# Chapter 7

## Memory and Programmable Logic

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## §7-3

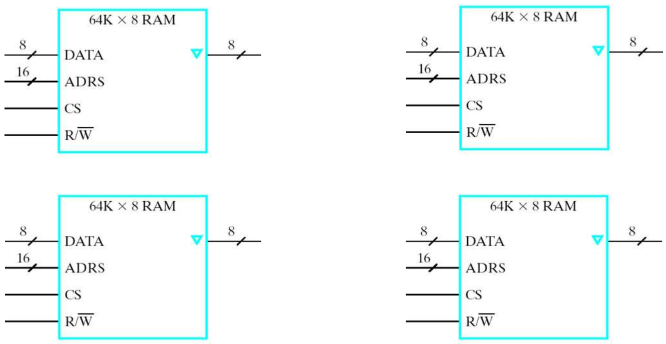
1. An 8K×4 RAM chip is to be constructed.
   (a) If linear decoding scheme is used for the chip, what is the size of the decoder? Describe the hardware requirement of the decoder including the number of AND gates and the number of inputs per gate.
   (b) If coincident decoding scheme is used by splitting the internal decoder into row select and column select, what is the size of each decoder? Assume that the RAM cell array is as square as possible. Describe the hardware requirement of the decoders the same way as that in (a).

EX-2

## §7-3

2. Construct a 128K×16 RAM by using 64K×8 RAM ICs.


<Ans>




EX-3

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## §7-5

3. (a) Design a combinational circuit for the following functions by using a ROM (Read-Only memory).

$A(X, Y, Z) = \Sigma m(0,1,3,6,7)$
$B(X, Y, Z) = \Sigma m(0,1,4,5)$
$C(X, Y, Z) = \Sigma m(2,5)$
$D(X, Y, Z) = \Sigma m(1,2,4,5,6,7)$

i. Tabulate the truth table of the ROM.

ii. Specify the size of the ROM, i.e., the number of words × the number of bits per word.

iii. Reduce the size of the ROM without using external gates, if possible. Assume that the complements of the input variables are available.

(b) Repeat (a) for a combinational circuit with three inputs and three outputs. The input of the circuit is a 3-bit number ($A_2\ A_1\ A_0$) and the output ($F_2\ F_1\ F_0$) is the Gray code of the input number.

EX-4

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(a) $A(X, Y, Z) = \Sigma m(0,1,3,6,7)$
$B(X, Y, Z) = \Sigma m(0,1,4,5)$
$C(X, Y, Z) = \Sigma m(2,5)$
$D(X, Y, Z) = \Sigma m(1,2,4,5,6,7)$

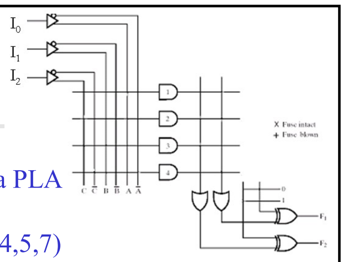
ROM truth table:

| X | Y | Z | A | B | C | D |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | | | | |
| 0 | 0 | 1 | | | | |
| 0 | 1 | 0 | | | | |
| 0 | 1 | 1 | | | | |
| 1 | 0 | 0 | | | | |
| 1 | 0 | 1 | | | | |
| 1 | 1 | 0 | | | | |
| 1 | 1 | 1 | | | | |





## §7-6




4. (a) Implement the following two functions using a PLA (Programmable Logic Array):
   $A(x, y, z) = \Sigma m(0,2,3,5,6)$, $B(x, y, z) = \Sigma m(1,4,5,7)$

   The outputs of the PLA are available in both “True” (non-complemented) and “Complement” form. An example of PLA is given below.

   i. Derive the Boolean expressions for each of the function and its complement in SoP forms.
   ii. Explain and specify the size required of the PLA as ***the number of inputs*** × ***the number of distinct product terms*** × ***the number of outputs***. Be sure to share product terms between functions.
   iii. Derive the PLA programming table for the functions. (Note that the number of product terms should be minimized.)

   (b) Repeat (a) for a the following two functions:
   $A(w, x, y, z) = \Sigma m(2, 3, 8, 9, 10, 12, 13, 14)$
   $B(w, x, y, z) = \Sigma m(0, 1, 2, 4, 5, 6, 8)$

(a)

A(x, y, z) = Σm(0,2,3,5,6)

| x \ yz | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | | |
| 1 | | | | |

B(x, y, z) = Σm(1,4,5,7)

| x \ yz | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | | |
| 1 | | | | |

PLA programming table:

| | | | | | **outputs** | |
|---|---|---|---|---|---|---|
| | | inputs | | | T/C | T/C |
| Product terms | | x | y | z | A | B |
| | 1 | | | | | |
| | 2 | | | | | |
| | 3 | | | | | |
| | … | | | | | |

EX-7



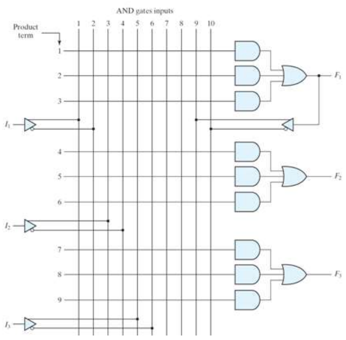
# §7-7

5. (a) Implement the following two functions using the PAL (Programmable Array Logic) given below.

   A(x, y, z) = Σm(0, 2, 3, 5, 6),
   B(x, y, z) = Σm(1, 4, 5, 7)

   i. Derive the Boolean expressions of the functions.

   ii. Derive the PAL programming table of the functions.



(b) Repeat (a) by using a similar PAL with four inputs for the following two functions:

A(w, x, y, z) = Σm(2, 3, 8, 9, 10, 12, 13, 14)

B(w, x, y, z) = Σm(0, 1, 2, 4, 5, 6, 8)

EX-8

(a)

$A(x, y, z) = \Sigma m(0,2,3,5,6)$

| $x$ \ $yz$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | | |
| 1 | | | | |

$B(x, y, z) = \Sigma m(1,4,5,7)$

| $x$ \ $yz$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | | | | |
| 1 | | | | |

PAL programming table:

| Product terms | AND inputs | | | | outputs |
|---|---|---|---|---|---|
| | x | y | z | C | |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |

EX-9

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## Brief Answers of the Exercises

1. (a) Decoder: one $13 \times 2^{13}$ decoder ; #AND gates: $2^{13}$ ; #inputs/gate: 13
   (b) Decoders: one 7-to-$2^7$ decoder and one 6-to-$2^6$ decoder;
   $2^7$ 7-input & $2^6$ 6-input AND gates

3. (a) ii. $8 \times 4$ ROM iii. $8 \times 3$ ROM
   (b) ii. $8 \times 3$ ROM iii. $8 \times 2$ ROM

4. (a) i. $A = xy'z + x'y + x'z' + yz'$ , $A' = xy'z' + x'y'z + xyz$
   $B = xy' + xz + y'z$ , $B' = x'y + yz' + x'z'$
   ii. $3{\times}4{\times}2$ PLA
   (b) i. $A = wy' + wz' + w'x'y$ , $A' = w'x + w'y' + wyz$
   $B = x'y'z' + w'y' + w'z'$ , $B' = wx + wy + wz + yz$
   ii. $4{\times}5{\times}2$ PLA

5. (a) i. $A = xy'z + x'y + x'z' + yz' = C + x'z' + yz'$ * One of the possible solutions!
   $B = xy' + xz + y'z$
   (b) i. $A = wy' + wz' + w'x'y$ , $B = x'y'z' + w'y' + w'z'$

EX-10

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