

## Project 2.1.6 AOI Logic Design: Majority Vote

### Introduction

The United States 2000 Presidential Election between George W. Bush (Republican) and Albert "Al" Gore (Democrat) will be best remembered for the controversy over who won Florida's 25 electoral votes, and ultimately, who won the presidency.



At the heart of the controversy was the use of antiquated and unreliable paper ballots. The use of these paper ballots resulted in an unacceptable amount of over-votes and under-votes. An over-vote occurs when someone's vote is counted more than once, and an under-vote occurs when someone's vote is not counted at all.

To ensure that this type of controversy does not occur at your company, the board of directors has asked you to design an electronic voting machine. The voting machine will allow the four board members to cast their ballots and will display the pass/fail status of each of their decisions.



The board of directors has four members; a president, a vice-president, a secretary, and a treasurer. Each member has a single yes/no vote. For a decision to pass, a majority of the board members must vote yes. In the event of a tie, the president's vote is used to break the tie (i.e., if the president votes yes, the decision passes. If the president votes no, the decision fails.).

In this project, you will use only AND, OR & Inverter logic gates, frequently referred to as AOI logic, to design, simulate, and build a **Majority Vote** voting machine that meets these design specifications.

### Equipment

- Circuit Design Software (CDS)
- Breadboard (DLB or DMS)
- #22 Gauge solid wire
- Integrated Circuits (74LS04, 74LS08, & 74LS32)

## Procedure

Complete the following steps to design, simulate, build, and test your Majority Vote - Voting Machine. For each step, **be sure to document all your work in your engineering notebook.**

1. Using the following variable names and assignment conditions, create a truth table shown for your Majority Vote – Voting Machine.
  - P: President → 0=No / 1=Yes
  - V: Vice President → 0=No / 1=Yes
  - S: Secretary → 0=No / 1=Yes
  - T: Treasurer → 0=No / 1=Yes
  - Decision → 0=Fail / 1=Pass
2. Using the truth table, write the *un-simplified* logic expression for the output function Decision. Be sure that your answer is in the Sum-of-Products form.
3. Design an AOI logic circuit that implements the un-simplified logic expression Decision. Limit your implementation to only 2-input AND gates (74LS08), 2-input OR gates (74LS32), and inverters (74LS04).
4. Using the CDS, enter and test your *un-simplified* Majority Vote – Voting Machine. Use switches for the inputs *P*, *V*, *S*, & *T* and a probe or LED circuit for the output Decision. Verify that the circuit is working as expected. Print a copy of the final circuit and paste it in your engineering notebook/portfolio.
5. Using the theorems and laws of Boolean algebra, simplify the logic expression Decision. Be sure to put your answer in Sum-Of-Products (SOP) form.
6. Design an AOI logic circuit that implements the *simplified* logic expression Decision. Limit your implementation to only 2-input AND gates (74LS08), 2-input OR gates (74LS32), and inverters (74LS04).
7. Using the CDS, enter and test your *simplified* Majority Vote – Voting Machine. Use switches for the inputs *P*, *V*, *S*, & *T* and a probe or LED circuit for the output Decision. Verify that the circuit is working as expected. Print a copy of the final circuit and paste it in your engineering notebook/portfolio.
8. Using the DLB, build and test the *simplified* Majority Vote – Voting Machine logic circuit that you designed and simulated. Verify that the circuit is working as expected and that the results match the results of the simulation.

## Conclusion

In the aftermath of the 2000 Presidential Election, federal and state governments pushed for election reform. Many states passed laws that eliminated the use of paper ballots and required the use of electronic voting machines. Unfortunately, confusion on how to use these new electronic voting machines caused mistrust among the voting public. Ironically, this mistrust was particularly widespread among retirees living in Florida.

For this project write a conclusion (minimum 500 words) that describes the process that you used to design, simulate, and build your Majority-Vote Voting Machine. Here's the catch: you must write this conclusion in the form of a letter to your grandmother who is retired and living in Florida. Assume that your grandmother is a retired 3rd grade teacher and has no knowledge of digital electronics.