Data Provided: Statistical tables A and B

The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Autumn Semester 2006-2007 (2 hours)

Electromagnetic Compatability 6

Answer **THREE** questions. **No marks will be awarded for solutions to a fourth question.** Solutions will be considered in the order that they are presented in the answer book. Trial answers will be ignored if they are clearly crossed out. **The numbers given after each section of a question indicate the relative weighting of that section.**

1. **a.** Radio frequency emissions may be classified as being either “narrowband” or “broadband”. Define these terms in an e.m.c. context and give examples of such emissions. **(2)**

b. Describe in detail, with the aid of diagrams, a receiver suitable for carrying out radio frequency emissions testing at frequencies up to 1 GHz. Why should the receiver have a wide dynamic range and be provided with several types of detector? **(8)**

c. Describe the types of pickup transducer which might be used with such a receiver and explain, briefly, how they might be used in practice. **(6)**

d. A measurement receiver fitted with a quasi-peak detector is to be used to measure the radiated emissions from a laptop computer over the frequency range 30 MHz to 1 GHz. Using the data given below, estimate the time required to carry out the measurement.

Receiver 6dB bandwidth = 120 kHz

Charge time constant = 1mS

Discharge time constant = 550mS

(4)

2. **a.** Write brief descriptive notes, supported by diagrams where appropriate, on ***two*** of the following

(i) Radiated susceptibility testing
(ii) ESD testing
(iii) Measurement of shielding effectiveness

(8)

b. Explain what is meant by sample testing to the so-called X%/Y% rule. **(2)**

c. Explain the difference between a normal distribution and a t-distribution. **(2)**

d. The gain at a certain frequency was measured for a batch of 6 e.m.c. testing antennas that were randomly selected from a large production run. The results were as follows:

Sample No	1	2	3	4	5	6
Gain (dB)	9.9	10.1	9.8	9.7	9.9	10.2

Using the 90%/90% rule, determine whether the production run of these antennas meets the required gain specification of at least 9.5 dB. **(8)**

3. **a.** Approximating a co-axial cable to two concentric cylinders, and given that the relative permittivity of the insulator between the cylinders (ε_r) is 20, and the relative permeability of the insulator (μ_r) is 1. Calculate the capacitance and inductance per unit length for the cable, and its characteristic impedance given that the diameter of the inner conductor is 1mm and the diameter of the outer conductor is 4mm. ($\mu_o = 4\pi.10^{-7}$ H/m, ε_o=8.85.10^{-12} F/m). **(5)**

b. Draw a lumped parameter model for two wires in close proximity, highlighting the coupling mechanisms between the wires. **(5)**

c. A drive system has the sensor wires from the motor Hall-effect sensor running next to the main drive output cables for 1m along one side of the enclosure. It is known that the mutual inductance between the two cables varies with the separation between the cables, and the value of the mutual inductance may be found from figure 1. The rate of change of current in the drive output cables is 10A/μsec during the drive switching transients, and you may assume that the source and load impedances are equal to the characteristic impedance of the cables. Calculate the magnitude of the noise voltage induced at the input to the drive electronics given that the cables are initially 1mm apart. (Assume that any capacitive coupling between the cables is negligible). **(5)**

d. How far apart do the cables need to be, in section (b) above, to ensure that the magnitude of any induced voltage at the input to the drive remains below a logic level threshold of 1.2V. **(5)**

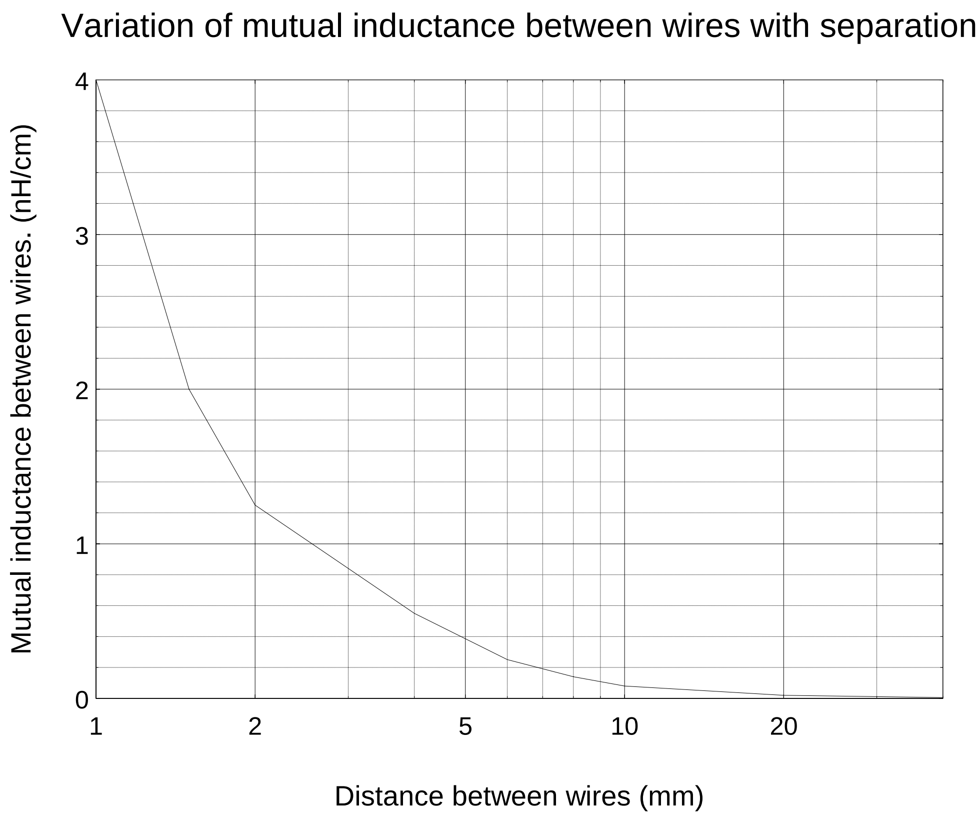

Figure 1.

4. a. With the aid of a diagram, explain the 3 modes in which screening material prevents interference passing into an enclosure. As part of your answer, give the equation expressing screening effectiveness. **(7)**

b. Ignoring the loss due to multiple scattering, and the effect of any apertures, calculate the shielding effectiveness for a 0.25mm thick stainless steel computer casing at 100MHz, given that the relative permeability of the stainless steel, μ_r = 1, and the relative conductivity is $\sigma_r = 0.1$ ($\sigma_{cu} = 5.8\text{x}10^7$ S/m, $\mu_o = 4\pi\text{x}10^{-7}$ H/m). **(6)**

c. Discuss the effect of poor joints between the sections of the casing, and suggest three ways to increase the shielding at the joint over that given by a simple butt joint. **(7)**

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