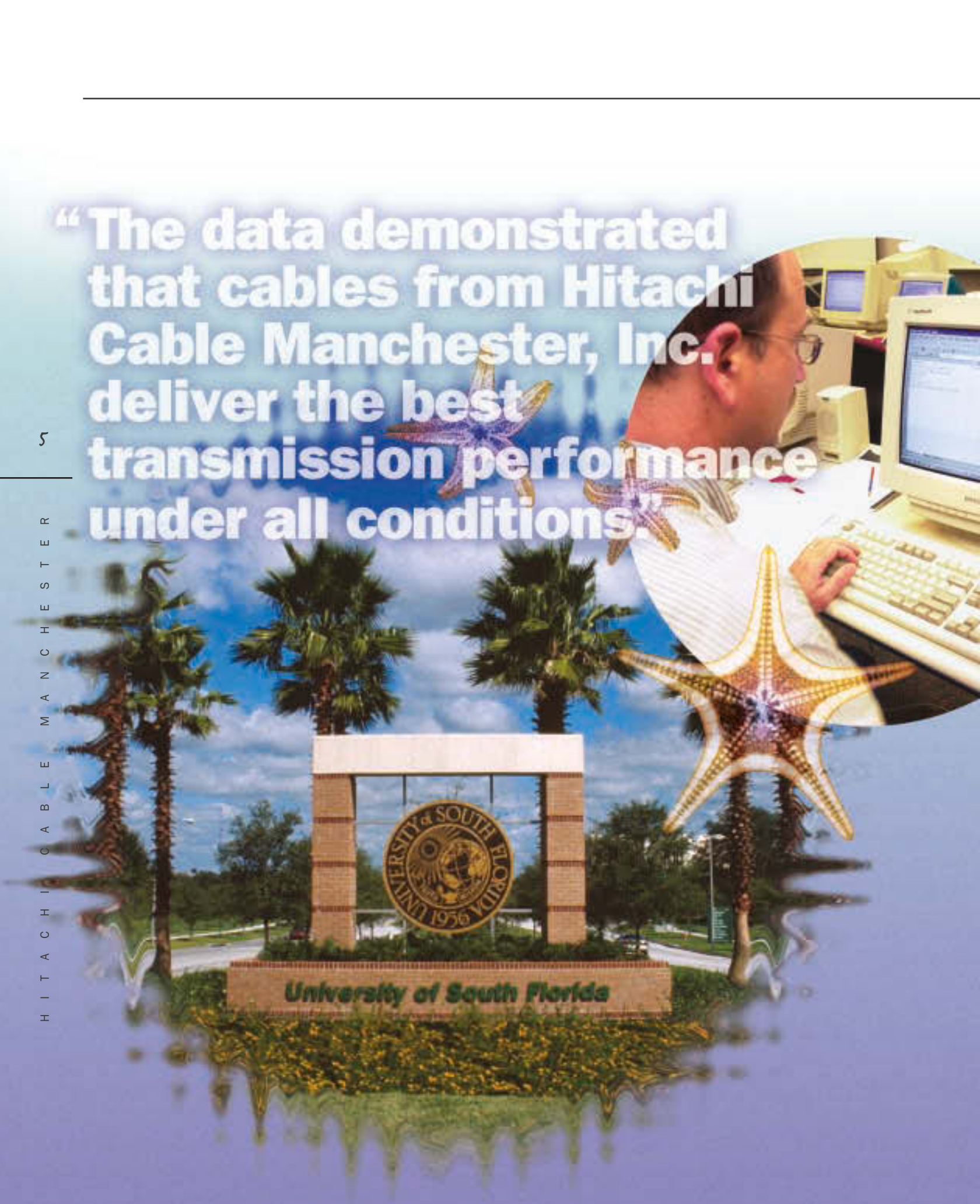
★ Industry's First Category 5e Multipair Backbone Cables

- TIA/EIA-568-B.2 component compliant
- Fully verified for compliance by an independent test lab
- Supports c(UL) CMP/FT6 plenum and c(UL) CMR/FT4 riser rated applications
- Available in a 25-pair configuration
- Perfect for supporting Gigabit Ethernet and other data-grade applications in backbone cabling solutions

★ Industry's First Category 6 Riser-rated Hybrid Cables

- TIA/EIA-568-B.2-1 component compliant
- Fully verified for compliance by an independent test lab
- Supports c(UL) CMR/FT4 riser rated applications
- Available configurations include three 4-pair (3x4), four 4-pair (4x4), and six 4-pair (6x4) cables covered by an overall jacket
- Advantages of specifying hybrid cables include a reduction in the number of individual cables brought to each workstation and the use of color-coding to identify applications
- Hybrid cables are an ideal means to support redundant voice and data services in critical service areas such as trading floors and communications centers

"The data demonstrated that cables from Hitachi Cable Manchester, Inc. deliver the best transmission performance under all conditions."



Site Story

issue 2

University of South Florida: A campus cabling standard supports rapid growth

Roland Johnson, Manager of Telecommunications at the University of South Florida (USF), oversees cabling operations at one of the country's fastest growing educational facilities. The successful implementation of a campus-wide cabling standard was a critical element in allowing his installation team to keep pace with the rapid expansion occurring at USF. Roland elaborates, "USF is the second largest university in Florida and the 12th largest university in the nation, and the campus growth rate is high. For example, one of our directives to re-cable 22 campus buildings in 5 years has now been squeezed to a project completion time frame of 6 months! The University's long-term plans call for the construction of two new buildings a year, as well as continual maintenance and cabling upgrades to the existing buildings."

Setting the standard

Since USF also supplies voice and data services to offsite entities (such as the Tampa Port Authority, various community colleges, and at least 4 Florida IT providers), managing cabling infrastructure designs, inventories, and staff is a challenge. "Ten years ago, our communications department didn't have much input as to how the building was wired. It was a hassle for us to keep track of what materials were in each facility," Roland says. "In 1995, we developed a 40-page telecommunications standard documenting the materials, installation practices, and design of each telecommunications area served by the University. After implementing this standard, we were able to reduce our inventories by 25% and our labor overhead by 50%. Of course, the key to the success of the campus-wide standard was to select cable and connectivity partners that could support our need for quick turnaround times and deliver high performance under a variety of conditions."

Lab testing proves superior performance

USF adopted a unique experimental approach to identify their preferred cabling providers. Since USF is a research facility, Roland and his staff could procure samples of a wide range of telecommunications products and independently evaluate their performance in the installation environment. Combinations of cables, connecting hardware, and patch cords were assembled into links and channels representative of USF's standard topology and then subjected to a range of aggressive tests. Roland explains, "Being an educational institution, we were able to research the performance of various products ourselves. Each channel configuration under review was evaluated for baseline performance using an Agilent Technologies WireScope handheld field tester. We then re-tested each configuration after purposely stressing the cable by crushing it and tying it in knots. Our tests even included wrapping the cabling around a fluorescent lighting fixture to verify electromagnetic compatibility! The data demonstrated that cables from Hitachi Cable Manchester, Inc. deliver the best transmission performance under all conditions. We have paired HCM cables with connectivity manufactured by Superior Modular Products, Inc. and have realized trouble-free network operation since the campus standard was implemented."

Although the original evaluations focused on transmission performance under aggressive installation conditions, the cabling technicians at USF praise the features of HCM cables that make for quicker and easier installation. "Since USF standardized on Reelex® packaging, our technicians appreciate the easy pay-out design of the HCM cable boxes. The cable pulls without snagging and handles well. Furthermore, because the majority of our installations occur at night when the classrooms are empty, the bright pair coloring of the Hitachi cables helps to reduce eye strain during the termination process."

Roland admits that he has many projects ongoing at the University to keep him occupied. "With 30,000 USF students attending classes on the Tampa campus alone and additional telecommunications services provided to 4 satellite campuses and other offsite facilities, we have put our campus cabling standard to the test. Through it all, the support from Hitachi has been outstanding. Our group is focused and we have the strategic cabling partnerships necessary to expand and grow our telecommunications facilities wherever we need to in South Florida."

Propagation Delay & Delay Skew:

CableMania

Don't Overlook these Critical Performance Parameters

"The result of our efforts has been to identify a design strategy that significantly reduces the maximum delay skew in our premium cables at no additional cost to our customer."

The specification of signal propagation delay and propagation delay skew first received focused attention in the mid-1990's when a shortage of FEP (Fluorinated Ethylene Propylene) caused an upheaval in the cable manufacturing industry. Because FEP is highly flame retardant, it's the primary conductor insulation material used in plenum-rated cable. (It's also used to coat the inside of non-stick cooking pans.) As the availability of FEP became scarce, engineers scrambled to replace it with other materials. Kevin Boisvert, HCM's Process Engineering Manager, recalls, "The results were disastrous. In an effort to stretch FEP supplies, many manufacturers were using FEP on some insulated conductor pairs and other compounds, such as polyolefin, on the remaining pairs. Because the two materials have drastically different dielectric properties, differences in signal propagation speeds were unacceptable. Unfortunately, not many manufacturers were paying attention to the situation."

This unforeseen consequence of using mixed dielectric insulating materials was brought to the attention of TIA in 1995 through a contribution presented by Hitachi Cable Manchester, Inc. At the time, only applications that transmitted information simultaneously over multiple pairs required compliant signal propagation delay and propagation delay skew performance in order to perform properly. For example, in 100BASE-T4 (Fast Ethernet) operation, 3 pairs support 33.3 Mbps of parallel information throughput and 1 pair is left for collision-detection purposes. An internal clock establishes the data sampling speed. As long as the packets of data transmitted over each pair arrive within the anticipated window of time, the application can successfully recombine the data streams without loosing synchronization. The result of excessive propagation delay and/or delay skew is throughput errors introduced due to lost timing synchronization. TIA quickly reacted to implement signal propagation delay and delay skew performance limits in the TIA/EIA-568-B.2 standard for category 3 and category 5e cabling to ensure that cable designs would support minimum application's requirements.

Paying attention to the parameters

Today, it is common knowledge that other characteristics besides the dielectric properties of the insulation material affect signal propagation and delay skew performance. The tighter pair twists that deliver improved crosstalk margins also contribute to greater signal propagation delay. The difference in twist rate between pairs, which minimizes pair-to-pair crosstalk, also increases cable delay skew.

(Continued on page 9)

Key Technical Concepts

Propagation Delay: The amount of time, typically measured in nanoseconds (ns), between when a signal is launched from the applications equipment and when it is received at the network interface card (NIC) in the equipment at the work area and vice versa.

Propagation Delay Skew: The difference in propagation delay, typically calculated in nanoseconds (ns), between the pair with the slowest signal propagation delay and the pair with the fastest signal propagation delay. In Figure A, the propagation delay skew would be calculated as follows:

	Propagation Delay of Slowest Pair	520 ns
–	**Propagation Delay of Fastest Pair**	495 ns
	Propagation Delay Skew	25 ns

Nominal Velocity of Propagation (NVP): A measure of the speed of a signal traveling along a transmission line, typically expressed as a percentage of the speed of light traveling in a vacuum. The NVP for riser-rated HCM cables is 68% and the NVP for plenum-rated HCM cables is 70%.

TIA and ISO Standards Requirements:

Propagation Delay Limits

Category 3, 5e, & 6

Connector	2.5 ns	all frequencies
Cable	545 ns	at 10 MHz
Channel	555 ns	at 10 MHz
Permanent Link	498 ns	at 10 MHz

Propagation Skew Limits

Category 3, 5e, & 6

Connector	1.25 ns	all frequencies
Cable	45 ns	all frequencies
Channel	50 ns	all frequencies
Permanent Link	44 ns	all frequencies

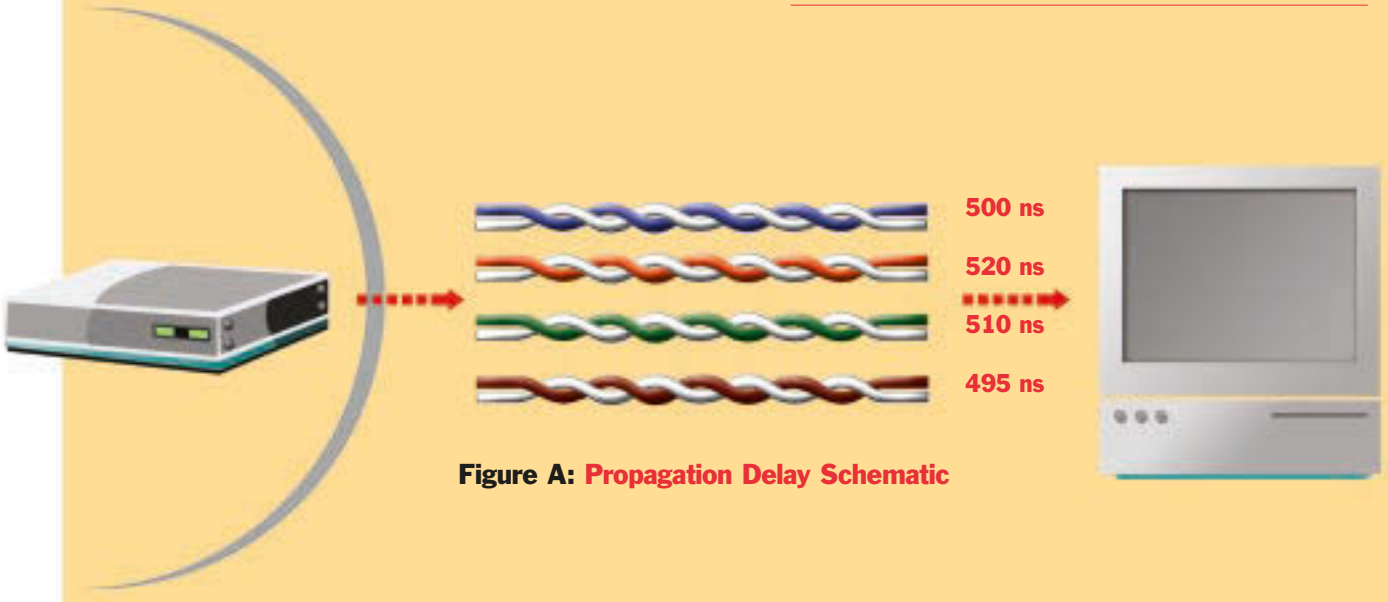
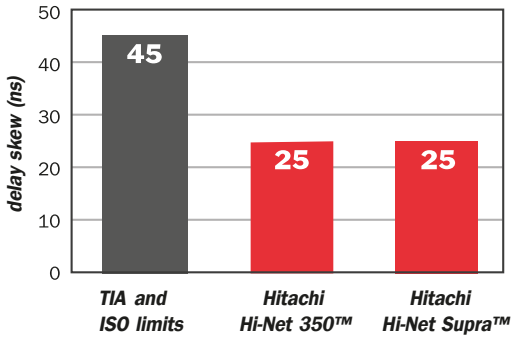


Figure A: Propagation Delay Schematic

HCM Guaranteed Maximum Delay Skew



Secondary factors, such as the mechanical and electrical characteristics of the primary copper conductor, also contribute to variances in propagation delay and delay skew performance. Unfortunately, the industry trend has been to design cables with performance headroom built into every transmission parameter except propagation delay and delay skew.

Kevin Boisvert and his team studied propagation delay and delay skew and linked excessive levels to potential complications in supporting next generation applications. "Our engineers have carefully investigated the role of signal timing in data transmission and are suggesting that the existing TIA and ISO propagation delay and delay skew requirements may not be stringent enough to support new applications. In particular, our research indicates that, since delay skew affects signal timing and the re-fresh rate of transmitted data, the quality of video transmission (where red, green, and blue color channel information is transmitted over different pairs) could benefit from reduced delay skew. In fact, future video applications will likely require significantly better channel delay skew than the 50 nanosecond limit imposed by the TIA standards in order to deliver optimum picture quality."

Research driven design and manufacturing

In response to their findings, the HCM engineering team endeavored to unlock the secret to significantly reducing propagation delay skew in cables. Kevin Boisvert summarizes, "The result of our efforts has been to identify a design strategy that significantly reduces the maximum delay skew in our premium cables at no additional cost to our customers. Our solution uses FEP on all pairs to avoid having to compensate for skew introduced by mixed dielectrics. We subsequently developed techniques to optimize the electrical properties of the insulation dielectric and the copper conductor to best match signal propagation speeds between the cable pairs. The result is a design with over 45% headroom to the standard's requirements for delay skew."

Applying technology

In anticipation of the need to support video applications over twisted-pair media, it is prudent to specify cabling solutions with delay skew performance significantly better than currently specified in the TIA and ISO standards. To ensure next generation applications support, HCM guarantees that the maximum delay skew on their Hi-Net 350™ (category 5e with headroom) and Hi-Net Supra™ (category 6 with headroom) cables shall not exceed 25 nanoseconds.

Understanding 3x1 and 2x2 Plenum Cable Constructions

To reduce material costs in plenum rated cable designs, it is possible to use mixed dielectric conductor pair insulations as long as compliant propagation delay and delay skew performance of the finished product is validated. A 3x1 construction contains 3 FEP insulated pairs and 1 non-FEP insulated pair, as shown in Figure 1. A 2x2 construction contains 2 FEP insulated pairs and 2 non-FEP insulated pairs. The key to manufacturing a compliant mixed dielectric cable is to understand the relationship between the NVP of FEP and non-FEP materials. Typically, signals propagate faster over conductors insulated with FEP. Armed with this knowledge, a cable engineer will specify FEP insulations to be applied to the cable pairs with the tightest twist rates (the shortest electrical length). The net effect is that signals traveling the longest distance are "sped-up" by the FEP insulation and signals traveling the shortest distance are "slowed-down" by the non-FEP insulation.

Although 3x1 and 2x2 plenum cable constructions deliver standards compliant performance, due to the nature of mixed dielectric insulation materials, they can never deliver the delay skew performance headroom that can be provided by a cable designed with FEP insulation on all pairs. For this reason, mixed dielectric cables will likely not be the optimum media to support next generation applications requiring reduced delay skew performance.

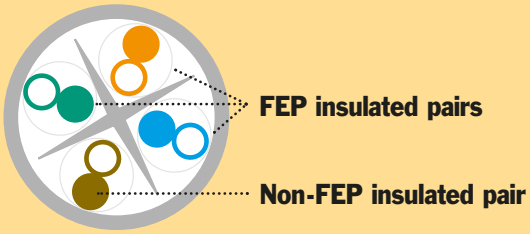


Figure 1: 3 x 1 Example

Cable Rave™

Issue 2

If you have a Cable Rave™ that you would like to have featured in CableMania,™ please forward it to the Editor at
CableMania@hcm.hitachi.com
If we print your rave, we'll send you a CableManiac t-shirt.

"We've been making cable assemblies for 19 years and Hitachi responds to our needs like no other supplier.

Last month, we encountered some difficulty cutting the jacket on our category 5e patch cords. Two of Hitachi's engineers drove down to watch our process and help solve the problem. Within 48 hours, the challenge had been met and we were up and running again at full speed.

It's that kind of service that makes Hitachi our #1 supplier!"

Randi Sosnowitz
President
Interface Technology

Hitachi Cable Manchester, Inc. Data-Master™ Patch Cable Features

- Data-Master™ patch cables are available in category 5e, category 5e with headroom, category 6, and category 6 with headroom performance grades.
- Soft and flexible jacket is easy to terminate.
- Standard cable length is 1,000 feet (305 m).
- Eight standard jacket colors (white, gray, red, orange, yellow, green, blue, and black) are always in stock. We are pleased to support requests for custom colors.

Fun CableMania Time

HCM wants you to have fun, too. Unscramble the letters on the left to form cable-related words. Unscramble the circled letters to solve the puzzle below.

First ten correct answers to be e-mailed to CableMania@hcm.hitachi.com will receive a FREE CableManiac t-shirt.

JUMBLE

CROPPE

LENNACH

MICEPOOST

DIHNDTWAB

Puzzle:
How do HCM's engineers drive to work in the morning?

Strange but True

What's for dessert?

This delectable confection was recently seen at our favorite local restaurant. Although patrons were intrigued by it's colorful appearance, we didn't actually see anybody eat any! We hear it was high in fiber. **Share your pictures with us, and we'll send you a FREE "CableManiac" t-shirt. Send your pictures to CableMania, 900 Holt Avenue, Manchester, NH 03109**

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we're obsessed with making great cable

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