

Engs 31 / CoSc 27  
**DIGITAL ELECTRONICS**  
Spring 2004  
*18: Tuesday, April 27*

Tuesday, April 22, 2004 18.1

**Agenda**

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Wednesday's reading  
Sections 3.8.8, 6.2.1, 7.14.1, 7.14.2, 10.1.3

Today's topic:  
Displays

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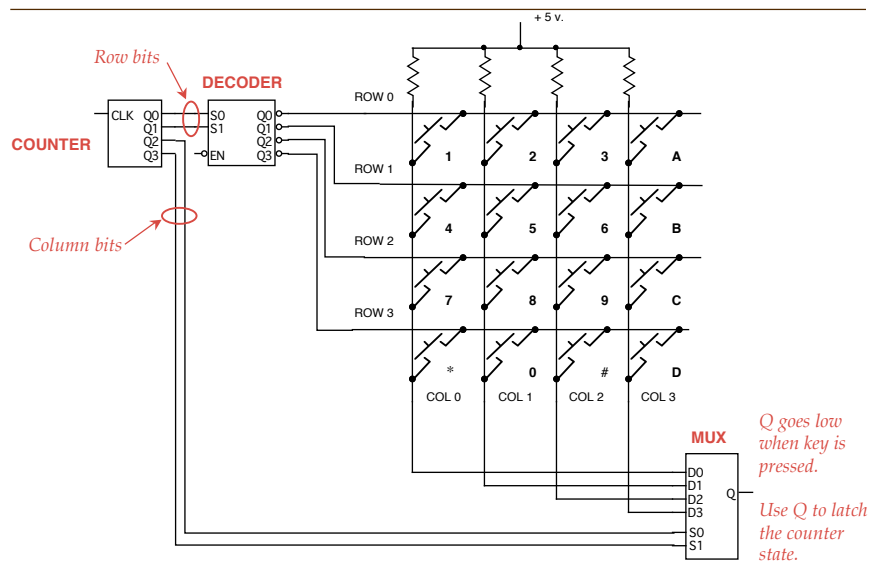
### Practical aspects of digital design — so far

- Debouncing pushbutton switches
- Keypad encoding
- Synchronizing asynchronous inputs
- Bypass capacitors on each chip
- Power-on reset
- Clocks
- Power and clock distribution

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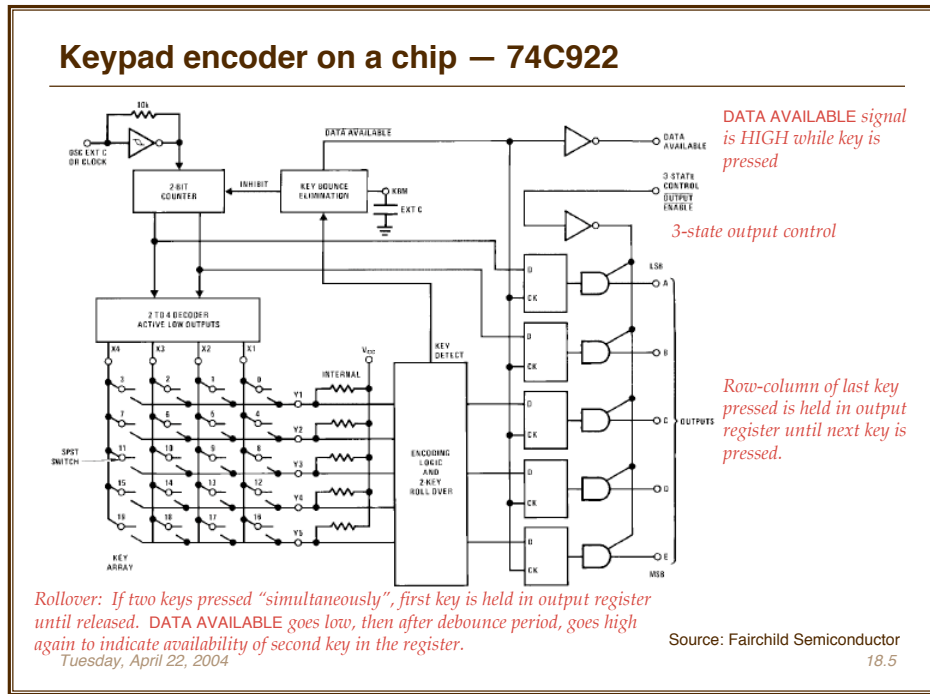
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### Keypad encoding — corrected description



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## Display technology

Single LED (light-emitting diode)

Seven-segment and alphanumeric LED displays

Multiplexed seven-segment and alphanumeric LED displays

LED matrix displays

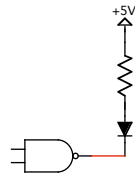
LCD (liquid crystal) — difficult to use with Engs 31 technology (need a microprocessor, Engs 62).

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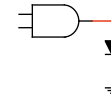
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### Review — driving a light-emitting diode

Low-side drive:  
Sink current through cathode



High-side drive:  
Source current into anode

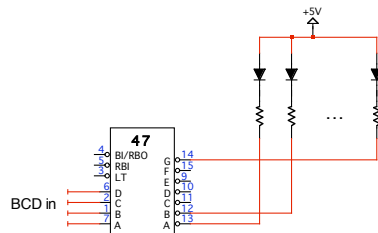


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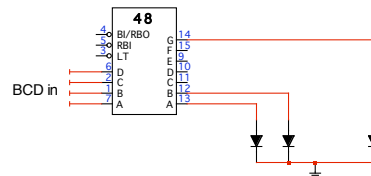
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### Driving a seven-segment display

Common-anode display



Common-cathode display



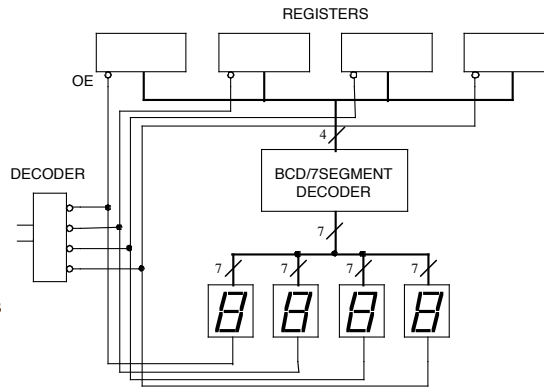
- For large displays, lots of wiring, high chip count.
- High-side drive may not provide sufficient current for desired brightness — use extra driver transistors.
- LS47 and LS48 chips are obsolete — but other devices still exist (e.g., MC14511B)

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### Multiplexed 7-segment display — principle

- One digit is active at a time.
- Digits are rapidly cycled to overcome flicker and give illusion of a continuous display.
- Instantaneous current to LEDs is high, but average power (= average heating) is within limits.

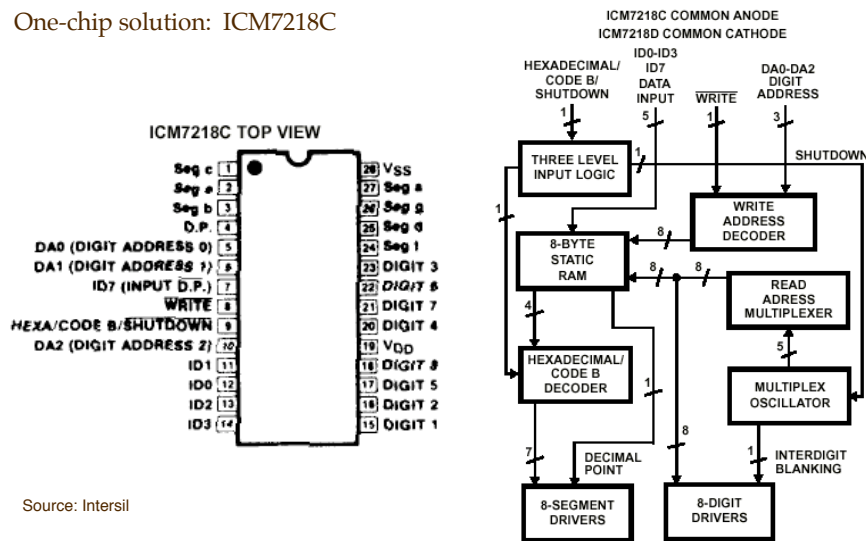


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### Multiplexed 7-segment display — implementation

One-chip solution: ICM7218C



Source: Intersil

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### Multiplexed 7-segment display — implementation

7218C/D timing — looks like a memory chip, digits can be independently altered.

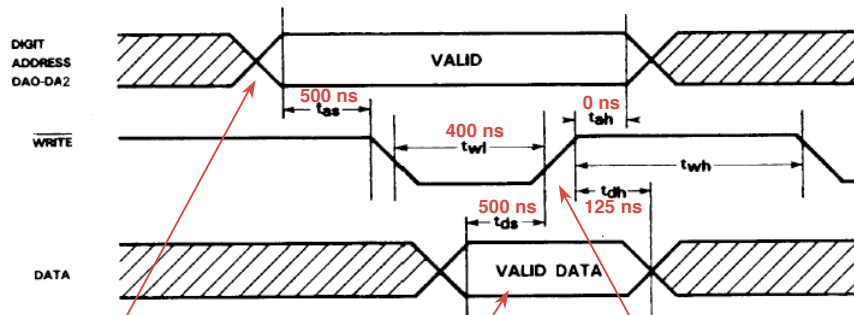


FIGURE 7. TIMING DIAGRAM FOR ICM7218C/D

Address bits determine which digit is being written to.

Data bits must satisfy setup and hold requirements.

Data bits are stored in the internal memory by the rising edge of the WRITE signal.

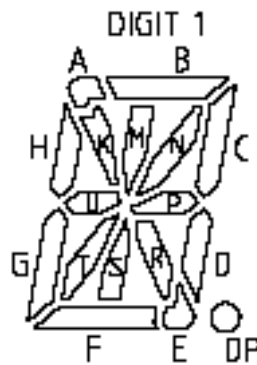
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Source: Intersil 18.11

### Alphanumeric display

14 or 16 segments instead of 7.

One-chip multiplexed drivers available, e.g., ICM7243



Source: LITE-ON

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