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Automation systems and integration — Quality information framework (QIF) — An integrated model for manufacturing quality information

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National foreword

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Foreword

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This document was prepared by the Digital Metrology Standards Consortium (DMSC) (as ANSI QIF 3.0 - 2018) and drafted in accordance with its editorial rules. It was assigned to Technical Committee ISO/TC 184, Automation systems and integration, Subcommittee SC 4, Industrial data, and adopted under the "fast-track procedure".

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Foreword

The Digital Metrology Standards Consortium (DMSC, Inc.) is an American National Standards Institute (ANSI) accredited standards developing organization, as well as an A-Liaison to the International Organization for Standardization (ISO) Technical Committee (TC) 184. The mission of the DMSC is to identify urgently needed digital standards in the field of dimensional metrology, and to promote, foster, and encourage the development and interoperability of these standards, along with related and supporting standards that will benefit the industry as a whole. More information about the DMSC can be found at www.dmsc-inc.org.

The Quality Information Framework (QIF) was developed by domain experts from the manufacturing quality community representing a wide variety of industries and quality measurement needs. Contributors to this version 3.0 of the QIF standard include:

- Capvidia
- Datapixel
- Honeywell Federal Manufacturing and Technology
- John Deere
- Metrosage
- Mitutoyo America
- National Institute of Standards and Technology
- Origin International
- QIF Solutions
- The Manufacturing Technology Centre
- University of North Carolina at Charlotte

This document was written by the QIF Working Group, and given final approval for ANSI review by the DMSC's Quality Measurement Standards (QMS) Committee. More information about DMSC's QIF effort can be found at www.qifstandards.org.

The QIF standard, version 3.0, consists of the following subject areas under the general title *Quality Information Framework (QIF) — An Integrated Model for Manufacturing Quality Information*:

Overview and Fundamental Principles

QIF Library Information Model

QIF Model Based Definition (MBD) Information Model

QIF Plans Information Model

QIF Resources Information Model

QIF Rules Information Model

QIF Results Information Model

QIF Statistics Information Model

The Overview and Library clauses describe the overview and central concepts of the QIF standard. The following clauses describe information models for the six *application areas* of QIF; Model Based Design, Plans, Resources, Rules, Results, and Statistics.

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This version of QIF, designated ANSI/QIF 3.0 – 2018, is a revision of the previous QIF standard, version 2.1, which was published in 2015. This document comprises the fourth release of the QIF suite of standards, denoted version 3.0. This QIF version 3.0 document cancels and replaces all documents of version 2.1. QIF version 3.0 is solely a product of the DMSC and its committees and working groups.

Each major release of the QIF standard from 1.0 through 2.1 was composed of eight Parts documents, namely, Part 1 Overview, Part 2 QIF Library, Part 3 MBD, Part 4 Plans, Part 5 Resources, Part 6 Rules, Part 7 Results, and Part 8 Statistics. Version 3.0 of QIF dispenses with the separate Parts format and includes all subject area clauses in a single document.

HTML-based data model viewer

The DMSC will make available an html-file based data dictionary for the entire QIF information model as an aid to understanding QIF. This data dictionary is non-normative material, but describes the normative content of the QIF data model. The html files facilitate viewing the complete data model, including all six application areas and Library content, using pictures and text. A user has the ability, through an internet browser, to follow navigation links forward and backward through the data model description using mouse clicks.

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Introduction

This Quality Information Framework (QIF) standard defines an integrated set of information models which enable the effective exchange of metrology data throughout the entire manufacturing quality measurement process – from product design to inspection planning to execution to analysis and reporting. This clause of the QIF standard introduces the purpose and design approach behind QIF, as well as its content. The QIF information models are contained in files written in the XML Schema Definition Language (XSDL). Additional constraints to ensure data quality are contained in files written in the EXtensible Stylesheet Transformation language (XSLT). The models for Version 3.0 consist of six application schema files plus a library of schema files containing information items used by all applications. The Library is described in Clause 6 of this standard. Clause 7 defines the Model Based Definition application model which deals with CAD data plus product manufacturing information (PMI). Clause 8 defines the QIF Plans application model, which deals with plans for quality measurement. Clause 9 defines the QIF Resources application model, which describes hardware and software resources used for inspection. Clause 10 defines the QIF Rules application model which describes practices to be used in an inspection. Clause 11 defines the QIF Results application model which deals with the results of part measurements. Clause 12 defines the QIF Statistics application model which conveys analysis of multiple part inspections.

The QIF models include quality characteristics and measurement features as defined in the ASME Geometric Dimensioning and Tolerancing (GD&T) related and ISO Geometrical Product Specifications (GPS) related specifications, and the Dimensional Measuring Interface Standard (DMIS). The QIF standard covers a wide variety of use cases including dimensional metrology inspection, first article inspection, reverse engineering, and discrete quality measurement.

Type face conventions for this document are:

Attribute and element names: **bold**

The words: “attribute”, “element”, “include”, “key”, and “keyref”: *italicized*
when they are formal terms of XSDL.
In their other meanings, those words are not italicized.

Type names: ***bold and italicized***

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1 Scope of the integrated model and fundamental principles

1.1 Contents of this document

This clause describes the general content and structure of the entire QIF information model. It describes the highest level data structures of QIF, that are expanded in Clauses 6 through 12 using data dictionaries and XML schema files. All QIF XML schema files can be found at www.qifstandards.org.

This clause also describes practices for forming QIF instance files, called “documents,” that support quality workflow scenarios. Its focus is to show how the QIF information model, and data formed into XML instance files, support the entire scope of model based definition manufacturing quality workflow. It describes how the information model is partitioned among the XML schema files and contains all terms used in the subject area clauses.

The purpose of this clause is to orient potential users of QIF to the organization of the information model to make their study of the details more rewarding and efficient. It should also help solution providers and users to evaluate QIF for their uses, without needing to go to the lowest technical details of the XML schemas. The information model narrative focuses on the approach to modeling the core data structures of QIF, which model the content of ASME GD&T and ISO GPS, and the plans and results data elements defined in Dimensional Measuring Interface Standards (DMSI) ISO 22093 and ANSI/DMSC DMIS 5.3. The material on XML practices describes consistent design practices to be used by QIF working groups who will be designing new schemas. It should also help data processing experts to write software that writes and reads manufacturing quality data using the XML schemas.

1.2 Scope of the QIF Version 3.0 information model

Figure 1 shows a high level view of the QIF information architecture for version 3.0 standardization. At the core of the QIF architecture is the reusable QIF library which contains definitions and components that are referenced by the application areas, thereby ensuring interoperability and extensibility. Around the QIF library core Figure 1 shows the six QIF application area information models, MBD, Plans, Resources, Rules, Results, and Statistics. The DMIS application, which references the DMSC's Dimensional Measuring Interface Standard (DMIS), is a placeholder for a future QIF execution model that is not a part of QIF. Each QIF application model reuses the QIF Library. QIF data is contained in a QIF Document. The order of generation of QIF data in an enterprise generally proceeds clockwise around the diagram, beginning with QIF MBD and ending with QIF Statistics. Use of the QIF information model does not place any requirements on a user’s workflow architecture.

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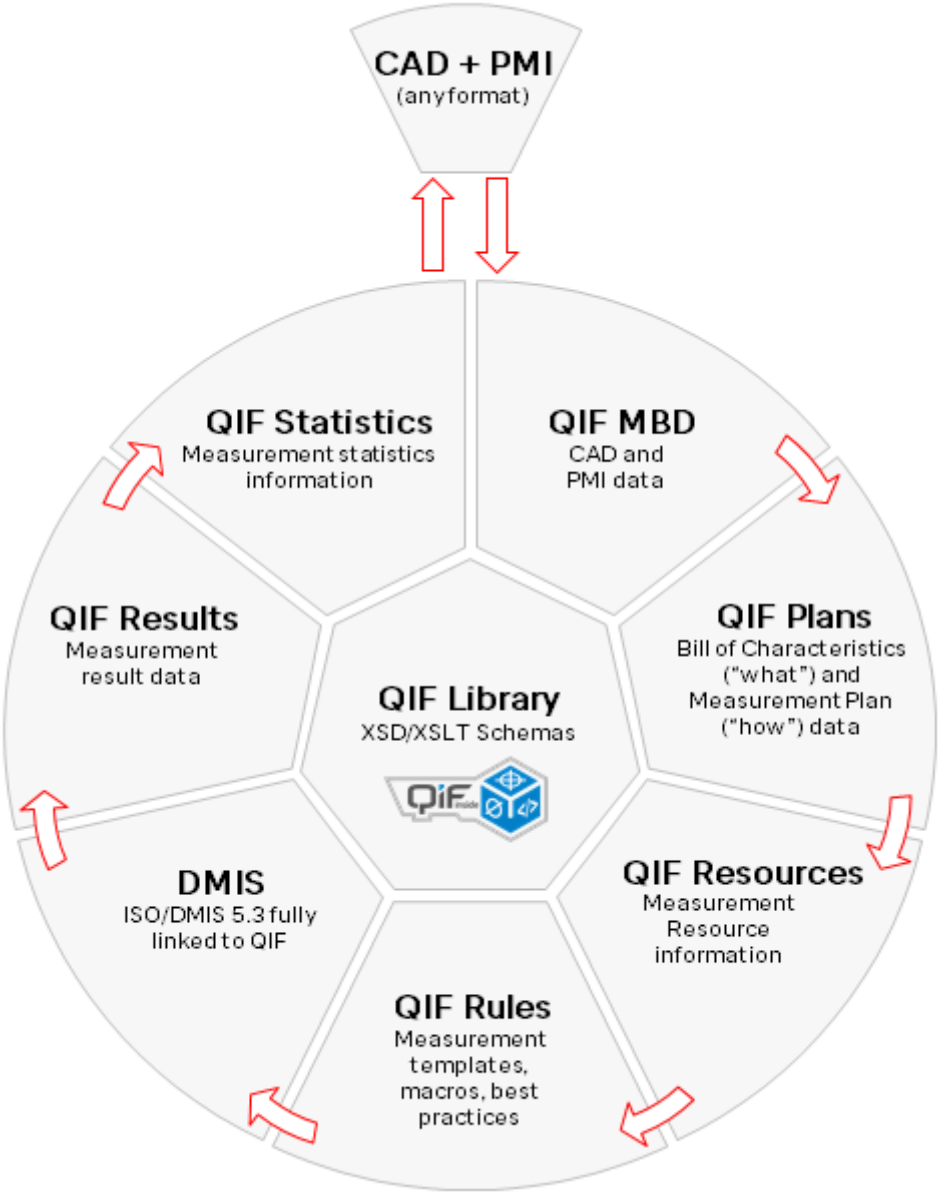

Figure 1 – QIF version 3.0 information architecture

The flow of QIF data typically starts with generation of CAD + PMI data exported as QIF MBD application data. Then Quality planning systems import the MBD and generate measurement requirements as part of the Plans of "what" to measure, then with import of Resources and Rules information, Plans generate an inspection plan on "how" to verify. Then Programming systems import Plans to generate DME-specific programs, or general instructions to guide inspection. Dimensional measurement equipment executes programs and evaluates characteristics of a single manufactured part or assembly and exports the measurements as Results. Analysis systems, typically performing statistical process control, import single parts Results and generate analysis of multiple part batches as QIF Statistics data.

Users of the QIF information model are not required to implement the entire model. Any of the six application models may be used singly for exchange of quality data in its specific application area between a software system that produces QIF data for that area and a software system that

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consumes QIF data for the area. Further, other data models and exchange formats can coexist in an enterprise with QIF data.

1.3 Conformance

Software programs that implement this specification to write QIF XML instance files must:

- follow the rules of XML when writing QIFDocument instance files
- generate instance files that validate against the QIFDocument schema
- generate instance files that validate against the Check.xsl XSLT constraints
- employ semantics of the information written that complies with the referenced standards and with the QIF data dictionaries in this specification.

Software programs that implement this specification to read QIF instance files must:

- be able to read any valid QIF XML instance file and extract all numerical and semantic data correctly.

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2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

AIAG MSA Reference Manual 4th Edition, Automotive Industry Action Group *Measurement Systems Analysis*

AIAG SPC – Automotive Industry Action Group *Statistical Process Control* 2nd Edition

ANSI/DMIS 105.3, Part 1-2016, *Dimensional Measuring Interface Standard, DMIS 5.3 Standard, Part 1*

ISO DMIS: ISO 22093:2011 *Industrial automation systems and integration -- Physical device control -- Dimensional Measuring Interface Standard (DMIS)*

ASME B1.7 - 2006, *Screw Threads: Nomenclature, Definitions, and Letter Symbols*

ASME Y14.36 - 1996, *Surface Texture Symbols*

ASME Y14.6 - 2001, *Screw Thread Representation*

ASME Y14.5M-1994 (reaffirmed 2004), *Dimensioning and Tolerancing - Engineering Drawing and Related Documentation Practices*

ASME Y14.5-2009, *Dimensioning and Tolerancing - Engineering Drawing and Related Documentation Practices*

ASME Y14.41-2012, *Digital Product Definition Data Practices*

ASME B89.4.10360.2-2008 *AcceptanceTest and Reverification Test for Coordinate Measuring Machines (CMMs) – Part 2: CMMs Used for Measuring Linear Dimensions*

ASME B89.4.22-2004, *Methods for Performance Evalulation of Articulated Arm Coordinate Measuring Machines*

AWS A2.4:2012 Standard Symbols for Welding, Brazing, and Nondestructive Examination

Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation 26 November 2008

ISO/IEC 9834-8:2008. *Information technology -- Open Systems Interconnection -- Procedures for the operation of OSI Registration Authorities: Generation and registration of Universally Unique Identifiers (UUIDs) and their use as ASN.1 Object Identifier components*

ISO/IEC 11578:1996: *Information technology - Open System Interconnection - Remote Procedure Call (RPC)*

ISO/IEC JCGM 200 – *International vocabulary of metrology – Basic and general concepts and associated terms* (VIM)

ISO/IEC Guide 99:2007 (E/F) – *International vocabulary of metrology – Basic and general concepts and associated terms* (VIM)

SAE Aerospace Standard, AS9102B*: Aerospace First Article Inspection Requirement. 2014.*

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ISO 1101:1983 *Technical drawings -- Geometrical tolerancing -- Tolerancing of form, orientation, location and run-out -- Generalities, definitions, symbols, indications on drawings*

ISO 1101:2017 *Geometrical Product Specifications (GPS) -- Geometrical tolerancing -- Tolerances of form, orientation, location and run-out*

ISO 1302:2002 *Geometrical product specifications (GPS) -- Indication of surface texture in technical product documentation*

ISO 5459:2011 *Geometrical Product Specifications (GPS) -- Geometrical tolerancing -- Datums and datum systems*

ISO 14405-1:2016 *Geometrical Product Specifications (GPS) — Dimensional tolerancing — Part 1: Linear sizes*

ISO 14405-2:2016 *Geometrical Product Specifications (GPS) — Dimensional tolerancing — Part 2: Dimensions other than linear sizes*

ISO 14406:2010, *Geometrical product specifications (GPS) – Extraction*

ITU-T X.509 | ISO/IEC 9594-8 (10/2012) *Public-key and attribute certificate frameworks*

RFC 2045 *MIME Part One: Format of Internet Message Bodies*

XML Schema Part 1: Structures Second Edition, W3C Recommendation 28 October 2004

XML Schema Part 2: Datatypes Second Edition, W3C Recommendation 28 October 2004

XSL Transformations (XSLT) Version 2.0, W3C Recommendation 23 January 2007

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Terms defined in ISO 22093:2011 and ANSI/DMIS 105.3-2016, Part 1

3.1.1 **actual**

referring to features or tolerances, the actuals are the real-world, physical instances which can be measured creating feature and tolerance measurements.

Note 1 to entry: Referring to parts and assemblies, the actuals are physical instances called actual components.

3.1.2 **dimensional measuring equipment (DME)**

a class of equipment used to inspect parts and evaluate dimensions and tolerances

Note 1 to entry: DME includes, but is not limited to, coordinate measuring machines, video inspection equipment, optical comparators, robotic measuring devices, theodolites, photogrammetry, laser-based measuring devices, and manual measuring devices such as micrometer and caliper.

3.1.3 **nominal**

a target value of a dimension, feature, or characteristic

Note 1 to entry: A nominal is usually based on as designed engineering criteria.

Note 2 to entry: See also “nominal aspect” at subclause 3.4.11.

3.1.4 **measurement**

referring to a feature, dimension, or tolerance, an approximate representation or value inferred from the actual feature, dimension or tolerance by measurement with DME

Note 1 to entry: See also “measurement aspect” at subclause 3.4.11.

3.1.5 **part coordinate system (PCS)**

a datum reference frame associated with the part to be measured

3.2 Terms defined in XML Schema Part 0: Primer Second Edition, W3C Recommendation 28 October 2004

3.2.1 **attribute**

information represented as an XML attribute in an instance file, usually conforming to an *attribute* declaration in an XML schema

3.2.2 **complexType**

a value type that has elements or attributes

3.2.3 **element**

information represented as an XML element in an instance file, usually conforming to an *element* declaration in an XML schema

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3.2.4 instance file

a file containing an information set intended to conform to an XML schema

3.3 Terms defined in XML Schema Part 1: Structures Second Edition, W3C Recommendation 28 October 2004

3.3.1 attribute information item

information modeled using an *attribute* declaration in an XML schema

Note 1 to entry: often shortened to "attribute." An attribute information item is a field of a data structure. The data type of the field must be a primitive type such as string or number. In an XML instance file, attributes are represented in the form attributeName="attributeValue".

3.3.2 element information item

information modeled using an *element* declaration in an XML schema

Note 1 to entry: often shortened to “element.” An *element* information item may be a field of a data structure or an entire data structure. The data type of an *element* may be either a primitive type (such as string or number) or a structured type. In an XML instance file, *element*s are delimited by matching opening and closing tags.

3.3.3 enumeration

a term indicating that a single indivisible value follows

3.3.4 extension

a term in a complexType definition indicating that the type being defined is derived from a more general type

Note 1 to entry: Extension is the XSDL mechanism used in QIF for building hierarchies of complex types. XSDL also provides for restrictions of complex types, but that is not used in QIF.

3.3.5 key

a constraint requiring that selected data fields exist and be unique

Note 1 to entry: In XSDL, a key may require that a combination of data fields be unique, but QIF never uses more than a single data field.

3.3.6 keyref

a constraint requiring that there is a match between two sets of values in an instance file

3.3.7 schema (or XML schema)

a complete information model in the XML schema definition language

Note 1 to entry: A schema is defined by one or more schema files.

3.3.8 schema document (or schema file)

a file containing a well-formed XML schema declaration

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Note 1 to entry: Such a file does not necessarily contain a complete information model; it may reference other schema files needed to make the model complete.

3.3.9 simple type

a value type that is indivisible or is a list of indivisible items

EXAMPLE number example: 10

EXAMPLE string example: 10 Downing Street

EXAMPLE list example: 10 34 -7

Note 1 to entry: In XSDL, *union* type is also simple, but it is not used in QIF.

3.3.10 string

a data type that is a sequence of Unicode characters

3.3.11 token

a string in which there is no leading or trailing white space, and the only white space occurring between visible characters is a single space character

3.4 Terms defined in the QIF standard

3.4.1 accuracy test

a defined process for determining conformance of a measurement device to specifications

3.4.2 action

a plan element that gives information about what to measure or validate

3.4.3 action group

a plan element that organizes sets of actions

Note 1 to entry: An action group can be an ordered group, unordered group, one-of group, partially ordered group, or pick-some group.

3.4.4 action method

a prescription of how an action is to be performed

Note 1 to entry: Actions with action methods form the core of a measurement plan.

3.4.5 actual component

a physical instance of a component

Note 1 to entry: By analogy to a car, the design of a wheel is a *part*; the design of the wheel placed at the front right of the design of a car is a *component*; the front right wheel of a physical car is an *actual component*.

3.4.6 actual component set

a set of actual components

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3.4.7 **application area**

one of the six QIF workflow interface types, i.e., MBD, Plans, Resources, Rules, Results, and Statistics

3.4.8 **articulating arm CMM**

a coordinate measuring meachine with articulating links

3.4.9 **aspect**

one of four categories used to incrementally accumulate characteristic or feature data based on data source and data shareability

Note 1 to entry: In QIF there are four aspects of characteristics and features: definition, nominal, item, and measured.

3.4.10 **definition aspect**

the aspect of feature or characteristic data categorized by its shareability among different features or characteristics

3.4.11 **nominal aspect**

the aspect of feature or characteristic data particular to an individual feature or characteristic

3.4.12 **item aspect**

the aspect of feature or characteristic incremental data particular to an individual measurement of a feature or characteristic

3.4.13 **measured aspect**

the aspect of feature or characteristic data particular to the results of the measurement of a feature or characteristic

3.4.14 **assembly**

a number of parts or combination thereof that are joined together to perform a specific function and subject to disassembly without degradation of any of the parts

Note 1 to entry: In QIF, assembly means the design of an assembly, and a physical instance of an assembly is called an actual component.

3.4.15 **assembly path**

a sequence with an id of the ids of components

Note 1 to entry: An assembly path shows where in an assembly design a specific instance of a part design or a subassembly design is located

3.4.16 **assignable cause**

a cause of variation in a process which is not random and has some source which can be determined and perhaps eliminated

3.4.17 **attribute characteristic**

a characteristic described using attribute data, or using data that do not have numerical values

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EXAMPLE color, malleability

3.4.18 **attribute data**

a result from a characteristic or property that is appraised only as to whether it does or does not conform to a given requirement (for example, go/no-go, accept/reject, pass/fail, etc.)
[1]

3.4.19 **autocollimator**

an optical instrument for non-contact measurement of angles

3.4.20 **bias**

a measure of a gage's tendency toward specific values when compared to a master value

3.4.21 **bill of characteristics (BoC)**

a list of all the characteristics applied to a product.

3.4.22 **boolean condition**

a statement which can be unambiguously evaluated as true or false

EXAMPLE "The feature is a cylinder" would evaluate to "true" if and only if the feature in question is a cylinder feature.

3.4.23 **calibration**

a process that verifies instrument performance or develops correction values to assure claimed accuracy

3.4.24 **caliper**

a device used to measure distance between two points on a workpiece

3.4.25 **capability**

a measure of a process's stability and centralization against a nominal value and tolerance values, also, the ability of a process to produce acceptable parts

3.4.26 **capacitive sensor**

a non-contact instrument that uses change in capacitance to measure displacement

3.4.27 **carriage**

a mechanical element of a measurement device, generally a CMM, that functions as part of the tool-carrying structure

3.4.28 **Cartesian CMM**

a coordinate measuring machine with orthogonal axes

3.4.29 **characteristic**

a control placed on an element of a feature such as its size, location or form, which may be a specification limit, a nominal with tolerance, a feature control frame, or some other numerical or non-numerical control

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3.4.30 **characteristic item**

a tolerance or specification applied to a feature or product that needs verification

3.4.31 **charge coupled device camera sensor**

a sensor that senses by means of using a charge coupled device camera

3.4.32 **checked**

refers to a measured feature or characteristic being measured directly or being constructed from previously measured or constructed data

3.4.33 **clipping plane**

a bounding plane surface which abbreviates the intended display of data to that portion which lies on one or the other side of the plane

3.4.34 **complex tactile probe sensor**

a touch probe with more than one stylus

3.4.35 **component**

an instance of a part or an assembly aligned to its parent's space

3.4.36 **composite feature**

a feature composed of two or more sub-features which act as a functional group and to which shared characteristics may be applied

3.4.37 **computed tomography**

an imaging procedure that uses special x-ray equipment to create detailed pictures, or scans, of areas inside the part.

Note 1 to entry: It is also called computerized tomography.

3.4.38 **confocal chromatic sensor**

an optical sensor that takes advantage of chromatic aberration to carry out a chromatically coded distance detection of a target form the focusing lens

3.4.39 **constructed feature**

a feature that is computed from other features

Note 1 to entry: Contrast to a measured feature, which is computed from measured point data.

3.4.40 **control limits**

statistical limits that represent boundary conditions of a process that is in control

Note 1 to entry: Processes that are out of control are said to have unnatural causes or assignable causes of variation.

3.4.41 **control points**

a set of points that determine the shape of a NURBS object

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3.4.42 **coordinate measuring machine**

a machine that measures a part by sensing 3D points on the surface of the part

3.4.43 **control polygon**

a polygon formed by the control points of a NURBS object

3.4.44 **corrective action**

a countermeasure that can be applied to an assignable cause of variation in order to reduce the likelihood of recurrence

3.4.45 **corrective action plan**

information related to the establishment of lists of assignable causes of variation and associated corrective actions in the manufacturing process

Note 1 to entry: In production statistical studies, a key aspect of manufacturing process control is the identification of assignable causes of variation that can occur. These special causes of variation are typically associated with corrective action plans that help the manufacturing operator with the ability to adjust processes to eliminate these unnatural causes of variation from occurring again thereby bringing the manufacturing process into a greater state of stability and control.

3.4.46 **data/information quality**

an assessment of the fitness of the data and information to serve its purpose in a given context

3.4.47 **datum definition**

definition of a datum label and optionally, its association with datum targets or feature instances

3.4.48 **datum reference frame**

three mutually perpendicular intersecting datum planes

Note 1 to entry: A datum reference frame establishes a coordinate system.

3.4.49 **dial caliper**

a caliper that has a dial that is read by a human

3.4.50 **digital caliper**

a caliper that is read electronically

3.4.51 **digital micrometer**

a micrometer that is read electronically

3.4.52 **draw wire sensor**

an instrument that measures distance by recording the length of wire drawn out of it using potientiometers or encoders

3.4.53 **DVRT sensor**

A system that detects the position of its core by measuring the differential reluctance in two coils surrounding the core

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3.4.54 **eddy current sensor**

a non-contact sensing probe that uses magnetic field interaction and subsequent generation of eddy currents to measure displacement of a target

3.4.55 **entity**

the basic unit of information in a file

Note 1 to entry: The term applies to single items which may be individual elements of geometry, collections of annotations to form dimensions, or collections of entities to form structured entities.

3.4.56 **evaluation**

refers to the process by which the status of a characteristic measurement is determined from nominal, measured and specification limit information

3.4.57 **event**

an occurrence, usually unplanned, which may have an effect on the outcome of a measurement or inspection operation and which should be recorded

3.4.58 **external product definition**

a product shape definition not included in a QIFDocument

EXAMPLE a PDF file, a drawing, or a physical part.

3.4.59 **feature**

an aspect of a part which can be (1) a tangible portion of a physical part, (2) an element of a technical drawing, 3D model, or other abstract representation of the part, or (3) a derived, constructed, intangible portion of a part, such as a feature of size, minimum circumscribed sphere, maximum inscribed cylinder, axis, center plane, theoretically extended edge on a technical drawing, and projected point/line from the part.

3.4.60 **file unit**

a unit defined in the file units section of a QIF instance file

EXAMPLE radian, meter, inch

3.4.61 **fixture**

a device used for workpiece positioning and holding

3.4.62 **gage**

a measurement device that is used to measure one or more characteristics of a workpiece

Note 1 to entry: It may be a general purpose device, e.g. a ring gage, or it may be specially designed hardware dedicated to measuring a specific workpiece or family of workpieces.

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3.4.63 **gage repeatability and reproduceability (gage R&R)**

a source of measurement variation based on the ability of a gage to repeat measurements on the same parts and the ability of two or more inspectors using this gage to achieve the same measurement results

3.4.64 **generatrix**

a curve to be swept to generate an extruded surface, or revolved to generate a surface of revolution

3.4.65 **generic feature**

a feature which can be referenced by a user-defined characteristic

Note 1 to entry: Usually, this is a portion of the surface of a part that is not correctly described by any other feature type.

3.4.66 **geometric**

related to shape information

EXAMPLE points, curves, surfaces, and volumes

3.4.67 **geometric characteristic**

a concept characterizing the size, form, orientation or location of a feature or of a component of a feature

EXAMPLE diameter, flatness, parallelism, or position.

3.4.68 **inspection**

a measurement of characteristics on a physical part to determine whether the features are within allowed tolerance, commonly in order to accept or reject the part

3.4.69 **inspection traceability**

information about the circumstances of a quality measurement process

3.4.70 **internal product definition**

a product shape definition contained in a QIFDocument

3.4.71 **item**

an aspect of a characteristic or feature, or an individual instance of an object.

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3.4.72 **key characteristic**

a characteristic of a feature, material, process, or part whose variation has a significant influence on product fit/function, safety/compliance, performance, service life, or manufacturability

Note 1 to entry: A key characteristic can be identified by a designator and can have a criticality class.

3.4.73 **knot vector**

an increasing sequence of real numbers which divides the parametric space of a NURBS into intervals (called spans)

Note 1 to entry: The number of knots is equal to the number of control points plus the order. The knot vector is a uniform one if all knots are equally spaced and of multiplicity one.

3.4.74 **laser radar**

a large-scale-metrology instrument that measures the coordinates of a point on a part without using an optical target by directing a frequency modulated laser beam and heterodyne detection of the returned beam

3.4.75 **laser tracker**

an instrument that is typically used to measure large workpieces by determining the positions of optical targets held against the workpiece

3.4.76 **laser triangulation sensor**

a laser source and detector system that uses triangulation principle for non-contact measurement of displacement of a target

3.4.77 **light pen CMM**

a coordinate measuring machine that uses a light pen for measuring

3.4.78 **linearity**

the ability of a gage to accurately measure across a range of values

3.4.79 **Long Term Archiving and Retrieval**

defining and storing digital information models so that the information can be fully retrieved and the item corresponding to the model can be fully realized at any future time, even if the systems used to define and store the information are then obsolete

3.4.80 **LVDT sensor**

A non-contact sensor that uses electromagnetic coupling to measure the linear displacement of a core from its central or null position

3.4.81 **magneto-inductive sensor**

a non-contact positioning sensor that combines magnetic and inductive principles to determine the absolute distance to a permanent magnet fixed to a target

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3.4.82 **manufacturing traceability**

information about the circumstances of a manufacturing process.

3.4.83 **measurand**

quantity intended to be measured

Note 1 to entry: An object, quantity, property, or condition to be measured for a specific purpose.

Note 2 to entry: Two examples of a measurand are the measurement of a shape feature to evaluate a specified characteristic (for example tolerance) and the measurement of a shape feature to establish a datum (for example primary datum) within the context of a datum reference frame. One could measure the same feature differently or apply a different substitute feature data fitting algorithm..

3.4.84 **measure feature method**

an action method for measuring a feature

3.4.85 **measurement**

an estimate of a dimension associated with a feature or features on a physical part generated using a physical device

3.4.86 **measurement device**

a measurement resource that provides an indication for a dimensional characteristic of a workpiece

Note 1 to entry: This indication may either be a value (variables) or simply conformance (attributes).

3.4.87 **measurement plan**

a complete plan that contains information on what and how to measure

3.4.88 **measurement resource**

a piece of dimensional metrology equipment that can be used to measure features and/or characteristics on a workpiece

3.4.89 **measurement result**

the measured value of an actual feature or characteristic

Note 1 to entry: A measurement result is obtained by measuring a feature or characteristic with a measurement resource.

3.4.90 **measurement room**

an environmentally controlled room in which measurements are made

3.4.91 **mesh**

a collection of vertices, edges, and facets linked together to form a 3D shape; the facets are typically triangular in shape, but quadrilateral representations are also possible

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3.4.92 **micrometer**

a mechanical device for measuring very small distances based on the rotation of a finely threaded screw

3.4.93 **microscope**

an optical instrument used for viewing very small workpieces typically magnified several hundred times

3.4.94 **multiple carriage CMM**

a coordinate measuring machine with two or more carriages

3.4.95 **non-dimensional quality data**

data expressed as either attributes or variables, e.g., number of non-conformities like burrs or dents, color of paint, etc.

3.4.96 **normal**

perpendicular to a surface and pointing away from the surface material

3.4.97 **normal vector**

a unit vector perpendicular to a surface in 3 dimensions or a unit vector perpendicular to a curve in 2 dimensions

3.4.98 **notable event**

a description of a planned or unplanned event that inspection processes should monitor and should record if it occurs during inspection

3.4.99 **note**

an explanatory or descriptive statement in natural language

Note 1 to entry: In QIF, notes provide information in addition to that which is formally modeled.

3.4.100 **noted event**

an event occurring and reported during inspection

3.4.101 **optical comparator**

an optical instrument utilized for measuring

Note 1 to entry: It is also referred to as a profile projector or shadowgraph

3.4.102 **parallel link CMM**

a coordinate measuring with parallel links (e.g., Renishaw equator)

3.4.103 **part**

one item, or two or more items joined together, that is not normally subject to disassembly without destruction or impairment of designed use

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Note 1 to entry: In QIF, part means the design of a part, and a physical instance of a part is called an actual component.

3.4.104 **persistent identifier**

a permanent, location and instance independent identifier for a digital object

3.4.105 **plan element**

an action or an action group

Note 1 to entry: A combination of actions and action groups can be structured in a directed hierarchical tree of actions.

3.4.106 **plan note**

descriptive information that applies to an entire measurement plan

3.4.107 **plan root**

the top level plan element (an action or action group) of a measurement plan

3.4.108 **point sampling strategy**

the geometric pattern that is used to distribute the measurement points on a given feature

Note 1 to entry: The range of possible values is taken from ISO-14406:2010. Examples include: an orthogonal grid, a helix, a “birdcage“, etc.

3.4.109 **process variation**

the variation of a process in achieving the same characteristic values across time

3.4.110 **product**

a generic term for a part or an assembly

3.4.111 **product and manufacturing information (PMI)**

non-geometric attributes in 3D Computer Aided Design/Manufacturing/Inspection/Engineering (CAD/CAM/CAI/CAE) systems necessary for manufacturing product components or subsystems

Note 1 to entry: PMI may include geometric dimensions & tolerances (GD&T), 3D annotation (text) and dimensions, surface finish, and material specifications.

3.4.112 **production**

a manufacturing process or operation designed to produce goods

3.4.113 **QIF persistent identifier (QPId)**

a standard universally unique identifier used in QIF

3.4.114 **qualification**

a check on or the refinement of the calibration of a measurement device performed using a known artifact such as a tooling ball or gage block

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3.4.115 **rule**

in the context of QIF Rules, a pair usually consisting of a Boolean condition and a specification of the type of measurement activity that should be carried out if the condition evaluates to true

Note 1 to entry: The Boolean condition is actually optional so that unconditional rules (i.e., actions that must or may always be taken) may be written.

Note 2 to entry: For example, if “the feature is a cylinder” evaluates to true, the corresponding action may be requested: “measure 13 points”.

3.4.116 **sampling category**

a number representing a category of rules use

Note 1 to entry: The exact meaning of each category and the number of possible levels is meant to be defined and evaluated by the user. For example, the number 1 might represent first article inspection and the number 2 might represent process control.

3.4.117 **sampling method**

a statistical method of grouping manufactured products for measurement

Note 1 to entry: Key concepts include sample size (how many) and sampling frequency (how often).

3.4.118 **sensor**

a measurement resource that detects a surface or measurement feature of a workpiece

3.4.119 **sensor qualification**

the process of measuring a reference artifact to determine sensor attributes

Note 1 to entry: an example is measuring a reference sphere to determine stylus tip diameters and probe tip offsets for a touch probe on a CMM

3.4.120 **set**

refers to a measured feature or characteristic being set to its nominal without any measurement taking place

3.4.121 **simple tactile probe**

a touch probe with a single stylus

3.4.122 **sine bar**

a hardened, precision ground body with two precision ground cylinders used for measuring angles

3.4.123 **stability**

the ability of a gage to arrive at the same measurements against a master value over time

3.4.124 **standard deviation**

a measure of the dispersion or frequency distribution around a population mean or average

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3.4.125 **statistical study plan**

information, defined in the QIF Statistics model, that provides a method for establishing the quality approach and criteria for data studies associated with measurement in manufacturing

Note 1 to entry: Statistical study plans provide a method for establishing the quality approach and criteria for data studies associated with measurement in manufacturing. A supplier may be provided with these plans from a customer in order to ensure the expectation that correct quality control information will be supplied with each manufactured lot.

Note 2 to entry: Statistical sStudy plans can contain the number of expected products to be inspected. They can also contain the expected quality conformance thresholds such as the characteristics to be measured and monitored, sample size, process capability, and gage repeatability and reproduceability requirements.

3.4.126 **statistical study results**

information that contains the measurement summary data that provides an overview of measured product quality

Note 1 to entry: Statistical study results contain the measurement summary data that provides an overview of product quality. From single first article inspection, to capability and production studies, statistical study information can include the measured process capability and performance quality indices that are commonly accepted in manufacturing.

3.4.127 **structured light sensor**

a non-contact optical measurement system that projects a known fringe pattern on a surface to characterize it using the distorted pattern recorded by the detector

3.4.128 **tactile probe sensor**

synonym for touch probe

3.4.129 **theodolite**

an instrument for measuring angles in the horizontal and vertical planes

3.4.130 **thread specification**

a description of the shape and size of a thread

Note 1 to entry: This is thread in the sense of the grooved/ridged portion of a nut or bolt.

3.4.131 **tolerance**

an upper and lower specification of a characteristic dimension

Note 1 to entry: A tolerance usually provides the allowable range for part acceptance based on designed engineering criteria for fit and function.

3.4.132 **tool**

a measurement resource that mounts one or more sensors to a measurement device

3.4.133 **touch probe**

a sensor that is actuated by physical contact with a workpiece

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3.4.134 **traceability**

information about the circumstances of a quality measurement process or a manufacturing process

Note 1 to entry: QIF defines five types of traceability. None of these is the classical traceability of measurements from an international standard through intermediate steps to a specific measurement.

3.4.135 **trimming contour**

a 3D contour which is used for trimming a surface

3.4.136 **ultrasonic sensor**

a proximity sensor that uses time of flight of sound waves to determine the absolute distance to a target

3.4.137 **universal length measuring machine**

a one dimensional measuring device used in precision applications

3.4.138 **version**

a unique, non-trivial instance of a document or schema

3.4.139 **weld characteristic**

a characteristic that indicates a desired type of weld

3.4.140 **weld symbol**

a pictorial representation of a weld characteristic

3.4.141 **wire-frame**

a method of geometric modeling in which a two- or three-dimensional object is represented by object edges

3.4.142 **work instruction**

information that provides instructions about actions or action methods to be used in executing a measurement plan

3.4.143 **workpiece**

a physical artifact, real or virtual, intended for subsequent transformation within some manufacturing operation

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4 Symbols and abbreviated terms

ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
ASME	American Society of Mechanical Engineers
BREP	Boundary Representation
CAD	Computer-Aided Design
CAIPP	Computer-Aided Inspection Process Planning
CAM	Computer-Aided Machining or Computer-Aided Manufacturing
CAX	Computer-Aided Technologies
CMM	Coordinate Measuring Machine
CoP	Cloud of Points
COTS	Commercial Off-The-Shelf
DME	Dimensional Measuring Equipment
DMIS	Dimensional Measuring Interface Standard
DMSC	Digital Metrology Standards Consortium
DRF	Datum Reference Frame
ERP	Enterprise Resource Planning
GD&T	Geometric Dimensioning and Tolerancing
GPS	Geometrical Product Specifications
GUID	Globally Unique Identifier
ISO	International Organization for Standardization
LOTAR	Long Term Archiving and Retrieval
MBD	Model Based Definition
MES	Manufacturing Execution Systems
MRI	Measurement Resources Information
MRP	Materials Resource Planning
MSA	Measurement Systems Analysis
PDPMI	Product Definition with Product and Manufacturing Information

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