



## N3 - Ethernet 10 Gigabit

*This course covers IEEE802.3 Ethernet 10 gigabit and SFP+*

### OBJECTIVES

- This course explains the theory of Ethernet 10 Gigabit from IEEE802.3 standard.
- Implementation examples are provided for MAC and PHY.
- The hardware interfaces are fully detailed: XGMII, XAUI, XSBI and XFP+.
- The course describes the purpose of each unit present in the transmit and receive path.
- Software aspects, such as 10GBASE-T autonegotiation and more generally registers implemented in PHY sublayers are also covered.
- The course details the implementation of 10G Ethernet for backplanes, clarifying 10GBASE-KR FEC, training and autonegotiation.

A more detailed course description is available on request at [training@ac6-training.com](mailto:training@ac6-training.com)

### PREREQUISITES

- Knowledge of gigabit Ethernet, see our course: Ethernet and switching, reference cours [N1 - Ethernet and switching](#)

### Environnement du cours

- Cours théorique
  - Support de cours au format PDF (en anglais) et une version imprimée lors des sessions en présentiel
  - Cours dispensé via le système de visioconférence Teams (si à distance)
  - Le formateur répond aux questions des stagiaires en direct pendant la formation et fournit une assistance technique et pédagogique
- Au début de chaque demi-journée une période est réservée à une interaction avec les stagiaires pour s'assurer que le cours répond à leurs attentes et l'adapter si nécessaire

### Audience visée

- Tout ingénieur ou technicien en systèmes embarqués possédant les prérequis ci-dessus.

## Course Outline

### INTRODUCTION TO ETHERNET 10G

- Clarifying the various types of Ethernet 10G PHYs
- Maintaining backwards compatibility with Ethernet 10/100/1000 Mbps
- Full duplex only operation

### MAC / PHY INTERFACE

- MAC frame assembly
- XGMII transfer protocol, the 4 Bytes lanes
- XAUI electrical interface, delay constraints

### MANAGEMENT INTERFACE

- Extension to this Clause 22 specification

- MDIO Manageable Device
- Electrical interface

## 10GBASE-X

- PCS and PMA sublayers
  - 8b/10b coding
  - PCS code-groups, utilization of control characters for signalling
  - Control code groups
  - SKIP sequence
- PMD 10GBASE-LX4
  - Introduction to transmission on optical fiber
  - Wave Division Multiplexing
- PMD 10GBASE-CX4
  - Using a twinaxial cable
  - Test fixture characteristics

## 10GBASE-W/R PCS

- 10GBASE-W/R PCS layer
  - Block formats
  - 64b-66b encoder
  - Scrambler
  - Test pattern functionality
- WAN Interface Sublayer (10GBASE-W)
  - Introduction to SONET / SDH
  - Framing, scrambling, defect/anomaly detection
  - Mapping of data-units from the PCS into the payload capacity of a STS-192c SPE
  - Receiver, delineation of octet boundaries, checking the BIP octets
  - Error propagation
- PMA type serial
  - XSBI interface
  - Signal detect handling
- PMD, TYPE 10GBASE-S, 10GBASE-L, 10GBASE-E
  - Link power budgets
  - Tests
  - PMD registers
- APM QT2035 SFI/XFI-XAUI PHY and S19235 SONET/SDH transceiver

## ELECTRICAL DISPERSION COMPENSATION

- Chromatic dispersion
- Polarization dispersion
- Modal dispersion
- Equalization algorithms
- Linear vs Limiting electrical interface

## PMD, TYPE 10GBASE-LRM (Long Reach Multimode)

- Preferred launch, alternative launch
- Fiber types
- Measurement methods

## 10GBASE-T

- 16-level PAM signaling
- Two-dimensional (2D) symbols
- 2D symbol selection from a constrained constellation of 128 maximally spaced 2D symbols

- 65-bit block formats
- Link training, master / slave operation
- Scrambling
- Signaling, forward error correction
- Test pattern generators
- PMA stages
- Compensating for signal attenuation
- 10GBASE-T PHY specific registers
- Auto-negotiation, page utilization
- MDI specification, automatic MDI/MDI-X configuration
- Test modes, test fixtures

## **ENHANCED SMALL FORM FACTOR PLUGGABLE MODULE SFP+**

- Low speed electrical and power specification
- High speed electrical specification
- I2C interface

## **10G BACKPLANES**

- Introduction to 10G backplane clauses
- 10GBASE-KX4
- 10GBASE-KR
- Autonegotiation for Ethernet backplanes
- Forward Error Correction (FEC)