Indicator Lamps (1)

• Indicates information
  – Lamp itself has no information
  – Information comes from context

![Diagram of indicator lamps and floor indicators]

- Green circle: Okay
- Red circle: Error

Engine Malfunction Indicator Lamp

- Third floor
- Second floor
- First floor
- Basement floor

Elevator Floor Indicator
Indicator Lamps (2)

• Light-Emitting Diodes
  – Switched on or off by control pin
  – Two operation
    • Active high (on = 1)
    • Active low (on = 0)
Indicator Lamps (3)

- LEDs can be combined
  - Common Cathode
    - Active High
  - Common Anode
    - Active Low
Seven-Segment Displays (1)

• Mode of Operation
  – Seven segments display a number

![Diagram of Seven-Segment Display]

Number Representation
Seven-Segment Displays (2)

- Seven-Segment Driver

![Diagram of 7-Segment Driver and Display]

- 7-Seg Driver
  - VCC
  - D1
  - D2
  - D3
  - D4
  - GND

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Common Ground
Dot-Matrix Displays (1)

• LEDs arranged in a block
  – Arranged in
    • Columns
    • Rows
  – Example
    • 8×8 dot-matrix
Dot-Matrix Displays (2)

• Electrical Setup

![Dot-Matrix Display Diagram]

Detailed View

Column (write)

Row (write)
Dot-Matrix Displays (3)

- Dot-Matrix Controller

![Diagram of Dot-Matrix Display]

- MAX7129
- Rows
- Columns
- Microcontroller

Display Drivers
Liquid-Crystal Display (1)

• Functional Principle

A twisted nematic cell with zero potential is transparent and the pixel is white.

A twisted nematic cell with a nonzero potential is opaque and the pixel is black.
Liquid-Crystal Display (2)

- LCD Controller

![Diagram of LCD Controller with Microcontroller and Display Drivers](image-url)