Data Provided: NONE

The University of Sheffield

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

Spring Semester 2004-2005 (2 hours)

Microsystem Packaging 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.** Describe:
(i) the construction of a plastic dual in-line pin (DIP) package and
(ii) its assembly using wave soldering **(6)**

b. What is the junction temperature T_j for a chip dissipating 500mW when packaged in a plastic DIP16 without active cooling? (Notes: use data in Figure 1, assume ambient temperature = 20°C)

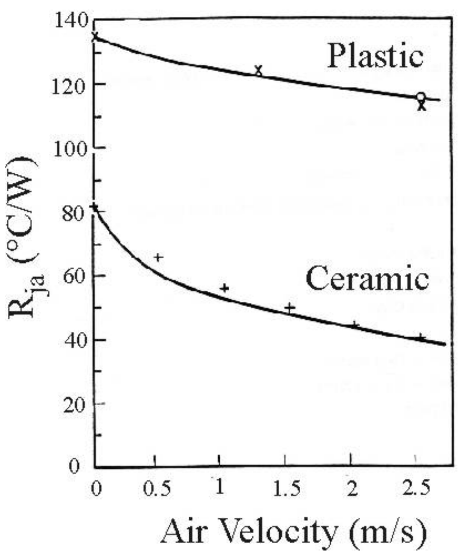

Figure 1 Thermal resistance of 16-pin DIP package as a function of air velocity from fan **(3)**

c. What upgrades to the above packaging solution would be needed to keep the junction temperature T_j of a chip dissipating 2W below 100°C? **(3)**

d. Why does a ceramic DIP have a lower thermal resistance than a plastic DIP? **(2)**

e. Explain the physical factors that govern the data in Figure 1 **(6)**

2. **a.** Describe the construction of a six-layer glass-epoxy printed circuit board (PCB) with through, blind and buried vias. **(8)**

b. The internal layers of a four-layer FR4 PCB are used for power and ground planes, whilst the surface layers are used for signals. State the equation for the impedance for a microstrip line and use it to calculate the impedance of a 1mm wide track on a surface layer. (ε_{eff} = 3.5). Comment on the calculated value. **(4)**

c. What is the impedance if the track is realised as a 100µm-wide stripline on a polyimide microvia substrate? (ε_{eff} = 4.5) **(4)**

d. Discuss the measures that are taken to minimise cross talk between signals in an electronic system. **(4)**

3. **a.** Describe the three principal methods used to make electrical connections to IC die and their relative advantages and disadvantages. **(6)**

b. Why should impedances be controlled in a high-speed signal path? What are the principal sources of parasitic impedance in an IC package? **(4)**

c. Explain the origins of simultaneous switching noise and crosstalk. Describe how these two issues in electromagnetic interference may be minimised by appropriate packaging design. **(4)**

d. Microprocessor chips generally obey Rents rule for the number of pin Input/Outputs, with Rents constant (K)= 1.5 and Rents Exponent p=0.4. Calculate the number of pin outs for a typical modern microprocessor with 10^7 logic gates.

If the IC has dimensions 25mm x 25mm, calculate the typical pin separation for (i) a surface mount package with interconnects on all 4 sides and (ii) a ball grid array. Explain why ball grid arrays offer a viable solution to packaging this type of device. **(6)**

4. **a.** Describe the principal advantages of flip chip packaging of ICs over that of dual in-line packages (DIP). **(4)**

b. Describe the special considerations which need to be taken in the packaging of (i) a silicon photodetector and (ii) a fibre coupled telecommunications laser. **(5)**

c. A $1cm^2$ chip, dissipating 10W, is epoxy glued to a 5mm thick alumina substrate, which is in turn epoxy glued to a 10mm thick aluminium heat sink, as shown in Figure 4a. The chip temperature needs to be less than 120°C. Assuming linear heat conduction, what is the maximum allowed temperature at the surface of the heat sink? Assume the epoxy is coated to a thickness of 100μm.

Data: k_{epoxy} = 0.4W/m.K $k_{alumina}$ = 30W/m.K $k_{aluminium}$ = 216W/m.K

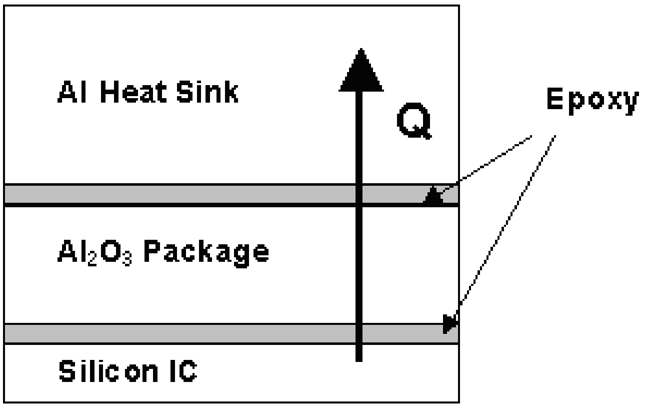

Figure 4a Thermal conduction from a Silicon IC to an Al heat sink, via an Alumina (Al_2O_3) package

(5)

d. A square Aluminium plate heat sink of dimensions 50x50mm is being heated to a temperature of 80°C on one face. Forced convection is maintaining the other face at 20°C. Assuming a heat transfer coefficient (h) =110W/m^2K, calculate the total heat transfer from the heatsink. If a single rectangular fin of dimensions L =50mm, W=50mm and T=5mm is now attached to the cooled side (see Figure 4b), calculate the total heat transfer from the finned heatsink. Assume the efficiency of the heat-sink is 0.8

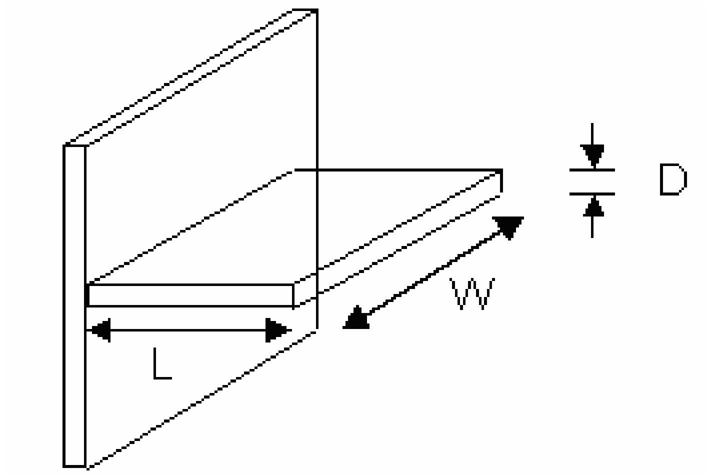

Figure 4b Schematic of finned heat sink **(6)**