

# MODULE 2: Circuits, Signals and the Analog Discovery Board

## SUMMER CHALLENGE

Electrical Engineering: Smart Lighting

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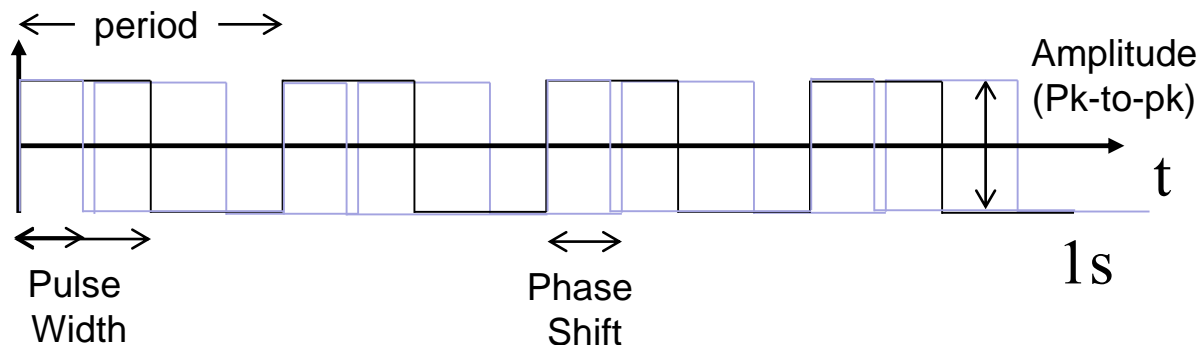
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# Teams

- Team 1: Ricky and Sean
- Team 2: Becca and Yutong
- Team 3: Charlotte and Genie
- Team 4: Eliza and Madeline
- Team 5:
- Team 6:
- Team 7:
- Team 8:

## Signal Analysis - Recap

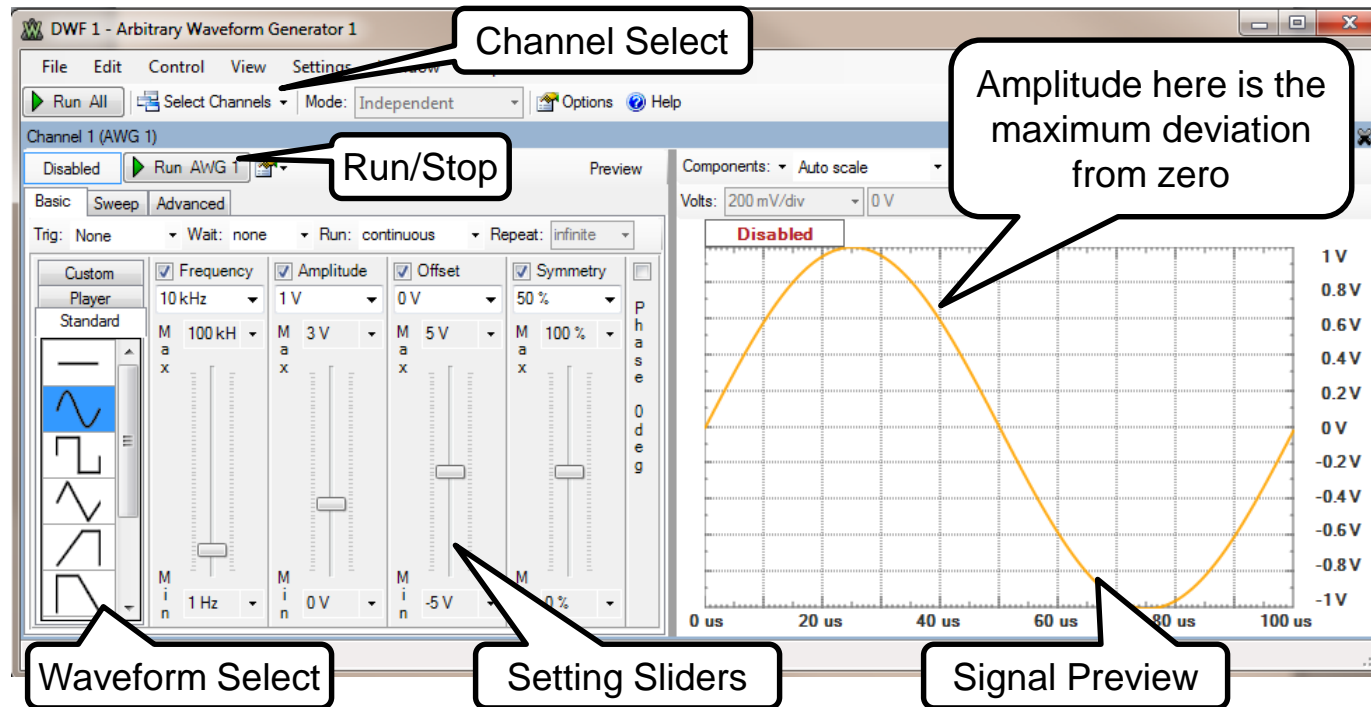
- Draw 3 more periods of the square wave
- What is the frequency of this waveform?
- Label the peak-to-peak amplitude
- Label the pulse width
- What is the duty cycle of this square wave?
- Draw another signal with 25% duty cycle
- Draw another signal with a phase shift



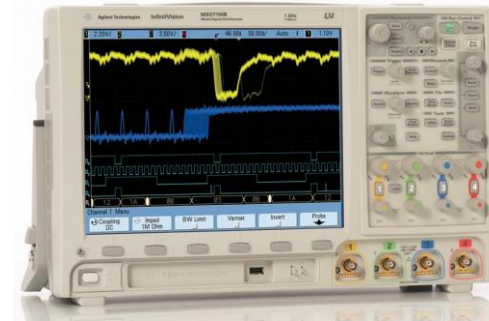
# Signal Generation



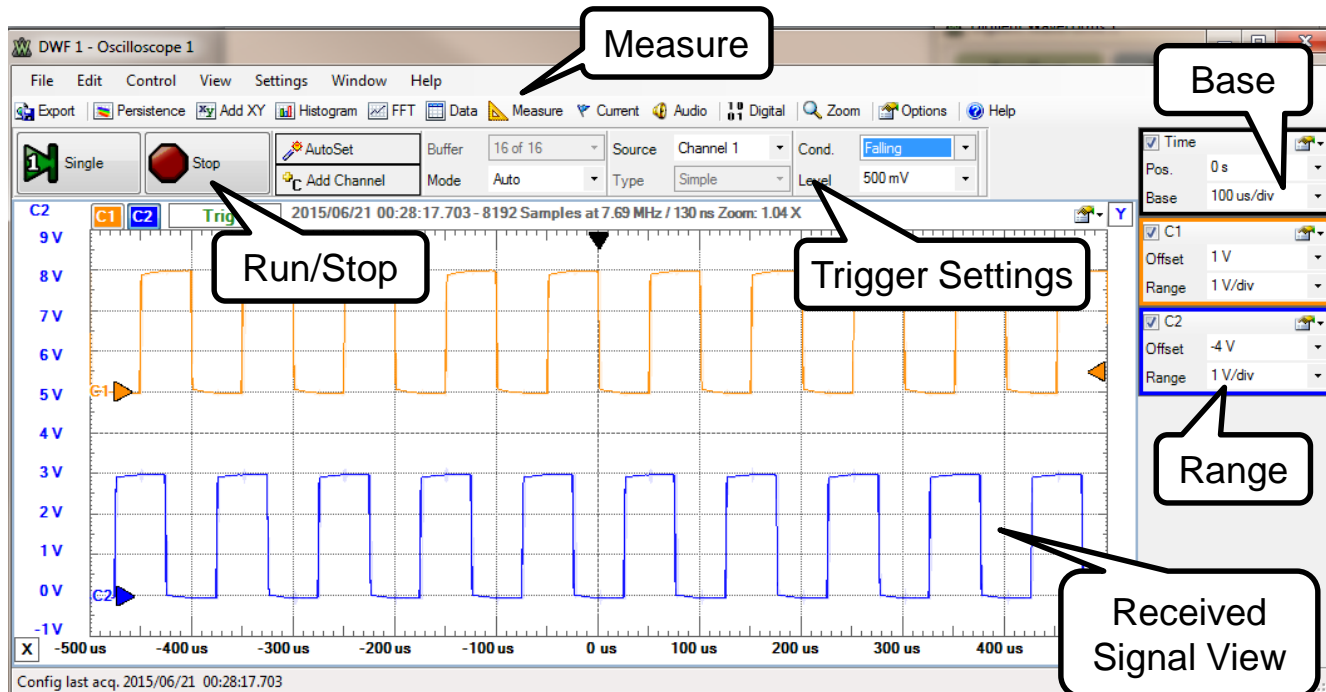
Function Generator



# Signal Observation

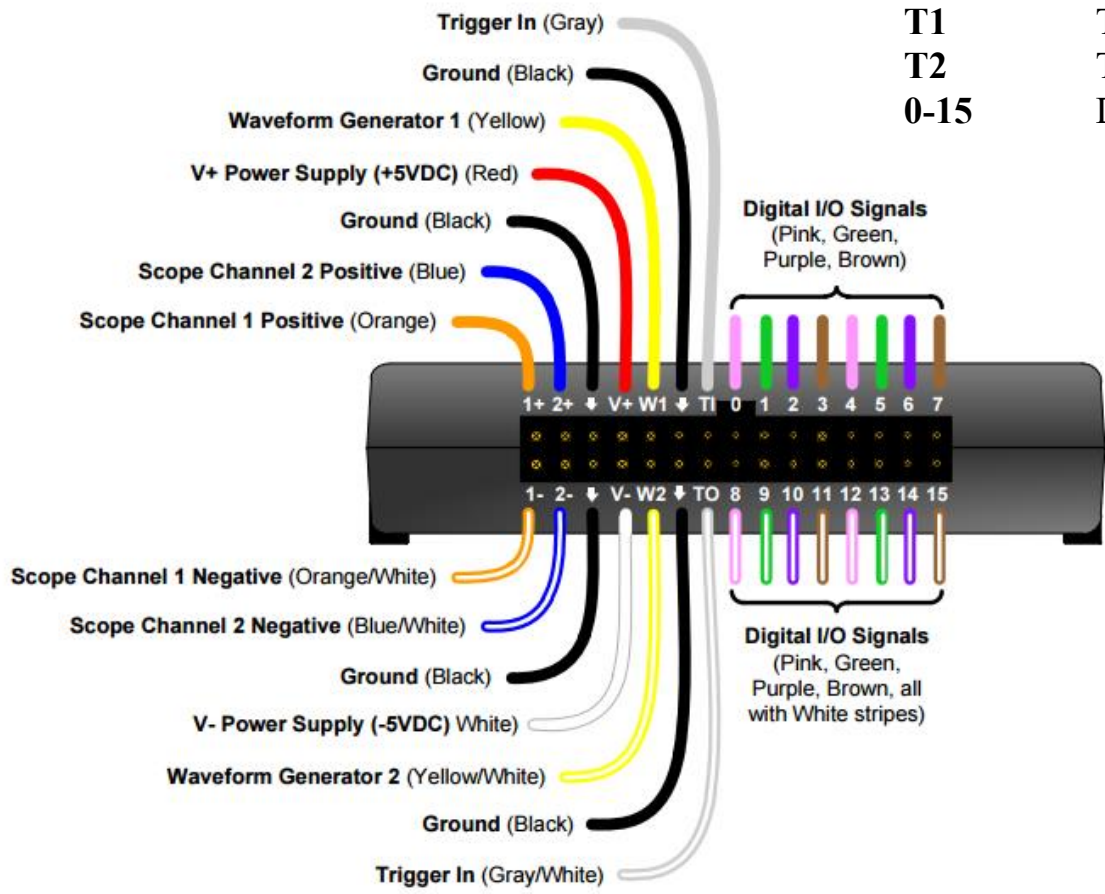


Oscilloscope



# AD Board Pinout

- 1+/- Analog Input 1 (Oscilloscope and Voltmeter)
- 2+/- Analog Input 2 (Oscilloscope and Voltmeter)
- ↓ Ground
- V+/- 5V DC Supply
- W1 Analog Output 1 (Waveform Generator)
- W2 Analog Output 2 (Waveform Generator)
- T1 Trigger 1
- T2 Trigger 2
- 0-15 Digital Input and Output

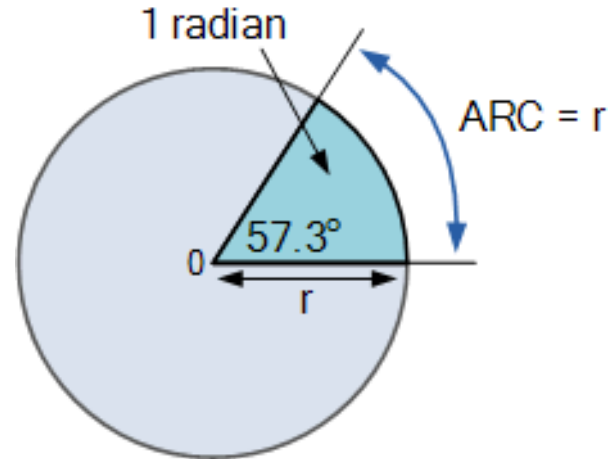
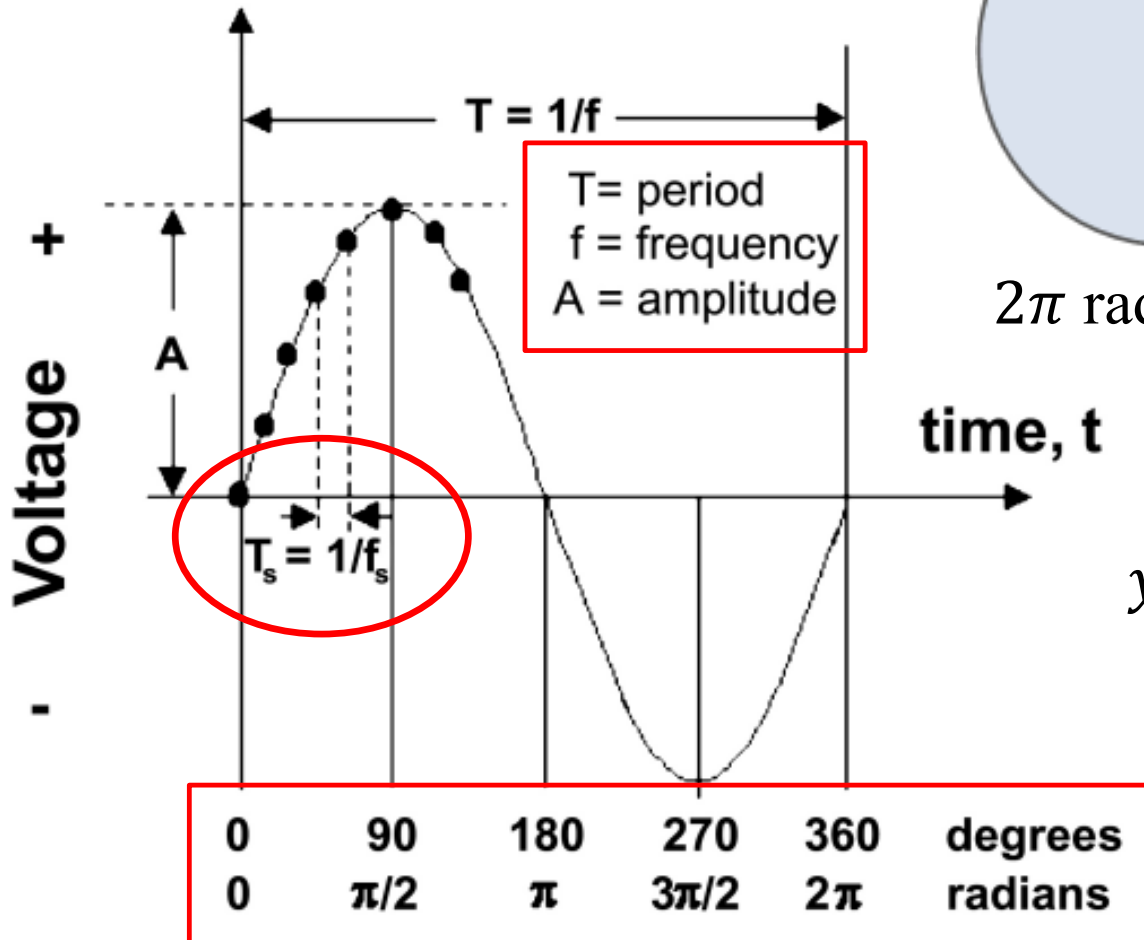


## Experiment II

- WaveForms Signal Generation
  - Function Generator (i.e., waveform generator)
  - Oscilloscope
- NOTES
  - *Take screen shots of your work! (PrtSc, then paste in paint)*

# Analog Signals

## Oscillating Sine Wave



$2\pi \text{ radians} = 360^\circ$

$y(t) = A \sin(2\pi f t + \varphi)$

$\omega = 2\pi f$

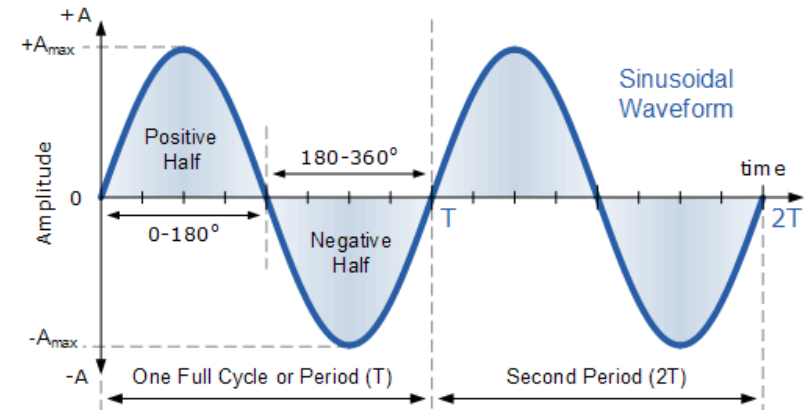
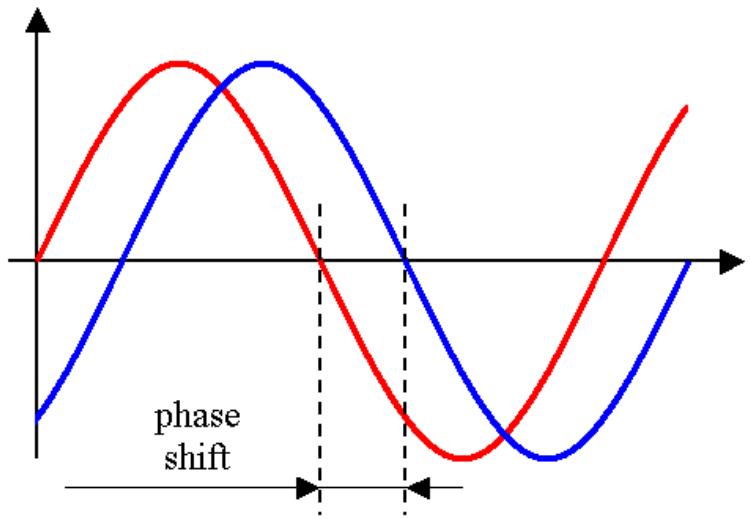
$y[n] = A \sin(\omega n + \varphi)$



# Analog Signals

## Example: Sine Wave

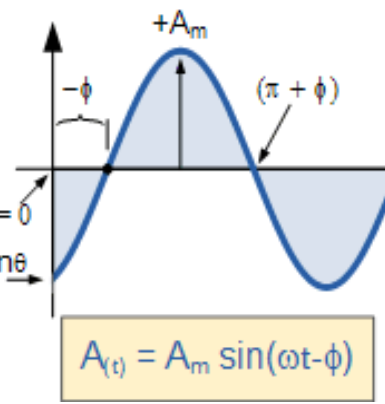
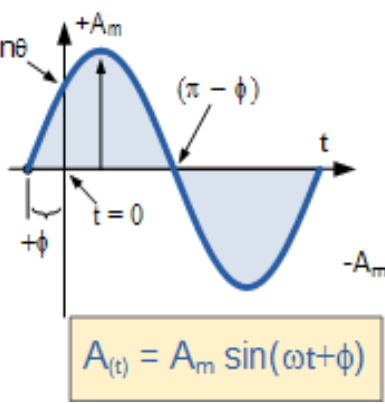
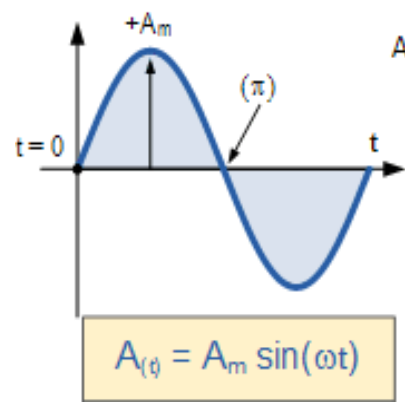
$$y(t) = A \sin(\omega t + \varphi)$$



In-phase ( $\phi = 0^\circ$ )

Positive Phase ( $+\phi$ )

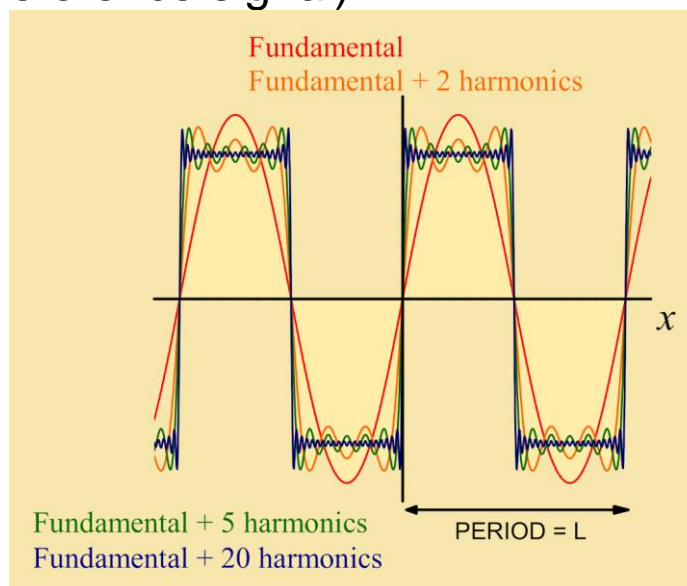
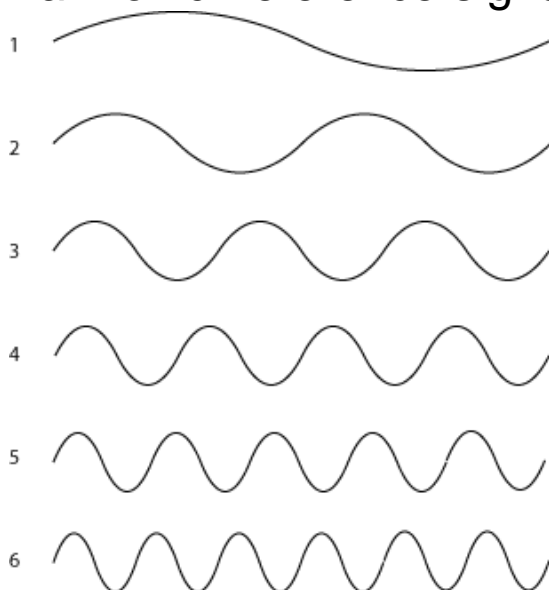
Negative Phase ( $-\phi$ )



(Time shift)  
 Time difference =  $\varphi_{\text{degrees}} / (360 * f)$

# Frequency Domain Analysis

- Time domain signals have a frequency domain representation
- Sine waves generate a “pure” frequency
  - Every analog signal can be generated with a combination of sine waves
- Harmonics
  - A signal whose frequency is a positive integer multiple of a reference signal
  - First harmonic: reference signal(i.e., reference signal)



## Experiment III

- Arbitrary Waveform Generator (AWG)
  - Standard signals are a subset of potential AWG signals!
- Spectrum Analyzer
  - Frequency domain analysis
  - Harmonics
- NOTES
  - *When you connect the headphones, be careful! It might be very loud. Run the AWG BEFORE putting your headphones on.*

# Recap

- References:
  - <http://www.physicsclassroom.com/>
  - <http://www.allaboutcircuits.com/>

- What did you  today?

