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Industrial automation systems and integration — Product data representation and exchange —

Part 35:
Conformance testing methodology and framework: Abstract test methods for standard data access interface (SDAI) implementations

Systèmes d'automatisation industrielle et intégration — Représentation et échange de données de produits —

Partie 35: Méthodologie et cadre pour les essais de conformité: Méthodes d'essai abstraites pour mises en application SDAI

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of normative document:

— an ISO Publicly Available Specification (ISO/PAS) represents an agreement between technical experts in an ISO working group and is accepted for publication if it is approved by more than 50 % of the members of the parent committee casting a vote;

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 10303-35 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC 4, *Industrial data*.

ISO 10303 is organized as a series of parts, each published separately. The structure of ISO 10303 is described in ISO 10303-1.

Each part of ISO 10303 is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part is a member of the conformance testing ethodology and framework series.

A complete list of parts of ISO 10303 is available from the Internet:

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http://www.tc184-sc4.org/titles/
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Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the conformance testing methodology and framework series. It specifies the abstract test methods for SDAI implementations. SDAI is the standard data access interface specification to data that has been defined using ISO 10303-11. SDAI is specified in ISO 10303-22. This part follows the general concepts of conformance testing defined in ISO 10303-31.

Major subdivisions in this part of ISO 10303 are:

— Abstract test cases, groups, suite and verdict criteria in clause 6;

— SDAI operations wrapped in EXPRESS procedures and functions with verdict criteria in clause 7;

— The EXPRESS structure test schema *ESTS* as the target for the abstract test cases in clause 8.

Industrial automation systems and integration — Product data representation and exchange —

Part 35:

Conformance testing methodology and framework: Abstract test methods for standard data access interface (SDAI) implementations

1   Scope

This part of ISO 10303 specifies the abstract test methods and requirements for conformance testing of an implementation of a language binding of the SDAI. Since the SDAI is specified independently of any programming language, the abstract test methods presented in this part are applicable to all SDAI language bindings. The abstract test methods support as well the various implementation classes as specified in ISO 10303-22.

The following are within the scope of this part of ISO 10303:

— abstract test methods for software systems that implement the SDAI;

— the specification, in a manner that is independent of any SDAI language binding, of the methods and approaches for testing of various SDAI operations;

— the specification and documentation of abstract test cases.

The following are outside the scope of this part of ISO 10303:

— the development of test data and/or test programs for specific language bindings;

— the specification of test methods, algorithms, or programs for the conformance testing of applications that interact with SDAI implementations;

— the architecture and implementation approach for a conformance test system that realizes the test methods specified in this part of ISO 10303.

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.

ISO 10303-1:1994, *Industrial automation systems and integration — Product data representation and exchange* — Part 1: *Overview and fundamental principles*

ISO 10303-11:1994, *Industrial automation systems and integration — Product data representation and exchange* — Part 11: *Description methods: The EXPRESS language reference manual*

ISO 10303-21:2002, *Industrial automation systems and integration — Product data representation and exchange* — Part 21: *Implementation methods: Clear text encoding of the exchange structure*

ISO 10303-22:1998, *Industrial automation systems and integration — Product data representation and exchange* — Part 22: *Implementation methods: Standard data access interface*

ISO 10303-31:1994, *Industrial automation systems and integration — Product data representation and exchange* — Part 31: *Conformance testing methodology and framework: General concepts*

ISO 10303-32:1998, *Industrial automation systems and integration — Product data representation and exchange* — Part 32: *Conformance testing methodology and framework: Requirements on testing laboratories and clients*

3 Terms, definitions, and abbreviations

3.1 Terms defined in ISO 10303-1

For the purpose of this document, the following terms defined in ISO 10303-1 apply:

— abstract test suite;

— application protocol;

— conformance class;

— implementation method;

— PICS proforma;

— protocol implementation conformance statement (PICS).

3.2 Terms defined in ISO 10303-22

For the purpose of this document, the following terms defined in ISO 10303-22 apply:

— application schema;

— implementation class;

— repository;

— schema instance;

— SDAI language binding;

— SDAI-model;

— session;

— validation.

3.3   Terms defined in ISO 10303-31

For the purpose of this document, the following terms defined in ISO 10303-31 apply:

— abstract test case (ATC);

— abstract test group;

— abstract test method;

— conformance;

— conformance log;

— (conformance) test report;

— conformance testing;

— executable test case;

— executable test suite;

— fail (verdict);

— implementation under test (IUT);

— inconclusive (verdict);

— pass (verdict);

— PIXIT proforma;

— Protocol Implementation eXtra Information for Testing (PIXIT);

— test campaign;

— test case error;

— testing laboratory;

— test purpose;

— test report;

— (test) verdict;

— verdict criteria.

3.4 Other terms and definitions

For the purpose of this document, the following definitions apply:

3.4.1
abstract test operation
a function or procedure that encapsulate an SDAI operation to test its proper behaviour, including the possible error code and error base. An abstract test operation is a verdict criterion operation

3.4.2
executable test operation
an instantiation of an abstract test operation for a particular programming language and SDAI implementation.

3.4.3
SDAI operation
an operation defined in clause 10 of ISO10303-22:1998

3.4.4
verdict criterion operation
a function or procedure defining a verdict criterion

3.5 Abbreviations

For the purposes of this document, the following abbreviations apply.

IUT   Implementation Under Test

PICS   Protocol Implementation Conformance Statement

PIXIT   Protocol Implementation eXtra Information for Testing

SDAI   Standard Data Access Interface, ISO 10303-22

ESTS   EXPRESS Structure Test Schema

4 Overview and characteristics

This part of ISO 10303 describes abstract test methods that conformance test systems would implement in order to test SDAI implementations. General principles and an overall framework for conformance testing are provided in ISO 10303-31. Requirements on test laboratories are defined in ISO 10303-32. The methods for preparing, controlling, observing and analysing implementations during testing are defined in this part of ISO 10303.

Abstract test methods are given for the SDAI implementation classes 1 to 7. An abstract test method is a set of instructions on how to apply specified abstract test cases for particular SDAI implementations. The abstract test cases are grouped into abstract test groups with the SDAI abstract test suite at the top level. The abstract test cases adjust themselves to the actual implementation class by accessing the information in the object, representing an instance of entity type *implementation* (see ISO 10303-22, 7.4.2).

The abstract test suite for SDAI implementations is defined by EXPRESS functions and procedures. For conformance testing an executable test suite has to be derived from the abstract test suite, suitable for the underlying programming language of the SDAI implementation.

NOTE   This part of ISO 10303 does not specify how to derive an executable test suite from the abstract test suite. This is the task of a testing laboratory or its client.

Clause 8 defines the EXPRESS Structure Test Schema (ESTS) as the basic application schema operated by the IUT. The abstract test suite in clause 6 specifies test cases and verdict criteria for particular entities and attributes of the ESTS. The test cases and verdict criteria refer to the "wrapper" functions and procedures for the SDAI operations in clause 6.

4.1   Testing characteristics

The characteristics of the test methods specified in this part of ISO 10303 are:

— An SDAI implementation may be early bound, late bound, or both. Test methods specified in this part of ISO 10303 address all such implementations;

— An SDAI implementation obeys the state model described in ISO 10303-22. The specified tests ensure this;

— ISO 10303-22 is written independent of any programming language. To keep the language independence this part of ISO 10303 is using EXPRESS to specify the abstract tests;

— SDAI operations provide means for data manipulation and transactions. Testing these operations will provide assurance of their correctness and whether they had the desired effect on the persistent storage. These operations include create, delete, modify, validate and various manipulation operations that act on schema instances, SDAI-models, and instances of application schema entities;

— In situations of error, SDAI operations return error codes. Testing will encompass all reasonable error situations for an operation to ensure that appropriate error codes are returned;

— The testing of error handling requires checking the returned error value against the actual error condition that triggered that return value;

— Environment and session operations provide the capability for changing the state of the SDAI session. Conformance testing will ascertain that only the permitted transitions take place and that only permitted operations for a state are allowed;

— Aggregate operations play important roles in SDAI implementations, facilitating the successful completion of other complex operations or sequences of operations;

— Test purposes and verdicts criteria are provided for all test cases;

— Specification of the conformance log along with the test purpose and verdict criteria definitions.

5   Testing process

The testing process consists of the preparation of the test, running the campaign, making a conclusion and producing the final test report.

5.1   Preparation for testing

PICS and PIXIT proformas are completed by IUT vendors prior to testing. The PICS shall be based on the PICS proforma of ISO 10303-22, Annex B. The PICS shall further specify:

— the SDAI language binding;

— the binding style: late binding and/or early binding as defined in the particular SDAI language binding.

An executable test suite, derived from the abstract test suite in clause 6 and the abstract test operations in clause 7 shall be available.

The application schema ESTS shall be made available to the IUT.

NOTE   The way how an application schema is made available to an SDAI implementation is usually implementation dependent.

The SDAI entity **implementation** contains information that shall match to the PICS. This information is printed into the conformance log by the abstract test case *atc_implementation* (see 6.3).

5.2   Test campaign

A conformance test campaign is a sequenced execution of all required executable test cases (ETCs) starting from the executable test suite. The results of this sequenced execution determines conformance.

Modifications to the IUT are not permitted during a test campaign. Modifications to the ETCs or to the sequence of their execution is not permitted during a test campaign, except in the situation where the ETC is determined to be in error.

If an ETC is determined to be in error, a verdict of INCONCLUSIVE shall be assigned to its execution until the error is resolved and the test repeated.

5.3   Test conclusion

A test campaign may terminate for any reason. A normal termination of a test campaign occurs when all its executable tests have been run. A PASS verdict shall be assigned to a campaign if all the tests of the campaign have returned PASS verdicts and no violation of any ISO 10303 part is detected.

5.4   Test report production

A conformance test report shall be created after a test campaign terminates. In addition to the requirements specified in ISO 10303-31 and ISO 10303-32 this report shall contain:

— used programming language;

— type of tested SDAI language binding, late binding or early binding;

— tested SDAI implementation classes;

— the executable test suite being used;

— a detailed conformance log as specified in clause 6.

Any relevant information on the testing environment shall be included as well.

6 SDAI abstract test schema

This clause specifies the SDAI_abstract_test_schema containing the abstract test cases for SDAI implementations formulated in a hierarchical manner. A test campaign starts with the *SDAI_abstract_test_suite* procedure (see 6.1). From this root node other abstract test groups and abstract test cases are invoked.

The following EXPRESS specification begins the **SDAI abstract test schema**.

<u>EXPRESS specification:</u>

```
*)
SCHEMA SDAI_abstract_test_schema;

USE FROM SDAI_dictionary_schema; -- ISO 10303-22

USE FROM SDAI_population_schema; -- ISO 10303-22

USE FROM SDAI_session_schema;   -- ISO 10303-22

USE FROM SDAI_parameter_data_schema;   -- ISO 10303-22

REFERENCE FROM SDAI_operation_schema; -- ISO 10303-35

USE FROM ESTS;    -- ISO 10303-35
(*
```

NOTE   The schemas referenced above are specified in the following parts of ISO 10303:

SDAI_dictionary_schema   ISO 10303-22

SDAI_population_schema   ISO 10303-22

SDAI_session_schema   ISO 10303-22

SDAI_parameter_data_schema   ISO 10303-22

SDAI_ operation_schema   Clause 7 of this part of ISO 10303

ESTS   Clause 8 of this part of ISO 10303

6.1   Introduction

The subject of the SDAI_abstract_test_schema is to define **abstract test cases** for testing SDAI implementations. An abstract test case specifies one or several test purposes, verdict criterion operations and verdict statements. The structure of an abstract test case is as follows:

— preparation of test data;

— writing the name of the abstract test case in the conformance log with the *atc* procedure (see 6.164);

— writing the description of a test purpose to the conformance log with the *purpose* procedure (see 1.165);

— performing one or several verdict criterion operations. The verdict criterion operations are *assert* (see 6.2.162), *check_instance* (see 6.2.163), and the executable test operations (see 7.2);

— assigning a verdict of the test purpose, based on the results of the verdict criteria. This is accomplished by invoking the *verdict* procedure (see 6.2.166) that writes the verdict result to the conformance log.

Some abstract test cases are dependent of the supported implementation levels, as defined in the *implementation* object. Whenever an SDAI operation is dependent on a specific implementation level, the EXPRESS algorithms query this information in order to determine if the test case is applicable to the implementation under test.

The abstract test cases specified in this clause are built around SDAI operations specified in ISO 10303-22. For conformance testing executable test cases shall be derived from the abstracted test cases to build up an equivalent executable test suite. Since there exists no guaranteed one-to-one relationship between operations in ISO 10303-22 and a particular SDAI language binding, the statements of a executable test case may not be identical to those in the abstract test case. However the statements of an executable test case shall reflect the logical structure of its abstract test case, defined by the test purposes and the specified verdict criteria. The executable test cases shall also follow the specifications of the corresponding SDAI language bindings defined in other parts of ISO 10303. SDAI language bindings may specify modified or extended functionality for some SDAI operations to that defined in ISO 10303-22. In the case that the specifications in an SDAI language binding conflicts with the ones given in ISO 10303-22, the executable test cases shall be adopted for the specifications of the SDAI language bindings.

Attributes of the session and population entities sdai_session, sdai_transaction, implementation, sdai_repository, sdai_repository_contents, sdai_model, sdai_model_contents, entity_extent and schema_instance are accessed by usual EXPRESS expressions. All application entities and attributes of the ESTS schema are accessed by the abstract test operations only.

6.2 SDAI abstract test schema function and procedure definitions

The root of the **abstract test suite** is given by the *SDAI_abstract_test_suite* procedure (see 6.2.1). From this root node other procedures and functions, representing the **abstract test groups** and **abstract test cases** are invoked.

Abbreviated names are used in the identifiers of the functions and procedures declared in this schema. Prefixes used in these identifiers have the following meanings:

atg   abstract test group

atc   abstract test case

Further auxiliary functions and procedures are defined to prepare test data, generate the conformance log and establish the verdict criteria.

Functions with the prefix 'macro' are used to prepare the IUT for a specific state. The specified macros are:

— macro_get_closed_repository (see 6.2.147);

— macro_get_open_repository (see 6.2.148);

— macro_get_schema_instance (see 6.2.149);

— macro_get_sdai_model_unset_mode (see 6.2.150);

— macro_get_sdai_model_read_only (see 6.2.151);

— macro_get_sdai_model_read_write (see 6.2.152);

— macro_get_sdai_model_read_write_different (see 6.2.153);

— macro_get_data_dictionary_model (see 6.2.154);

— macro_get_entity_extent (see 6.2.155);

— macro_check_extent_if_populated (see 6.2.156);

— macro_check_instance_if_values_unset (see 6.2.157);

— macro_compare_aggregates (see 6.2.158);

— macro_convert_primitive_to_aggregate (see 6.2.159);

— macro_clear_aggregate (see 6.2.160).

The *asp* function (see 6.2.161) is used to construct values of type assignable_primitive for testing.

Besides the abstract test operations defined in clause 7 the following procedures participate in the preparation for the verdict criteria used to establish the verdict:

— assert (see 6.2.162);

— check_instance (see 6.2.163);

— purpose (see 6.2.165);

— verdict (see 6.2.166).

The following procedures are used to generate the conformance log:

— atc (see 6.2.164);

— purpose (see 6.2.165);

— verdict (see 6.2.166);

— print (see 6.2.167).