



Boolean Logic through 7447



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Abstract—This manual shows how to use the 7447 BCD-Seven Segment Display decoder to learn Boolean logic.

1 COMPONENTS

| Component | Value | Quantity |
|-----------------------|--------------|----------|
| Breadboard | | 1 |
| Resistor | 220 Ω | 1 |
| Arduino | Uno | 1 |
| Seven Segment Display | Common Anode | 1 |
| Decoder | 7447 | 1 |
| Jumper Wires | M-M | 20 |

TABLE I

2 HARDWARE

Problem 2.1. Make connections between the seven segment display in Fig. 1 and the 7447 IC in Fig. 2 as shown in Table II

Problem 2.2. Make connections to the lower pins of the 7447 according to Table III and connect $V_{CC} = 5V$. You should see the number 0 displayed

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| 7447 | \bar{a} | \bar{b} | \bar{c} | \bar{d} | \bar{e} | \bar{f} | \bar{g} |
|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Display | a | b | c | d | e | f | g |

TABLE II

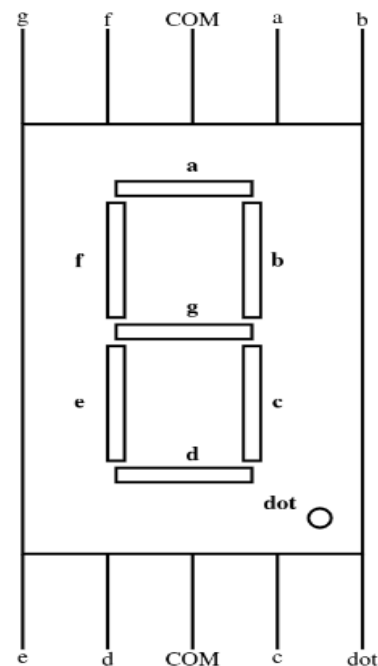


Fig. 1

for 0000 and 1 for 0001.

Problem 2.3. Complete Table III by generating all numbers between 0-9.

3 SOFTWARE

Problem 3.1. Now make the connections as per Table IV and execute the following program after downloading

| D | C | B | A | Decimal |
|---|---|---|---|---------|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |

TABLE III



Fig. 2

```
wget https://raw.githubusercontent.com/gadepall/arduino/master/7447/codes/gvv_ard_7447/gvv_ard_7447.ino
```

| 7447 | D | C | B | A |
|---------|---|---|---|---|
| Arduino | 5 | 4 | 3 | 2 |

TABLE IV

In the truth table in Table V, W, X, Y, Z are the inputs and A, B, C, D are the outputs. This table represents the system that increments the numbers 0-8 by 1 and resets the number 9 to 0. Note that $D = 1$ for the inputs 0111 and 1000. Using *boolean* logic,

$$D = WXYZ' + W'X'Y'Z \quad (1)$$

Note that 0111 results in the expression $WXYZ'$ and 1000 yields $W'X'Y'Z$.

Problem 3.2. The code below realizes the Boolean logic for B, C and D in Table V. Write the logic for A and verify.

```
wget https://raw.githubusercontent.com/gadepall/arduino/master/7447/codes/inc_dec/inc_dec.ino
```

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

TABLE V

Problem 3.3. Now make additional connections as shown in Table VI and execute the following code. Comment.

```
wget https://raw.githubusercontent.com/gadepall/arduino/master/7447/codes/ip_inc_dec/ip_inc_dec.ino
```

Solution: In this exercise, we are taking the number 5 as input to the arduino and displaying it on the seven segment display using the 7447 IC.

Problem 3.4. Verify the above code for all inputs

| | Z | Y | X | W |
|---------|---|---|---|---|
| Input | 0 | 1 | 0 | 1 |
| Arduino | 9 | 8 | 7 | 6 |

TABLE VI

from 0-9.

Problem 3.5. Now write a program where

- 1) the binary inputs are given by connecting to 0 and 1 on the breadboard
- 2) incremented by 1 using Table V and
- 3) the incremented value is displayed on the seven segment display.

Problem 3.6. Write the truth table for the 7447 IC and obtain the corresponding boolean logic equations.

Problem 3.7. Implement the 7447 logic in the arduino. Verify that your arduino now behaves like the 7447 IC.