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Department of Electrical Measurements

EXAM

EMC, noise and noise reduction

2005-06-01

Part 1 consists of "questions with short answers" where each gives one credit for correct answer.
The questions are answered without help from the book during the first two hours. Thereafter the answers are handed in and part 2, consisting of three problems that may be solved with help
from the book, is dealt with during the following two hours.

A furmula book like TEFYMA and an electronic calculator are allowed for both part 1 and 2.

Max credits: Part 1 - 15 credits, part 2 - 15 credits.
Limits: 15 credits - 3, 20 credits - 4, 25 credits - 5.

Part 1:

1. In what ways may interference be coupled to a circuit?

2. How is inductively coupled interference modelled between two wires? What happens if the ”receiving” wire is shielded and the shield is grounded at both ends?

3. Why is a ground plane normally used in digital circuits?

4. The European EMC-directive only states that equipment must not disturb or be disturbed in its normal use. How do you get to know what actual emission and immunity limits you should test against as a designer?

5. How is the wave impedance defined and what is the value for a plane wave in vacuum? Is the wave impedance higher, lower or the same close to a source where the E-field and the H-field dominates, respectively?

6. How can you check if the source of emission is of high or low impedance type when measuring with near field probes?

7. What types of signal grounding do you know about and in what situations are they recommended to be used?

8. Sketch the impedance vs. frequency behaviour of a 10 ohm, 100 ohm and 1000 ohm metal film resistor, respectively. Explain shortly the reason to the behaviour.

9. What is demanded of a circuit where ferrite beads can be used for attenuating unwanted signals?

10. Why are small holes in a row preferred over an equally long slit if one needs an opening in a shield surrounding an equipment?

11. What characteristics do you find important of a room where emission testing is being performed? Why?

12. What measures can be taken to reduce influence of varying ground potential when connecting two systems e.g. via I/O cables?

13. When performing ESD immunity tests, a test finger is used where a 150 pF capacitor is discharged through a 330 ohm resistor. Why have those values of the components been chosen?

14. What main types of transient protection devices are there and when are they recommended to be used?

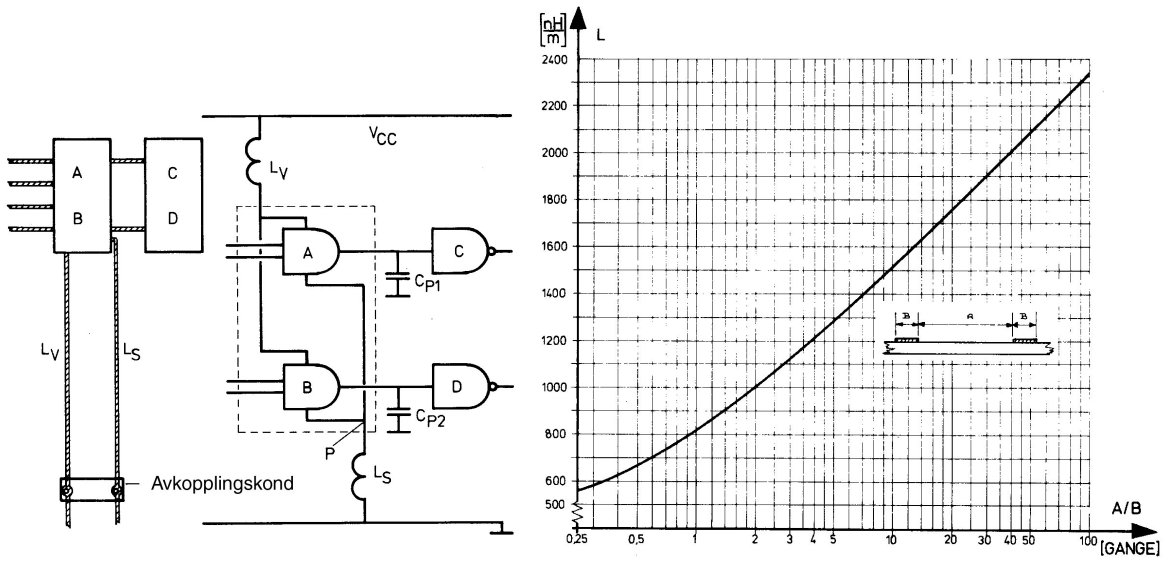
15. Which two modes of emissions may be found in digital circuits and what may cause those?

Del 2:

Problem 1

Calculate the shielding effectiveness of a 0.3 mm thick copper shield at a distance of 5 cm from a low impedance 50 kHz source. What will the shielding effectiveness be at a very large distance from the source? (5 credits)

Problem 2



The figure shows a detail of a circuit where a digital IC is powered via two 0.3 mm wide copper connectors on a single sided PCB. The distance between the wires is 12 mm an a decoupling capacitor is connected 100 mm from the IC. When the output of gate A goes from high to low the current consumption of IC AB goes from 2 to 27 mA in 5 nanoseconds.
The figure to the right shows the self inductance of each of two parallell copper connectors on a PCB as a function of distance/width in nH/m. Assume that the output of gate B is low and has a voltage of 0.3 V with respect to the IC ground (P). The threshold for switching of gate D is 0.8 V. The IC CD is connected to a power supply separat from the power supply of IC AB. Calculate if the switching of gate A will cause problems on the input of gate D (3 credits) (The parasitic capacitances Cp1 and Cp2 may be omitted in then calculations). Suggest improvements to the circuit (2 credits).

Problem 3

A digital signal should be transferred between two pieces of equipment using a cable. At hand is a 1.5 m long 230V cable. The conductors in the cable are 4 mm apart. The digital signal has a frequency of10 MHz with rise- and falltimes of 3 ns. The digital ICs in the two pieces of equipment are of High-Speed C-MOS (HC) type and are powered from a 5V supply. The output impedance can be assumed to be ca10 ohm and the input impedance ca 150 ohm for the frequencies present in the signal. The impedance of the cable itself is omitted. Calculate if the connection will pass an emission test using the limits of residential, commercial and light industry environment (Fig. below). Sketch the envelop of the emitted spectrum including levels and frequency. How can the connection be improved?