ISO 14253-2:2011-04 (E)

Geometrical product specifications (GPS) - Inspection by measurement of workpieces and measuring equipment - Part 2: Guidance for the estimation of uncertainty in GPS measurement, in calibration of measuring equipment and in product verification

Contents

Page

Foreword v

Introduction vi

1 Scope 1

2 Normative references 2

3 Terms and definitions 2

4 Symbols 4

5 Concept of the iterative GUM method for estimation of uncertainty of measurement 5

6 Procedure for Uncertainty MAnagement -- PUMA 6
6.1 General 6
6.2 Uncertainty management for a given measurement process 6
6.3 Uncertainty management for design and development of a measurement process/procedure 7

7 Sources of errors and uncertainty of measurement 10
7.1 Types of errors 10
7.2 Environment for the measurement 12
7.3 Reference element of measurement equipment 12
7.4 Measurement equipment 12
7.5 Measurement set-up (excluding the placement and clamping of the workpiece) 13
7.6 Software and calculations 13
7.7 Metrologist 13
7.8 Measurement object, workpiece or measuring instrument characteristic 13
7.9 Definition of the GPS characteristic, workpiece or measuring instrument characteristic 14
7.10 Measuring procedure 14
7.11 Physical constants and conversion factors 14

8 Tools for the estimation of uncertainty components, standard uncertainty and expanded uncertainty 14
8.1 Estimation of uncertainty components 14
8.2 Type A evaluation for uncertainty components 15
8.3 Type B evaluation for uncertainty components 15
8.4 Common Type A and B evaluation examples 17
8.5 Black and transparent box model of uncertainty estimation 20
8.6 Black box method of uncertainty estimation -- Summing of uncertainty components into combined standard uncertainty, uc 21
8.7 Transparent box method of uncertainty estimation -- Summing of uncertainty components into combined standard uncertainty, uc 21
8.8 Evaluation of expanded uncertainty, U, from combined standard uncertainty, uc 22
8.9 Nature of the uncertainty of measurement parameters uc and U 22

9 Practical estimation of uncertainty -- Uncertainty budgeting with PUMA 23

9.1 General 23
9.2 Preconditions for an uncertainty budget 23
9.3 Standard procedure for uncertainty budgeting 24

10 Applications 26
10.1 General 26
10.2 Documentation and evaluation of the uncertainty value 27
10.3 Design and documentation of the measurement or calibration procedure 27
10.4 Design, optimization and documentation of the calibration hierarchy 28
10.5 Design and documentation of new measurement equipment 29
10.6 Requirements for and qualification of the environment 29
10.7 Requirements for and qualification of measurement personnel 29

Annex A (informative) Example of uncertainty budgets -- Calibration of a setting ring 31

Annex B (informative) Example of uncertainty budgets -- Design of a calibration hierarchy 38

Annex C (informative) Example of uncertainty budgets -- Measurement of roundness 63

Annex D (informative) Relation to the GPS matrix model 69

Bibliography 71