COL215P Assignment 1

Aniruddha Deb 2020CS10869

Sachit Sachdeva 2020CS10840

September 2022

Approach

Input output behaviour of 7 segment display (For a given digit)

We first created a manual switch driven display for digit 0-9. For this we designed the combinational logic, with input as 4 switches/ 4 one bit numbers (representing digits from 0-9) for these switches the output was active high or low states of corresponding cathodes and anodes .

Digit	a_3	a_2	a_1	a_0	ca	cb	cc	cd	ce	cf	cg
0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	1	1	0	0	1	1	1	1
2	0	0	1	0	0	0	1	0	0	1	0
3	0	0	1	1	0	0	0	0	1	1	0
4	0	1	0	0	1	0	0	1	1	0	0
5	0	1	0	1	0	1	0	0	1	0	0
6	0	1	1	0	0	1	0	0	0	0	0
7	0	1	1	1	0	0	0	1	1	1	1
8	1	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	0	0	0	0	1	0	0

Minimizing these gave us the following:

$$ca = a_0\overline{a_1a_2a_3} + a_2\overline{a_1a_0a_3}$$
$$cb = a_0a_2\overline{a_1a_3} + a_1a_2\overline{a_0a_3}$$
$$cc = a_1\overline{a_0a_2a_3}$$
$$cd = a_0\overline{a_1a_2a_3} + a_2\overline{a_0a_1a_3} + a_0a_1a_2\overline{a_3}$$
$$ce = a_0\overline{a_3} + a_2\overline{a_1a_3} + a_0\overline{a_1a_2}$$
$$cf = a_0\overline{a_2a_3} + a_0a_1\overline{a_3} + a_1\overline{a_3a_2}$$
$$cg = a_0a_1a_2\overline{a_3} + \overline{a_1a_2a_3}$$

LED driver

It takes four 3 digit `std_logic_vectors` and a clock as input. This entity down-samples the given clock to produce a clock with frequency $10^8/2^{13} = 12,207$ Hz. With this frequency the entity iterates over the 4 input standard logic vectors. At any point the a digit is displayed by setting its corresponding anode and cathodes as low. The led corresponding the third and first decimal point of the 7 segment displays are switched on. The outputs from this entity i.e. the anode, cathode and decimal point bits are given to the top level entity

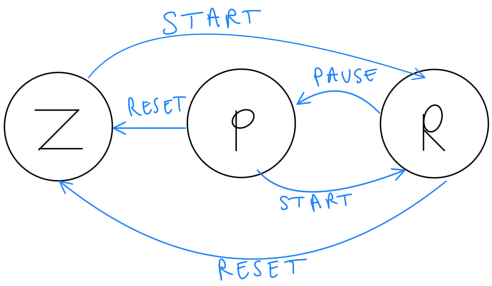
Digit counter

This entity was designed to give update and output the digit corresponding to a particular unit of time. The inputs were the clock (100 Mega-Hertz), two generics indicating the scale by which the clock needs to be scaled down to give appropriate updates, and modulo value after which the digit wraps around, and the state of our stopwatch

Main entity and Debouncer

The main entity has input as the 100 Mega-Hertz clock and the output are the bits driving the cathode, anode and decimal point. Internally we are down-sampling the 100 Mega-Hertz clock to 10 Kilo-Hertz, which is given as input to each of the digit counter (tens, tenth of second, units of second, minutes). The generic modulo and scale are given their appropriate values to update each LED segment with the required frequency.

The debouncer entity takes as input, the noisy signal corresponding to the push buttons, it waits for the input to be high for a continuous interval of 100 microsecond, on which the state of stopwatch changes. State of stopwatch is described by the following FSM, consisting of three states - ZERO(Z), RUNNING(R), PAUSED(P)



Block Diagram