INTERNATIONAL STANDARD ISO 16337

First edition
2021-04

Application of statistical and related methods to new technology and product development process — Robust tolerance design (RTD)

Application des méthodes statistiques et des méthodes liées aux nouvelles technologies et de développement de produit — Plans d'expériences robustes

Reference number
ISO 16337:2021(E)

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 69, *Applications of statistical methods*, Subcommittee SC 8, *Application of statistical and related methodology for new technology and product development*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The designer of a product typically decides the specifications of the product and passes them on to the manufacturing section for use in manufacturing the product. The specifications include the designed nominal values and tolerances for the parts and/or elements of the product. The optimum nominal values of the design parameters are determined by robust parameter design (RPD), and the optimum tolerances are determined by robust tolerance design (RTD).

RPD, as described in ISO 16336, is applied to the product prior to RTD. In RPD, the major noise factors are used to evaluate robustness as measured by the signal-to-noise ratio, which represents the variability of product output. It is a measure for comparing robustness between levels of control factors. RPD identifies the combination of the values of the design parameters as an optimum RPD condition for minimizing the variability, that is, maximizing the robustness.

RTD, as described in this document, is a method for selecting the degree of errors of the parts or elements of the product from the viewpoint of variability under the optimum RPD condition, that is, the combination of optimum nominal values of the design parameters. If a manufactured product has errors from the designed nominal values, the product output will deviate from the designed value. The error in a design parameter should be smaller than the designed error limit to keep the product output within the designed variability. This is why the design parameters need a tolerance.

The design of a product can be finalized by setting the optimum error limits of the design parameters by using RTD. The expected variance in output of a product manufactured with errored parts or elements can be estimated using RTD. After RPD is used to identify a set of optimum values for the design parameters, RTD is used to check whether the estimated variance is smaller than the target variance under the optimum RPD condition.

RPD can be used to set the optimum nominal values of the design parameters without increasing manufacturing cost while RTD is closely related to the manufacturing cost. Smaller tolerances, meaning higher-grade parts or elements, result in higher costs, while larger tolerances, meaning lower-grade parts or elements, result in lower costs. To finalize the product design, the cost of manufacturing the product is considered. The loss function in the Taguchi methods is used to transform the benefits of an improvement in quality into a monetary amount, the same as a cost.

The cost of the improvement and the benefits of the improvement in quality should be balanced in deciding the tolerances. RPD and RTD together provide a cost-effective way of optimizing product design.

If RPD cannot achieve the product variability smaller than the target variability, the tolerances of the design parameters are reduced to improve the variability, but smaller tolerances result in higher costs.

On the other hand, if RPD can achieve the product variability much smaller than the target variability, the tolerances of the design parameters are increased to reduce manufacturing cost, so larger tolerances result in lower costs.

Products manufactured with optimum nominal values and tolerances of design parameters are robust to noise situations under usage conditions after shipment. Robust products minimize users' quality losses due to defects, failures, and quality problems.