Seven Segment Displays

Digital Electronics
Seven Segment Displays

This presentation will demonstrate how

• A seven-segment display can be used to display the decimal numbers 0-9 and some alpha characters.

• A common anode seven-segment display works.

• A common cathode seven-segment display works.

• To select the resistor value for a seven-segment display.
Segment Identification

• A Seven-Segment Display (SSD) is simply a figure eight grouping of LEDs {some include a decimal point (DP)}.
• Each Segment is labeled (a) thru (g).
• SSDs are available in two configurations
  – Common Cathode (all LED cathodes are connected)
  – Common Anode (all LED anodes are connected)
SSD Display Possibilities

Decimal Digits 0-9

Select Alpha Characters

Simple Messages

COLD  SODA
Basic LED Operations

To understand how a seven-segment display works, we must review how an LED works.

To Turn an LED ON . . .

• The ANODE must be at a higher voltage potential (~1.5v) than the CATHODE.

• The amount of current flowing through the LED will determine the brightness of the LED.

• The amount of current is controlled by a series resistor. (not shown)
LED Configuration – Anode @ 5 Volts

Switch @ 5v
- Top Circuit
- LED Off

Switch @ 0v
- Bottom Circuit
- LED On
- ANODE @ 5v
- CATHODE @ 0v (nearly)
- The 220 Ω resistor controls the current.
- A larger resistor . . . less current . . . dimmer LED
- A smaller resistor . . . more current . . . brighter LED
Example #1: Common Anode SSD

Example

What value would be displayed in the common anode seven-segment display shown?
Example #1: Common Anode SSD

Example

What value would be displayed in the common anode seven-segment display shown?

Solution

Common Anode:
- 0 volts = Segment On
  - b, c, f, & g
- 5 volts = Segment Off
  - a, d, & e

![Diagram of 4-digit common anode SSD display](image)
LED Configuration – Cathode @ Ground

Switch @ 5v
• Top Circuit
• LED On
• ANODE @ 5v (nearly)
• CATHODE @ 0v
• The 220 $\Omega$ resistor controls the current.
• A larger resistor . . . less current . . . dimmer LED
• A smaller resistor . . . more current . . . brighter LED

Switch @ 0v
• Bottom Circuit
• LED Off

Common Cathode SSD Configuration (5v=On / 0v=Off)
Example #2: Common Cathode SSD

**Example**

What value would be displayed in the common cathode seven-segment display shown?
Example #2: Common Cathode SSD

Example

What value would be displayed in the common cathode seven-segment display shown?

Solution

Common Cathode:
- 5 volts = Segment On
  - a, b, d, e, & g
- 0 volts = Segment Off
  - c & f
Resistor Values for SSD

• The resistor value determines the amount of current that is flowing through the LED in the SSD.

• This is why they are sometimes called current limiting resistors.

• The amount of current determines how luminous (bright) the LED will be.

• If the resistor is too large, the current will be too small and the LED will not be visible.

• If the resistor is too small, the current will be too large and the LED will be damaged.

• So, how do you select the correct value? You must read the data sheet for the SSD that you are using.
A Review of Circuit Theory

• The diagram below is a single segment of a common anode seven-segment display.
• The voltage across the LED (when on) is 1.5 volts.
• Using Kirchhoff's Voltage Law, we know that the voltage across the resistor is 3.5 volts (i.e., $5v - 1.5v = 3.5v$).
• Thus, using Ohm’s Law, we can calculate the value of the resistor if we know the current that is to flow through the LED.

$$R = \frac{3.5v}{I}$$
Selecting A Resistor Value

LTS-4801JR Common Anode Seven-Segment Display
Luminous Intensity vs. Forward Current Graph

• Let’s arbitrarily pick a luminous intensity of 1.5 (not too bright, not too dim).

• From the graph, we need a current of 15mA.

• Using Ohm’s Law:

\[
R = \frac{3.5\text{v}}{15\text{mA}} = \frac{3.5\text{v}}{15\text{mA}} = 233.33\ \Omega
\]

\[
R = 220\ \Omega \ (closest\ standard\ value)
\]
Example #3: Resistor Value

Example

Calculate the resistor value required to have a luminous intensity of 2.5.

Fig 4. RELATIVE LUMINOUS INTENSITY VS. FORWARD CURRENT
Example #3: Resistor Value

Example

Calculate the resistor value required to have a luminous intensity of 2.5.

Solution

• From the graph, we need a current of 25mA.

• Using Ohm’s Law:

\[
R = \frac{3.5\, \text{v}}{25\, \text{mA}} = 140 \, \Omega
\]

\[
R = 150 \, \Omega \text{ (closest standard value)}
\]