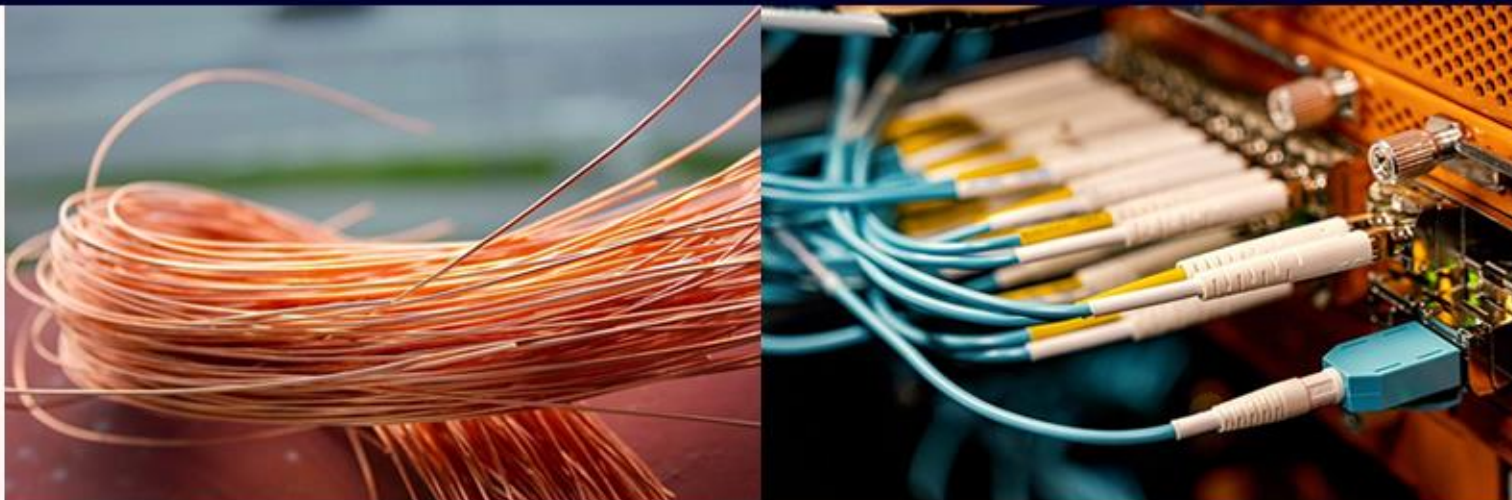


High-Speed Copper & Fiber Optic Connectors

Research Report P-675-20
November 2020



High-Speed Copper & Fiber Optic Connectors

Report No. P-675-20
November 2020

Bishop & Associates has just released a 15-chapter, 234-page research report that examines high-speed copper & fiber optic connectors. **High-Speed Copper & Fiber Optic Connectors**, reviews how high-speed copper and fiber optic connectors are continuing to evolve to support the ever-increasing demand for higher bandwidth, signal integrity, increased panel density, and reduced power. Current, state of the art copper printed circuit board interfaces continue to exceed perceived performance limitations through a combination of fine tuning of the internal signal path, optimized PCB launch, advanced signal conditioning, and adoption of PAM4 modulation. High-performance shielded differential pair cables can significantly increase the reach of high-speed signals.

High-Speed Copper & Fiber Optic Connectors



Design engineers are beginning to find applications that require performance beyond the practical limits of copper. In addition to inherent bandwidth size and weight advantages, newer fiber optic connectors are becoming smaller, easier to terminate, less susceptible to contamination and capable of terminating many single mode fibers simultaneously. In the past, fiber was limited to long-reach applications that were measured in kilometers. Advanced optical signaling technology including coherent signaling can greatly increase the data capacity of a single fiber. Today, fiber links are being considered for rack-to-rack, server to top of rack, and even select inside the box applications. Attenuation and signal degradation attributed to PCB laminates is stimulating the growth of both copper and fiber optic links that lift high-speed signals out of the board entirely.

This report focuses primarily on telecom and computing applications with some additional discussion in related consumer and military/aerospace applications. The basic characteristics of high-speed copper and fiber optic connectors are reviewed, as well as advanced silicon photonic transceiver technology. Also discussed are high-speed copper cable assemblies both passive and those with active equalization features, which enable greater bandwidth and length.

Additional chapters discuss the evolution of small form factor pluggable interfaces that provide options for both copper and fiber links. The advantages and typical applications of active optical cables are also reviewed.

One chapter is focused on the role of formal and industry sponsored standards that facilitate the implementation and certification of both copper and fiber optic links.

Another chapter identifies a series of applications that are driving the development of high-speed communications and represent long-term growth for both copper and fiber optic connectors.

The report also reviews the many alternative wireless technologies that are available to address high-speed link applications. Emerging millimeter band communication including 5G are reviewed.

Mid-board optical transceivers and co-packaged optics are emerging technologies that provide packaging solutions for high-performance circuits. Both topics are discussed along with their potential long-term impact on system design.

High-Speed Copper & Fiber Optic Connectors

The following table of contents shows the detail provided in this new report.

Table of Contents

Chapter 1 – Report Scope and Methodology

Report Objectives
Report Issues Explored
Methodology and Approach

Chapter 2 – Executive Summary

Global Average IP Traffic Per Device

Chapter 3 – Introduction

Introduction
Copper Interconnect Technology
Optical Interconnect Technology
Basic Principles of Optical Transmission
Optical Fiber Types
Fiber Types and Typical Specifications
Fiber Optic Connector Loss Characteristics
Optical Connector Types
Copper Connector Termination Process
Optic Connector Termination Process

Chapter 4 – Evolution of High-Speed Copper Interconnects

Extending the Bandwidth of Copper
Advanced Signal Conditioning
High-Speed Signal Measurement and Verification
Advanced Signal Modulation Techniques
Evolving High Performance Connector Trends

Chapter 5 – Evolution of Fiber Optic Connectors

Fiber Optic Connector Basics
Single Fiber Connectors
Multi-Fiber Connectors
Fiber Optic Adapters, Special Purpose Interfaces
Optical Backplane Connectors
Ruggedized Optical Connectors

Chapter 6 – Small Form Factor Pluggable Transceivers

Why Pluggables?
Thermal Management

Chapter 7 – Active Optical Cables

Filling the Gap
AOC Construction/Features
AOC Applications
Representative AOC Manufacturers and Products

Chapter 8 – The Case for Optical Components Inside the Box

Hitting the Limits of Copper
Copper Jump-Over Cable Assemblies
Optical On-Board Mounted Transceivers and Cable Assemblies
Benefits and Tradeoffs of On-board Optics

Chapter 9 – Optic Interconnect Industry Standards

Evolving Standards
FOCIS Standards
TIA / EIA / IEC Standards
SONET
Ethernet
OIF Implementation Agreements
COBO

Chapter 10 – Making the Copper or Fiber Decision

Factors and Choices
Balancing Feature and Requirements

Chapter 11 – Advanced Copper and Optical Fiber Technology

Advanced Copper Transmission Technology
Advanced Fiber Optic Transmission Technology
Silicon Photonics
Co-Packaged Optics

Chapter 12 – Alternative Technologies

Wireless Transmission
Low-Power/Short Range RF Data Links
Cellular Telephony
Wi-Fi
Millimeter Wave Interconnect Technology
Plastic mm Waveguide

Chapter 13 – Emerging Copper and Fiber Applications

Introduction
5G Cellular Communications
Internet of Things (IoT)/Industrial Internet of Things (Industry 4.0)
Hyperscale Data Centers/Cloud Computing/Disaggregated Data Centers
Autonomous Transportation
Artificial Intelligence
Advanced Military Electronics

Chapter 14 – Copper and Fiber Market Estimates and Forecast

Introduction
World Fiber Optic Cable Terminated Connector Market by Region 2019-2020
World Fiber Optic Cable Terminated Connector Market by Region 2020-2021
World High-Speed Copper Cable Terminated Connector Market by Region 2019-2020
World High-Speed Copper Cable Terminated Connector Market by Region 2020-2021
World Fiber Optic Cable Terminated Connector Market, Telecom/Datacom Applications by Region 2019-2020
World Fiber Optic Cable Terminated Connector Market, Telecom/Datacom Applications by Region 2020-2021

High-Speed Copper & Fiber Optic Connectors

Chapter 14 – Copper and Fiber Market Estimates and Forecast (continued)

World High-Speed Copper Cable Terminated Connector Market, Telecom/Datacom Applications by Region 2019-2020
World High-Speed Copper Cable Terminated Connector Market, Telecom/Datacom Applications by Region 2020-2021
World Fiber Optic Cable Terminated Connector Market, Computing Applications by Region 2019-2020
World Fiber Optic Cable Terminated Connector Market, Computing Applications by Region 2020-2021
World High-Speed Copper Cable Terminated Connector Market, Computing Applications by Region 2019-2020
World High-Speed Copper Cable Terminated Connector Market, Computing Applications by Region 2020-2021
World Fiber Optic Cable Assembly Market, Telecom/Datacom Applications by Region 2019-2020F
World Fiber Optic Cable Assembly Market, Telecom/Datacom Applications by Region 2020F-2021F
World High-Speed Copper Cable Assembly Market, Telecom/Datacom Applications by Region 2019-2020F
World High-Speed Copper Cable Assembly Market, Telecom/Datacom Applications by Region 2020F-2021F

Chapter 14 – Copper and Fiber Market Estimates and Forecast (continued)

World Fiber Optic Cable Assembly Market, Computing Applications by Region 2019-2020F
World Fiber Optic Cable Assembly Market, Computing Applications by Region 2020F-2021F
World High-Speed Copper Cable Assembly Market, Computing Applications by Region 2019-2020F
World High-Speed Copper Cable Assembly Market, Computing Applications by Region 2020F-2021F
World Fiber Optic Connector Forecast, Telecom/Datacom Applications by Region 2020F-2025F
World High-Speed Copper Connector Forecast, Telecom/Datacom Applications by Region 2020F-2025F
World Fiber Optic Connector Forecast, Computing Applications by Region 2020F-2025F
World High-Speed Copper Connector Forecast, Computing Applications by Region 2020F-2025F
World Fiber Optic Cable Assembly Forecast, Telecom/Datacom Applications by Region 2020F-2025F
World Fiber Optic Cable Assembly Forecast, Computing Applications by Region 2020F-2025F
World High-Speed Copper Cable Assembly Forecast, Telecom/Datacom Applications by Region 2020F-2025F
World High-Speed Copper Cable Assembly Forecast, Computing Applications by Region 2020F-2025F

Chapter 15 – Major Findings and Conclusions

What's New ?

Bishop & Associates has recently completed several new research reports about the worldwide connector industry. A table of contents for each report can be found at <https://store.bishopinc.com>.

- Report P-675-20** **High-Speed Copper & Fiber Optic Connectors (November 2020) NEW**
- Report F-2020-02** **Connector Industry Forecast (October 2020) NEW**
- Report M-980-20** **5G Infrastructure – How 5G is Impacting Infrastructure Hardware and Connector Buying Trends (September 2020) NEW**
- Report M-121-20** **2020 Top 100 Connector Manufacturers (August 2020) NEW**
- Report M-1501-20** **Medical Electronics Market for Interconnect Solutions (July 2020) NEW**
- Report P-780-20** **World RF Coax Connector Market 2020 (June 2020) NEW**
- Report C-122-20** **2020 Connector Industry Yearbook (June 2020)**
- Report M-799-20** **2020 World Cable Assembly Market (May 2020)**
- Report M-700-20** **World Connector Market Handbook (April 2020)**
- Report M-4100-20** **Non-Automotive Transportation Market for Connectors (February 2020)**
- Report P-606-19** **Connector Types and Technologies Poised for Growth (October 2019)**
- Report M-1010-19** **World Automotive Connector Market (August 2019)**
- Report M-970-19** **World Consumer Market for Connectors - 2019 (June 2019)**
- Report CA-785-19** **Top 100 Cable Assembly Companies (February 2019)**

THE BISHOP REPORT - CONNECTOR INDUSTRY YEARBOOK

An annual subscription to [THE BISHOP REPORT](#) (12 issues) is available for \$1,750. *The Bishop Report* subscription includes access, through Bishopinc.com, to prior issues of The Bishop Report, 30-40 yearly News Briefs, Industry Financial Benchmarks, and various connector industry indices. In addition, your subscription will include the *Connector Industry Yearbook* report (normally \$1,500).

An annual Corporate Subscription is available for \$2,950, which includes an unlimited number of subscribers and one PDF version of the *Connector Industry Yearbook*.

[Click here](#) to view an expanded report description, and a complete table of contents, for all Bishop & Associates' research reports.



1209 Fox Glen Drive • St. Charles, IL 60174
Phone: 630.443.2702 • bishop@bishopinc.com • ConnectorIndustry.com
Online Ordering: <https://store.bishopinc.com>