Lab 7: Combinatorics

Physics 116B

January 5, 2022

Introduction

In this lab, you will construct a 2-bit decoder and a 2-bit adder circuit using discrete logic gates. The parts you will need and their pin-outs are shown in the Appendix.

2-bit Decoder

Using AND gates and inverters, construct the two-bit digital decoder shown in Figure 1; that is, a device for which the numerical binary input $i = (A_1 A_0)_2$ will cause output Q_i, and only that output, to be TRUE (e.g. $A_1 = 1, A_0 = 0 \rightarrow Q_2 = 1$). Use as few devices as possible.

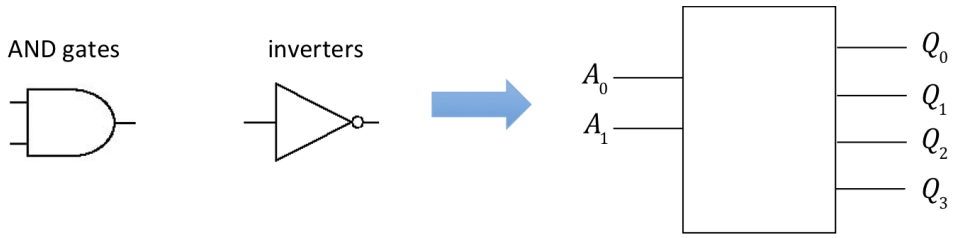

Figure 1: Two-bit decoder

Connect the inputs to the logic switches on the proto-boards and the outputs to the LED indicators.

Verify that that the outputs behave as expected for all combinations of the input bits and fill out a truth table with the state of the four outputs for all possible states of A_0 and A_1.

2-bit Adder with Carry Out

Wire up the following 2-bit adder circuit shown in Figure 2. Connect the inputs to the logic switches on the proto-board and the outputs to the LED indicators.

Fill out a truth table for all 16 combinations of the input switches, and verify that the circuit behaves as expected.

Disconnect the A_0 bit from the switch and connect it to the TTL function generator. Set bit A_1 to 0 and B_0 and B_1 to 1. Measure the propagation delay from A_0 changing state (both high and low) to Q_0, Q_1, and CO

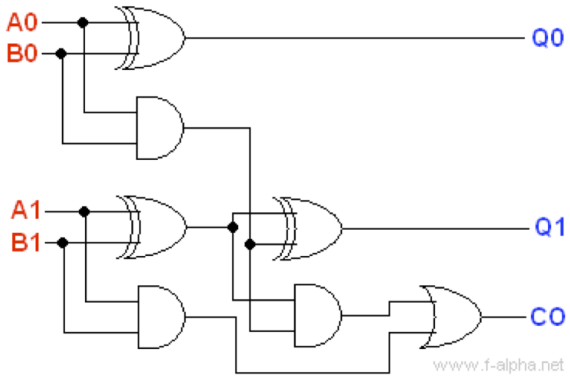

Figure 2: Two-bit adder with carry out.

reaching their final values. Include the appropriate scope traces in your lab report.

Appendix: Chips Used in this Lab