smiths interconnect

White Paper

Cat 5e and Cat 6A Data Transmission Modules

High durability and signal integrity up to 10 Gbps for ethernet protocol applications

Content

1. Scope

The need for Gigabit data transmission with lower latency is growing in industrial, military and aerospace applications. While all users ask for reliable Ethernet solutions, the applications also require reduced crosstalk for high reliability, operate in harsh environmental conditions with high vibration, mechanical shock and hundred thousand mating cycles. The scope of this document is to present the performance of the Data transmission modules Cat 5e/Cat 6A over current alternatives available in the market.

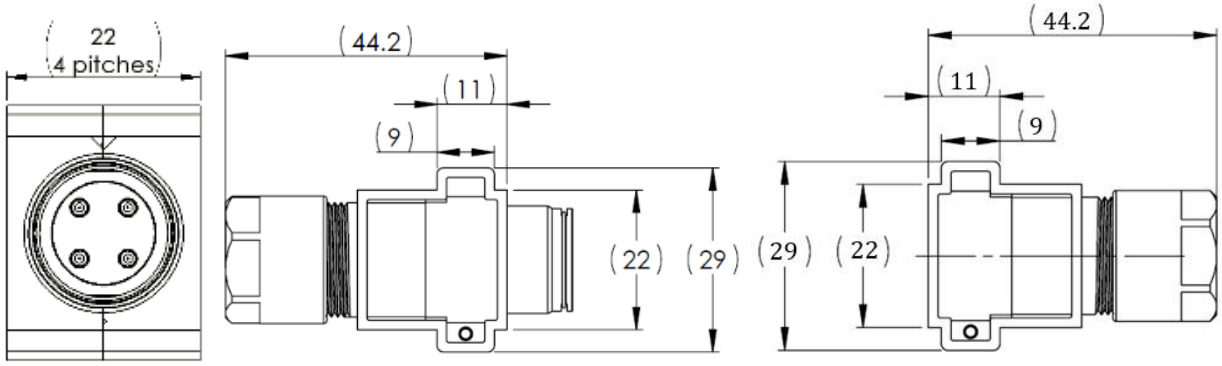
2. Background and description of Cat 5e and Cat 6A data transmission modules

Smiths Interconnect is a leading provider of high-reliability connectivity products and solutions in the aerospace and defense sector, medical, semiconductor test, and industrial market segments. We design, manufacture, and test technically differentiated custom electronic components, microwave, optical, and RF products and subsystems that connect, protect, and control critical applications.

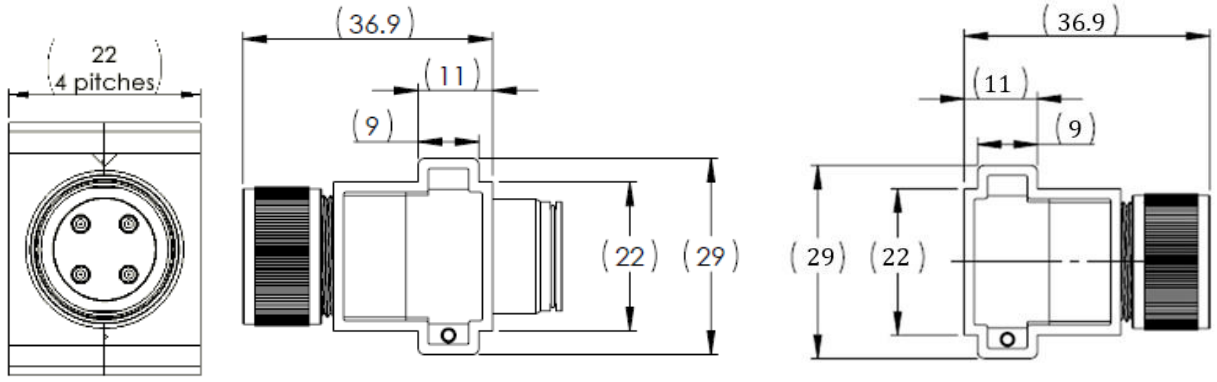
At Smiths Interconnect, we prioritize quality and performance in our product design. We select the compliant materials who satisfy Railway standards (EN 45545-2 HL3 R22-R22), such as the polycarbonate family, to ensure high-quality insulator materials for test and measurements applications. This thermoplastic polymer offers excellent electrical and thermal insulation properties, is lightweight, can support heavy loads, and is resistant to abrasion, steam, and weather, all contributing to the safety and reliability of our products.

Our configurations of Cat 5e and Cat 6A modules used for standard cable categories enable data transmission to satisfy specific technical requirements in ethernet protocol applications.

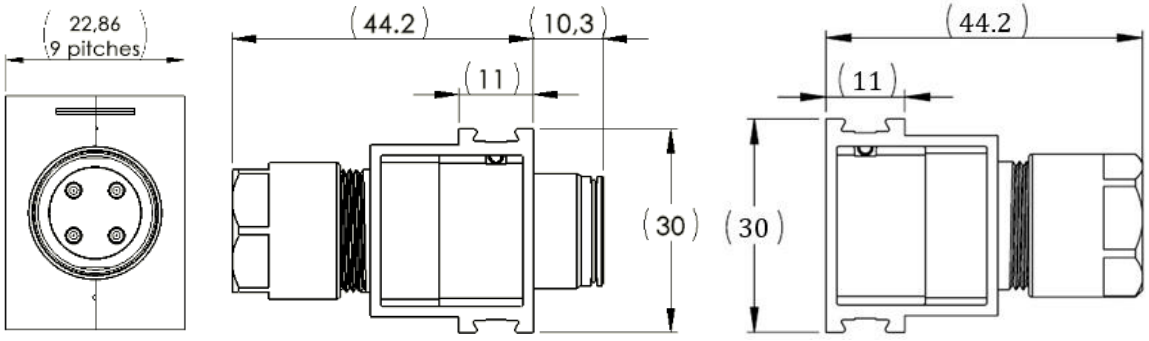
Data Transmission Cat 5e Module features two classes: Standard version and Low profile Cat 5e Module. Each class is divided into configurations for L series (dimensions 22mm × 29mm × 44.2mm for the standard version and 22mm × 29mm × 36.9mm for low profile version) and H/N series (dimensions 22.86mm × 30mm × 44.2mm for the standard version and 22.86mm × 30mm × 36.9mm for low profile version). The following drawings show our configurations of different Cat 5e Modules.



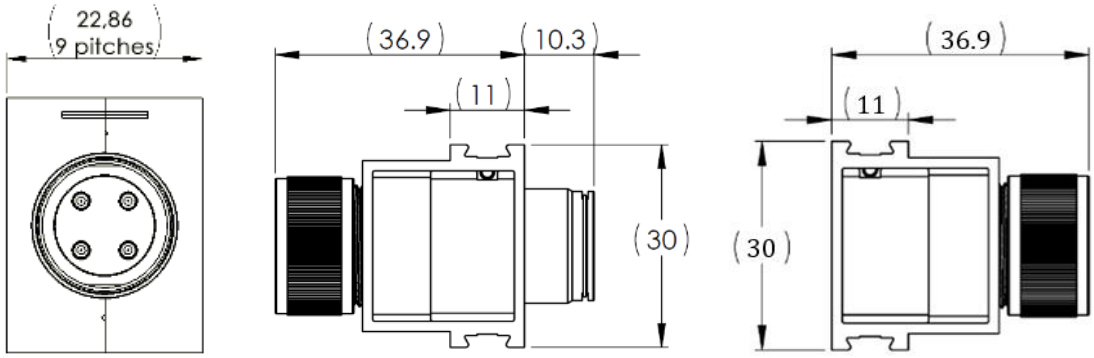
Configuration of Standard Version Cat 5e Module in L series male and female.



Configuration of Low profile Version Cat 5e Module in L series male and female.



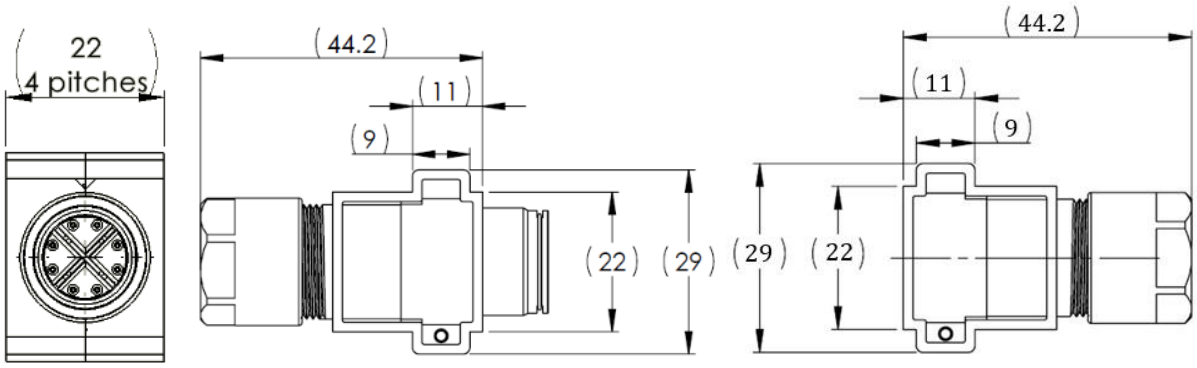
Configuration of Standard Version Cat 5e Module in H/N series male and female.



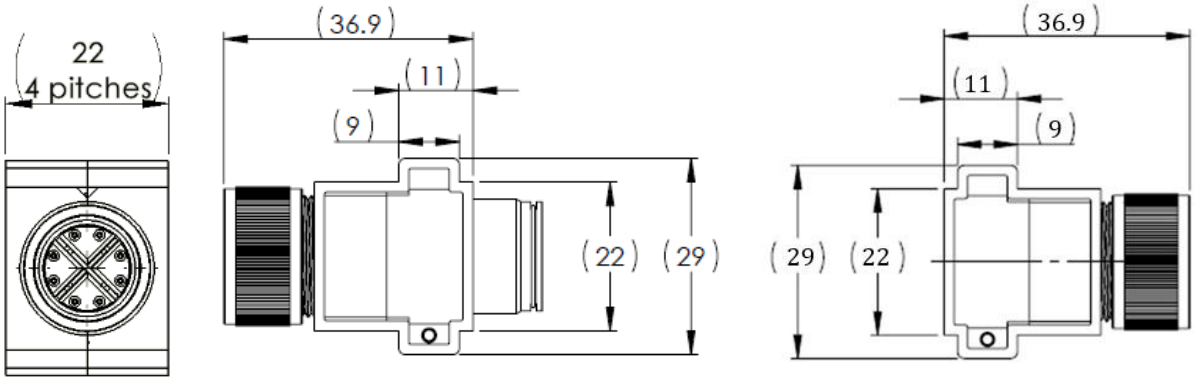
Configuration of Low profile Version Cat 5e Module in H/N series male and female.

Data Transmission Cat 5e Module offer electrical performance with a bandwidth of 100 MHz, that satisfies the ANSI TIA 568 C.2 standard, which uses UTP and STP cables for data transmission up to 1 Gbps appropriate for IEEE 802.3 standard. It allows a wide range of temperature operation between -55°C to +125°C and it is is higher than competitors (the best of competitors present a temperature range of -40°C to +90°C). Our product passes vibration and shocking tests (0-33 Hz and 15 g)and RoHS compliance except 6c, in which our contacts contain copper alloy up to 4% lead in weight and REACH standards. For safety reasons, our modular connectors with Cat5e modules are compliant to UL1977, and EN 45545-2 (HL3 R22 and R23) standards that prevent fire risk, electrical failures and personal injuries. ;. Inner contacts have a diameter of 1mm, that are suitable for crimping standard cables like AWG 24 to18 or AWG 30 to 22. Our solution is tested for more than 100,000 mating cycles as a connector mating which is significantly higher than all other alternatives available in the market. Our design offers EMI/EMC shielding for protection from external electromagnetic signals in both terminations (male and female connectors) with 360° shielding range.

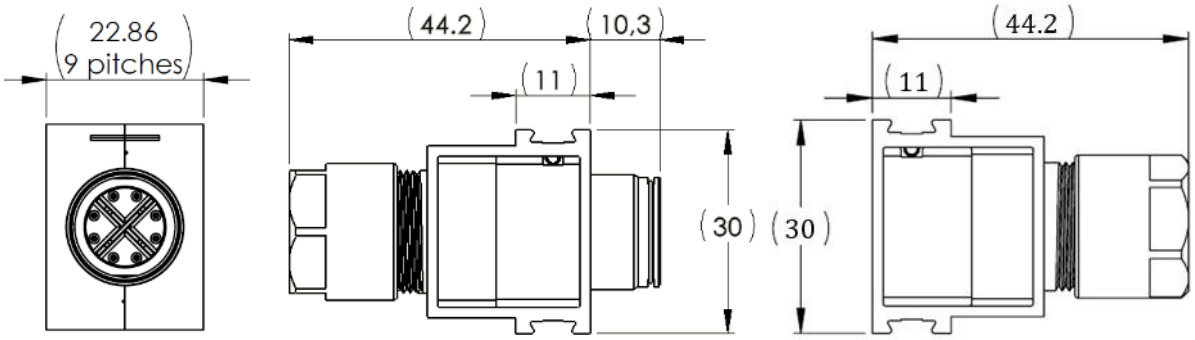
Data Transmission Cat 6A Module features two classes: Standard version and Low profile Cat 6A Module. Each class is divided into configurations for L series (dimensions 22mm × 29mm × 44.2mm for the standard version and 22mm × 29mm × 36.9mm for low profile version) and H/N series (dimensions 22.86mm × 30mm × 44.2mm for the standard version and 22.86mm × 30mm × 36.9mm for low profile version). The follow drawings shows our configurations of different Cat 6A Modules.



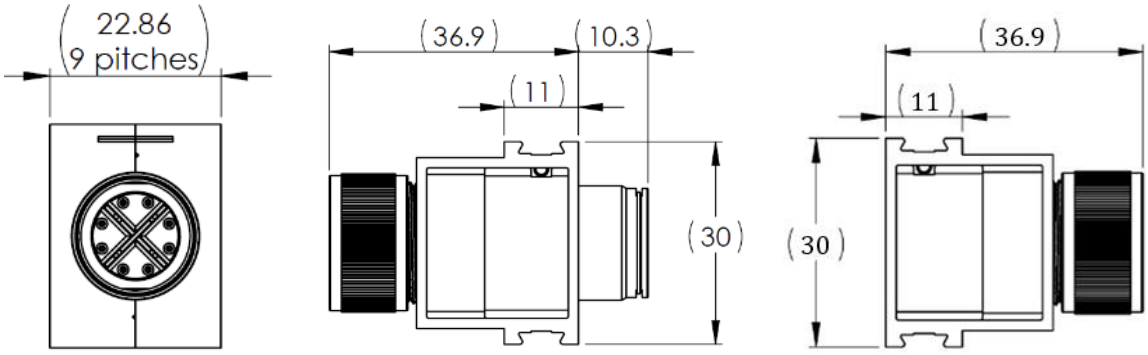
Configuration of Standard Version Cat 6A Module in L series male and female.



Configuration of Low profile Version Cat 6A Module in L series male and female.



Configuration of Standard Version Cat 6A Module in H/N series male and female.



Configuration of Low profile Version Cat 6A Module in H/N series male and female.

Data Transmission Cat 6A Module offers electrical performance with a bandwidth of 500 MHz, this satisfied the ANSI TIA 568 C.2 standard, which uses STP, S/STP and S/FTP cables for data transmission up to 10 Gbps appropriate for IEEE 802.3 standard. It allows a wide range of operation temperature between -55°C to +125°C appropriate for IEC 61984:2008 Standard. our product performance is higher than competition (the next best alternative offers a temperature range of -40°C to +90°C). Our product passes vibration and shocking tests (0-33 Hz and 15 g) and RoHS compliance except 6c, where our contacts contain copper alloy up to 4% lead in weight and REACH standards. For safety reasons, our modular connectors with Cat 6A modules are compliant to UL1977, and EN 45545-2 (HL3 R22 and R23) standards that prevent fire risk, electrical failures and personal injuries.. Inner contacts have a diameter of 0.5mm, that are suitable for crimping standard cables like AWG 26 to 22. Our solution guarantees more than 100,000 mating cycles (mating connector) which is significantly higher than all other alternatives available in the market. Our design offers EMI/EMC shielding for protection from external electromagnetic signals in both terminations (male and female connectors) with 360° shielding range.

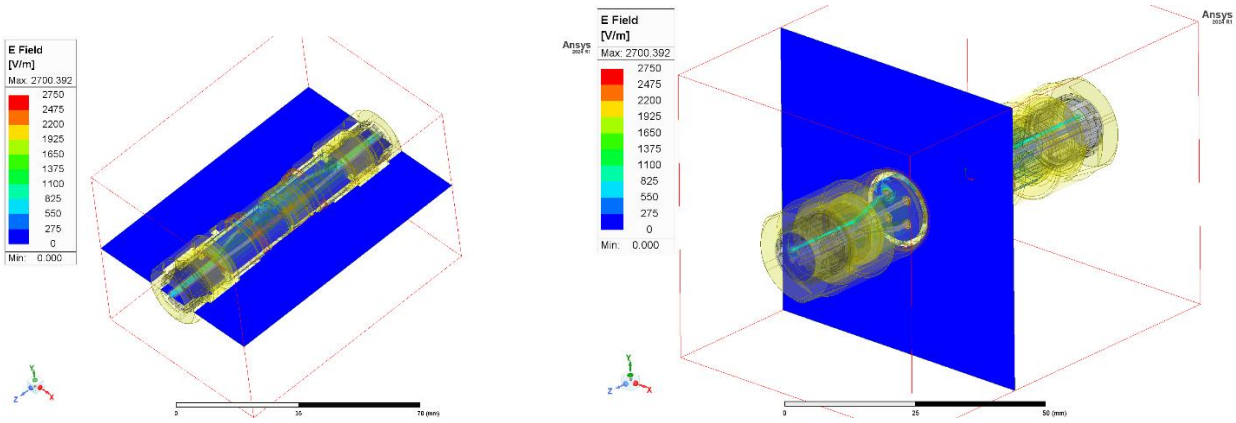
3. Electrical Performance

Electromagnetic simulation software is used in engineers' design processes to study the electromagnetic properties of components or entire systems. Electromagnetic (EM) systems often pose multiscale challenges, such as wide frequency ranges and electrically large structures with fine details. EM simulation can be applied throughout the entire design process to analyze electromagnetic performance under operating conditions: virtual prototypes are transforming the design cycle. Radiofrequency simulation (RF) is largely based on the solution using the finite element method (FEM) for high-frequency electromagnetic analyses. Also, it includes alternative methods and solvers for specific types of analyses. RF simulation ensures that you feel confident that your analysis is correct and that the design is supported by robust numerical solutions. FEM is used for frequency domain and transient analysis.

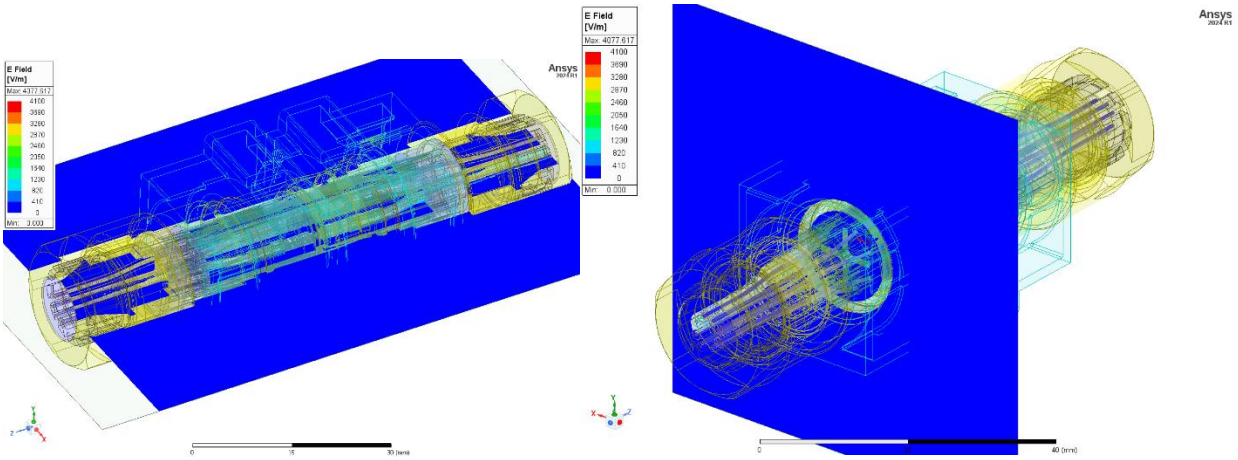
For frequency-domain analysis, resonant frequencies, S-parameters, near/far electric fields, Insertion Loss, Return Loss, Crosstalk, Q-factors, propagation constants, etc. can be calculated through a frequency sweep study. For transient analysis, signal propagation and time-domain reflectometry (TDR) can be calculated. Electromagnetic simulation software is an important step toward further design and optimization since it can reduce the expensive and tedious prototype construction process.

In the RF simulation process, technicians normally verify the main target requested by customer, including all electrical requirement like Insertion Loss, Return Loss and Crosstalk for frequency

domain, and it is also possible to verify EMC performance plotting Electric field inside of connector and plot cut plane to compute total electric field across and cut plane.

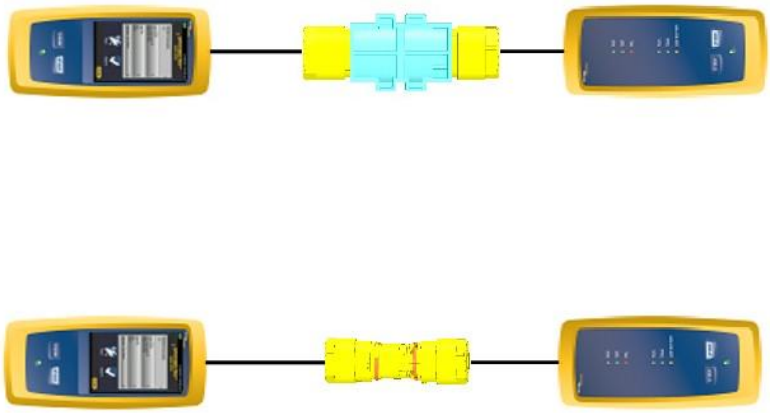


Electromagnetic simulation of model Cat5e in different cut planes

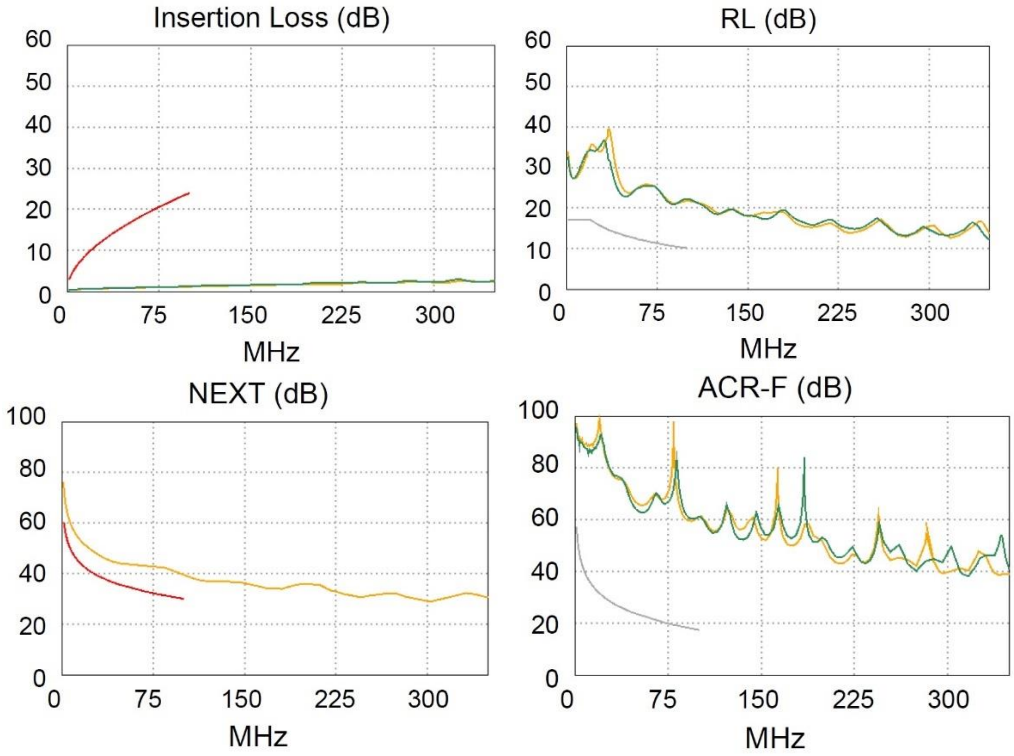


Electromagnetic simulation of model cat6A in different cut planes

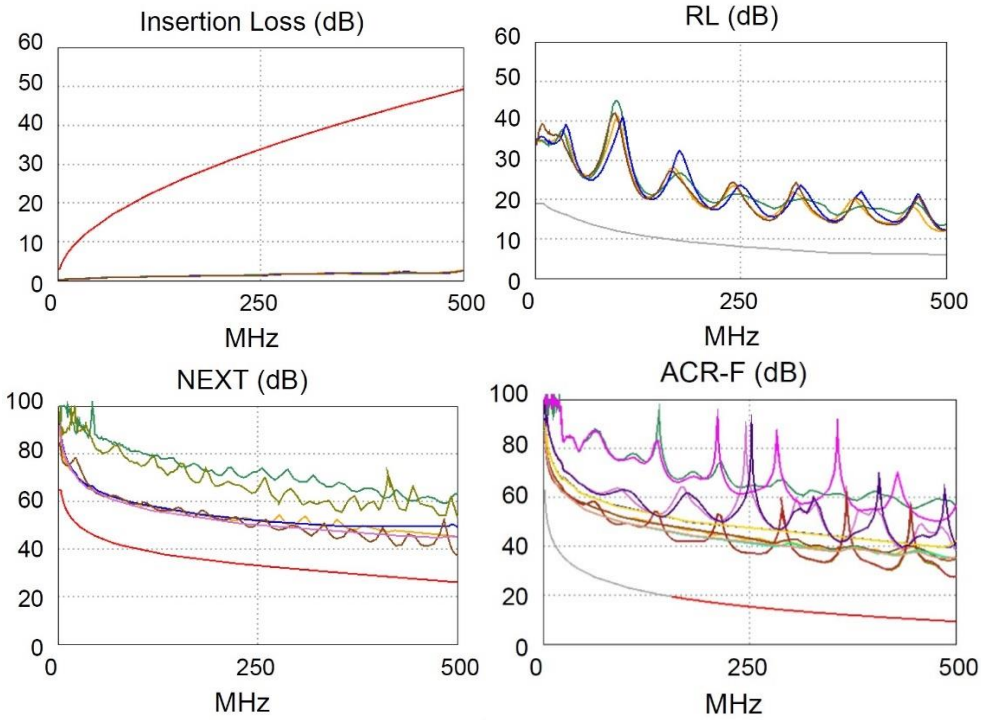
After building prototype, it is important to measure electrical performance, we used DSX-8000 cable analyzer made by Fluke Network company, which is shown in the figure below. All data is exported using Linkware PC report, indicating if all requirements have successfully passed the test. All results are shown in the next figures.



Configuration of measurement using DSX-8000 cable analyzer with competitor contact for Category 5e and Category 6A.



Experimental results of Cat 5e contact vs frequency, Insertion loss, Return Loss, Near-End Crosstalk NEXT and Attenuation Crosstalk Ratio Far-End (FEXT)



Experimental results of Cat 6A contact vs frequency, Insertion loss, Return Loss, Near-End Crosstalk NEXT and Attenuation Crosstalk Ratio Far-End (FEXT)

4. Conclusions

Smiths Interconnect Cat 5e / Cat 6A data transmission modules offer robust performance in terms of electric requirement, and EMC shielding to external sources for protection and minimization crosstalk.
The electrical performance of these modules is optimized through low insertion loss, controlled impedance, and high return loss characteristics. These factors contribute to efficient signal transmission with minimal attenuation and reflection, reducing data errors and ensuring high-speed communication. Additionally, the use of high-quality conductors and advanced shielding techniques enhances resistance to electromagnetic interference (EMI), further stabilizing data transmission.

The high-quality insulator material plays a crucial role in maintaining dielectric properties, reducing signal degradation, and ensuring minimal crosstalk between conductors. By offering a high insulation resistance and low dielectric constant, the material supports consistent signal propagation and prevents unwanted capacitance effects. Moreover, its thermal and mechanical stability ensures long-term reliability, even in demanding environmental conditions.

Compared to existing commercial solutions available in the marketplace, our Cat 5e and Cat 6A data transmission modules surpass various limitations, particularly in terms of operating temperature range and durability over multiple mating cycles.

Our modules are designed to withstand higher +125°C and lower temperature -55°C extremes, ensuring reliable performance in harsh environments where standard commercial solutions may fail due to material degradation, signal instability, or mechanical stress. This makes them ideal for applications in aerospace, defense, industrial automation, and other demanding sectors requiring consistent performance under varying environmental conditions.

Additionally, our connectors are engineered for an extended number of mating cycles (up to 100,000), utilizing high-quality contact materials and advanced surface treatments that resist wear, oxidation, and contact degradation. This enhanced durability ensures stable electrical performance over repeated connections and disconnections, reducing maintenance requirements and improving the overall lifespan of the product.

As a result, Smiths Interconnet Cat 5e and Cat 6A modules offer significantly greater robustness and longevity compared to competitive solutions, providing customers with a more reliable, cost-effective, and future-proof data transmission solution.

For more information on Cat 5e and Cat 6A Data Transmission Modules, please contact your local Smiths Interconnect Sales team, or visit www.smithsinterconnect.com

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