EEC 180 Lab 5Bradley Manzo
916953788

Objective and Introduction: The objective of this lab is to construct two dependent counters in such a manner as to alter the speed of the counter, as well as the behavior including counting up, down, to half of the max, or to run continuously.

Prelab:

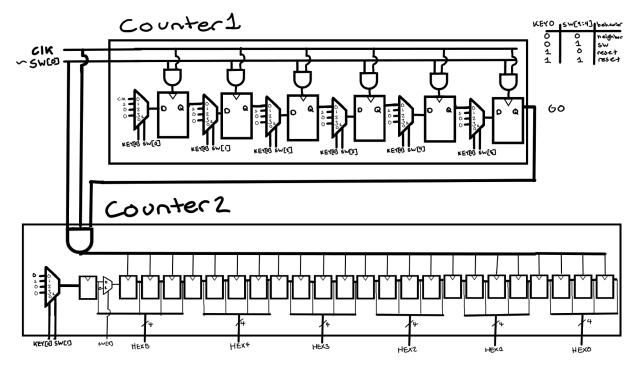


Figure 1: top.v Block Diagram

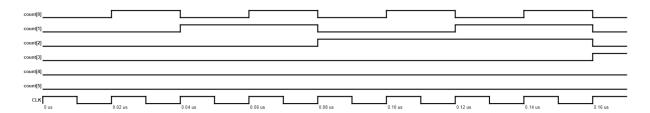


Figure 2: counter1.v Timing Diagram

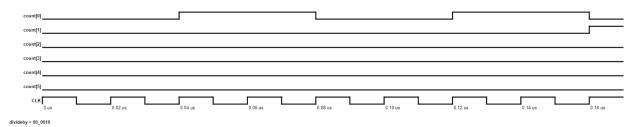


Figure 3: counter2.v Timing Diagram

- 1) one least significant digit increment: 50 MHz = 0.02us
- 2) a) divideby = 000001: 16,777,215 x 0.02us = 0.3355
 - b) divideby = 110010: (16,777,215 x 0.02us) x 50 = 16.7772

Results:

```
# Case: Normal Operation to 6
                                   # Case: Normal Operation to 15
# count: 0, go: 1
                                   # (Reset to zero)
# count: 1, go: 0
                                   # count: 0, go: 1
# count: 2, go: 0
                                   # count: 1, go: 0
# count: 3, go: 0
                                   # count: 2, go: 0
# count: 4, go: 0
                                   # count: 3, go: 0
# count: 5, go: 0
                                   # count: 4, go: 0
# count: 0, go: 1
                                  # count: 5, go: 0
                                  # count: 6, go: 0
# count: 1, go: 0
                                  # count: 7, go: 0
# count: 2, go: 0
                                  # count: 8, go: 0
# count: 3, go: 0
                                 # count: 9, go: 0
# count: 4, go: 0
                                  # count: 10, go: 0
# count: 5, go: 0
                              # count: 11, go: 0
# count: 12, go: 0
# count: 13, go: 0
# count: 14, go: 0
# count: 0, go: 1
# count: 1, go: 0
# count: 2, go: 0
# count: 3, go: 0
# count: 4, go: 0
                                  # count: 1, go: 0
# count: 5, go: 0
                                   # count: 2, go: 0
# count: 0, go: 1
                                   # count: 3, go: 0
# count: 1, go: 0
                                   # count: 4, go: 0
# count: 2, go: 0
                                   # count: 5, go: 0
# Case: Reset Mid-Operation # Case: Divideby set to 0 Mid-Operation
                           # (Reset to zero)
# (Reset to zero)
                           # count: 0, go: 1
# count: 0, go: 1
                           # count: 1, go: 0
# count: 1, go: 0
                          # count: 2, go: 0
# count: 2, go: 0
                          # count: 3, go: 0
# count: 3, go: 0
                          # count: 4, go: 0
# count: 4, go: 0
                           # count: 5, go: 0
# count: 5, go: 0
                           # count: 6, go: 0
# count: 6, go: 0
                           # count: 7, go: 0
                          # count: 8, go: 0
# count: 7, go: 0
# count: 8, go: 0
                          # count: 9, go: 0
                           # count: 10, go: 0
# count: 9, go: 0
                          # (Reset to zero)
# count: 10, go: 0
                          # count: 0, go: 1
# (Reset to zero)
                          # (Divideby set to 0)
# count: 0, go: 1
                          # count: 0, go: 0
# count: 1, go: 0
                           # count: 0, go: 0
# count: 2, go: 0
                           # count: 0, go: 0
# count: 3, go: 0
                           # count: 0, go: 0
# count: 4, go: 0
                          # count: 0, go: 0
# count: 5, go: 0
                          # count: 0, go: 0
# count: 6, go: 0
                           # count: 0, go: 0
                           # count: 0, go: 0
# count: 7, go: 0
                          # count: 0, go: 0
# count: 8, go: 0
                          # count: 0, go: 0
# count: 9, go: 0
                            # count: 0, go: 0
# count: 10, go: 0
```

Figure 4: Unit tests for Counter 1

```
# Case: run up, halfmax = 6
# Case: free up
                         0 # count:
                                               0, LEDR:
               0, LEDR:
                                                           0
# count:
                                              1, LEDR:
               1, LEDR: 0 # count:
                                                           0
# count:
                           0 # count:
                                              2, LEDR:
               2, LEDR:
# count:
                           0 # count:
                                              3, LEDR:
              3, LEDR:
# count:
                         0 # count:
                                              4, LEDR:
              4, LEDR:
# count:
              5, LEDR: 0 # count:
                                              5, LEDR:
# count:
                        0 # count:
                                              6, LEDR:
              6, LEDR:
# count:
                                              6, LEDR:
               7, LEDR: 0 # count:
                                                           0
# count:
              8, LEDR: 0 # count:
                                             6, LEDR:
# count:
                                              6, LEDR:
              9, LEDR: 0 # count:
                                                           0
# count:
                         0 # count:
                                             6, LEDR:
              10, LEDR:
# count:
                                             6, LEDR:
                        0 # count:
                                                           0
              11, LEDR:
# count:
                                             6, LEDR:
                         0 # count:
# count:
              12, LEDR:
                                                           0
                         0 # count:
                                              6, LEDR:
                                                           0
              13, LEDR:
# count:
                         0 # count:
                                             6, LEDR:
              14, LEDR:
                                                           0
# count:
                         0 # count:
                                             6, LEDR:
                                                           0
# count:
              15, LEDR:
# count:
                                             6, LEDR:
              16, LEDR:
                         0 # count:
                          0 # count:
                                             6, LEDR:
                                                           0
# count:
              17, LEDR:
              18, LEDR:
                                             6, LEDR:
# count:
                           0 # count:
                                                           0
                           0 # count:
# count:
              19, LEDR:
                                             6, LEDR:
              20, LEDR:
# count:
                          0 # count:
                                               6, LEDR:
                       # Case: run down, halfmax = 6 # Case: Reset Hold
# Case: free down
# count: 0, LEDR: 0 # count: 0, LEDR: 0 # count: 0, LEDR:
          19, LEDR: 0 # count:
                                   19, LEDR: 0 # count:
                                                            1, LEDR:
# count:
                                                            2, LEDR:
          18, LEDR: 0 # count:
                                   18, LEDR: 0 # count:
# count:
          17, LEDR: 0 # count:
                                   17, LEDR: 0 # count:
                                                            3, LEDR:
# count:
                                                            4, LEDR:
          16, LEDR: 0 # count:
                                   16, LEDR: 0 # count:
# count:
          15, LEDR: 0 # count:
                                   15, LEDR: 0 # count:
                                                            5, LEDR:
# count:
                                            0 # count:
                                                            6, LEDR:
           14, LEDR: 0 # count:
                                   14, LEDR:
# count:
                                              0 # count:
                                                            7, LEDR:
           13, LEDR: 0 # count:
                                   13, LEDR:
# count:
                                              0 # count:
                                                           8, LEDR:
           12, LEDR: 0 # count:
                                    12, LEDR:
# count:
                                              0 # count:
                                                            9, LEDR:
                                    11, LEDR:
           11, LEDR: 0 # count:
# count:
                                              0 # count:
                                                           10, LEDR:
                                                                      0
                                   10, LEDR:
          10, LEDR: 0 # count:
                                             0 # count:
# count:
                                                           0, LEDR:
                                    9, LEDR:
                                             0 # count:
           9, LEDR: 0 # count:
# count:
           8, LEDR: 0 # count:
                                    8, LEDR:
# count:
                                              0 # count:
0 # count:
                                                            2, LEDR:
                                    7, LEDR:
# count:
            7, LEDR: 0 # count:
                                                           3, LEDR:
                                              0 # count:
                                    6, LEDR:
# count:
           6, LEDR: 0 # count:
                                                           4, LEDR:
                                    6, LEDR:
                                              0 # count:
           5, LEDR: 0 # count:
# count:
                                                           5, LEDR:
           4, LEDR: 0 # count:

3, LEDR: 0 # count:

2, LEDR: 0 # count:

1, LEDR: 0 # count:
                                    6, LEDR:
                                              0 # count:
# count:
                                                            6, LEDR:
                                    6, LEDR:
                                              0 # count:
# count:
                                                            7, LEDR:
                                              0 # count:
# count:
                                    6, LEDR:
                                                           8, LEDR:
                                    6, LEDR:
                                              0 # count:
# count:
                                                            9, LEDR:
                                                                      0
                                    6, LEDR:
            0, LEDR: 0 # count:
                                              0 # count:
# count:
                                                           10, LEDR:
```

Figure 5: Unit tests for Counter 2

Conclusion:

After testing my counters and verifying the behavior on the DE10-Lite Board, it is clear that counter1 divides the frequency and multiplies the time to count up or down. The operation of top.v should be clear from the unit tests for counter1.v and counter2.v.