

VIRTUAL INSTRUMENT DESIGNED FOR DETECTING DISTORTION REGIME CAUSED BY FREQUENCY VARIATION

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ABSTRACT: Virtual instrumentation became a trend for simulating real life events from a wide variety of applications, bringing various advantages, especially in engineering research. Tools of software developed for these areas of interest allow us to transpose a problem in the virtual space, in order to simulate its issues, gather results and analyze for further solving. Present paper presents design of a virtual instrument used to detect distortions in a signal obtained by means of frequency variation.

KEY WORDS: virtual instrument, distortion, frequency, LabView, simulation.

1. VIRTUAL INSTRUMENTATION IN SIGNAL ANALYSIS

Virtual instrumentation was initially thought and designed as a tool for replacing measuring instruments [1-3]. Current software development directions open up a world of possibilities, especially in the engineering field where is mainly used for complex applications. Nowadays a virtual instrument can be used in applications where simultaneous measurements at thousands of control points are required, or where processing of a large amount of measurement information and access to re-mote information is imposed. Various combinations of numerical, programmable, stand-alone, computer-controlled tools with different built-in tools can be used for different complex applications. In present paper we have used virtual instrumentation software in order to design an instrument used to detect distortion regime caused by frequency variation [4,5].

The deforming regime usually refers to deviation of the waveform from the ideal sinusoidal waveform caused by different types of distortions: continuous component, harmonics, inter-harmonics, switching of polyphased electronic power devices, noise. Harmonics are signals whose frequencies are integer multiples of frequency [6,7].

At inter-harmonics their frequencies do not meet this condition but both are usually generated by consumers with nonlinear loads and can be described by the spectrum of harmonics, distortion factor, etc.

2. VIRTUAL INSTRUMENT DESIGN

As mentioned, a virtual instrument is used for simulating behavior of a real life event, by means of a dedicated software and specific hardware interface which contains signal processing modules [1,8].

For designing a virtual instrument used to detect distortion regime caused by frequency

variation we took advantage of tools provided by LabView software.

Block diagram of virtual instrument that analyzes, in the first phase, the frequency spectrum of two distinct sinusoidal signals, and in the second phase, the frequency spectrum of the combined sinusoidal signal

(added) using the mathematical operator Add “+” is shown in figure 1.

In order to obtain the frequency spectrum, the Fast Fourier Transform (FFT) is used, which is available as a function implemented in Waveform Measurements Pallet, by means of virtual sub-instrument Spectral Measurements.

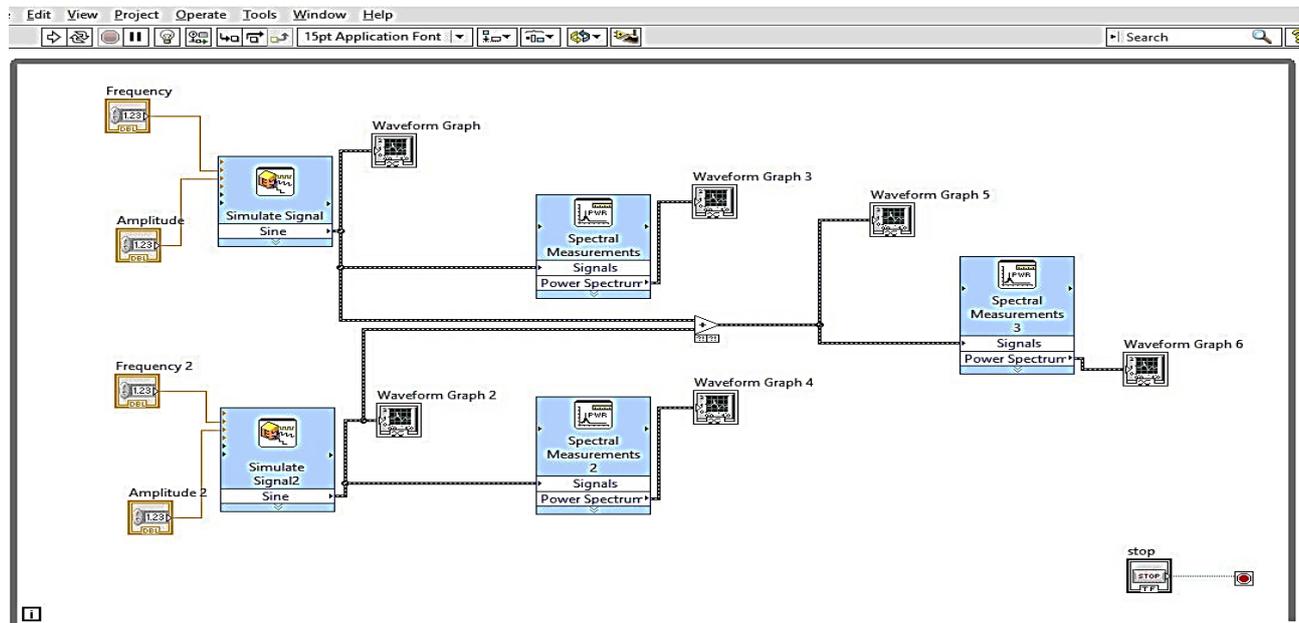


Figure 1. Block diagram of virtual instrument

The Simulate Signal Sine function was used to generate the two sinusoidal signals and the WaveForm Graph 1 and WaveForm Graph 2 indicators were used to display the amplitude, frequency and phase of the generated signals. The signals are applied to the Spectral Measurements 1 and Spectral Measurements 2 sub-instruments, and the WaveForm Graph 3 and WaveForm Graph 4 indicators display the frequency spectrum of each sinusoidal signal. The combined signal obtained by using the mathematical operator Add “+”, displayed in the WaveForm Graph 5 indicator, is transferred to the Spectral Measurements 3 sub-instrument which calculates the frequency spectrum of the composite signal [9,10]. This result is displayed in the WaveForm Graph 6 indicator.

3. TESTING DESIGNED VIRTUAL INSTRUMENT

In order to test designed virtual instrument we have generated two sinusoidal signals by

configuring the two sub-instruments Simulate Signal Sine, where we can set up signal values as:

- signal 1:
 - amplitude \rightarrow 325;
 - frequency = 50Hz;
 - phase $\Phi = 0^\circ$.
- signal 2:
 - amplitude \rightarrow 163;
 - frequency = 50Hz;
 - phase $\Phi = 0^\circ$.

Generated signals can be seen in WaveForm Graph 1 and WaveForm Graph 2, as shown in figure 2. Each resulting signal is transmitted to the Spectral Measurements 1 and Spectral Measurements 2 sub-instruments, which can be found in the Signal Processing / Waveform Measurements menu. The signals processed with these sub-instruments are sent to WaveForm Graph 3 and WaveForm Graph 4 being used with the purpose to display the Power Spectrum of each signal (figure 2).

The two generated signals are further combined by adding with the mathematical

operator Add +, and the resulted signal is displayed with WaveForm Graph 5. The combined signal is applied to a virtual sub-instrument called Spectral Measurements 3

that calculates and displays the signal power spectrum in WaveForm Graph 6 indicator.

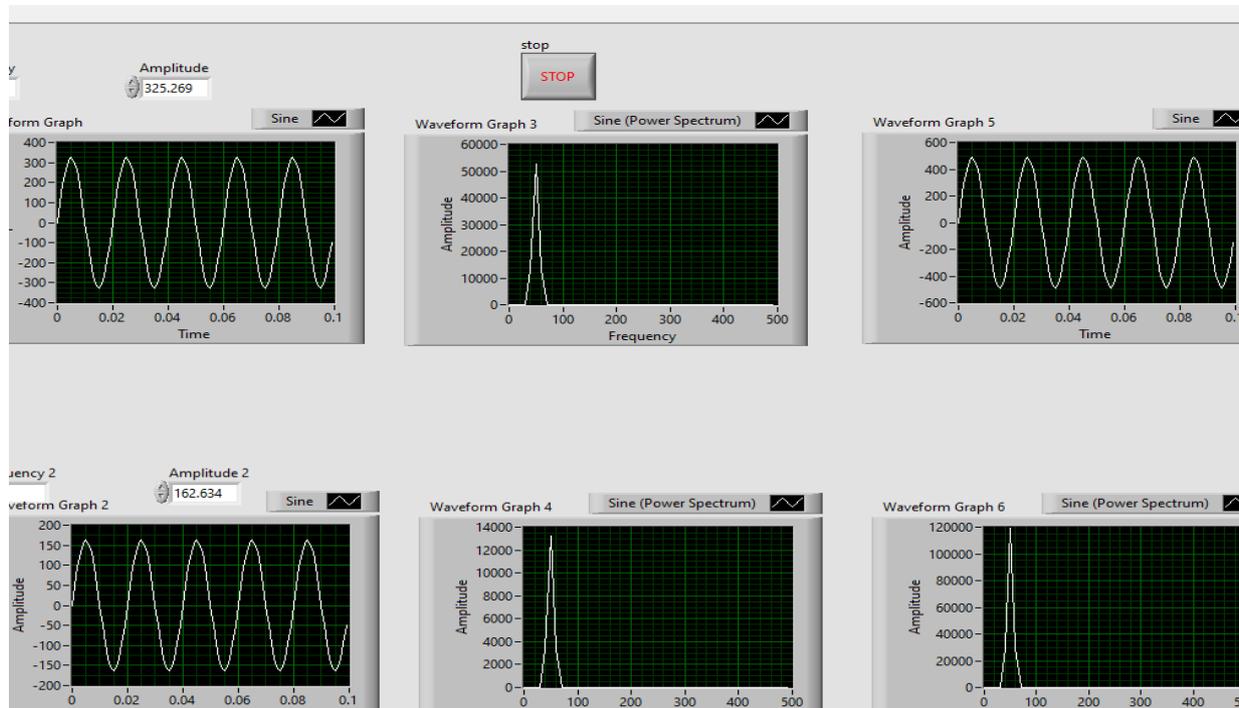


Figure 2. Front panel – resulted undistorted sinusoidal signal

In figure 2 there can be seen graphical representations for the generated two sinusoidal signals for equal frequency but different values of amplitude. Analyzing signals obtained in WaveForm Graph 5 and WaveForm Graph 6 we can notice that the waveform of the composite signal and the frequency spectrum of this signal follow both the sinusoidal regime and the resulting amplitude which $\rightarrow 488$.

With the help of the control buttons, the frequency, amplitude and phase values for each signal can be varied, thus changing the values of the input signals that generate normal and distorting regimes of the composite signal and the power spectrum for the sinusoidal signal resulting from composing the initial signals.

For simulating distorted regime, we have chosen two signals of different frequencies, as follows:

- signal 1:

- amplitude $\rightarrow 325$;
- frequency = 50Hz;
- phase $\Phi = 0^\circ$.

- signal 2:

- amplitude $\rightarrow 163$;
- frequency = 50Hz;

- phase $\Phi = 0^\circ$.

Simulation results are shown in figure 3, made with the same virtual instrument. In this case, when the two signals with different frequency are composed, meaning $f_1 = 50\text{Hz}$ and $f_2 = 63\text{Hz}$, a distortion of the composite signal is observed in the result caused by the frequency difference of the initial signals. In practice, this distortion regime is a voltage potential drop or a variable voltage frequency that can bring negative effects.

Analyzing signal obtained in WaveForm Graph 5 and WaveForm Graph 6 we can notice that the waveform of the composite signal and the frequency spectrum of this signal don't follow both the sinusoidal regime and the resulting amplitude.

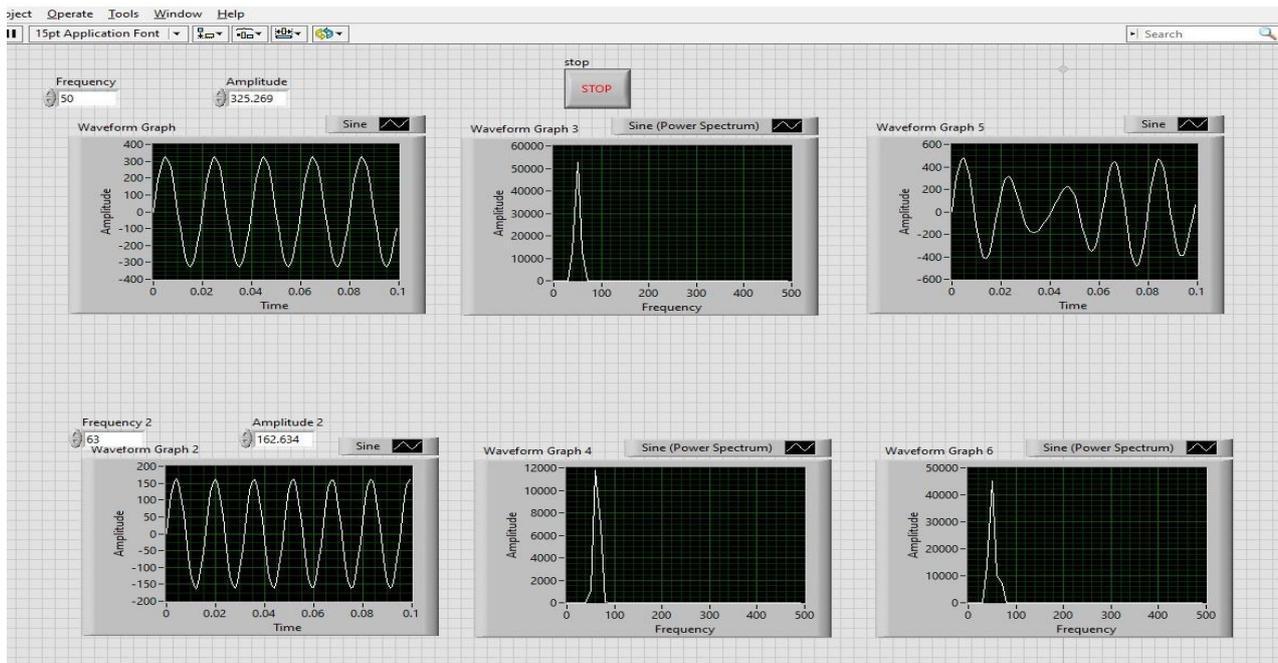


Figure 3. Front panel – resulted distorted sinusoidal signal

4. CONCLUSION

Due to a variety of advantages offered by virtual instrumentation, as expandability, high precision, flexibility, and the tools involved in this area we can extend designed instrument according to different applications which signal distortion analysis. Results obtained by means of virtual instrument designed for detecting distortion regime caused by frequency variation can be further used in finding solutions for problems specific to this area of interest.

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