Push-button driven counter.

Describe the synchronous circuit which contains 4-bit counter (up-counter) with asynchronous reset, decoder from 4-bit binary value to seven segment 8-bit value, output register, and input synchronization logic according to figure 1.

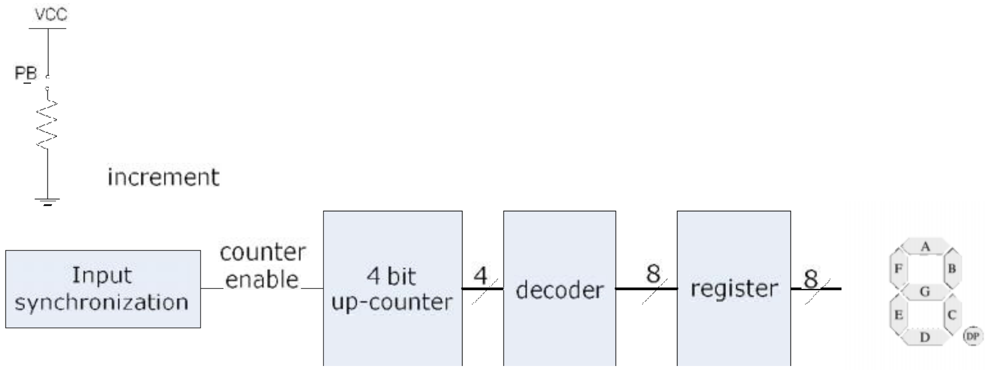

Fig 1: Push-button driven counter architecture.

The push-button used as counter increment signal, i.e. each push is reason to counter counting by one. The input synchronization block perform the push-button de-bouncing (prevents bouncing problem), additionally this block used as meta-stability filter (double synchronization by two consecutive flip-flops) and pulse derivation (fig. 4).

Decoder for seven-segment indicator provides translation from 4-bit binary value to 8-bit value than presents hex values.

Bouncing is the tendency of any two metal contacts in an electronic device to generate multiple signals as the contacts close or open; de-bouncing is any kind of hardware device or software that ensures that only a single signal will be acted upon for a single opening or closing of a contact. The following figure 2 illustrates the switch bouncing problem for normally-closed push-button.

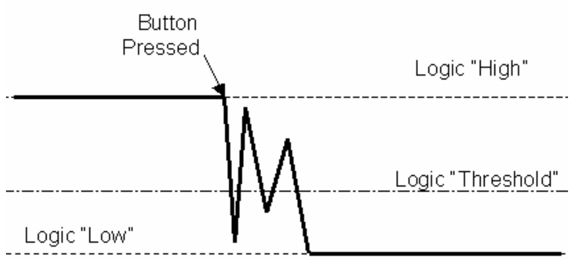

Fig 2: Push-button behaviour.

Figure 3 presents the relevant timing of push-button from Altera board.

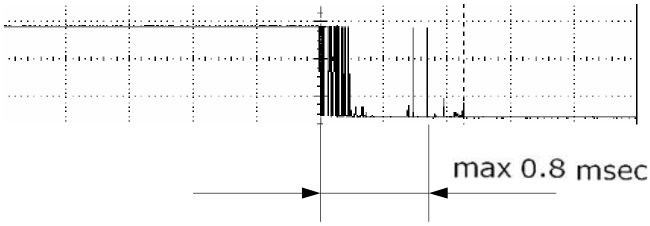

Fig 3: Push-button timing.

The popular hardware solutions for bouncing problem are:

a) SR-latch based solution
b) RC delay circuit
c) Timer based delay (the best solution for programmable devices).

For this experiment we chose the timer based solution with following requirements:

- Clock frequency 50 MHz
- Push-button – normally closed (initialize '0' when pressed)
- Fully synchronous implementation (without reset lines).

The fall-detect problem should be solved by following circuit:

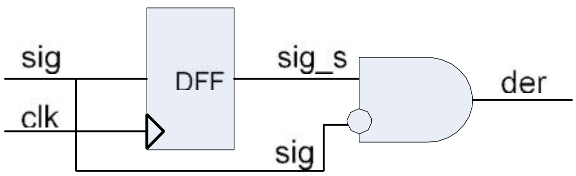

Fig 4: Fall detecting circuit.