Discussion of Proposed Text for Clause 113.5.4.3

Pete Cibula, Intel Corporation

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Purpose & Goal

- Review text proposed in the 2/18 Rx CMNR ad hoc meeting.
- Summarize & discuss comments received on the text.
  - Not a formal comment resolution, just walking through the list.
- Define some minimal text that can be included as a technically complete specification.
  - Include an appropriate editor's note to allow the ad hoc/commentors to finalize details of the specification (source-adjustment criteria, measurement points, levels, etc.) in subsequent working group ballots.
- Ad hoc will work will continue to refine these details of implementation, while keeping the core of the base specification (immunity to external EM fields from 80MHz to 2GHz) essentially intact.

Text for Clause 113.5.4.3

From February 18th Meeting (For Reference)

113.5.4.3 Rejection of External EM Fields

- When the cabling system is subjected to electromagnetic fields, currents are generated in the shield which may be converted to interference. This specification is provided to limit the sensitivity of the PMA receiver to external EM fields picked up by the cabling system. It provides an assessment method of the electromagnetic performance of the link segment and the PHY, including the MDI.
- A test can be made using the cable clamp test defined in 40.6.1.3.3. A 6 dBm sine wave source from 80 MHz to 2000 MHz can be used to generate an external electromagnetic field and corresponding shield current.
- A system integrating a 40GBASE-T PHY may perform this test. Operational requirements of the transceiver during the test are determined by the manufacturer.

Summary of Comments on 2/18 Text

#1. It is critical that the test conditions be well controlled.

#2. The ferrite clamps described in the clamp characterization study are not well specified.

#3. The exact layout and condition of the rest of the cable (from the ferrites to the link-partner) have also not been well defined in the past.

- Exact and shorter distance between the DUT and the clamp.
- Exact number of ferrites and ferrite properties.
- Cable over entire plane without any coiling of any section of the cable; serpentines are allowed with minimum spacing between the segments defined.
- Shorten the length of the specified cable.

#4. It is important that the inner tube sits well over the cable under test

#5. A better and more relevant clamp (EM clamp) is available that is used in regular EMC setups.

- Specifications for, and a description of, this clamp will be posted to the ad hoc area.

#6. Another alternative clamp is the tubular wave coupler used for automotive EMC applications (similar to bulk current injection for conducted immunity).

#7. Propose that the test setup use a cable vs. a channel (assumed to include connectors) as believed to be defined in the original 1000BASE-T test.

#8. Calibrating the sine wave source over frequency to 6dBm measured at the clamp output does not specifically correlate the clamp test to the EMC chamber test.

#9. Using a fixed 20cm distance may not accommodate/comprehend variations in coupling. Suggest using 3 distances, for example 10cm, 20cm, 30cm.

Discussion of Comments on 2/18 Text (1/2)

Reply to #3 and comment on far-end cabling

- It is believed that the ferrite attenuates enough of the shield energy in the far end direction so that the far end positioning (coiling, ground plane spacing, etc.) is not critical since the induced energy in that part of the cabling is mostly inside the shield.

Notes on Comment #7 and single-cable vs. channel

- The original specification does have some ambiguity. Clause 40.6.1.3.3 specifies “A 100-meter, 4-pair Category 5 cable that meets the specification of 40.7”. Clause 40.7 states that “The cabling system components (cables, cords, and connectors) used to provide the link segment shall consist of Category 5 components as specified in ANSI/TIA/EIA-568-A:1995 and ISO/IEC11801:1995.”, and this is further defined in 40A.2 Cabling configurations.
- Given that real-world EMC test environments can include a mix of cables, cords and connectors, should we prohibit a channel (up to a 2-connector implementation for 25Gbps/40Gbps)?

Amplification of Comment #8 and the source power level

- During the EMC chamber tests, the highest induced voltages are in the 80to 150MHz range, whereas during the clamp test the calibration of the signal source stipulated in the 1000BASE-T and 10GBASE-T specs result in high induced voltages around 500MHz. The reason is that around 500MHz, the specified calibration asks for a higher signal amplitude at the signal generator than for 80-150MHz.
- Suggested remedy: *A sine wave with the amplitude held constant over the whole frequency range from 80MHz to 2GHz, such that the signal power measured at the output of the clamp does never exceed 6dBm, is used to generate the external electromagnetic field and corresponding shield current.*

Discussion of Comments on 2/18 Text (2/2)

Additional comments on Comment #8

- Constant output of the signal generator and constant power at the output of the CM rejection clamp are two different and mutually exclusive parameters. If you want to keep the power at the output of the clamp constant, the signal generator power needs constant adjustment during the sweep, so you need a power meter in the measurement loop.
- Suggested remedy: Set the signal generator power to some level, perhaps 6dBm, terminating the output if the clamp, and sweeping like that with the signal generator at constant power.
- Testing this way would mean that for different DUTs, coupled levels may be different, depending on their construction. This is more realistic than adjusting for constant coupling.

Interpretation/implementation suggestion to resolve #8 and #9:

- 1) Put the setup in place at the first separation distance and do a quick non-operational scan to measure the clamp output level across the band
- 2) Fix the source level so the clamp output level at the worst (to be defined – minimum level?) frequency point is 6 dBm.
- 3) Run the PHY operational scan
- 4) Repeat 1 & 2 for each of the other two clamp/MDI separation distances
- *Do we have, or is anyone planning, contributions to assess this suggested implementation?*

Most Recent B. Moffitt Proposal

113.5.4.3 Rejection of External EM Fields

- When the cabling system is subjected to electromagnetic fields, currents are generated in the shield which may be converted to interference. This specification is provided to limit the sensitivity of the PMA receiver to external EM fields picked up by the cabling system. It provides an assessment method of the electromagnetic performance of the link segment and the PHY, including the MDI.

- An 80 MHz to 2000 MHz test can be made based on the cable clamp test defined in 40.6.1.3.3, a 30 meter plug terminated category 8 cable, and suitable broadband ferrite. The ferrite loss should be verified as greater than 25 dB from the clamp source to the cable shield so the induced energy is directed onto the MDI. Three tests help overcome EMC test variability: with the clamp positioned 20 CM, 10 CM and 5 CM from the MDI. For all three clamp positions, the ferrite is placed starting 2 CM behind the clamp. All components in the test remain over the ground reference plane with complete and direct contact with it. A sine wave with the amplitude held constant over the whole frequency range from 80MHz to 2GHz, the amplitude chosen so that the signal power measured at the output of the clamp never exceeds 6dBm, is used to generate the external electromagnetic field and corresponding shield current.

- A system integrating a 40GBASE-T PHY may perform this test. Operational requirements of the transceiver during the test are determined by the manufacturer.

Updated Proposal (“Minimal text”)

113.5.4.3 Rejection of External EM Fields

- When the cabling system is subjected to electromagnetic fields, currents are generated in the shield which may be converted to interference. This specification is provided to limit the sensitivity of the PMA receiver to external EM fields picked up by the cabling and interconnect system. It provides an assessment method of the electromagnetic performance of the link segment and the PHY, including the MDI.

- An 80 MHz to 2000 MHz test can be made based on the cable clamp test defined in 40.6.1.3.3, a 30 meter plug-terminated Category 8 channel that meets the requirements of 113.7, and suitable broadband ferrites. All components in the test remain over the ground reference plane. A sine wave with the amplitude held constant over the whole frequency range from 80MHz to 2000MHz, with the amplitude calibrated so that the signal power measured at the output of the clamp does not exceed 6dBm, is used to generate the external electromagnetic field and corresponding shield current.

- A system integrating a 40GBASE-T PHY may perform this test to evaluate anticipated performance in regulatory test environments. Operational requirements of the transceiver during the test are determined by the manufacturer.

- *Editor’s note (to be removed prior to publication): Commenters are encouraged to confirm the source-adjustment criteria, measurement points, and levels used with the clamp methodology in this subclause.*

Next Steps

- Agree on minimal text to include during P802.3bq Draft 1.2 comment resolution
- Include minimal text in ad hoc report; follow up with motion to adopt the minimal text during discussion of Comment #237
- Continue technical work in the ad hoc to refine details of implementation
  - Submit updates as comments in upcoming Working Group ballot(s)

Thank You!