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

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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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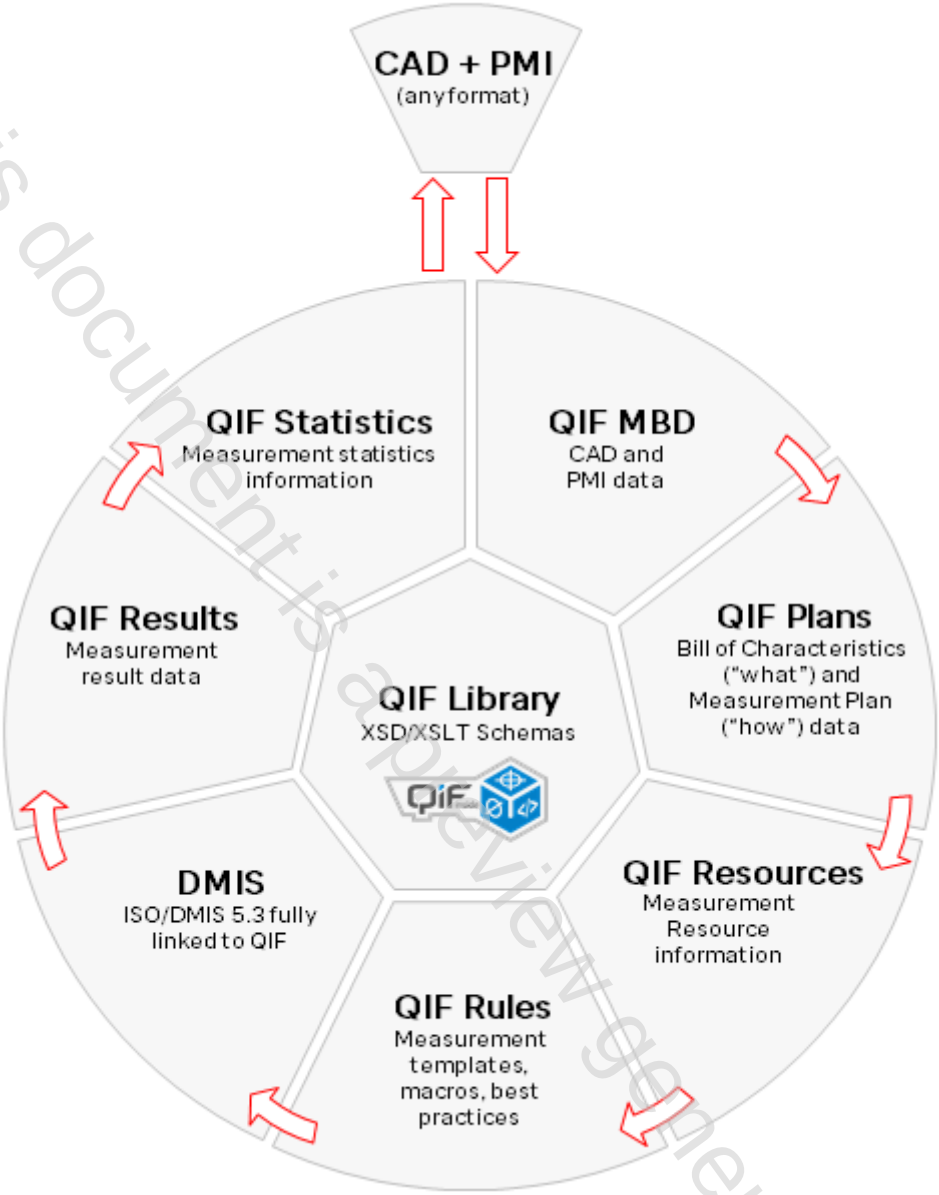

Figure 1 – QIF version 3.0 information architecture

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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