

Decimal system: 0123456789     $356 = 3 \cdot 10^2 + 5 \cdot 10 + 6$

Binary system: 01                       $110 = 1 \cdot 2^2 + 1 \cdot 2^1 + 0$

Why do computer use binary numeral system?

Why do we use decimal system? 10 fingers? Why do we have 10 fingers?

Why not decimal time?

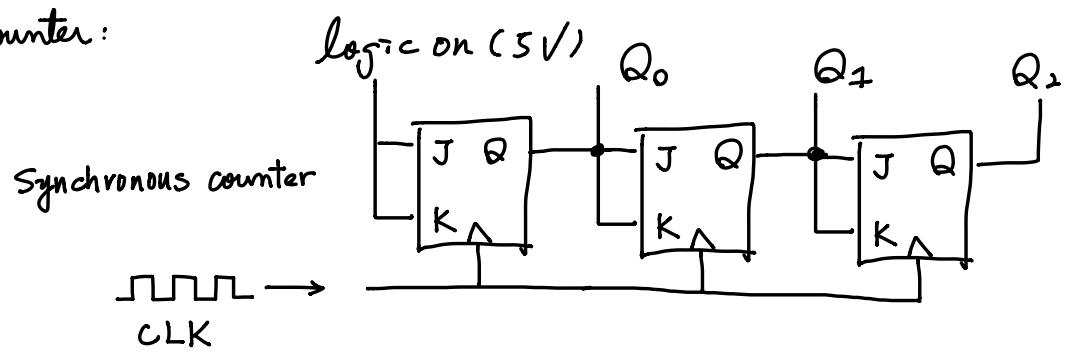
Ancient China: decimal and duodecimal systems (base 12)

France revolution: duodecimal vs. decimal system 1795~1805

$$3:65:78 = 0.36578 \text{ day}$$

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Counter:



Let's remind ourselves

truth table of JK FF

	J	K	Q
* rising edge triggered.	CLK 0	any	any
	CLK 1	0	0
	1	0	1
	0	1	0
	1	1	$\bar{Q}$

⇒ Q<sub>0</sub> flips every time it's triggered

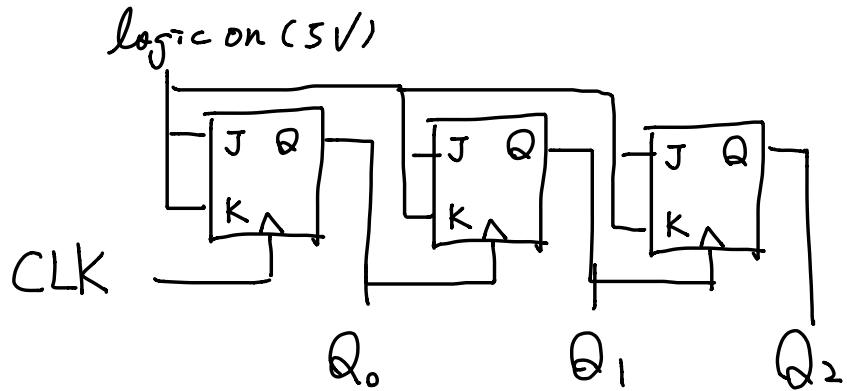
Q<sub>1</sub> flips every time Q<sub>0</sub> & CLK switch on

Q<sub>2</sub> flips every time Q<sub>1</sub> & CLK switch on

⇒  $\overbrace{\begin{array}{cccccc} Q_0 & 0 & 1 & 0 & 1 & 0 & 1 \\ Q_1 & 0 & 0 & 1 & 1 & 0 & 0 \\ Q_2 & 0 & 0 & 0 & 0 & 1 & 1 \end{array}}^{\text{time}}$

(Q<sub>2</sub>Q<sub>1</sub>Q<sub>0</sub>) 0 1 2 3 4 5 ...

There is also the ripple counter: Nth JKFF triggered by (N-1)th JKFF.

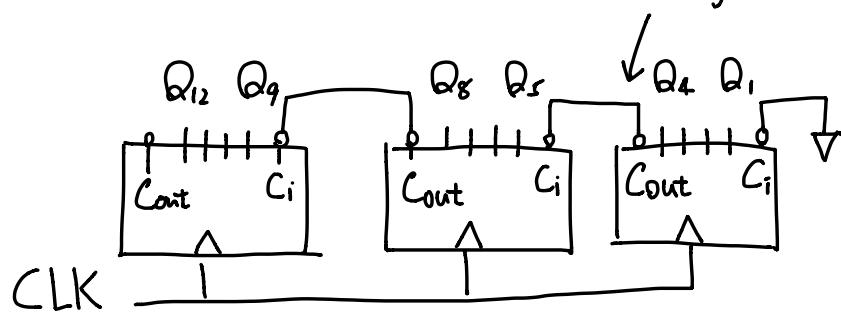


But the cascade leads to delay which accumulates.

Variations:

Counting huge #:

Cout: overflow, when 111.



$$Q = (Q_{12} \dots Q_1)_2 = (H_3 H_2 H_1)_{16} \quad \text{Hexadecimal}$$

$$\begin{aligned} H &= (Q_3 Q_2 Q_1)_2 \\ &= 123 \dots 9 ABCDEF \end{aligned}$$

Other useful functions: reset  $\rightarrow 000\dots$

decimal counter

reverse counting

Reset is typically provided by the IC.

decimal counting  $\Rightarrow$  overflow when  $Q = 100_2 = 9$

