SFF-8470 (CX4) / Copper Concepts for 802.3ba

Bob Thornton
Connector Business Group
FUJITSU COMPONENT LIMITED
bthornton@us.fujitsu.com
Contributors

Team members:

• Hideo Miyazawa, General Manager, Connector Business Group
• Robert Thornton, Director of Marketing
• Toshihiro Kusagaya, Dept. Manager, Development
• Shigeyuki Takizawa, Project Manager
• Dr. Edward P. Sayre, NESA
• Tadashi Kumamoto, Senior Design Engineer
• Tohru Yamakami, Engineer
• Jeon Byong Hoon, Engineer
• John Sawdy –Meritec
• Vivek Telang -Broadcom
Supporters:

• Carl Booth, Amphenol Spectra-Strip
• John Sawdy, Meritec
• Greg McSorley -Amphenol
• Gourgen Oganessyan –Quellan
• Herb Van Deusen –WL Gore
• Mike Savage –Cinch
• Tom Dineen, Dineen Consulting
The following are Fujitsu’s commitments to the IEEE 802.3ba Objectives:

- Support full-duplex operation only
- Preserve the 802.3 / Ethernet frame format utilizing the 802.3 MAC
- Preserve minimum and maximum Frame Size of current 802.3 standard
- Support a BER better than or equal to $10^{-12}$ at the MAC/PLS service interface
- Provide appropriate support for OTN
- Support a MAC data rate of 40 Gb/s
- Provide Physical Layer specifications which support 40 Gb/s operation over:
  - at least 100m on OM3 MMF
  - at least 10m over a copper cable assembly
- Support a MAC data rate of 100 Gb/s
- Provide Physical Layer specifications which support 100 Gb/s operation over:
  - at least 40km on SMF
  - at least 10km on SMF
  - at least 100m on OM3 MMF
  - at least 10m over a copper cable assembly
This presentation will provide information regarding:

- The 10Gbps/lane performance adherence of the SFF-8470 (current IEEE 802.3ak CX-4 I/O interface) connector and 10 meter and 0.5 meter cable link reach according to the S-Parameter Return Loss, Insertion Loss and Cross-talk criteria as defined by 10GBASE-KR.
IEEE 802.3ba Link Model
SFF-8470 / CX4 Connector Structure

Cover, Plug

Sectional View (Connection area)

- Ground/Power Contact
- Patented Stripline edge coupled structure
- Differential pair contacts
- Outer shield

Socket

- Section X-X (Signal section)
- Section Y-Y (Ground section)
Connector and Cable assembly 24AWG 10m and 0.5m
Frequency Domain Measurement Set-up

Return Loss RL(f) Measurement

CX4/IB 10 G Test Board

CX4/IB Cable assembly with Amphenol cable 24AWG 10m and 0.5m

CX4/IB 10 G Test Board

TP1

TP4

Agilent 20 GHz Multi-channel Differential VNA & cabling
SFF-8470 (CX4) + 10 and 0.5 meter SkewClear EXD Cable Channel Return Loss Compliance

Ansoft & HSPICE Simulated Return Loss for 0.5 and 10 meter Cables and SFF-8470 (CX4) Connectors

-100.00
-90.00
-80.00
-70.00
-60.00
-50.00
-40.00
-30.00
-20.00
-10.00
0.00

10 100 1,000 10,000

Frequency (MHz)

Return Loss (dB)

Return Loss Limit
10m Return Loss
0.5m Return Loss
Insertion Loss IL(f) Measurement Set-up

CX4/IB 10 G Test Board

CX4/IB Cable assembly with Amphenol cable 24AWG 10m and 0.5m

CX4/IB 10 G Test Board

TP1

TP4

Agilent 20 GHz Multi-channel Differential VNA & cabling
SFF-8470 (CX4) + 10 and 0.5 meter SkewClear EXD Cable
Channel Insertion Loss Compliance

Insertion Loss (dB) for 0.5 and 10 meter cables
with IEC 8470 Connectors

Frequency (MHz)

Insertion Loss (dB)

Amax

IL max
SFF-8470 (CX4) + 10 and 0.5 meter SkewClear EXD Cable Channel Insertion Loss Compliance

Simulated Insertion Loss for 0.5m and 10m #24 AWG Cable Assemblies Terminated in SFF 8470 (CX4) Connectors
Insertion Loss Deviation for 0.5 and 10 meter cable Assemblies with IEC 8470 (CX4) Connectors

- Frequency (MHz)
- Insertion Loss Deviation (dB)

- Upper Limit
- 10m Cable Assembly
- 0.5m Cable Assembly
- Lower Limit
**SFF-8470 (CX4 CN) NEXT/FEXT Measurement Set-ups**

**NEXT Set-up**
- CX4/IB Cable assembly
  - With Amphenol cable 24AWG 10m and 0.5m

**Agilent 20 GHz Multi-channel Differential VNA & cabling**

**FEXT Set-up**
- CX4/IB Cable assembly
  - With Amphenol cable 24AWG 10m and 0.5m

**CX4/IB 10 G test Cards**

**TP1**

**TP4**

**50 Ω terminations**
802.3 CX4 Channel Insertion Loss to Crosstalk Ratio

Insertion Loss to Crosstalk Ratio computed from S-Parameter Insertion Loss and Crosstalk Components of the 10 and 0.5 meter CX4 SkewClear EXD Copper Cable Assembly

4 Near End X-talk (NEXT) Aggressors

3 Far End X-talk (FEXT) Aggressors
SFF-8470 Insertion Loss and Crosstalk Parameters: 10 meter NEXT, PSNEXT

NEXT COMPONENTS and POWERSUM NEXT for 10m #24 AWG Cable Assembly with IEC 8470 (CX4) Connectors
SFF-8470 Insertion Loss and Crosstalk Parameters:
10 meter FEXT, PSFEXT

FEXT COMPONENTS and POWERSUM NEXT for 10m #24AWG Cable Assembly with IEC 8470 (CX4) Connectors
SFF-8470 Insertion Loss and Crosstalk Parameters: 0.5 meter NEXT, PSNEXT

NEXT COMPONENTS and POWERSUM NEXT for 0.5 m Cable Assembly with IEC 8470 (CX4) Connectors
SFF-8470 Insertion Loss and Crosstalk Parameters: 0.5 meter FEXT, PSFEXT

FEXT COMPONENTS and POWERSUM NEXT for 0.5 m Cable Assembly with IEC 8470 (CX4) Connectors
CX4/IB Insertion Loss to Crosstalk Ratio – 0.5 m

Insertion Loss to Power Sum Ratio 0.5 m #24 AWG Cable Assembly with IEC 8470 Connectors

- 0.5m Cable Assembly ICR
- 0.5 Cable Assembly Fitted ICR
- ICR Minimum
CX4/IB Insertion Loss to Crosstalk Ratio – 10 m

Graph showing Insertion Loss to Power Sum Ratio for 10 m #24 AWG Cable Assembly with IEC 8470 Connectors.

- 10m IL to DIFF PSUM Ratio
- 10m Fitted ICR to PSUM Ratio
- ICRmin Ratio
CX4/IB Insertion Loss to Crosstalk Ratio – 10 m

Meritec Measured Insertion Loss to Crosstalk Ratio
with 10 m of Leoni #24AWG Cable and Meritec IEC 8470 connectors

ICR(f measured)
ICR(f min [2007])
ICR(f fit)
Channel Model Componentss

Insertion Loss (dB) for 0.5 and 10 meter cables with IEC 8470 Connectors

Return Loss

Measured Return Loss for 0.5 and 10 meter Cables and SFF-8470 (CX4) Connectors

Crosstalk

NEXT, PSNEXT, FEXT, PSFEXT and PSXFT Crosstalk (dB) for IEC 8470 Connectors + 0.5 meter cable

10 meter Cable Assembly Channel Model

NEXT 1 st neighbor
NEXT 2nd neighbor
NEXT 3 rd neighbor
NEXT 4 th neighbor
PSNEXT
FEXT 1 st neighbor
FEXT 2 nd neighbor
FEXT 3 rd neighbor
PSFEXT
PSXFT

Simulation Results

Results Courtesy: Vivek Talang, Broadcom
Summary of SFF-8470 (CX4) Measurement Results for IEEE 802.3ba Compliance

The measurements and analyses of the SFF-8470 (CX4) connector and attached 10 and 0.5 meter cable assembly show the following compliance to the current IEEE802.3ap requirements:

- The measured Return Loss meets the 802.3ap Return Loss limits.
- The measured Insertion Loss satisfies the maximum attenuation limit. The fitted data are lower than the 802.3ap maximum attenuation limit.
- The measured ICR satisfies the 802.3ap minimum limit for 0.5 meter and 10 meter with low crosstalk connector.
- The current SFF-8470 based cable assemblies will meet the requirements of 802.3ap.
Summary

- The data suggests that SFF-8470 (CX4) cable connector with 0.5 thru 10 meters of twinaxial cable be considered for 40GBASE-CR4 cable assembly.