Simulation of measurand for examples 2A and 2B

Contents

1 Introduction

This document describes the information that must be provided by the user when generating the measurand values in the examples contained in MATLAB scripts `DataFusionSoftware_2A.m` and `DataFusionSoftware_2B.m`.

In particular, section 2 contains a list of all the input that the user is expected to provide. For users who are interested, section 3 provides a full mathematical description of how the measurand values are calculated by the functions `FourierSeries.m` and `GenerateFourierSeries.m`.

2 User input

The 'true' measurand is defined by the following information provided by the user:

Measurand name and unit

- (optional) the name of the measurand, e.g., 'Temperature' [cell B4],
- (optional) the unit of the measurand, e.g., 'C' [cell B5].

If provided by the user, the name and unit will be used on the figures generated when running the software.

Sampling

- f_1, the sampling frequency [cell B9],
- D, the total duration (in seconds) [cell B10].

Fourier components

- n_{F}, the number of Fourier components [cell B11 – filled in automatically from information in column C],

- $\tilde{f}_k,\ u_{\mathrm{r}}(\tilde{f}_k),\ k = 1, \ldots, n_{\mathrm{F}}$, the estimates of the frequency components and their associated relative standard uncertainties [columns C and D],
- $A_k,\ u_{\mathrm{r}}(A_k),\ k = 1, \ldots, n_{\mathrm{F}}$, the estimates of the amplitude components and their associated relative standard uncertainties [columns E and F],
- $\phi_k,\ u_{\mathrm{r}}(\phi_k),\ k = 1, \ldots, n_{\mathrm{F}}$, the estimates of the phase components and their associated relative standard uncertainties [columns G and H],
- σ, the level of additive noise [cell I9].

3 Measurand values

The vector $\mathbf{t}_1$ of time values is given by

$$\mathbf{t}_1 = \begin{bmatrix} t_{1,1} \\ \vdots \\ t_{1,m_1} \end{bmatrix},$$

where m_1 is the integer part of Df_1 and

$$t_{1,j} = j/f_1, \quad j = 1, \ldots, m_1.$$

The vector $\mathbf{y}_1$ of measurand values is given by

$$\mathbf{y}_1 = \begin{bmatrix} y_{1,1} \\ \vdots \\ y_{1,m_1} \end{bmatrix},$$

where

$$\mathbf{y}_{1,j} = \sum_{k=1}^{n_{\mathrm{F}}} A_k^* \sin(2\pi \tilde{f}_k^* t_{1,j} + \phi_k^*) + r_{k,j}, \quad j = 1, \ldots, m_1,$$

with

$$A_k^* \sim \mathrm{N}\left(0, \left(\frac{u_{\mathrm{r}}(A_k)A_k}{100}\right)^2\right), \quad \tilde{f}_k^* \sim \mathrm{N}\left(0, \left(\frac{u_{\mathrm{r}}(\tilde{f}_k)\tilde{f}_k}{100}\right)^2\right), \quad \phi_k^* \sim \mathrm{N}\left(0, \left(\frac{u_{\mathrm{r}}(\phi_k)\phi_k}{100}\right)^2\right),$$

and

$$r_{k,j} \sim \mathrm{N}(0, \sigma^2).$$