Experiment 6

MSI Circuit for Cold Switching Signals

It is sometimes awkward in an electronic instrument to have the switches on the front panel directly control the routing of signals (called ``hot switching") among circuits for several reasons. In hot switching, the signals have to be routed to the front panel for switching which introduces delays in the signal due to the length of the wire and possibly noise, not to mention the greater number of wires which must leave one board and be routed back to the board. The single largest source of failures in electronic circuits is connections.

A technique for time-division multiplexing signals can be used to alleviate this problem and serve to introduce "cold switching." In cold-switching, front panel switches indirectly redirect data signals by sending control signals from the switches to a circuit on the signal processing board which actually routes the signals from/to the desired processing circuit. This means that the data signal never leaves the circuit board and is therefore incurs no additional delay and is less susceptible to noise. Not only that, but by this method, 3 control lines can redirect 8 data lines thereby reducing the number of wires which must be used to connect the front panel to a signal processing board. The example presented here is used for routing digital signals, but the process is directly analogous for the routing of analog signals using digital control signals.

Time-division multiplexing means that multiple signals are transmitted over the same wire, but not at the same time as can be done with frequency-division multiplexing or other methods. The signal which is to be sent over the single data wire is specified by a set of n control signals, where 2^n is the number of signals which can be multiplexed. At the other end of the multiplexed signal data wire is a demultiplexer which selects which of the 2^n output signal lines to route the signal to. It is assumed here that the same address (control signals) is applied to both the multiplexer and demultiplexer.

With reference to the above problem do the following

1. Simulate and verify a multiplexer:
   a. Write a structural VHDL description of an 8-to-1 multiplexer.
   b. Demonstrate using a test bench that the output signal is the same as the selected input signal. Do this for all eight input signal lines.
2. Simulate and verify a demultiplexer:
   a. Write a structural VHDL description of a 1-to-8 demultiplexer.
   b. Demonstrate using a test bench that the input signal is routed to the correct output. Do this for all eight output signal lines.
3. Simulate and verify the complete TDM circuit:
   a. Write a structural VHDL description of an 8-to-1 multiplexer connected to a 1-to-8 demultiplexer.

b. Write a testbench with a counter to drive the control lines of both the multiplexer and the demultiplexer. Demonstrate the proper operation of the digital TDM circuit by verifying that the correct input signal is routed to the proper output.

4. Build an MSI implementation of the complete TDM circuit using parts from the ECE332 parts list and compare it to the TDM simulation.