

## 2004 Paper 2 Question 10

### Structured Hardware Design

A new scanner for small objects consists of a transmitting array of  $512 \times 512$  elements and a receiving array of similar size. Each array is 4 cm on a side and the two arrays are placed 4 cm apart so that a total volume of  $4^3$  cubic centimetres can be scanned. Each transmitting element has two inputs that may be directly connected to digital logic and which are internally ANDed by the element.

The scanner operates in still image mode by delivering a complex pattern of microsecond resolution pulses to the transmitting array over the course of one millisecond. The more pulses that can be delivered, the better quality the image. The complete pattern of pulses is determined in advance by software. The software will be aware of any constraints you may implement in the hardware that generates the pulses.

Please execute the following steps in the design of the transmitter array:

- (a) Design and sketch out the inter-wiring between the control electronics and the transmit array elements. Hence decide how many custom chips (integrated circuits) to use, taking into account a 100 pin limit for each chip. [8 marks]
- (b) Decide how much RAM is needed on each chip to store the pattern and explain the data representation in RAM you have selected. Justify your decision. [4 marks]
- (c) Show how the transmitting and receiving arrays may both be wired into the address space of a controlling microprocessor. [4 marks]
- (d) Sketch out the internal architecture of each transmitter chip, showing the major blocks. [4 marks]