

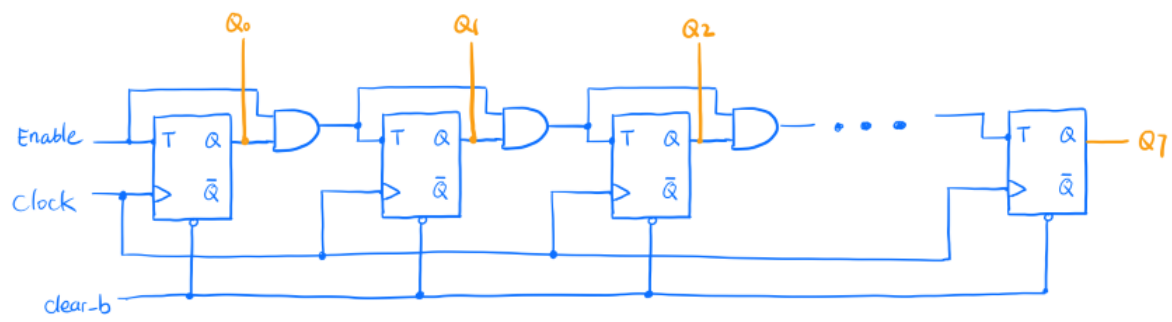
# Clocks and Counters

Shi Ran 1004793495

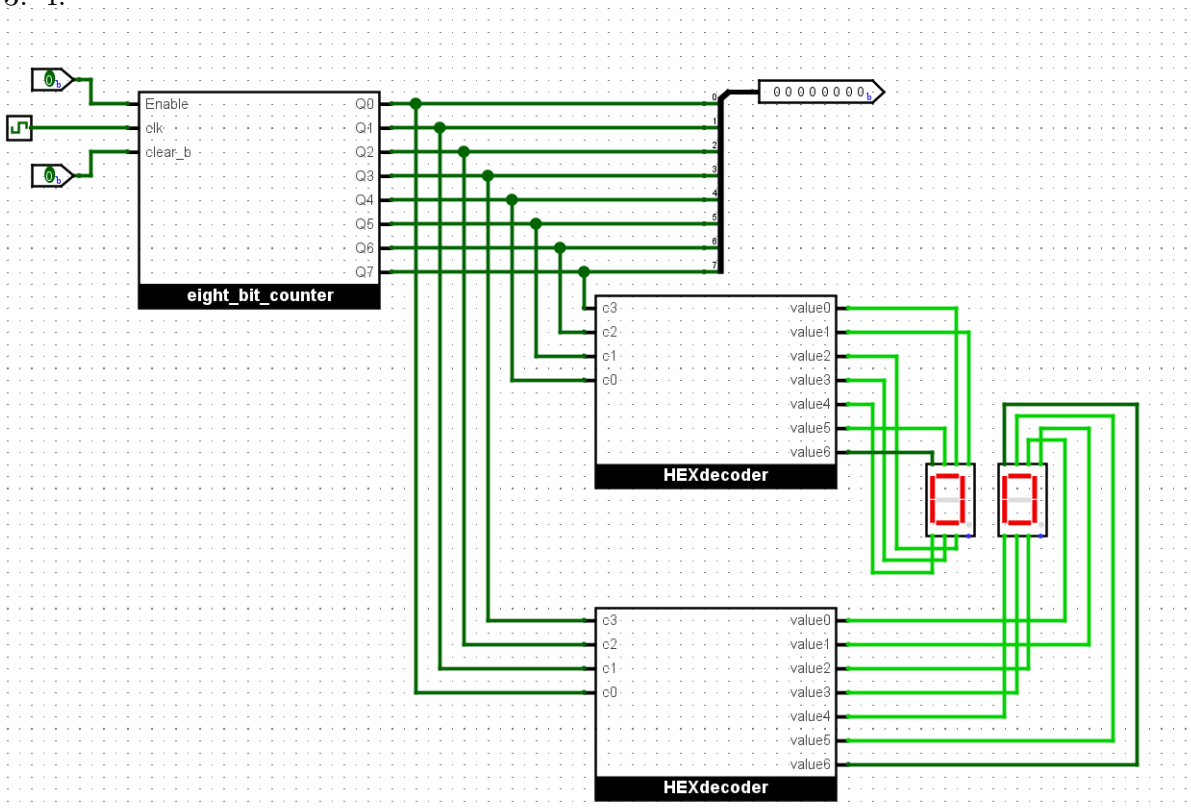
October 22, 2020

# Part I

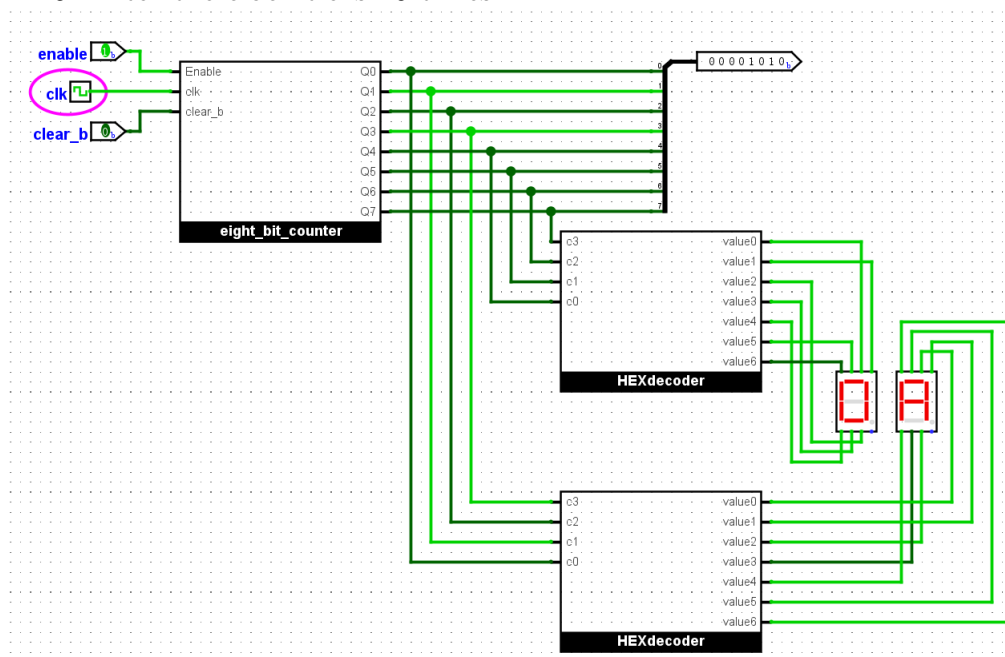
1. 2.



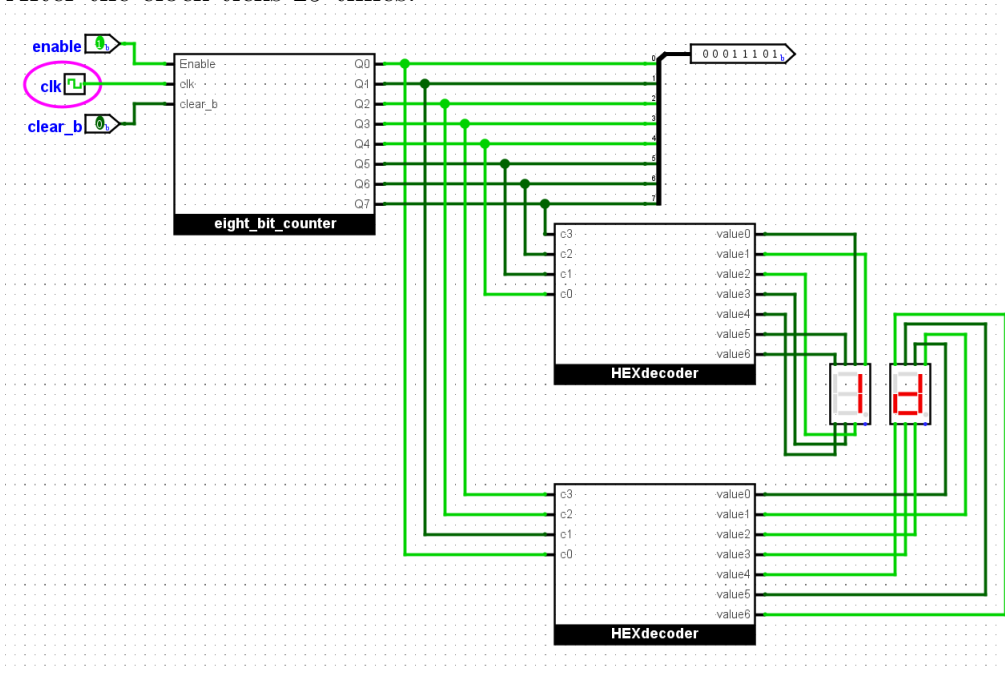
3. 4.



5. After the clock ticks 10 times.

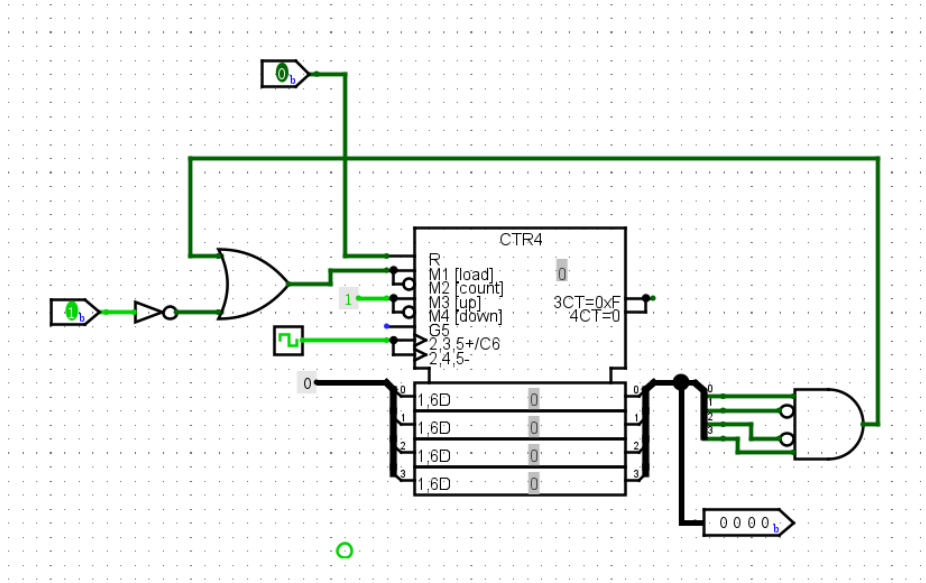


After the clock ticks 29 times.



## Part II

1. When the output reaches the maximum, it will load value from D so it becomes 0 at the next tick.
2. Makes the middle two inputs of the AND gate negated, the output of the AND gate will be TRUE when the value reaches 1001, causing the counter to load value from D.



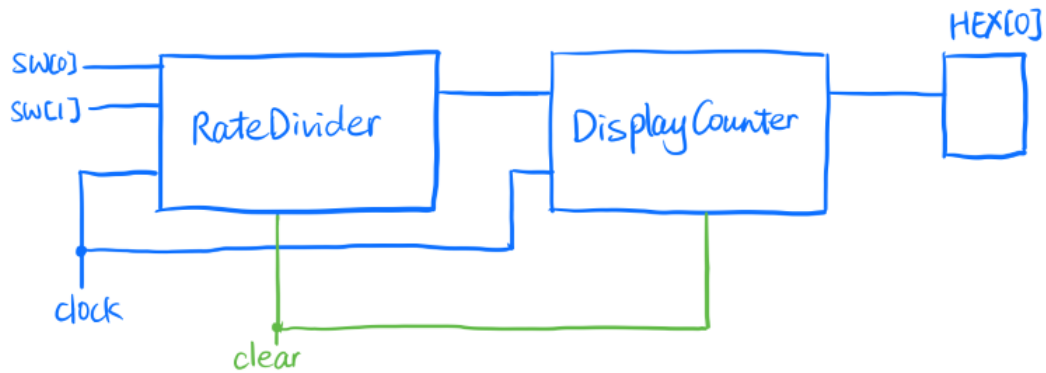
3. "Wrap around" let the output to goes to 0; "Stay at value" let the output stays at the maximum; "Continue counting" let the output goes to 0; "Load next value" let the output loads the input value of D.

Counting 50 million clock cycles:

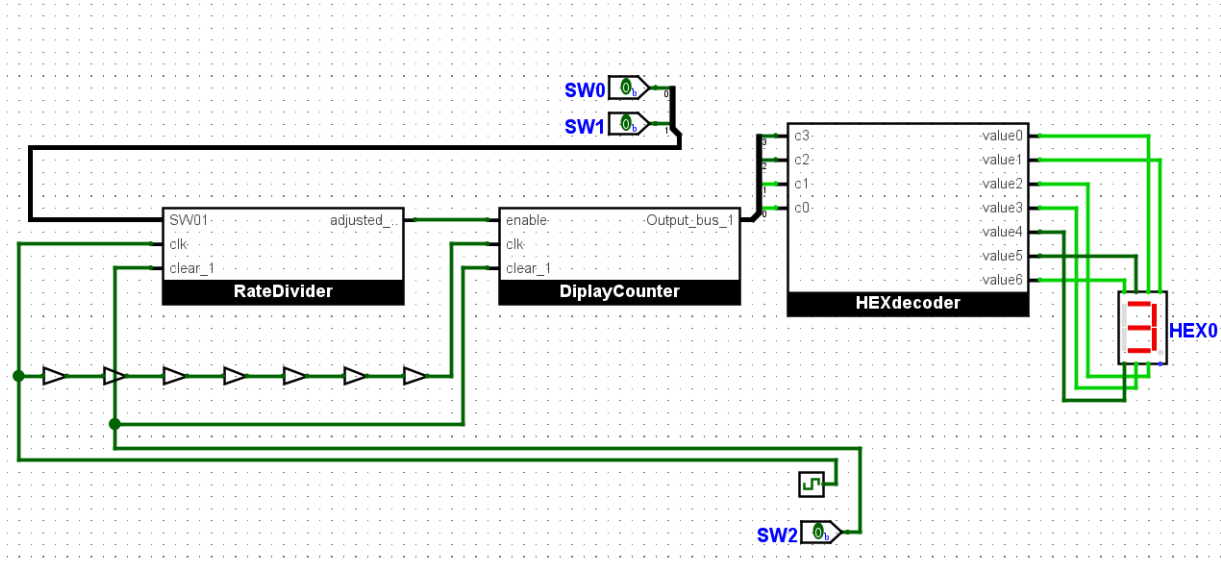
$\log_2 50,000,000 = 25.6$ , so we need 26 bits to represent the number.

# Circuit

## 1. Schematics:



## 2. 4.



3. Basically, the HEX display goes over all values in 1 second if the input is 00, 1 value each second if the input is 01, 1 value every 2 seconds if the input is 10, 1 value every 4 seconds if the input is 11.

## Part III

1. Sequence length is 14 bits.

S: 101010000000000

T: 111000000000000

U: 101011100000000

V: 101010111000000

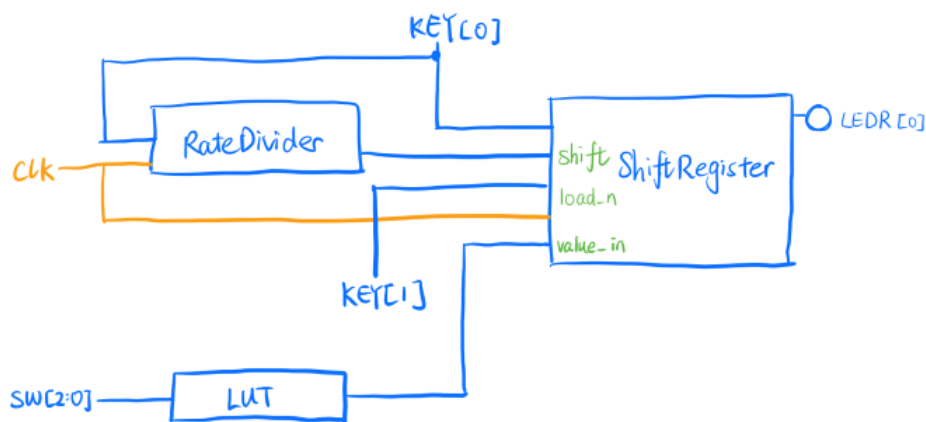
W: 101110111000000

X: 111010101110000

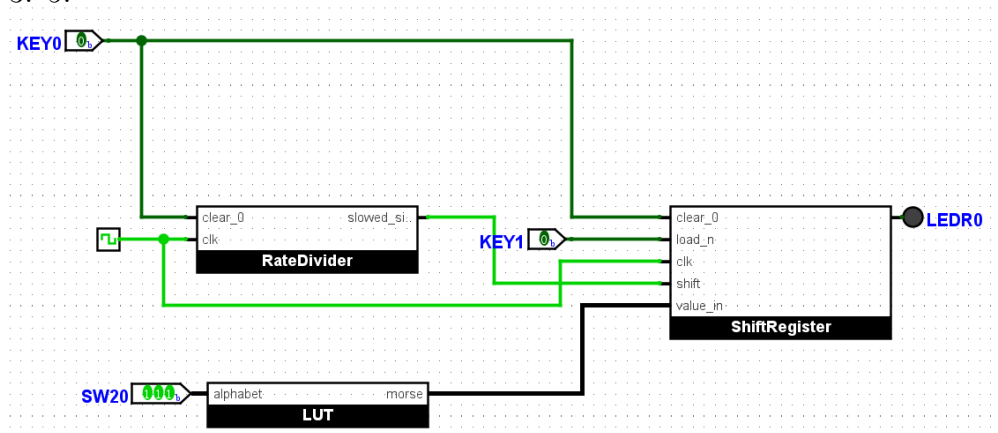
Y: 11101011101110

Z: 11101110101000

2. Schematics:



3. 5.



#### 4. test vectors of LUT:

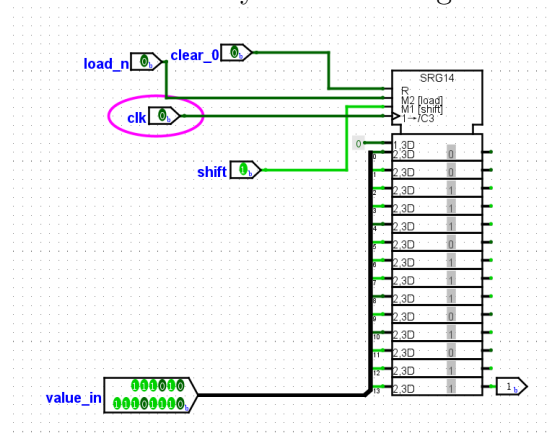
Logisim: Test Vector LUT of part3

Passed: 8 Failed: 0

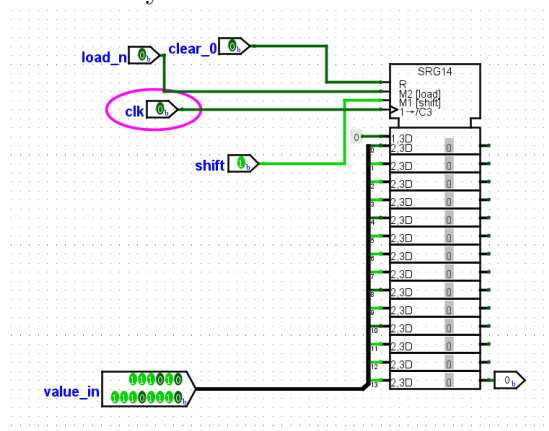
	status	x	morse
	pass	000	10 1010 0000 0000
	pass	001	11 1000 0000 0000
	pass	010	10 1011 1000 0000
	pass	011	10 1010 1110 0000
	pass	100	10 1110 1110 0000
	pass	101	11 1010 1011 1000
	pass	110	11 1010 1110 1110
	pass	111	11 1011 1010 1000

Load Vector Run Stop Reset Close Window

After one clock cycle in shift register:



After 13 cycles:



When `load_n` is on, the input value is loaded into the shift register, then turn it off, let `shift` be high and turn on the clock, the digits will move from top to the bottom in the stages, the output will be all zero at the end.

When encountering short pulses in the Morse code, the LED lights up for 0.5 second (1 flash of the shift input); when encountering long pulses, the LED lights up for 3 seconds (3 flashes of the shift input).