Simulation of principal measurand for examples 1A and 1B

Contents

1 Introduction

This document describes the information that must be provided by the user when generating the 'true' principal measurand values in the examples contained in MATLAB scripts `DataFusionSoftware_1A.m` and `DataFusionSoftware_1B.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 'true' principal measurand values are calculated by the functions `PiecewiseLinear.m` and `GeneratePiecewiseLinear.m`.

2 User input

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

Measurand name and unit

- (optional) the name of the principal measurand, e.g., 'Pressure' [cell B4],
- (optional) the unit of the principal measurand, e.g., 'bar' [cell B5].

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

Sampling

- $f_1^{(1)}$, the sampling frequency (in Hz) [cell B9],
- $D^{(1)}$, the total duration (in seconds) [cell B10].

Straight-line segments

- $n_{\mathrm{L}}^{(1)}$, the number of straight-line segments [cell B11 – filled in automatically from information in column C],
- $T_k^{(1)}, \ k = 1, \ldots, n_{\mathrm{L}}^{(1)}$, the start times (in seconds) for the straight-line segments [column C],
- $\alpha_k^{(1)}, \ u_{\mathrm{r}}\left(\alpha_k^{(1)}\right), \ k = 1, \ldots, n_{\mathrm{L}}^{(1)}$, the estimates of the 'intercept' components of the straight-line segments and their associated relative standard uncertainties [columns D and E],
- $\beta_k^{(1)}, \ u_{\mathrm{r}}\left(\beta_k^{(1)}\right), \ k = 1, \ldots, n_{\mathrm{L}}^{(1)}$, the estimates of the 'gradient' components of the straight-line segments and their associated relative standard uncertainties [columns F and G],
- $\sigma_k^{(1)}, \ k = 1, \ldots, n_{\mathrm{L}}^{(1)}$, the levels of additive noise for the straight-line segments [column H].

3 Measurand values

Let $T_{n_{\mathrm{L}}^{(1)}+1}^{(1)} = T_1^{(1)} + D^{(1)}$.

The vector $\mathbf{t}_1^{(1)}$ of time values is given by

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

where $m_1^{(1)} = \lfloor f_1^{(1)} D^{(1)} \rfloor$ and

$$t_{1,j}^{(1)} = T_1^{(1)} + j/f_1^{(1)}, \quad j = 1, \ldots, m_1^{(1)}.$$

The vector $\mathbf{y}_1^{(1)}$ of measurand values is given by

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

where for $t_{1,j}^{(1)}$ in the kth time interval $\left(T_k^{(1)}, T_{k+1}^{(1)}\right], \ j = 1, \ldots, m_1^{(1)}$,

$$y_{1,j}^{(1)} = \alpha_k^{(1)*} + \beta_k^{(1)*}\left(t_{1,j}^{(1)} - T_k^{(1)}\right) + r_j^{(1)},$$

$$\alpha_k^{(1)*} \sim \mathrm{N}\left(\alpha_k^{(1)}, \left(\frac{u_\mathrm{r}\left(\alpha_k^{(1)}\right)\alpha_k^{(1)}}{100}\right)^2\right),$$

$$\beta_k^{(1)*} \sim \mathrm{N}\left(\beta_k^{(1)}, \left(\frac{u_\mathrm{r}\left(\beta_k^{(1)}\right)\beta_k^{(1)}}{100}\right)^2\right),$$

and

$$r_j^{(1)} \sim \mathrm{N}\left(0, \left(\sigma_k^{(1)}\right)^2\right).$$