Clocks

Last updated 1/8/25

Clocks

- Clock
  - Periodic signal used to control the operation of Sequential (Synchronous) digital systems
  - Created by special components called Crystals

    or
  - Created by a special circuit called a Phased Locked Loop (PLL) or Delay Locked Loop (DLL)

  - Characterized by 3 values
    - Period
    - Frequency
    - Duty Cycle

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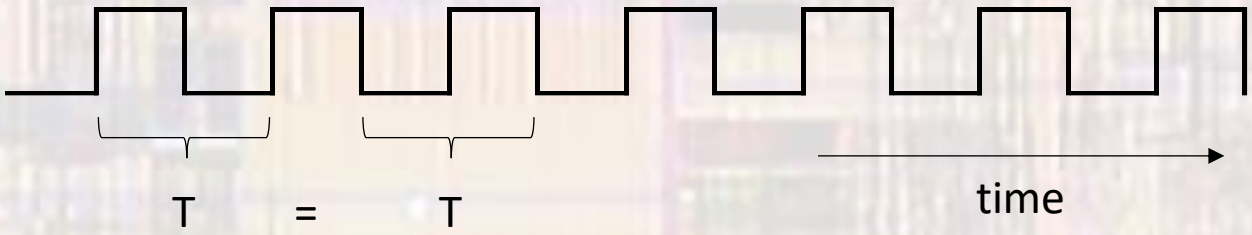
Clocks

- Clocks are Periodic Signals
  - Fixed repetition cycle
  - Period
    - Symbol: T
    - Units: seconds (s)
    - Shortest time between any 2 periodic signal values



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Clocks

- Clocks are Periodic Signals
  - Fixed repetition cycle
  - Frequency
    - Symbol: F
    - Units: Hertz (Hz)
      - 1 Hz = 1 / sec
    - Defined as: Frequency = 1 / Period

F (frequency) = 1/T (period)

50MHz ←→ 20ns

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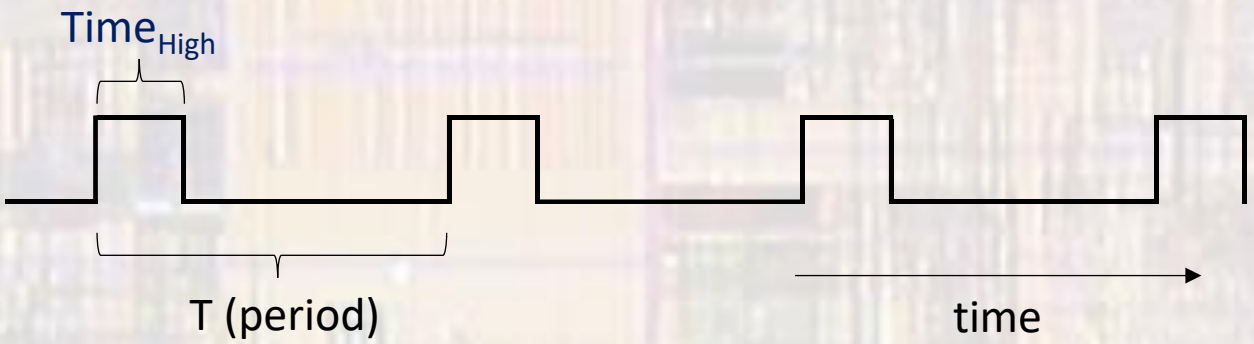
Clocks

- Clocks are Periodic Signals
  - Fixed time the signal is high in each period
  - Duty Cycle
    - Symbol: none
    - Units: %
    - Defined as: ($Time_{High}$ / Period) * 100%



Duty Cycle = ($Time_{High}$ / T) %

T = 40ns, T_{High} = 10ns → 25% Duty Cycle

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Clocks

- Engineering Notation
  - Special version of Scientific Notation
  - Scientific Notation
    - $234.567 \rightarrow 2.3456 \times 10^{2}$ 2.3456 E2
    - $0.009876 \rightarrow 9.86 \times 10^{-3}$ 9.86 E-3
  - Engineering Notation
    - Exponents are factors of 3

Symbol	T	G	M	K		m	u	n	p	f
$10^{Exponent}$	12	9	6	3	0	-3	-6	-9	-12	-15
Name	Tera	Giga	Mega	Kilo		milli	micro	nano	pico	femto

note the use of lower case and uppercase in Symbols and Names

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Clocks

- Engineering Notation
  - Rule: Always maintain at least 1 value to the left of the decimal point
    - 2365.54 → 2.36554×10^{3} 2.36554 K
    - .0000000234 → 23.4×10^{-9} 23.4 p
    - 1.234×10^{7} → 12.34×10^{6} 12.34 M
    - 23.654 → 23.654 23.654
    - 1.234×10^{7} → ~~$.01234 \times 10^{9}$~~ → 12.34×10^{6} 12.34 M

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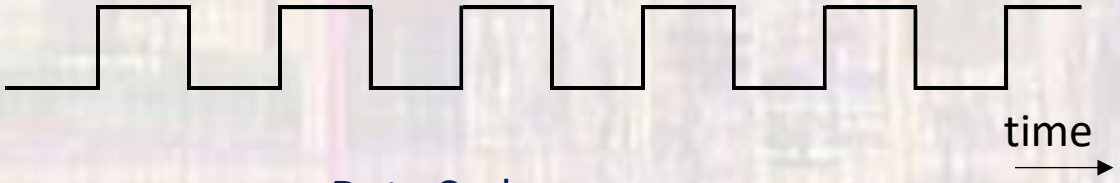
Clocks

- Examples

50MHz Clk

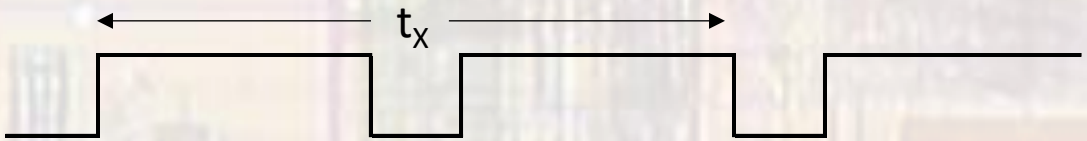


F = _____ T = _____ Duty Cycle = _____

t_{HIGH} = 25ns

F = _____ T = _____ Duty Cycle = _____

t_X = 875ns



F = _____ T = _____ Duty Cycle = _____

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Clocks

- Clock Systems – quick calculations
  - No calculator

Period = 1 / Frequency

Frequency	→	Period
$1MHz = 1 * 10^{6}$	→	$1/1 \times 1/1M \rightarrow 1x10^{-6} \rightarrow 1us$
$20KHz = 20 * 10^{3}$	→	$1/20 \times 1/1K \rightarrow 0.05x10^{-3} \rightarrow 0.05ms \rightarrow 50us$

Frequency = 1 / Period

Period	→	Frequency
$10us = 10 * 10^{-6}$	→	$1/10 \times 1/10^{-6} \rightarrow 0.1 \times 1M \rightarrow 0.1MHz \rightarrow 100KHz$
$50ns = 50 * 10^{-9}$	→	$1/50 \times 1/10^{-9} \rightarrow 0.02 \times 1G \rightarrow 0.02GHz \rightarrow 20MHz$

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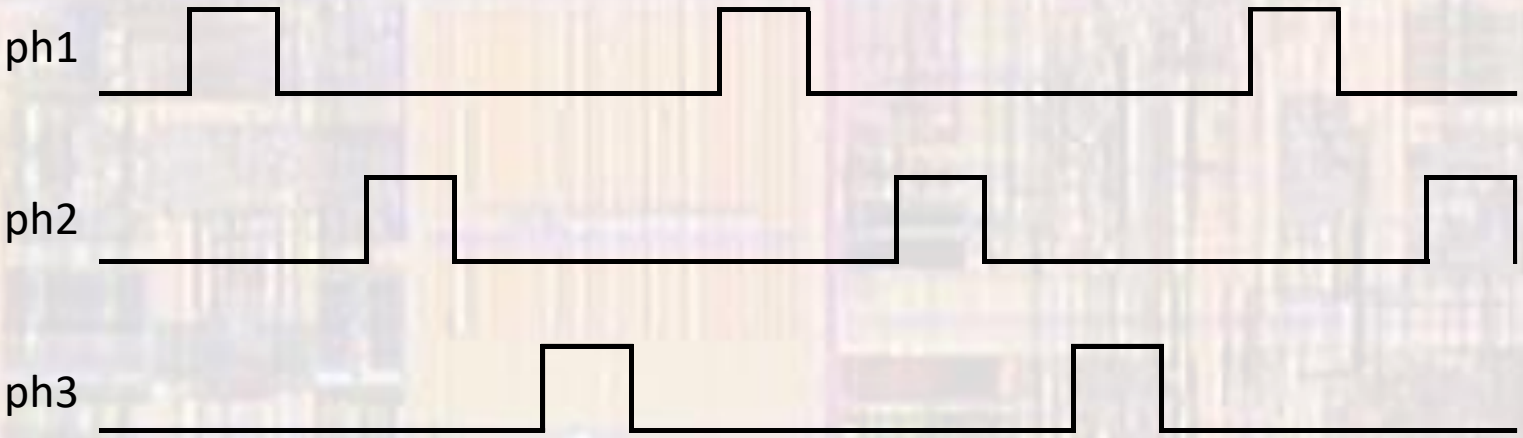
Clocks

- Clock Systems
  - 3 – phase, non-overlapping clock



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