Signal Generator

CAG 2024-2025 MATLAB Project

Documentation

David Pescariu | Group 2023 | ETTI UTCN

Table of Contents

1. ***About*** ***3***
2. ***Screenshots*** ***3***
3. ***Usage*** ***4***
4. ***What are harmonic signals?*** ***5***
   - Key Facts 5
5. ***What are Signal Generators?*** ***5***
   - Types of Generators 5
   - What Generator is this project 6
   - Possible improvements 6
6. ***Folder Structure*** ***6***
7. ***Repository*** ***7***
8. ***Credits & Citations*** ***7***

1. About

Visualize harmonic signals and how they can be used to create a resulting harmonic - essentially generate any waveform, composed of a sum of simple $x(t) = A * cos(2 * \pi * f * t) + \phi$ equations.

2. Screenshots

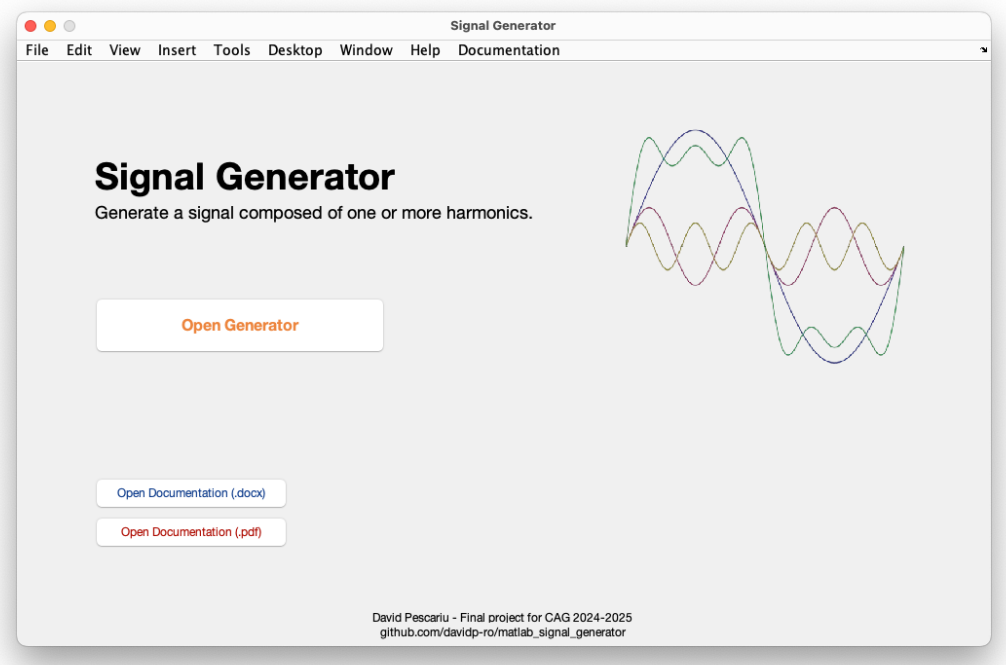


Figure 1 - Home Page

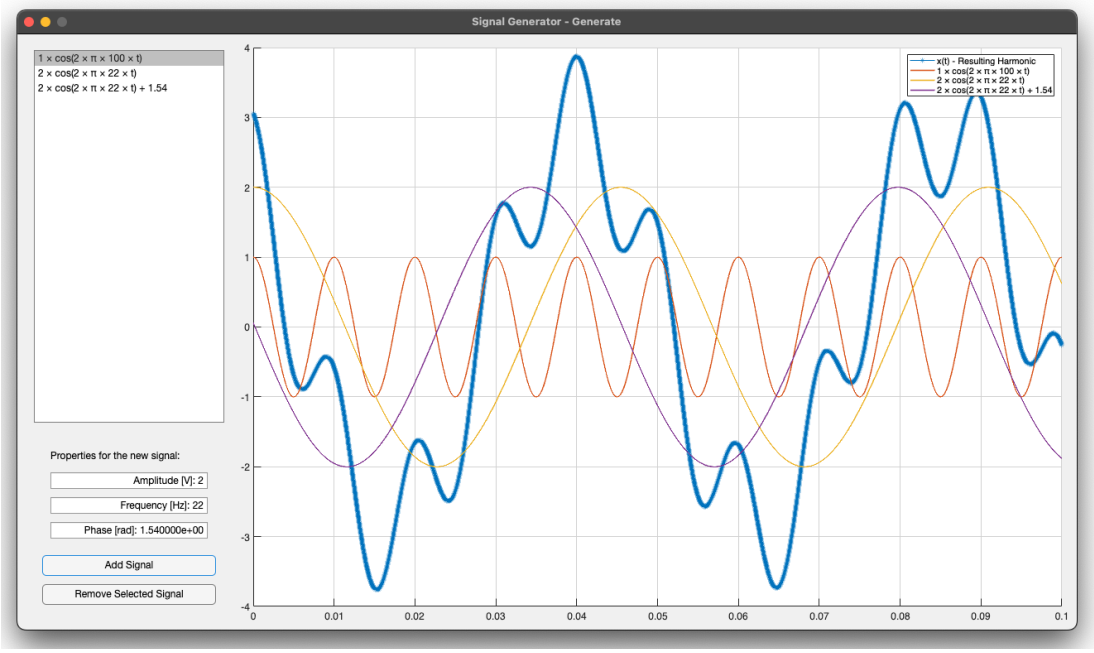
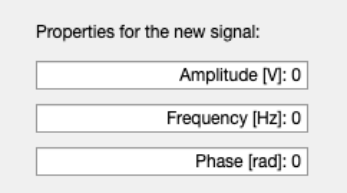


Figure 2 - Generator Page, with 3 harmonics used

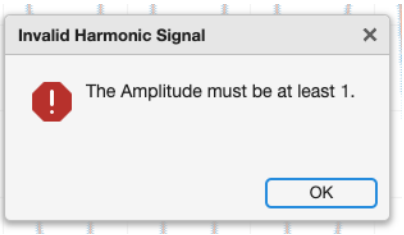
3. Usage

- Select “Open Generator” from the main page
- At this point, the generator will only have one “default” signal/harmonic: $1 * cos(2\pi\ 100t)\ [Hz]$

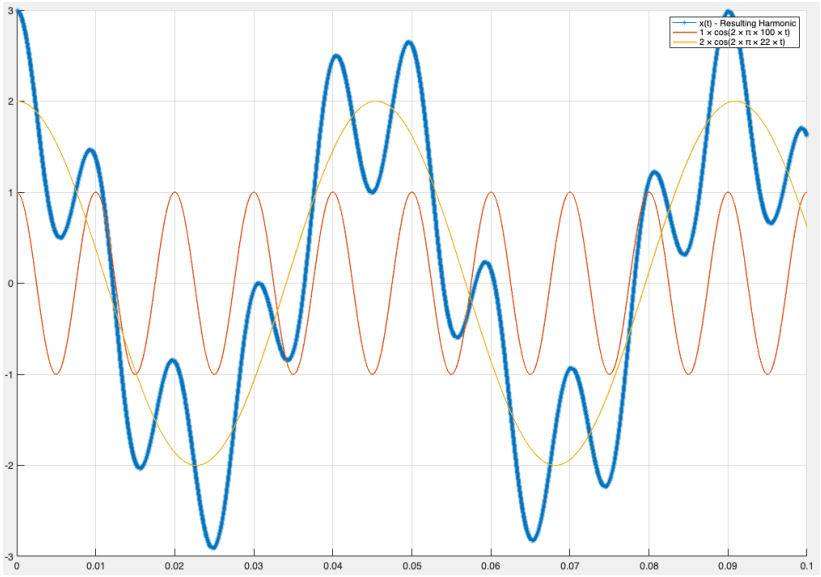
- To add a new signal, populate the fields on the left bar
  - Amplitude
  - Frequency
  - Phase



- Once ready, click “Add Signal”
  - *Note that you will receive an alert if you attempt to add a signal that is invalid*



- Suppose you add the signal $2 * cos(2\pi\ 22t)$:



See how the graph will show:
- The resulting harmonic in blue
- The composing signals in different colors.

You can always see what signals are being used by looking at the legend (top-right corner)

- If you now want to remove a signal, select it from the list on the left and click “Remove Selected Signal”
  - *Note that at least one signal is required at all time, so if you try to remove the last remaining signal, you will get an alert.*

4. What are harmonic signals?

Harmonic signals are periodic signals that consist of a fundamental frequency and its integer multiples, known as harmonics. These signals are essential in various fields like signal processing, physics, and engineering because they help analyze and synthesize complex waveforms.

Key Facts

1. **Fundamental Frequency**:
    - The fundamental frequency is the lowest frequency component in a harmonic signal.
    - All other frequency components are integer multiples of this fundamental frequency.
2. **Harmonics**:
    - Harmonics are signals with frequencies that are integer multiples of the fundamental frequency.
3. **Applications**:
    - **Signal Analysis**: Decomposing complex signals into harmonic components (e.g., Fourier analysis).
    - **Communication Systems**: Representing carrier signals and modulation.
    - **Music**: Understanding tones and timbre.
    - **Electrical Systems**: Analyzing alternating current (AC) waveforms.

5. What are Signal Generators?

A **signal generator** is an electronic device or software tool that produces electrical signals with varying characteristics, such as frequency, amplitude, waveform, and modulation. Signal generators are used in testing, designing, and troubleshooting electronic circuits and systems.

Types of Generators

1. **Function Generators**:

    - Generate standard waveforms such as sine, square, triangle, and sawtooth.
    - Useful for general-purpose testing and waveform generation.

2. **Arbitrary Waveform Generators (AWG)**:

    - Create user-defined, complex waveforms.
    - Offer more flexibility for custom signal generation in advanced applications.

3. **RF Signal Generators**:

    - Produce high-frequency signals in the radio frequency (RF) range.
    - Commonly used for testing wireless communication systems.

4. **Audio Signal Generators**:

    - Generate audio-frequency signals, typically within the 20 Hz to 20 kHz range.
    - Used in audio equipment testing.

4. **Pulse Generators**:

    - Generate pulse signals with specific characteristics like width, repetition rate, and delay.
    - Useful in digital circuit testing and timing analysis.

5. **Digital Pattern Generators**:

    - Generate digital signals or patterns for testing digital logic circuits.
    - Often used in microprocessor or memory testing.

What Generator is this project

This project attempts to be a barebones software Arbitrary Waveform Generator. It has basic features to add signals using varying parameters (Amplitude, Frequency and Phase), and remove signals.

Possible improvements

- Improve the controls
- Add more advanced features

6. Folder Structure

- `main.m` – handles scaffolding the program
- `/pages` – contains the page layouts & logic
    - `homePage.m` – home page, view docs & open generator
    - `generatorPage.m` – generator page, create the signals & view plot
- `/lib` – miscellaneous pieces of logic & resources
    - `openGenerator.m / openDocs.m` – utilities to open the generator page & documentation
    - `createHarmonic.m` – takes in the params of the equation, and builds it using the previously defined formula
    - `createHarmonicString.m` - builds the pretty representation of the equation so it can be shown in the UI
    - `createHarmonicFromString.m` - reconstructs the value of the equation, starting from the pretty representation. Used to rebuild the used equations so they can be plotted individually.

7. Repository

The project's progress was tracked using git, and the repository is hosted on GitHub: github.com/davidp-ro/matlab_signal_generator.

8. Credits & Citations

- CAG 2024-2025 Resources
  - Mihaela Cirlugea, Paul Farago
- The image used on the main page:
  - stevenvh (https://electronics.stackexchange.com/users/2064/stevenvh), What exactly are harmonics and how do they "appear"?, URL (version: 2012-05-21): https://electronics.stackexchange.com/q/32314
- Code snippets
  - OpenAI. (2025). ChatGPT [Large language model]. https://chatgpt.com, Prompts:
    - "how to set the argument of a function in matlab to be a string"
    - "and how can I check the string's value (if it matches a known one)"
    - "how can I make a figure be non-resizable?"
- The MATLAB Answers forum
  - © 1994-2024 The MathWorks, Inc.