Lab 2: Combinational Design

**Primary Objectives:**

1. Get experience designing and building a circuit in Logisim.
2. Implement and test a circuit that outputs pair if two of the four inputs are on and outputs trio if three of the four inputs are on. (Pair-trio detector)

**Design**

Table 1: Symbol Mapping

|  |  |
| --- | --- |
| Name | Symbol |
| A | A |
| B | B |
| C | C |
| D | D |
| Pair | P |
| Trio | T |

Table 1 lists the symbols used in the rest of the document

Table 2: Truth table for the pair-trio detector

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | B | C | D | P | T |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 0 |

Table 2 describes all possible outcomes for this device, the table specifically shows that P will only be active when two inputs are active, and that T will only be active when three inputs are active.

Boolean Expression of the truth table

P = A’B’CD+A’BC’D+AB’C’D+AB’C’D+AB’CD’+A’B’CD

T = A’BCD+AB’CD+ABC’D+ABCD’

**Implementation**

Figure 1: Implemented pair-trio detector

Diagram

Description automatically generated

The pair-trio detector is implemented as seen above in figure 1 with each output labeled.

**Testing**

Table 3: Log of outputs from the designed device

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| A | B | C | D | P | T |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 |

The log is similar to the truth table seen above in table 2. This demonstrates that the implemented design functions appropriately.

**Conclusion**

Experience building circuits in Logisim has been gained, and the device works as expected. P only turns on when two inputs are on and T only turns on when three inputs are on.