



400GBASE-CR8 / KR8

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Revision History

| Revision | Who | Date | Change Description |
|----------|----------|-----------|-----------------------|
| 0.1 | RJS/BRCM | 6/29/2018 | Initial Draft Release |
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1 Overview

This document provides a set of specifications for 400GE copper cables and backplanes (400GBASE-KR8, 400GBASE-CR8), based on the 400GBASE-R PCS specified in 802.3 Clause 119, and an extension of the electrical specifications outlined in 802.3 Clauses 136 and 137.

2 Standards Reference

References are made throughout this document to IEEE 802.3-2015 Ethernet Access Method and Physical Layer [base standards], in addition to 802.3bs-2017. It should be noted that at the time of publication of this specification 802.3cd was in draft status although at a state of high maturity, so the clauses in this drafts is also referenced. This document expands upon the 25/50G Consortium Specification, Schedule 3, available from <http://25gethernet.org/specification-download-agreement>.

Note: IEEE 802 (e.g. IEEE 802.3-2015, etc) standards documents are available free through IEEE’s Get program including IEEE 802 from <http://standards.ieee.org/about/get/>, six month after publication of each.

3 MAC, RS and PCS

Layers above the PMA are unchanged relative to the 400GBASE-R specifications in 802.3bs. It should be noted that 400GBASE-CR8 / KR8 is specified to only operate on 8 physical lanes.

4 PMA Sublayer

The PMA sublayer follows 802.3 Clause 120, with the inclusion of an optional precoder, following 802.3 Clause 135.5.7.2.

5 PMD Sublayer (400GBASE-CR/KR8)

5.1 Overview

Table 1 - Physical Layer clauses associated with 400GBASE-CR8 PMD

| Associated Clause | 400GBASE-CR8 |
|---|--------------|
| 802.3 117-RS | Required |
| 802.3 118-400GMII Extender Sub-layer | Optional |
| 802.3 119-PCS | Required |
| 802.3 120-PMA for 400GBASE-R | Required |
| 802.3 120B-400GAUI-16 C2C | Optional |
| 802.3 120D-400GAUI-8 C2C | Optional |
| 802.3 72 – Auto-Negotiation | Required |
| 802.3 136 – PMD Sublayer (50, 100, 200GE) | Required |
| 802.3 78 – Energy Efficient Ethernet ¹ | Optional |

¹ Energy Efficient Ethernet deep sleep is not supported.

5.2 PMD Service Interfaces

The 400GBASE-CR/KR8 PMD service interface is an instance of the inter-sublayer service interface defined in 802.3 Clause 116.3 with eight parallel symbol streams ($n = 8$).

The PCS supporting the 400GBASE-KR8 / CR8 PMD must support the AN interface primitive AN_LINK.indication as defined in 802.3 clause 73.9 (see also 802.3 clause 119.6).

5.3 PMD Transmit and Receive Functions

The 400GBASE-KR8 / CR8 PMD uses 802.3 Clause 136 with the following modifications:

- Number of PMD lanes is 8.
- The following training polynomials are used (referenced to 802.3 Clause 136.8.11.1.3). Note that the polynomials specified for lanes 0 – 3 are reused on lanes 4 – 7 it is recommended to ensure that physically adjacent lanes do not use the same polynomial.

Table 2 - Training Polynomials

| Lane | Training Polynomial | Polynomial $p, G(x)$ | Default Seed Bits |
|------|---------------------|---------------------------------|-------------------|
| 0 | $P = 0$ | $1 + x + x^2 + x^{12} + x^{13}$ | 0000010101011 |
| 1 | $P = 1$ | $1 + x^2 + x^3 + x^7 + x^{13}$ | 0011101000001 |
| 2 | $P = 2$ | $1 + x^2 + x^4 + x^8 + x^{13}$ | 1001000101100 |
| 3 | $P = 3$ | $1 + x^2 + x^5 + x^9 + x^{13}$ | 0100010000010 |
| 4 | $P = 0$ | $1 + x + x^2 + x^{12} + x^{13}$ | 0000010101011 |
| 5 | $P = 1$ | $1 + x^2 + x^3 + x^7 + x^{13}$ | 0011101000001 |
| 6 | $P = 2$ | $1 + x^2 + x^4 + x^8 + x^{13}$ | 1001000101100 |
| 7 | $P = 3$ | $1 + x^2 + x^5 + x^9 + x^{13}$ | 0100010000010 |

6 Auto-Negotiation

6.1 Overview

The auto-negotiation process is modified to include 400GBASE-KR8 / CR8 by adding an additional capability field bit (D34) to the 25/50G Consortium unformatted Next Page.

6.2 Speed Selection

To perform Auto-negotiation, base pages are exchanged between the two ends of the backplane or copper cable channel, with the exchange taking place on physical lane 0. After the exchange of the base page, the link partners exchange an OUI tagged formatted Next Page (using message code #5) and then the link partners exchange an OUI tagged unformatted Next Page with an extended technology abilities field, as detailed below. The link operating speed is determined by the highest common denominator advertised by the link partners, and resolved according to the priority table shown in Table 3.

The Organization Unique Identifier (OUI) tagged formatted Next Page, with the OUI set to the 25G Ethernet Consortium CID of 0x6A737D(h) and a message code of 5 is shown in Figure 1. Note that this is identical to Schedule 3, 3.2.5.

| Next Page | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 |
|-------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|
| | D16 | D17 | D18 | D19 | D20 | D21 | D22 | D23 | D24 | D25 | D26 | D27 | D28 | D29 | D30 | D31 |
| | D32 | D33 | D34 | D35 | D36 | D37 | D38 | D39 | D40 | D41 | D42 | D43 | D44 | D45 | D46 | D47 |
| MP5 (D0 - D15) | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | T | 0 | 1 | ACK | 1 |
| (D16 - D31) | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | Reserved | | | | |
| (D32 - D47) | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | Reserved | | | | |

message code #5 OUI [23:2]

Figure 1 - Auto-negotiation Next Page – OUI extended

The 25GE Consortium OUI tagged unformatted Next Page is shown below in Figure 2. D34 is designated to indicate 400GBASE KR8 / CR8 ability.

| Next Page | D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | D8 | D9 | D10 | D11 | D12 | D13 | D14 | D15 |
|--------------------|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|---------------|---------------|-----|-----|-----|
| | D16 | D17 | D18 | D19 | D20 | D21 | D22 | D23 | D24 | D25 | D26 | D27 | D28 | D29 | D30 | D31 |
| | D32 | D33 | D34 | D35 | D36 | D37 | D38 | D39 | D40 | D41 | D42 | D43 | D44 | D45 | D46 | D47 |
| UP-1 (D0 - D15) | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | T | 0 | 0 | ACK | NP |
| (D16 - D31) | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | Reserved (=0) | | | | |
| (D32 - D47) | Reserved (=0) | | 1 | LF1 | | LF2 | LF3 | F1 | F2 | F3 | F4 | LLR | Reserved (=0) | | | |

Code for extended technology abilities OUI [1:0]

400GBASE-KR8 / CR8 25GBASE-KR1 25GBASE-CR1 LL-RS-FEC Ability 50GBASE-KR2 FEC Control 50GBASE-CR2 LL-RS-FEC Request

Figure 2 - Consortium OUI tagged unformatted Next Page.

6.2.1 Autonegotiation Resolution

The highest common denominator link speed is established between link partners according to the priority in Table 3.

Table 3 - Resolution Priority

| Priority | Technology | Capability | Note |
|----------|---------------------|--------------------|-----------------|
| 1 | 40GBASE-KR8 / CR8 | 400 Gb/s, 8 lane | Consortium mode |
| 2 | 200GBASE-KR4 / CR4 | 200 Gb/s, 4 lane | IEEE mode |
| 3 | 100GBASE-KR2 / CR2 | 100 Gb/s, 2 lane | IEEE mode |
| 4 | 100GBASE-CR4 | 100 Gb/s, 4 lane | IEEE mode |
| 5 | 100GBASE-KR4 | 100 Gb/s, 4 lane | IEEE mode |
| 6 | 100GBASE-KP4 | 100 Gb/s, 4 lane | IEEE mode |
| 7 | 100GBASE-CR10 | 100 Gb/s, 10 lanes | IEEE mode |
| 8 | 50GBASE-KR / CR | 50 Gb/s, 1 lanes | IEEE mode |
| 9 | 50GBASE-R2 | 50 Gb/s, 2 lanes | Consortium mode |
| 10 | 40GBASE-CR4 | 40 Gb/s, 4 lanes | IEEE mode |
| 11 | 40GBASE-KR4 | 40 Gb/s, 4 lanes | IEEE mode |
| 12 | 25GBASE-KR / CR | 25 Gb/s, 1 lane | IEEE mode |
| 13 | 25GBASE-KR-S / CR-S | 25 Gb/s, 1 lane | IEEE mode |
| 14 | 25GBASE-R | 25 Gb/s, 1 lane | Consortium mode |
| 15 | 10GBASE-KR / CR | 10 Gb/s, 1 lane | IEEE mode |