Laboratory 5: Counters and registers

This week you will use an 8-bit shift register to convert data (i.e. a series of ones and zeros) between serial and parallel formats. You will also construct shift registers and counters.

1 Set-up an 8-bit shift-register circuit with a 74LS164 chip. Use logic switches in combination with either a very slow function generator clock or a debounced switch clock. Measure the input and clock with a slow oscilloscope time setting and verify that the parallel outputs are what they should be. Output the data from the serial out port (i.e. the last parallel out channel) and verify that the data is properly saved and outputted.

2. Use four D-type flip-flops to construct a 4-bit ripple counter. Make sure all your chips are from the same logic family. Test it with LEDs and a slow clock. Drive it with a 10 KHz clock and observe the output of each flip-flop. Can you see the out-of-sequence intermediate states? Sketch and described them in your write-up.

3. Use four D-type flip-flops to construct a 4-bit shift register. Use the TTL output of your function generator at a very slow frequency to convert from input from serial to parallel (and back to serial). Use a switch to input serial data, watch the LEDs to see the parallel data. Watch the sequence in the highest bit to see data as serial again.

4. Use Quartus II and the FPGA on the DE2 development board to count the number of positive edge triggers on an input pin for 100 ms (and every 100 ms after that) and display the result in little-endian binary format with red and green LEDs of the DE2 (LEDR[0-17] and LEDG[0-8]). Your counter should be able to measure the frequency of the 27 MHz clock attached to pin PIN_D13 (i.e. CLOCK_27).
What frequency do you measure for the 27 MHz clock? Also test your counter with the function generator.