



Lab-13

Counter & Display

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Objectives



- Understand the fundamental of a Binary counter and a BCD counter.
- Can implement a **4-bit Binary counter** using four **T-FFs** or a **TTL 7493**.
- Can implement a **4-bit BCD counter** revised from **4-bit Binary counter** or **TTL 7490**.
- Can implement *dual* **4-bit BCD counters** or a **CMOS 4518**.
- Can implement a **4-bit BCD up/down counter** or a **TTL 74190**.
- Can implement the combination of **counter + driven display**.

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2



What is Counter

- **Binary Counter: (e.g., $\div 16$)**
Up counting: 0000, 0001, ..., 1110, 1111. (**0 ~ 15**)
Down counting: 1111, 1110, ..., 0001, 0000. (**15 ~ 0**)
- **BCD Counter: ($\div 10$)**
Up counting: 0000, 0001, ..., 1000, 1001. (**0 ~ 9**)
Down counting: 1001, 1000, ..., 0001, 0000. (**9 ~ 0**)

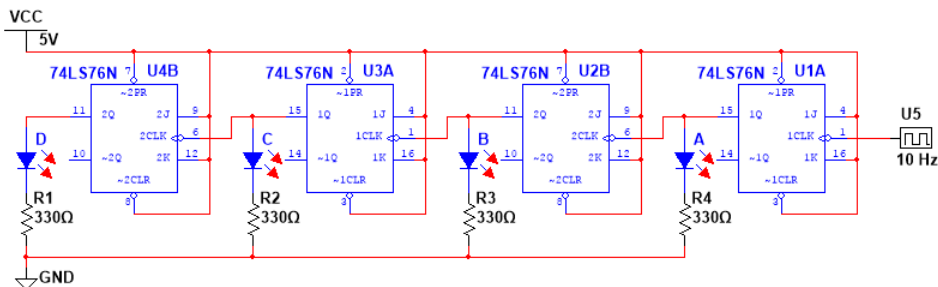
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3



4-bit Binary Counter

- **Consists of 4 T-type FFs (four $\div 2$, $2^4 = 16$), that is, 0000 ~ 1111 ($\div 16$)**



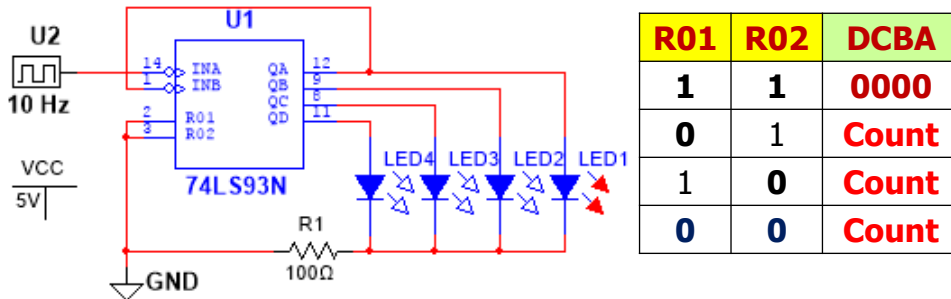
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4



4-bit Binary Counter

- TTL 7493:** $INB \div 8, DCB$; $INA \div 2, A$
That is, $\div 16 = \div 8 \div 2$, **DCBA = 0000 ~ 1111**



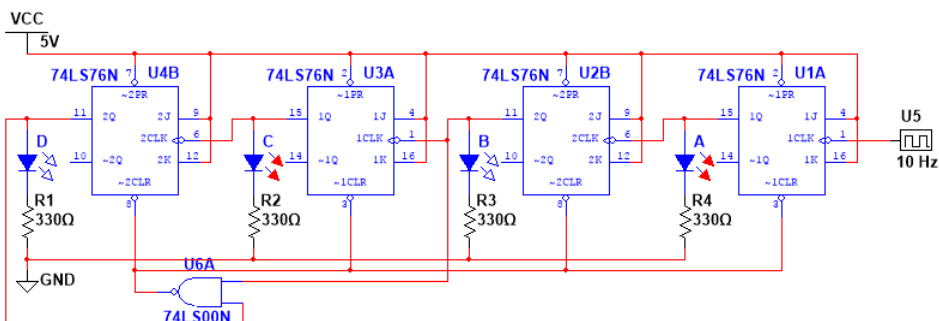
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5



4-bit BCD Counter

- Consists of 4 T-type FFs:** **0000 ~ 1001 ($\div 10$)**
0000, 0001, ..., 1000, 1001, 1010



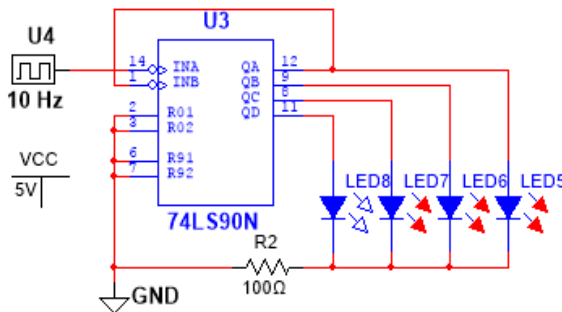
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6



4-bit BCD Counter

- TTL 7490: $\text{INB} \div 5, \text{D C B} ; \text{INA} \div 2, \text{A}$
That is, $\div 10 = \div 5 \div 2, \text{DCBA} = 0000 \sim 1001$



R01 (R91)	R02 (R92)	DCBA
1	1	0000
0	1	Count
1	0	Count
0	0	Count

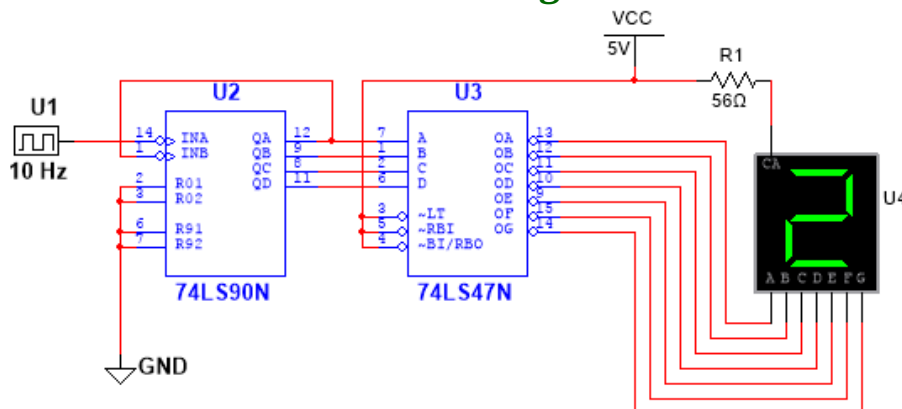
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7



4-bit BCD Counter & Display

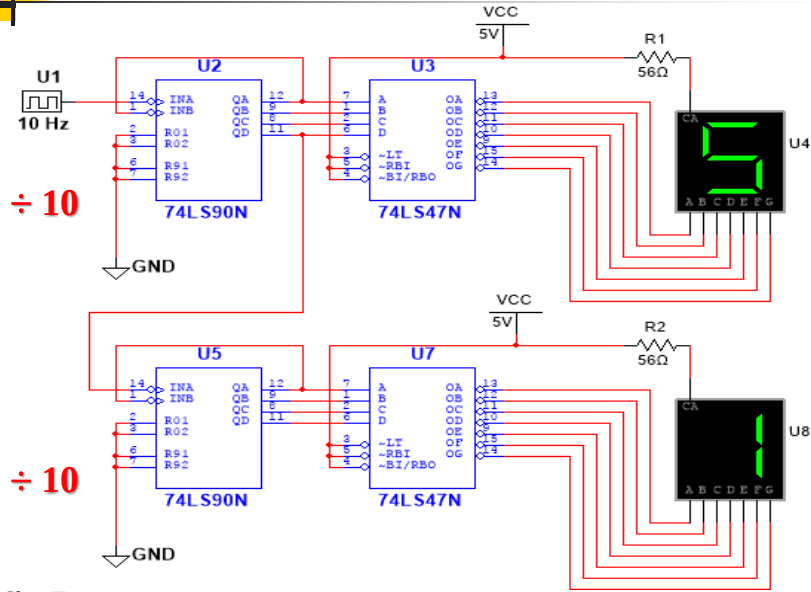
- TTL 7490: $\text{INB} \div 5, \text{D C B} ; \text{INA} \div 2, \text{A}$
That is, $\div 10 = \div 5 \div 2, \text{DCBA} = 0000 \sim 1001$
- TTL 7447: $\text{DCBA} \rightarrow 7\text{-segment CA}$



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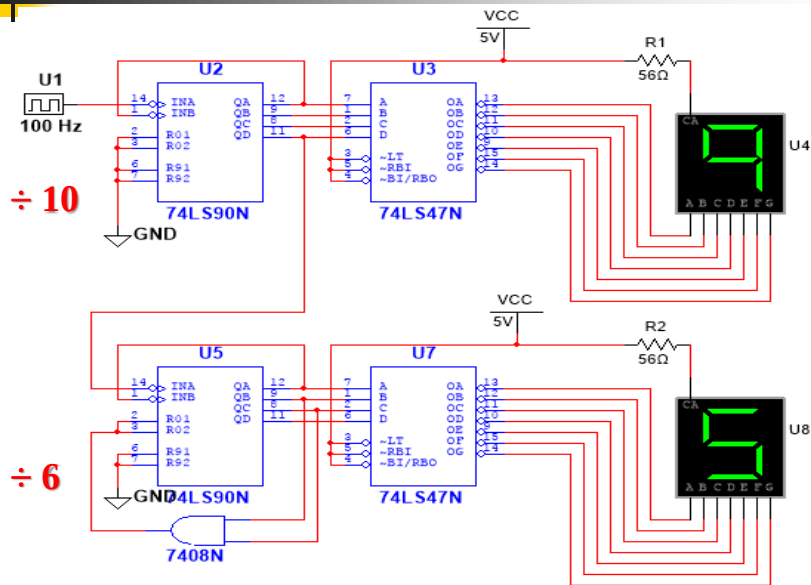
8

Two-Digit BCD Counter (00~99)



9

Two-Digit BCD Counter (00~59)

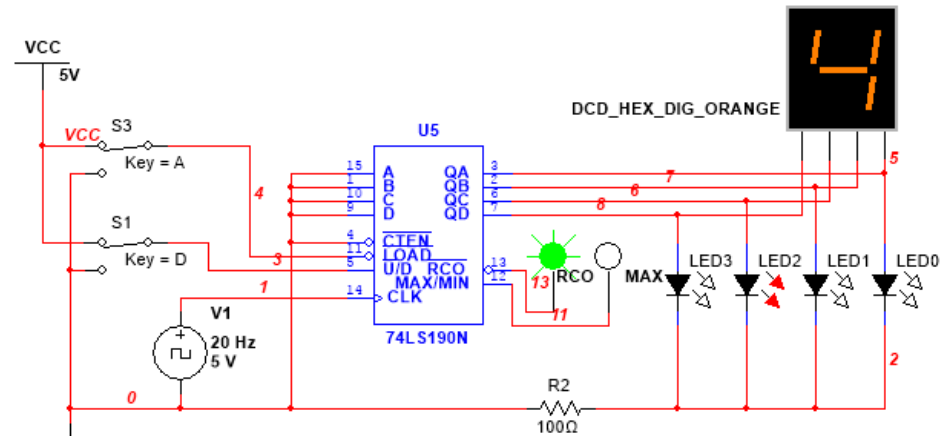


10

4-bit BCD Up/Down Counter



- **TTL 74190**: BCD Up counting 0000~1001 (0~9)
or BCD Down counting 1001~0000 (9~0)



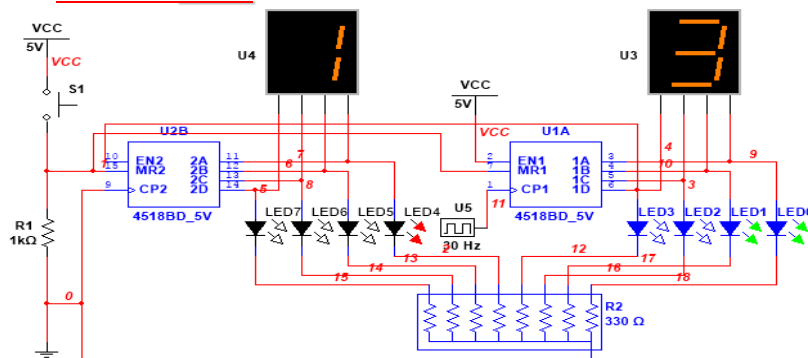
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11

Two-Digit BCD Counter



- **CMOS 4518**: Dual BCD counters

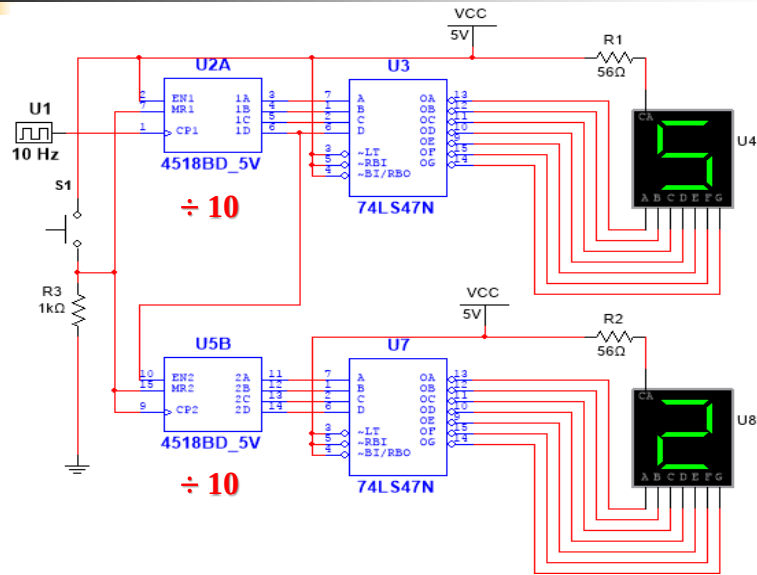


RST	En	D	C	B	A
1	X	0	0	0	0
0	1	Up Count			
0	0	Hold			

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12

Two-Digit BCD Counter



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13

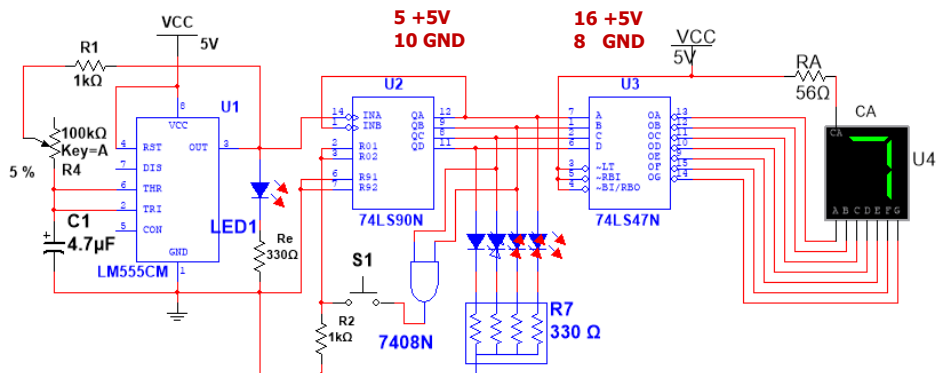
Experiment-1

4-bit BCD Counter & Display



BCD counting 0000~1001 (0~9) ($\div 10$)

Pushed S1: BCD counting 0000~0101 (0~5) ($\div 6$)



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14

Pushed S3: BCD **Down counting** 1001~0000 (9~0)



15