Lab 3: Counters

Objective

- ✓ Review synchronous sequential circuits.
- ✓ Review counter logics.

Prerequisite

- ✓ Fundamentals of logic gates.
- ✓ Clocking concepts
- ✓ Logic modeling in Verilog HDL.

Pre-labs

1 Consider a 4-bit synchronous binary up counter.
  1.1 Draw the logic diagram
  1.2 Construct Verilog RTL representation for the logics with verification.

Experiments

1 Frequency Divider: Construct a 27-bit synchronous binary counter. Use the MSB of the counter, we can get a frequency divider which provides a $1/2^{27}$ frequency output (f_{out}) of the original clock ($f_{crystal}$, 100MHz). Construct a frequency divider of this kind.
  1.1 Write the specification of the frequency divider.
  1.2 Draw the block diagram of the frequency divider.
  1.3 Implement the frequency divider with the following parameters.

I/O	$f_{crystal}$	f_{out}
Site	W5	U16

2 Frequency Divider: Use a count-for-50M counter and some glue logics to construct a 1 Hz clock frequency. Construct a frequency divider of this kind.
  2.1 Write the specification of the frequency divider.
  2.2 Draw the block diagram of the frequency divider.
  2.3 Implement the frequency divider with the following parameters.

I/O	$f_{crystal}$	f_{out}
Site	W5	U16

3 3 Construct a 4-bit synchronous binary up counter (b3b2b1b0) with the 1-Hz clock frequency from exp2 and use 4 LEDs for display.

I/O	$f_{crystal}$	b_3	b_2	b_1	b_0
Site	W5	V19	U19	E19	U16

4 Construct a single digit BCD up counter with the divided clock as the clock frequency and display on the seven-segment display.
- 4.1 Construct a BCD up counter.
- 4.2 Construct a BCD-to-seven-segment display decoder.
- 4.3 Combine the above two together.

5 (Bonus) Construct a 30 seconds count-down timer (stop at 00).

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