Updates on Magnetics for 10GBase-T

Thuyen Dinh

LAN Products Division

IEEE802.3 Interim Meeting

Vancouver B.C.

January 12-15, 2004

Objectives

- Study of downward (10/100/1000) compatibility in magnetics
  - Existing standard specifications
  - Actual BER test in a 10/100/1000 system
- Design examples and test results
  - Determine practical bandwidth for magnetics with and without a common-mode choke

Backward Compatibility

- 10Base-T has no requirement for inductance on magnetics.
- 100Base-Tx magnetics open-circuit inductance (OCL) spec is 350 uH minimum with 8 mA of DC bias (Clause 9.1.7, ANSI standard X3.263:199X for FDDI-TP-PMD). This requirement may be removed shortly.
- Typically, 10/100 magnetics upper bandwidth (3-dB) is about 150 MHz - 250 MHz.
- Since 10GBase-T magnetics needs much wider bandwidth (>500 MHz), inductance has to be lowered to reduce parasitic elements.

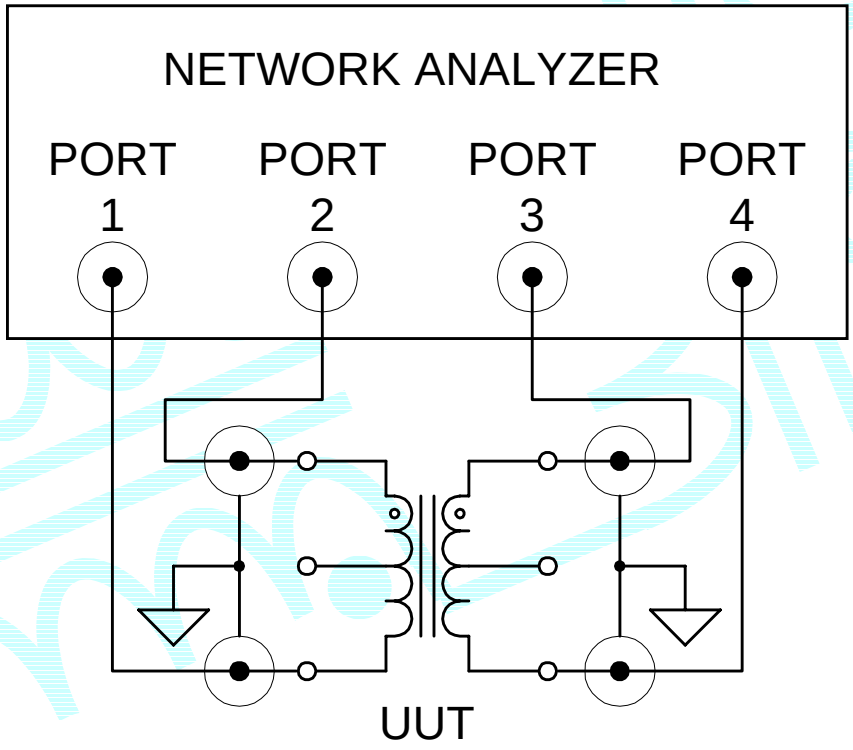
Backward Compatibility (cont'd)

- Two 10 / 100 / 1000 NIC cards tested using 10-dB cat-5 cable (approximately 140 meters in length).
- Transmission tests done with different data patterns, packet sizes, and speeds.
- As OCL of the magnetics was reduced to about 100 uH, 10 Mbps and 100 Mbps started showing errors.
- No error was observed with 1 Gbps operation.

10GBase-T magnetics design example1

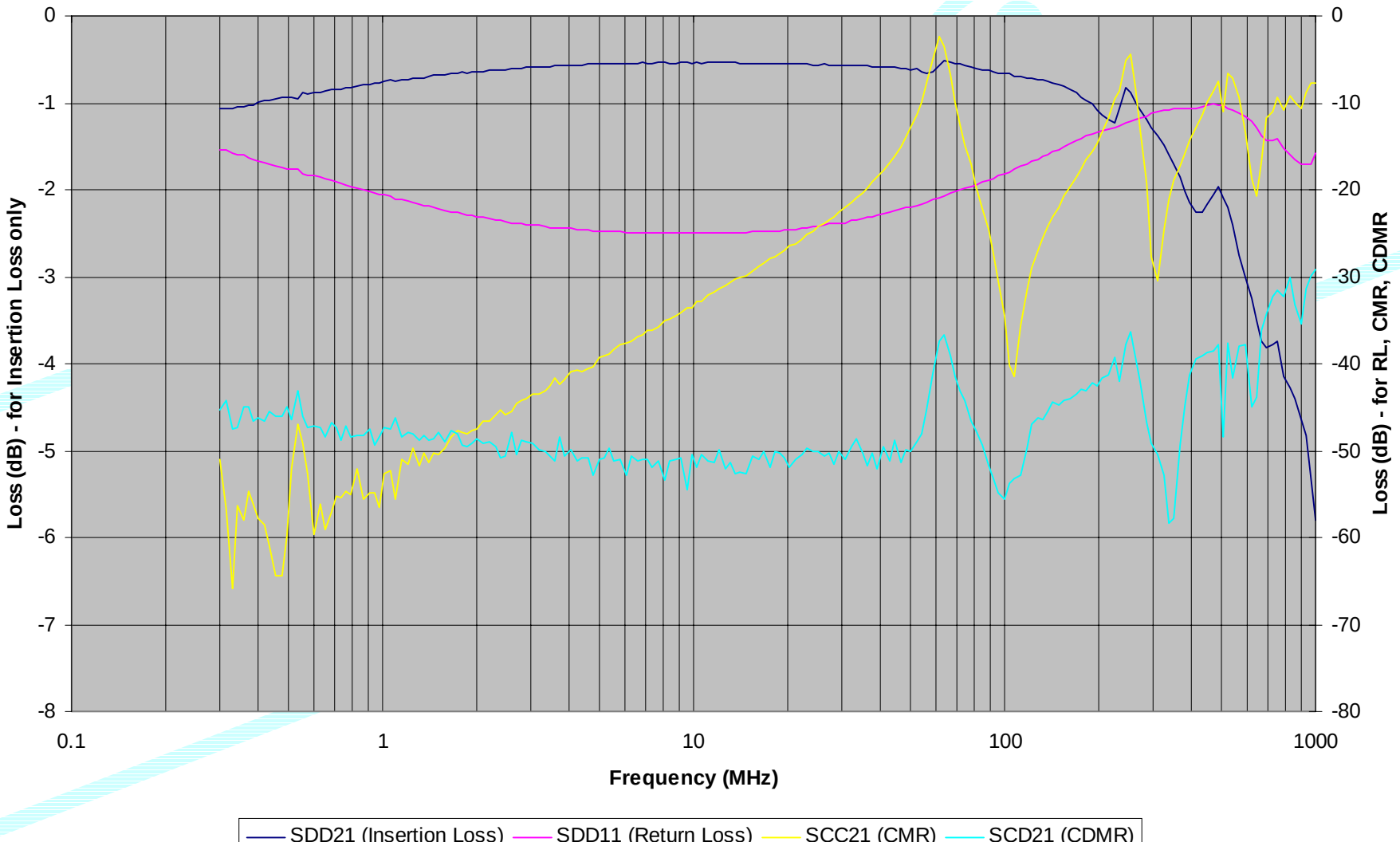
- Characteristics:
  - 1CT:1CT turns ratio (center tap on each side).
  - Insulation to meet 1500 VAC.
  - OCL of about 140 uH.
  - Wound on small core made out of common high-permeability ferrite material.
  - No common-mode choke.
  - Sample tested with direct connections to package from analyzer SMB connectors.

Test set up



TEST SET UP

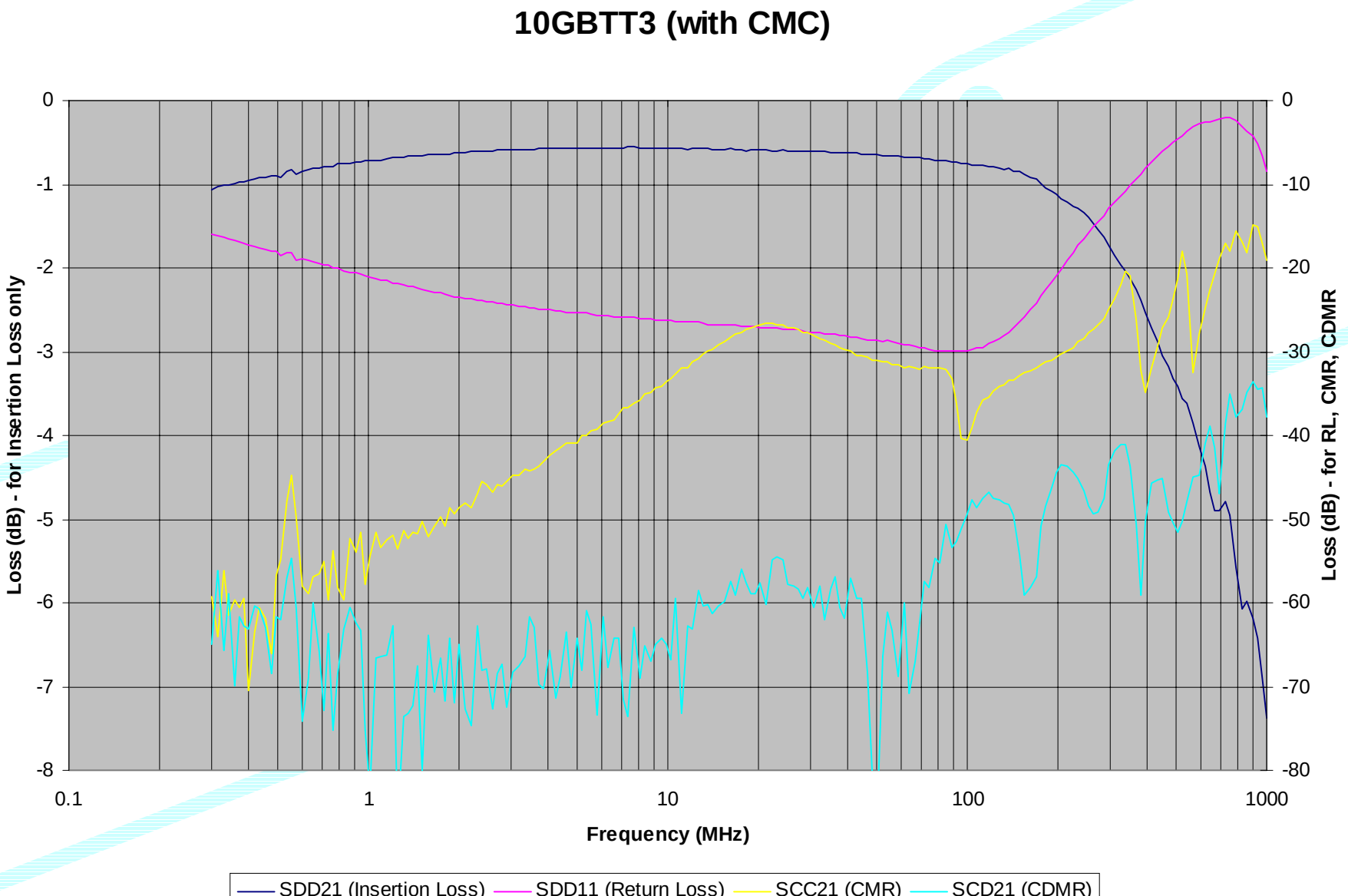
Test results, example 1



10GBase-T magnetics design example2

- Characteristics:
  - Same as in design example 1, but with a common-mode choke of same design as those in typical 10/100/1000 magnetics.
  - Same test setup.

Test results, example 2



Summary

- To be downward compatible with 10/100/1000 Ethernet, magnetics must have more than 100 uH of OCL (open-circuit inductance). Also, IEEE must waive or remove OCL requirement from current standard.
- Bandwidth (3dB) from less than 100 kHz to more than 500 MHz is feasible with transformer alone, but upper bandwidth may be reduced to less than 500 MHz with common-mode chokes.
- Since the numbers of turns will be small, odd turns ratios such as 1:1.4, 1:1.15, etc. may be difficult to implement.