Mechanics

Acoustics

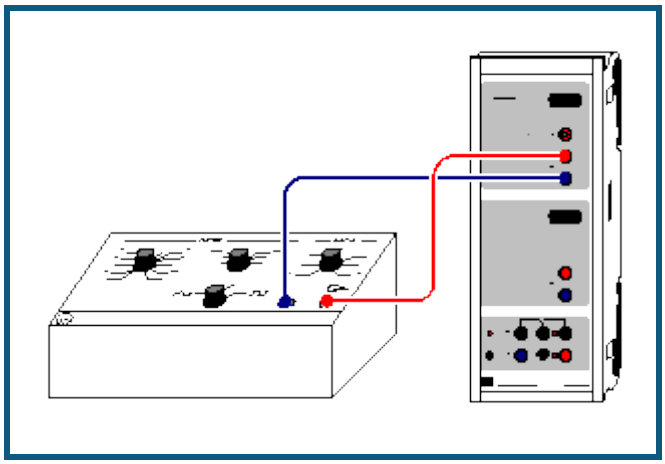
Fourier analysis

Fourier analysis of the periodic signals of a function generator

Description from CASSY Lab 2

For loading examples and settings, please use the CASSY Lab 2 help.

Fourier analysis of signals of a function generator



can also be carried out with Pocket-CASSY and Micro-CASSY

Experiment description

Harmonic analysis is a common method in many applications where time-variant signals (or measured values) occur. In acoustics, for example, exact knowledge of the overtones of a sound is important for the artificial generation of sounds or language. In metrology, Fourier analysis is used, for example, for checking electromagnetic compatibility (EMC) of electronic devices.

In this experiment, the Fourier transform of simple periodic signal shapes is studied as an introduction to the topic of Fourier transformation. Electric (analog) signals of a function generator are read, and the Fourier transform of the digitized signal is calculated. From the frequency spectrum the amplitudes of the different harmonics (Fourier analysis) are calculated and compared with the theoretical values.

Equipment list

1	Sensor-CASSY	524 010 or 524 013
1	CASSY Lab 2	524 220
1	Function generator S12	522 621
1	Pair of cables, 50 cm, red and blue	501 45
1	PC with Windows XP/Vista/7/8	

Experiment setup (see drawing)

Connect the continuously adjustable signal of the function generator to the input A of the Sensor-CASSY.

Remark: This experiment concerns the Fourier analysis of digitized signals of a function generator. For remarks concerning fast Fourier analysis and the treatment of the Fourier synthesis of corresponding signal shapes see the previous simulation experiment.

Experiment notes

For some types of function generators it may be necessary to set the DC offset exactly to zero in order to avoid distorted frequency spectra.

Carrying out the experiment

Load settings

- Set the desired signal shape and a frequency of approx. 500 Hz at the function generator (set the DC offset to zero).
- Start the measurement with for recording the signal.
- If necessary, adjust the sampling rate (interval) and the number of measuring points in the Measuring Parameters (**Window → Show Measuring Parameters**) corresponding to the selected signal frequency in order to obtain a frequency spectrum of sufficient resolution.

Evaluation

While the signal is recorded, the $U_{A1}(t)$ diagram already appears, representing a digitized version of the analog signal of the function generator. After the signal U_{A1} has been recorded, the Fourier transform of U_{A1} is available for the harmonic analysis in the display **Frequency Spectrum**.

For determining the amplitudes of the harmonics, carry out the following steps one after another:

- Select the display **Frequency Spectrum**, and determine the amplitudes of the harmonics of order N with a horizontal line.
- Go to the display **Evaluation**, transfer the value of the amplitude from the status line into the prepared table in column A using the mouse (drag & drop), and enter the order N of the N-th harmonic.

The theoretical dependence of the amplitudes of the N-th harmonics can be confirmed for the respective signal shape by a subsequent free fit to a hyperbola A/x^2 (delta: N = 1, 3, 5, ...) or A/x (square wave: N = 1, 3, 5, ...; sawtooth: N = 1, 2, 3, 4, ...), respectively. Alternatively, the dependence of the amplitudes on N obtained by way of theoretical calculations can be checked by converting the x-axis into $1/x^2$ (delta) or 1/x (square wave, sawtooth) and a subsequent fit to a line through the origin.

Depending on the signal shape selected, the frequency spectrum also exhibits contributions of small amplitudes at frequencies between the theoretical frequencies (e.g. between N = 1, 3, 5, ... in the case of the delta signal). This is due to the fact that the signal shape is not ideal and that the signal is not strictly periodic over the range covered by the recording time window.

Remark: for an example of using Power CASSY as a function generator see the experiment on sonic synthesis.