



BSI Standards Publication

Evaluation of the uncertainty of measurements from a stationary autocorrelated process

National foreword

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Evaluation of the uncertainty of measurements from a stationary autocorrelated process

*Évaluation de l'incertitude de mesure d'un processus
stationnaire autocorrélé*



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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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Introduction

In metrology, it is common practice that the dispersion or standard deviation of the average of repeated measurements, i.e., the standard uncertainty of the sample mean, is calculated by the sample standard deviation of the measurements divided by the square root of the sample size. The calculated standard uncertainty is an estimator of the standard deviation of the sample mean when the repeated measurements have the same mean and variance and are uncorrelated. However, it often happens that the measurements are correlated. In continuous productions such as in the chemical industry, most process data on quality characteristics are self-correlated over time or autocorrelated. In general, autocorrelation can be caused by the measuring system, the dynamics of the process, or both. In many cases, the data can exhibit a drifting behaviour. In biology, random biological variation, for example, the random burst in the secretion of some substance that influences the blood pressure, can have a sustained effect so that several consecutive measurements are all influenced by the same random phenomenon. In data collection, when the sampling interval is short, autocorrelation, especially positive autocorrelation of the data, is a concern.

When the measurements are from an autocorrelated process, it is inappropriate to evaluate the standard uncertainty of the sample mean as described above. As stated in ISO/IEC Guide 98-3:2008, 4.2.7, “If the random variations in the observations of an input quantity are correlated, for example, in time, the mean and experimental standard deviation of the mean as given in 4.2.1 and 4.2.3 may be inappropriate estimators (C.2.25) of the desired statistics (C.2.23).”

Autocorrelated processes can be classified to be two kinds of processes based on whether they are stationary or nonstationary:

- a) Stationary process – a direct extension of an independent and identically distributed (i.i.d.) sequence. An autocorrelated process is stationary if it is in a state of “statistical equilibrium”. This implies that the basic behaviour of the process does not change in time. In particular, a stationary process has a mean and variance that are constants over time;
- b) Nonstationary process – a process that is not stationary.

The aim of this document is to provide a method to evaluate the standard uncertainty of the mean of measurements from a stationary process.

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