Read-Only Memory (ROM)

- Non-volatile

ROM is often needed in digital systems such as:
  - Holding the instruction set for a microprocessor
  - Firmware
A 256-MByte Memory Chip

- Memory block contains $2^M + N$ storage locations
- When a bit is selected, sense amplifiers: used to read/write to the RAM location
Output 0 is high if both \( A_0 \) and \( A_1 \) are low

Row 0 = \((A_1 + A_0)\)'
Row 1 = \((A_1 + A_0')\)'
Row 2 = \((A_1' + A_0)\)'
Row 3 = \((A_1' + A_0')\)'
Figure 16.25 A NOR address decoder in array form. One out of eight lines (row lines) is selected using a 3-bit address.
• Output 3 is low if both A0 and A1 are high

Row 0 = \( (A_1' A_0')' \)
Row 1 = \( (A_1' A_0)' \)
Row 2 = \( (A_1 A_0')' \)
Row 3 = \( (A_1 A_0)' \)
Domino CMOS Address Decoders
Pass-transistor Column Decoder

- 3-bit column data selector using pass-transistor logic
Figure 16.27 A tree column decoder. Note that the colored path shows the transistors that are conducting when $A_0 = 1$, $A_1 = 0$, and $A_2 = 1$, the address that results in connecting $B_3$ to the data line.
Figure 16.26: A column decoder realized by a combination of a NOR decoder and a pass-transistor multiplexer.
Read-Only Memory (ROM)

- The basic structure of the NMOS static ROM is shown in the figure.
- The existence of a NMOS means a “0” is stored at that address otherwise a “1” is stored.
- The major downfall to this particular circuit is that it dissipates a lot of power.
Figure 16.30 A simple MOS ROM organized as 8 words × 4 bits.
Read-Only Memory (ROM)

- The domino CMOS ROM is one technique used to lower the amount of power dissipation.
NAND-array structure ROM

- Can be directly used with NAND decoder
- Active-low word bits:
  - All W's are HIGH except selected row
  - Absence of FET makes bit low;
  - Presence makes bit high
<table>
<thead>
<tr>
<th>address</th>
<th>$A_3A_2A_1A_0$</th>
<th>$D_O$</th>
<th>transistors “ON” (subscripts only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0101</td>
<td>0</td>
<td>0</td>
<td>3,4,5,6,10,13,17,18,22</td>
</tr>
<tr>
<td>1000</td>
<td>1</td>
<td>0</td>
<td>3,4,7,8,12,19,20,21</td>
</tr>
<tr>
<td>0010</td>
<td>0</td>
<td>0</td>
<td>1,2,7,8,9,11,15,19,20,22</td>
</tr>
<tr>
<td>1010</td>
<td>1</td>
<td>0</td>
<td>1,2,7,8,9,11,15,19,20,21</td>
</tr>
<tr>
<td>0001</td>
<td>1</td>
<td>1</td>
<td>3,4,5,6,10,13,19,20,22</td>
</tr>
</tbody>
</table>