

INTERNATIONAL STANDARD

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**Electronic railway equipment – Train communication network (TCN) –
Part 3-2: MVB (Multifunction Vehicle Bus) conformance testing**

**Matériel électronique ferroviaire – Réseau embarqué de train (TCN) –
Partie 3-2: Essais de conformité MVB (Bus de Véhicule Multifonctions)**



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRONIC RAILWAY EQUIPMENT –
TRAIN COMMUNICATION NETWORK (TCN) –****Part 3-2: MVB (Multifunction Vehicle Bus) conformance testing**

FOREWORD

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International Standard IEC 61375-3-2 has been prepared by IEC Technical Committee 9: Electrical equipment and systems for railways.

This first edition cancels the clauses of the IEC 61375-2 first edition published in 2007 relevant to the specification of MVB conformance testing and constitutes a technical revision.

It was prepared taking into account the IEC 61375-3-1 first edition.

The text of this standard is based on the following documents:

FDIS	Report on voting
9/1645/FDIS	9/1669/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 61375 series, under the general title *Electronic railway equipment – Train communication network (TCN)*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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INTRODUCTION

TCN is an International Standard with the aim of defining interfaces so as to achieve plug-in compatibility:

- a) between equipment located in different vehicles, and
- b) between equipment and devices located within the same vehicle.

One of the key success factors for the deployment of any technology is standardisation and ensuring interoperability among various implementations. To facilitate interoperability a conformance test should be implemented.

In this part of IEC 61375, the conformance testing of the MVB defined in IEC 61375-3-1 is specified.

This standard is structured into 5 clauses and 2 annexes.

The clauses and annexes are listed and briefly described in Table 1.

Table 1 – Document structure

Clause	Description
1 Scope	This clause describes the scope of this standard and.
2. Normative references	This clause contains a list of referred norms.
3 Terms and definitions	This clause introduces basic terms and abbreviations not reported in IEC 61375-3-1.
4 Conformance test: approach, requirements and boundaries	This clause is an overview of the methods of TCN implementation verification that are available to the developer and regulatory personnel. Supplies information concerning the ICS and IXITPro-forma(s).
5 Conformance test of an MVB device	This clause covers all tests on MVB devices that are grouped by classes, from Class 0 up to Class 4. The main contents are: the MVB PICS and PIXIT; the MVB test suites; the MVB test procedures.
6 Conformance test of RTP	This clause covers the conformance tests of real time protocols.
7 Conformance test of NM	This clause covers network management services' testing.
Annex A – Test laboratory role and client role	This annex is normative.
Annex B – Test instrumentation and dedicated test beds	This annex is informative.

ELECTRONIC RAILWAY EQUIPMENT – TRAIN COMMUNICATION NETWORK (TCN) –

Part 3-2: MVB (Multifunction Vehicle Bus) conformance testing

1 Scope

This part of IEC 61375 applies to all equipment and devices implemented according to IEC 61375-3-1, i.e. it covers the procedures to be applied to such equipment and devices when the conformance should be proven.

The applicability of this standard to a TCN implementation allows for individual conformance checking of the implementation itself and is a pre-requisite for further interoperability checking between different TCN implementations.

NOTE 1 An example of TCN implementation is given in UIC 556.

2 Normative references

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

IEC 60063: 1963, *Preferred number series for resistors and capacitors*
Amendment 1:1967
Amendment 2:1977

IEC 60571: *Electronic equipment used on rail vehicles*

IEC 60807 (all parts), *Rectangular connectors for frequencies below 3 MHz*

IEC 61375-2-1: *Electronic railway equipment – Train Communication Network (TCN) – Part 2-1: Wire Train Bus (WTB)*

IEC 61375-2-2: *Electronic railway equipment – Train Communication Network (TCN) – Part 2-2: Wire Train Bus conformance testing*

IEC 61375-3-1: *Electronic railway equipment – Train Communication Network (TCN) – Part 3-1: Multifunction Vehicle Bus (MVB)*

ISO/IEC 8482: 1993, *Information technology – Telecommunications and information exchange between systems – Twisted pair multipoint interconnections*

ISO/IEC 9646-1:1994, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 1: General concepts* (Also available as ITU-T Recommendation X.290 (1995))

ISO/IEC 9646-7:1995, *Information technology – Open Systems Interconnection – Conformance testing methodology and framework – Part 7: Implementation Conformance Statements* (Also available as ITU-T Recommendation X.296 (1995))

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 9646-1 and IEC 61375-3-1 apply.

4 Conformance test: approach, requirements and boundaries

4.1 Approach

This standard specifies a general methodology for testing the conformance to the TCN protocol standard of products in which the standard is claimed to be implemented.

This standard is organised into clauses structured into different phases of the conformance testing process, these phases being characterised by the following roles:

- a) the specification of abstract test suites for particular TCN protocols according to ISO/IEC 9646-1;
- b) the derivation of executable test suites and associated testing tools according to ISO/IEC 9646-7;

Annex A specifies the rules on clients and laboratory specifying:

- c) the role of a client of a test laboratory, having an implementation of TCN protocols to be tested;
- d) the operation of conformance testing, culminating in the production of a conformance test report which gives the results in terms of the test suite(s) used and the relevant documentation produced.

In all clauses of this standard, the scope is limited in order to meet the following objectives:

- e) to achieve an adequate level of confidence in the tests as a guide to conformance;
- f) to achieve comparability between the results of the corresponding tests applied in different places at different times;
- g) to facilitate communication between the parties responsible for the roles described above.

Each objective involves the framework for development of TCN test suites, as listed hereinafter:

- h) how they should relate to the various types of conformance requirement;
- i) the types of test to be standardised and the types not needing standardisation;
- j) the criteria for selecting tests for inclusion in a conformance test suite;
- k) the notation to be used for defining tests;
- l) the structure of a test suite.

Certification, an administrative procedure which may follow conformance testing, is outside the scope of this standard.

Requirements for procurement and contracts are outside the scope of this standard.

4.1.1 Requirements

4.1.1.1 General

In the context of TCN, a real system is said to exhibit conformance if it complies with the requirements of applicable TCN standard clauses in its communication with a reference system, i.e. the tester.

A TCN standard is a set of interrelated clauses which, together, define behaviour of TCN systems in their communication. Conformance of an IUT will, therefore, be expressed at two levels, conformance to each individual clause, and conformance to the set of clauses.

The following clauses define the conformance requirements and classify them according to attributes and into feasible groups. Attributes and grouping are defined from the general point of view with reference to a TCN specification itself and from the IUT point of view. In the second case, the requirement shall be declared in the appropriate PICS and PIXIT.

4.1.1.2 Conformance requirements

The conformance requirements can be:

- a) mandatory requirements: these are to be observed in all cases;
- b) conditional requirements: these are to be observed if the conditions, set out in the clause, apply;
- c) options: these can be selected to suit the implementation, provided that any requirements applicable to the option are observed.

TCN essential functionality are mandatory requirements; additional functionality can be either conditional or optional requirements.

Furthermore, conformance requirements in a Part can be stated:

- d) positively: they state what shall be done;
- e) negatively (prohibitions): they state what shall not be done.

Finally, conformance requirements fall into two groups:

- f) static conformance requirements;
- g) dynamic conformance requirements;

these are discussed in 4.1.1.3 and 4.1.1.4, respectively.

4.1.1.3 Static conformance requirements

To facilitate interoperability static conformance requirements define the allowed minimum capabilities of an implementation. These requirements may be at a broad level, such as the grouping of functional units and options into protocol classes, or at a detailed level, such as a range of values that have to be supported for specific parameters of timers.

Static conformance requirements and options in TCN parts can be of two varieties:

- a) those which determine the capabilities to be included in the implementation of the particular protocol;
- b) those which determine multi-layer dependencies, for example those which place constraints on the capabilities of the underlying layers of the system in which the protocol implementation resides. These are likely to be found in upper layer parts (e.g. network management vs real time protocols).

All capabilities not explicitly stated as static conformance requirements are to be regarded as optional.

4.1.1.4 Dynamic conformance requirements

Dynamic conformance requirements are all those requirements (and options) which determine what observable behaviour is permitted by the relevant TCN part in instances of communication. They form the bulk of each TCN protocol document. They define the set of allowable behaviours of an implementation or real system. This set defines the maximum

capability that a conforming implementation or real system can have within the terms of the TCN protocol document.

A system exhibits dynamic conformance in an instance of communication if its behaviour is a member of the set of all behaviours permitted by the relevant TCN protocol part in a way which is consistent with the PICS.

4.1.1.4.1 A conforming system

A conforming system or implementation is one which is shown to satisfy both static and dynamic conformance requirements, consistent with the capabilities stated in the PICS, for each protocol declared in the system conformance statement.

4.1.1.4.2 Interoperability and conformance

The primary purpose of conformance testing is to increase the probability that different implementations are able to inter-operate.

Successful interoperability of two or more real open systems is more likely to be achieved if they all conform to the same subset of a TCN part, or to the same selection of TCN parts, than if they do not.

To prepare two or more systems to successfully inter-operate, it is recommended that a comparison is made of the system conformance statements and PICSs of these systems.

If there is more than one version of a relevant TCN part indicated in the PICSs, the differences between the versions need to be identified and their implications for consideration, including their use in combination with other parts.

While conformance is a necessary condition, it is not on its own a sufficient condition to guarantee interoperability capability. Even if two implementations conform to the same TCN protocol part, they may fail to interoperate because of factors outside the scope of this standard.

Trial interoperability is recommended to detect these factors. Further information to assist interoperability between two systems can be obtained by extending the PICS comparison to other relevant information, including test reports and PIXIT. The comparison can focus on:

- a) additional mechanisms claimed to work around known ambiguities or deficiencies not yet corrected in the TCN standard or in peer real systems, for example solution of multi-layer problems;
- b) selection of free options which are not taken into account in the static conformance requirements of the TCN parts;
- c) the existence of timers not specified in the TCN parts and their associated values.

NOTE The comparison can be made between two individual systems, between two or more types of product, or, for the PICS comparison only, between two or more specifications for procurement, permissions to connect, etc.

4.1.2 Requirements declaration statements for an IUT

4.1.2.1 Protocol implementation conformance statement (PICS)

To evaluate the conformance of a particular implementation, it is necessary to have a statement of the capabilities and options which have been implemented, and any features which have been omitted, so that the implementation can be tested for conformance against relevant requirements, and against those requirements only. Such a statement is called a Protocol Implementation Conformance Statement (PICS).

In a PICS there should be a distinction between the following categories of information which it may contain:

- a) information related to the mandatory, optional and conditional static conformance requirements of the protocol itself;
- b) information related to the mandatory, optional and conditional static conformance requirements for multi-layer dependencies.

If a set of interrelated TCN protocol has been implemented in a system, a PICS is needed for each protocol. A system conformance statement will also be necessary, summarising all protocols in the system for each of which a distinct PICS is provided.

4.1.2.2 Protocol implementation extra information for testing (PIXIT)

In order to test a protocol implementation, the test laboratory will require information relating to the IUT and its testing environment in addition to that provided by the PICS. This "*Protocol Implementation eXtra Information for Testing*" (PIXIT) will be provided by the client submitting the implementation for testing, as a result of consultation with the test laboratory.

The PIXIT may contain the following information:

- a) information needed by the test laboratory in order to be able to run the appropriate test suite on the specific system (e.g. information related to the test method to be used to run the test cases, addressing information);
- b) information already mentioned in the PICS and which needs to be made precise (e.g. a timer value range which is declared as a parameter in the PICS should be specified in the PIXIT);
- c) information to help determine which capabilities stated in the PICS as being supported are testable and which are untestable;
- d) other administrative matters (e.g. the IUT identifier, reference to the related PICS).

The PIXIT should not conflict with the appropriate PICS.

The abstract test suite specifier, test implementor and test laboratory will all contribute to the development of the PIXIT pro-forma.

4.2 Boundaries

4.2.1 General

Conformance testing as discussed in this standard is focused on testing for conformance to TCN clauses as they are specified in IEC 61375-3-1.

In principle, the objective of conformance testing is to establish whether the implementation being tested conforms to the specification in the relevant clause. Practical limitations make it impossible to be exhaustive, and economic considerations may restrict testing still further.

Therefore, this standard distinguishes four types of testing, according to the extent to which they provide an indication of conformance:

- a) basic interconnection tests, which provide *prima facie* evidence that an IUT conforms;
- b) capability tests, which check that the observable capabilities of the IUT are in accordance with the static conformance requirements and the capabilities claimed in the PICS;
- c) behaviour tests, which endeavour to provide testing which is as comprehensive as possible over the full range of dynamic conformance requirements within the capabilities of the IUT;

- d) conformance resolution tests, which probe in depth the conformance of an IUT to particular requirements, to provide a definite yes/no answer and diagnostic information in relation to specific conformance issues; such tests are not covered by this standard.

Tests a), b), c) and d) are described in detail in the following subclauses.

Relations to interoperability and performance are hereinafter considered and defined to clarify their boundaries.

4.2.2 Basic interconnection tests

Basic interconnection tests provide limited testing of an IUT to establish that there is sufficient conformance for interconnection to be possible, without trying to perform thorough testing.

4.2.2.1 Applicability of basic interconnection tests

Basic interconnection tests are appropriate:

- a) for detecting severe cases of non-conformance;
- b) as a preliminary filter before undertaking more costly tests;
- c) to give a prima facie indication that an implementation which has passed full conformance tests in one environment still conforms in a new environment (e.g. before testing an (N)-implementation, to check that a tested (N – 1)-implementation has not undergone any severe change due to being linked to the (N)-implementation);
- d) for use by users of implementations, to determine whether the implementations appear to be usable for communication with other conforming implementations, for example as a preliminary to data interchange.

Basic interconnection tests are inappropriate:

- e) as a basis for claims of conformance by the supplier of an implementation;
- f) as a means of arbitration to determine causes for communications failure.

Basic interconnection tests are standardised a subset of a conformance test suite (including capability and behaviour tests). They can be used on their own or together with a conformance test suite. The existence and execution of basic interconnection tests are optional.

4.2.3 Capability tests

Capability tests provide limited testing of each of the static conformance requirements in a Part, to ascertain what capabilities of the IUT can be observed and to check that those observable capabilities are valid with respect to the static conformance requirements and the PICS.

4.2.3.1 Applicability of capability tests

Capability tests are appropriate:

- a) to check as far as possible the consistency of the PICS with the IUT;
- b) as a preliminary filter before undertaking more in-depth and costly testing;
- c) to check that the capabilities of the IUT are consistent with the static conformance requirements;
- d) to enable efficient selection of behaviour tests to be made for a particular IUT;
- e) when taken together with behaviour tests, as a basis for claims of conformance.

Capability tests are inappropriate:

- f) on their own, as a basis for claims of conformance by the supplier of an implementation;
- g) for testing in detail the behaviour associated with each capability which has been implemented or not implemented;
- h) for resolution of problems experienced during live usage or where other tests indicate possible non-conformance even though the capability tests have been satisfied.

Capability tests are standardised within a conformance test suite. They can either be separated into their own test group(s) or merged with the behaviour tests.

4.2.4 Behaviour tests

Behaviour tests test an implementation as thoroughly as is practical, over the full range of dynamic conformance requirements specified in a Part. Since the number of possible combinations of events and timing of events is infinite, such testing cannot be exhaustive. There is a further limitation, namely that these tests are designed to be run collectively in a single test environment, so that any faults which are difficult or impossible to detect in that environment are likely to be missed. Therefore, it is possible that a non-conforming implementation passes the conformance test suite; one aim of the test suite design is to minimise the number of times that this occurs.

Behaviour tests with capability tests are the basis for the conformance assessment process.

Behaviour tests are inappropriate:

- a) for resolution of problems experienced during live usage or where other tests indicate possible non-conformance even though the behaviour tests have been satisfied.

Behaviour tests are standardised as the bulk of a conformance test suite.

NOTE Behaviour tests include tests for valid behaviour by the IUT in response to valid, inopportune and syntactically invalid protocol behaviour by the real tester. This includes testing the rejection by the IUT of attempts to use features (capabilities) which are stated in the PICS as being not implemented. Thus, capability tests do not need to include tests for capabilities omitted from the PICS.

4.2.5 Conformance resolution tests

Conformance resolution tests provide diagnostic answers, as near to definitive as possible, to the resolution of whether an implementation satisfies particular requirements. Because of the problems of exhaustiveness, the definite answers are gained at the expense of confining tests to a narrow field.

The test architecture and test method will normally be chosen specifically for the requirements to be tested, and need not be ones that are generally useful for other requirements. They may even be ones that are regarded as being unacceptable for (standardised) abstract conformance test suites, for example involving implementation-specific methods using, say, the diagnostic and debugging facilities of the specific operating system.

The distinction between behaviour tests and conformance resolution tests may be illustrated by the case of an event such as a reset. The behaviour tests may include only a representative selection of conditions under which a reset might occur, and may fail to detect incorrect behaviour in other circumstances. The conformance resolution tests would be confined to conditions under which incorrect behaviour was already suspected to occur, and would confirm whether or not the suspicions were correct.

Conformance resolution tests are appropriate:

- a) for providing a yes/no answer in a strictly confined and previously identified situation (e.g. during implementation development, to check whether a particular feature has been correctly implemented, or during operational use, to investigate the cause of problems);

- b) as a means for identifying and offering resolutions for deficiencies in a current conformance test suite.

Conformance resolution tests are inappropriate:

- c) as a basis for judging whether or not an implementation conforms overall.

Conformance resolution tests are not standardised. As a by-product of conformance testing, errors and deficiencies in protocol parts may be identified.

4.2.6 Interpretation of clauses/subclauses and statements

The TCN described in IEC 61375-3-1 is subject to a sort of interpretation to translate some clauses/subclauses and requirements into realisable test suites. The complexity of most TCN protocols makes exhaustive testing impractical on both technical and economic grounds. To cope with a real implementation and extract from IEC 61375-3-1 all the relevant tests and some criteria were used. The criteria were grouped according to their characteristics:

- a) imperatives;
- b) illustrative;
- c) directives;
- d) options;
- e) weak phrases.

The following subclauses describe the criteria.

4.2.6.1 Imperatives

Imperatives are those words and phrases commanding that something shall be provided and are classified as mandatory. They are:

- a) **shall** – dictates the provision of a functional capability;
- b) **must** or **must not** – establishes performance requirements or constraints;
- c) **is required to** – is a specification statement written in the passive voice;
- d) **are applicable** – includes, by reference, standards or other documentation as an addition to the requirements being specified;
- e) **responsible for** – is a requirement written for architectures already defined. As an example, " In extended reply delay applications, the master is responsible for spacing the master frames so that the minimum time to transmit to a slave frame and the following master frame is greater than T_{safe}..";
- f) **will** – is generally used to cite things that the operational or development environment are to provide to the capability being specified. For example, " If it was a strong master, it will signal its demoting to all nodes and it will remain in control of the bus as a weak master until a strong node is appointed";
- g) **should** – when it is used, the specification statement is considered to be very weak. For example, " Devices supporting the message data capability should have a device address smaller than 256.".

Continuance

Phrases that follow an imperative and introduce the specification of requirements at a lower level, for a supplemental requirement count.

- a) as follows,
- b) below,
- c) following,

- d) in particular,
- e) listed,
- f) support.

Phrases that introduces temporal indication, that may lead to definite or indefinite actions, or enumerative that may lead to infinite test cases. See Table 2.

Table 2 – Continuance indication

	Statement	Example
1	for each	A PV_Set identifies a set of variables belonging to the same dataset, including for each variable the Memory_Address where it should be copied to (or from), and including for the whole dataset the Freshness_Time.)
2	while	While sending BD packets, the producer filters incoming BR packets and starts retransmission after insertion of a transmission pause (PAUSE_TMO in addition to the normal SEND_TMO)

The requirement containing temporal or enumerative is tested with a finite time or finite sample.

4.2.6.2 Illustrative

This is information within the requirements document. The data and information pointed to by illustrative strengthen the document's specification statements and whenever possible are used as sample category input for the test. Namely:

- a) **figure**;
- b) **table**;
- c) **example**;
- d) **note**.

4.2.6.3 Options

Options is the category of words that give the developer latitude in satisfying the specification statements that contain them. This category clearly forms the basis for the option statements declaration into the PICS. However, those requirements containing such a category of words loosen the specification, increase the risk of non-interoperability, and widen the tests sets.

- a) **can** (Example: Gateways with Bus_Administrator capability can synchronise the busses.);
- b) **may** (Example: Class 5 devices may offer the Bus_Administrator capability.);
- c) **optionally** (Example: The User_Programmable capability is optional.);
- d) **exclusion** (Example: while the IUT is naming the nodes, one node responds to the naming frame but not to the status request, or sends a wrong naming response frame).

Options shall drive the PICS production.

4.2.6.4 Weak statements

Weak statements are apt to cause uncertainty leaving room for multiple interpretations, such wording provides a basis for expanding a requirement or adding future requirements. For the extent of testing, this category generates test with test cases chosen among a representative set of samples. However, by no means such sets fully represent all significant cases foreseen by the clause under test. They are as shown in Table 3.

Table 3 – Weak statements

Phrases with	Example
adequate	The transmitter and the receiver connector shall be <i>adequately</i> identified, preferably: • light grey for the transmitter; • dark grey for the receive.
be able to	The link layer as well as the application shall <i>be able to</i> access a port consistently, i.e. write or read all its data in one indivisible operation
be capable	A device with double-line attachment shall <i>be capable</i> of being attached to both a single-line or to a double-line EMD segment, as shown in Figure 56
effective	The entity which <i>effectively</i> accesses the objects in each layer is called the Layer Management Entity, or LME
normal	While sending BD packets, the producer filters incoming BR packets and starts retransmission after insertion of a transmission pause (PAUSE_TMO in addition to the <i>normal</i> SEND_TMO.
provide for	The Application Layer for Variables (AVI) shall <i>provide for</i> Cluster access the following primitives, illustrated in Figure 14 and specified in the following subclauses

4.2.7 Relation to interoperability

One of the aims of this conformance test is to lead to comparability and wide acceptance of test results produced by different testers, and thereby minimise the need for repeated conformance testing of the same system. Interoperability plays a principal role, since the conformance test is aimed to facilitate interoperability, it has been taken into account with the domains shown in Table 4:

Table 4 – Relation to interoperability

Application interoperability	the ability of TCN to provide a consistent implementation of the syntax and semantics of the data which are interchanged
Protocol interoperability	the ability of TCN to interchange PDUs via the communications platform
Service interoperability	the ability of TCN to support a subset of its intended services
User perceived interoperability	the ability of the service user (human, application, machine) to exchange information via the TCN

No provision is made in this standard to implement or recommend an interoperability test.

4.2.8 Relation to performance test

Performance attributes relate deeply on services given by the TCN, even though this conformance test does not intend to implement a performance test, nevertheless performance attributes were taken into account in the way shown in Table 5:

Table 5 – Relation to performance test

Speed	This performance attribute describes the time interval that is used to perform the function or the rate at which the function is performed. (The function may or may not be performed with the desired accuracy.). An example of speed attribute evaluation is: freshness time supervision test
Accuracy	This performance attribute describes the degree of correctness with which the function is performed, no matter if the function is or is not performed with the desired speed. An example of accuracy evaluation is: the receiver hysteresis test
Dependability	This performance attribute describes the degree of certainty (or surety) with which the function is performed regardless of speed or accuracy, but within a given observation interval. An example of dependability attribute evaluation is: Connection stability for the entire inauguration time

No provision is made in this standard to implement or recommend a performance test as it is defined by IEC 60571.

4.3 Conformance assessment process outline

4.3.1 General

The main feature of the conformance assessment process is a configuration of equipment allowing exchanges of information between the IUT and a real tester. These are controlled and observed by the real tester.

In a conceptual outline, conformance testing should include several steps, involving both static conformance reviews and live testing phases, culminating in the production of a test report which is as thorough as is practical.

These steps are:

- compilation of the PICS;
- compilation of the PIXIT;
- test selection and parameterisation;
- basic interconnection testing (optional);
- capability testing;
- behaviour testing;
- review and analysis of test results;
- synthesis, conclusions and conformance test report production.

4.3.2 Analysis of results, outcomes and verdicts

The observed outcome (of the test execution) is the series of events which have occurred during execution of a test case; it includes all input to and output from the IUT at the points of control and observation.

The foreseen outcomes are identified and defined by the abstract test case specification taken in conjunction with the protocol Part. For each test case, there may be one or more foreseen outcomes. Foreseen outcomes are defined primarily in abstract terms.

A verdict is a statement of pass, fail or inconclusive to be associated with every foreseen outcome in the abstract test suite specification.

The analysis of results is performed by comparing the observed outcomes with foreseen outcomes.

The verdict assigned to an observed outcome is that associated with the matching foreseen outcome. If the observed outcome is unforeseen then the abstract test suite specification will state what default verdict shall be assigned.

The means by which the comparison of the observed outcomes with the foreseen outcomes is made is outside the scope of this standard.

NOTE Amongst the possibilities are:

- a) manual or automated comparison (or a mixture);
- b) comparison at or after execution time;
- c) translating the observed outcomes into abstract terms for comparison with the foreseen outcomes or translating the foreseen outcomes into the terms used to record the observed outcomes.

The verdict will be pass, fail or inconclusive:

- d) pass means that the observed outcome satisfies the test purpose and is valid with respect to the relevant TCN Parts and with respect to the PICS;
- e) fail means that the observed outcome is syntactically invalid or inopportune with respect to the relevant TCN Parts or the PICS;
- f) inconclusive means that the observed outcome is valid with respect to the relevant TCN Parts but prevents the test purpose from being accomplished.

The verdict assigned to a particular outcome will depend on the test purpose and the validity of the observed protocol behaviour.

The verdicts made in respect of individual test cases will be synthesised into an overall summary for the IUT based on the test cases executed.

5 Conformance test of an MVB device

5.1 PICS

PICS pro-forma is a set of tables containing questions to be answered by an implementer, and limitations on the possible answers.

It contains two types of questions:

- questions to be answered by either "YES" or "NO", related to whether a clause (ranging from a macroscopic functional unit to a microscopic one) has been implemented or not. The allowed answers, which reflect the base specification, are documented in the PICS as requirement; the answers constitute the support;
- questions on numerical values implemented (for timers, for sizes of messages, for frequencies, etc.). The legitimate range of variation of this value, which reflects the base specification, is given in IEC 61375-3-1. The answers constitute the supported values.

5.1.1 Instructions for filling the PICS pro-forma

PICS are organised in tables. Columns in the tables are:

- Ref.
- Supported subclause
- Supported capability
- Requirement
- Implementation
- Parameter values

5.1.1.1 Abbreviations

The following abbreviations are used in this PICS pro-forma:

- m:** mandatory
- n/a:** not applicable
- o:** optional
- c:** conditional
- d:** default
- Y:** yes
- N:** no

5.1.1.2 Ref. column

This column is used for reference purposes inside the PICS

5.1.1.3 Supported subclause column

This column gives the mapping between IEC 61375-3-1 and the corresponding entry in the PICS.

5.1.1.4 Supported capability column

The capability is supported if the Implementation Under Test (IUT) is able to:

- generate the corresponding service parameters (either automatically or because the end user explicitly requires that capability);
- interpret, handle and when required make available to the end user the corresponding service parameter(s).

5.1.1.5 Requirement column

This column indicates the level of support required for conformance to IEC 61375-3-1.

The values are as follows:

- m mandatory support is required;
- o optional support is permitted for conformance to the IEC 61375-3-1. If implemented it shall conform to the specifications and restrictions contained in the relevant clause. These restrictions may affect the optionality of other items;
- c the item is conditional, the support of this item is subject to a predicate which is referenced in the note column;
- n/a the item is not applicable.

If options are not supported the corresponding items shall be considered as not applicable.

5.1.1.6 Implementation column

This column shall be completed by the supplier or implementer of the IUT. The pro-forma has been designed so that the only entries required in its own column are:

- Y:** yes, the item has been implemented;
- N:** no, the item has not been implemented;
- :** the item is not applicable.

In the PICS pro-forma tables, every leading item marked 'm' should be supported by the IUT. Sub-items marked 'm' should be supported if the corresponding leading feature is supported by the IUT.

5.1.1.7 Parameter values columns

5.1.1.7.1 Allowed min.

This column is already filled and indicates the minimum value for a parameter.

5.1.1.7.2 Default value

This column indicates the default value for a parameter. When IEC 61375-3-1 defines the default for the parameter, such a value is used as the entry in this column. When the standard recommends a range, the mean value is used.

5.1.1.7.3 Allowed max.

This column is already filled and indicates the maximum value for a parameter.

5.1.1.7.4 Implemented value

This column shall be completed by the supplier or implementer. The pro-forma has been designed so that the entry required is the implemented value. In case of multiple values, the default value shall be chosen.

5.1.2 PICS tables**5.1.2.1 Identification of PICS**

The following table is intended to be filled in order to identify the pro-forma.

Ref. No.	Question	Response
1	Date of statement	
2	PICS serial number	

5.1.2.2 Identification of the implementation under test

The following table shall be filled in to identify the implementation under test.

Ref. No.	Question	Requirement	Response
1.	Implementation name	m	
2.	Version number	m	
3.	Special configuration	o	
4.	Power supply	m	
5.	Other information	o	

NOTE 1 Implementation name refers to the identifier of the IUT as indicated by the client. The specific conformance test shall be applied to the entity identified by the implementation name.

NOTE 2 This is the version number of the IUT.

NOTE 3 The special configuration should be indicated if PIXIT is provided for this IUT.

NOTE 4 The power supply should be indicated the applicable power supply. The power supply is chosen amongst the values specified by EN 50155.

NOTE 5 Other information the client considers relevant for IUT identification.

5.1.2.3 Identification of the IUT supplier and/or test laboratory client

The following table shall be filled in to identify the IUT supplier and the test laboratory client.

Ref. No.	Question	Requirement	Response
1.	Organisation name	m	
2.	Contact name(s)	m	
3.	Address:	m	
4.	Telephone number ^a	m	
5.	Fax number ^a	m	
6.	e-mail address ^a	m	
7.	Other information ^a	m	

^a Fill in if the information is available.

5.1.2.4 Identification of the standard

The following table shall be filled in to identify the standard applied to the IUT for the conformance test.

Ref. No.	Question	Requirement	Response
1	Title	m	
2	Reference number	m	
3	Date of publication	m	
4	Version number	m	

5.1.2.5 Global statement of conformance

This table shall be filled in by the IUT supplier in the “Implementation” column

Ref. No.	Question	Requirement	Implementation
1	Are all mandatory capabilities implemented?	m	[]

NOTE Answering "No" to this subclause indicates non-conformance to the protocol specification. Non-supported mandatory capabilities are to be identified in the PICS, with an explanation of why the implementation is non-conforming.

5.1.2.6 Device classes

This table shall be filled in by the IUT supplier in order to identify the device class of the IUT. An IUT implementing more than one class shall test each interface to determine to which class it belongs.

Ref. No.	Subclause	Capability	Implementation
1	4.2.2	Class 0	[]
2	4.2.3	Class 1	[]
3	4.2.4	Class 2	[]
4	4.2.5	Class 3	[]
5	4.2.6	Class 4	[]
6	4.2.7	Class 5	[]

5.1.2.7 Class 0

This table shall be filled in by the IUT supplier if the device class declared in the “Device classes” table is Class 0.

Ref. No.	Subclause)	Capability	Implementation
1	4.6.7	Active_Star_Coupler	[]
2	4.6.7 (refer to NOTE)	Star_coupler	[]
3	4.3	Repeater	[]
4	4.4.3.1	ESD backplane	[]
5	4.4.2.1	ESD cable	[]
6	4.5.2.1	EMD cable	[]

5.1.2.8 Class 1

This table shall be filled by the IUT supplier if the device class declared in the “Device classes” table is Class 1.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.2.3	Device status	m	[]
2	4.2.3	Process data	m	[]

5.1.2.9 Class 2

This table shall be filled in by the IUT supplier if the device class declared in the “Device classes” table is Class 2.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.2.4	Device status	m	[]
2	4.2.4	Process data	m	[]
3	4.2.4	Message data	m	[]
4	4.2.1	Network management (TNM)	m	[]

5.1.2.10 Class 3

This table shall be filled in by the IUT supplier if the device class declared in the “Device classes” table is Class 3.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.2.5	Device status	m	[]
2	4.2.5	Process data	m	[]
3	4.2.5	Message data	m	[]
4	4.2.5	User programmable	m	[]
5	4.2.1	Network management (TNM)	m	[]

5.1.2.11 Class 4

This table shall be filled in by the IUT supplier if the device class declared in the “Device classes” table is Class 4.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.2.6	Device status	m	[]
2	4.2.6	Process data	m	[]
3	4.2.6	Message data	m	[]
4	4.2.6	User programmable (TNM)	o	[]
5	4.2.6	Bus administrator	m	[]
6	4.2.1	Network management (TNM)	m	[]

5.1.2.12 Class 5

This table shall be filled in by the IUT supplier if the device class declared in the “Device classes” table is Class 5.

Note that the test of the TCN gateway is not covered by this standard due to incomplete specification in IEC 61375-1.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.2.7	Device status	m	[]
2	4.2.7	Process data	m	[]

Ref. No.	Subclause	Capability	Requirement	Implementation
3	4.2.7	Message data	m	[]
4	4.2.7	User programmable	o	[]
5	4.2.7	Bus administrator	o	[]
6	4.2.7	TCN gateway ^a	m	[—]

^aThis test is purposely crossed out to make evidence that TCN gateway test is not covered.

5.1.2.13 Segment

This table shall be filled in by the IUT supplier to declare which type of bus segment the device is designed to be attached to.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.1.1	ESD	o	[]
2	4.1.1	OGF ^a	e	[—]
3	4.1.1	EMD	o	[]

NOTE One of the given capabilities should be chosen and for the conformance test purpose, the chosen capability is considered mandatory (m).

^a This test is purposely crossed out to make evidence that OGF is not covered.

5.1.2.14 Redundancy

This table shall be filled by the IUT supplier to declare if the IUT implements the double-segment attachment and line redundancy.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.1.3	Physical redundancy media	o	[]

5.1.2.15 Redundancy configuration

This table shall be filled in by the IUT supplier if in the previous table, column "Implementation", the implementation is Y.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.5.4.2	Is line A marked?	m	[]
2	4.5.4.2	Is line B marked?	m	[]

5.1.2.16 Device address

This table shall be filled in by the IUT supplier declaring the device address of the IUT as supplied for this test.

Ref. No.	Subclause	Capability	Requirement	Implementation value
1	7.1.1	Device_Address	m	

5.1.2.17 Timing general values

This table shall be filled in by the IUT supplier who shall declare the implementation values of the Timing General Values.

All boundaries are derived from the IEC 61375-3-1 and they refer to the ALLOWED range.

Ref. No.	Sub-clause	Capability	Requirement	Allowed min.	Default value	Allowed max.	Implementation
1	4.3.2 6.2.2	T_reply_max	m	T_reply_def = 42,7 μs.	T_reply_def = 42,7 μs.	T_reply_def = 66,6 μs.	
2	6.2.4.1	T_ignore	m	T_ignore = 1 μs.	T_ignore = T_reply_def	T_ignore = 255 μs.	
3	6.2.5	T_alive	m	T_alive = 1,3 ms	T_alive = 1,3 ms	-	
4	6.2.4.1	T_safe	m	T_safe = T_reply_def	T_safe = T_reply_def	-	

5.1.2.18 Additional timing for Classes 4 and 5 only

This table shall be filled in by the IUT supplier who shall declare the implementation values of the scan rate value. The IUT supplier shall declare the tolerance, expressed as a percentage of the declared value. This table applies only to Class 4 and Class 5 devices.

Ref. No.	Subclause	Capability	Requirement	Default value	Implementation
1	8.4.3	Scan Rate	m	Scan Rate = 64 devices every 512,0 ms.	

5.1.2.19 Network manager agent services

This table shall be filled in by the IUT supplier who shall declare the network manager agent services implemented.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	8.4.2.4.2 of IEC 61375-2-1	WRITE_RESERVATION (03)	m	[]
2	8.4.3.1 of IEC 61375-2-1	READ_MVB_STATUS (10)	m	[]
3	8.4.3.3 of IEC 61375-2-1	READ_MVB_DEVICES (12)	m	[]

5.1.2.20 ESD section option

This subclause applies only if the response Y is given at the line referred to as 1 in 5.1.2.13. One of the given capabilities should be chosen and for the conformance test purpose the chosen capability is considered mandatory (m) .

Ref. No.	Subclause	Capability	Requirement	Implementation
1		Backplane bus used	o	[]
2		Cable used	o	[]

5.1.2.20.1 ESD backplane

This subclause applies only if the response Y is given at the line referred to as 1 in the tables of 5.1.2.20 and 5.1.2.7 reference 0.

Ref. No.	Subclause	Capability	Requirement	Allowed min.	Allowed max.	Implementation
1	4.4.3.1	Extension of a stub	c – 5.1.2.20 Ref. 1	-	10 cm.	[]
2	4.4.3.1	Pitch between adjacent taps	c – 5.1.2.20 Ref. 1	2,0 cm.	20 m.	[]

5.1.2.20.2 ESD cable

This subclause applies only if the response Y is given at the line referred to as 2 in the table of 5.1.2.20.

Ref. No.	Subclause	Capability	Requirement	Allowed min.	Allowed max.	Implementation
1	4.4.3.2	Equipotential wire	c – 5.1.2.20 Ref. 2	0,34 mm ² (AWG 22)	0,56 mm ² (AWG 20)	[]

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.4.3.1	Equipotential wire identification for LINE_A	c – 5.1.2.20 Ref. 2	[]
2	4.4.3.1	Equipotential wire identification for LINE_B	c – 5.1.2.20 Ref. 2	[]

5.1.2.20.2.1 ESD cable confectioned

Ref. No.	Clause	Capability	Requirement	Implementation
1	4.4.4	Shield connected to the casing of each connector	c – 5.1.2.20 Ref. 2	[]
2	4.4.4	Shield connected to the casing of each conductive connector	c – 5.1.2.20 Ref. 2	[]

5.1.2.20.3 ESD load

This subclause applies anyway if the response Y is given at the line referred to as 1 or 2 in the table of 5.1.2.20. This part is a declaration by the client, not subject to testing.

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.4.6.2	Conform to ISO/IEC 8482 (RS-485).	m	[]

5.1.2.21 ESD connector

This table shall be filled in by the IUT supplier who shall declare how the connection to the ESD segment is implemented.

5.1.2.21.1 Cable side

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.4.5.2	Line_A 9-pin and LINE_B Sub-D 9 connectors using metric screws (IEC 60807)	m	[]
2	4.4.5.2	Connector_1 Cable female	m	[]
3	4.4.5.2	Connector_2 Cable male	m	[]
4	4.4.5.2	Shielding	m	[]
5	4.4.5.2	Conductive casing connected to the cable shield	m	[]
6	4.4.5.2	Makes an electrical contact with the receptacle when fastened	m	[]

5.1.2.22 Receptacle side

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.4.5.2	Line_A and Line_B use 9 pin Sub-D 9 receptacle called mVB-S1	m	[]
2	4.4.5.2	MVB-S1 receptacle has metric screws (IEC 60807)	m	[]
3	4.4.5.2	MVB-S1 receptacle male	m	[]

Ref. No.	Subclause	Capability	Requirement	Implementation
4	4.4.5.2	Line_A and Line_B use 9 pin Sub-D 9 receptacle called mVB-S2	m	[]
5	4.4.5.2	MVB-S2 receptacle has metric screws (IEC 60807)	m	[]
6	4.4.5.2	MVB-S2 receptacle female	m	[]
7	4.4.5.2	Shielding	m	[]
8	4.4.5.2	Conductive casing connected to the cable shield	m	[]
9	4.4.5.2	Makes an electrical contact with the receptacle when fastened	m	[]

5.1.2.23 EMD section

This subclause applies only if the response Y is given at the line referred to as item 3) in 5.1.2.13.

5.1.2.23.1 EMD cable

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.5.4.1	Shielded cable	m	[]
2	4.5.4.1	Jacketed cable	m	[]
3	4.5.4.1	Twisted pair	m	[]
4	4.5.4.2	Individual wires marked distinctly ^a	m	[]
5	4.5.4.2	Line A identified as: A.Data_P A.Data_N	m	[]
6	4.5.4.2	Line B identified as: B.Data_P B.Data_N	m	[]

^aThe two pairs of wires may be geometrically laid out as a quadruple, in this case, diagonal wires should form one pair.

Ref. No.	Subclause	Capability	Requirement	Allowed min.	Allowed max.	Implementation
1	4.5.4.1	Cross-section wire	m	0,34 mm ² (AWG 22)	0,56 mm ² (AWG 20)	[]
2	4.5.4.1	Twist per metre		12	-	[]

Ref. No.	Subclause	Capability	Requirement	Value	Implementation
1	4.5.4.3	Impedance	m	Zw = 120,0 Ω (±10 %) between 0,5 BR and 2,0 BR	[]
2	4.5.4.4	Attenuation	m	Less than 15,0 dB/km at 1,0 BR	[]
3	4.5.4.4	Attenuation	m	Less than 20,0 dB/km at 2,0 BR	[]
4	4.5.4.5	Distributed capacitance	m	Less than 46 pF/m at 1,0 BR	[]
5	4.5.4.6	Capacitive unbalance to shield	m	Less than 1,5 pF/m at 1,0 BR	[]
6	4.5.4.7	Crosstalk	m	Greater than 45,0 dB between 0,5 to 2,0 MHz	[]
7	4.5.4.8	Transfer impedance	m	Less than 20,0 mΩ/m at 20,0 MHz	[]
8	4.5.4.8	Differential transfer impedance	m	Less than 2,0 mΩ/m at 20,0 MHz	[]
9	4.5.4.9	Continuity of wires	m	Less than 10,0 mΩ/m	[]

5.1.2.23.2 EMD line attachment

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.5.6.1	Passive tap attachment	m	[]
2	4.5.5.1	Shield continuity	m	[]
3	4.5.5.1	Case of device connected to receptacle	m	[]
4	4.5.5.1	Means to connect the shield to its device ground	m	[]
5	4.5.6.2	Double-line attachment	o	[]

Ref. No.	Subclause	Capability	Requirement	Allowed min.	Allowed max.	Implementation
1	4.5.6.1	Length of stub	m	-	10,0 cm	[]

5.1.2.23.3 EMD connector

The following cable side and receptacle side tables shall be filled by the IUT supplier who shall declare how the connection to the EMD segment is implemented.

5.1.2.23.3.1 Cable side

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.5.6.3	Line_A and Line_B are on 9-pin Sub-D9 connectors called Connector_1	m	[]
2	4.5.6.3	Connector_1 has metric screws (IEC 60807)	m	[]
3	4.5.6.3	Connector_1 male	m	[]
4	4.5.6.3	Line_A and Line_B are on 9-pin Sub-D9 connectors called Connector_2	m	[]
5	4.5.6.3	Connector_2 has metric screws (IEC 60807)	m	[]
6	4.5.6.3	Connector_2 female	m	[]
6a	4.5.6.3.1	Connector_2 male	o	[]
7	4.5.6.3	Shielding	m	[]
8	4.5.6.3	Conductive casing connected to the cable shield	m	[]
9	4.5.6.3	Makes an electrical contact with the receptacle when fastened	m	[]

Ref. No.	Subclause	Capability	Requirement	Value	Implementation
1	4.5.4.9	Transfer impedance	m	Less than 20,0 mΩ/m at 20,0 MHz	[]

5.1.2.23.3.2 Receptacle side

Ref. No.	Subclause	Capability	Requirement	Implementation
1	4.5.6.3	Line_A and Line_B 9-pin Sub-D 9 receptacle called mVB-M1	m	[]
2	4.5.6.3	MVB-M1 has metric screws (IEC 60807)	m	[]
3	4.5.6.3	MVB-M1 is female	m	[]
4	4.5.6.3	Line_A and Line_B 9-pin Sub-D 9 receptacle called mVB-2	m	[]
5	4.5.6.3	MVB-M2 has metric screws (IEC 60807)	m	[]
6	4.5.6.3	MVB-M2 is male	m	[]
7	4.5.6.3	Shielding	m	[]
8	4.5.6.3	Conductive casing connected to the cable shield	m	[]

Ref. No.	Subclause	Capability	Requirement	Implementation
9	4.5.6.3	Makes an electrical contact with the receptacle when fastened	m	[]

Ref. No.	Subclause	Capability	Requirement	Value	Implementation
1	4.5.4.9	Transfer impedance	m	Less than 20,0 mΩ/m at 20,0 MHz	[]

5.2 Test suites

This subclause specifies the test suites to be applied to an MVB device to assess its conformance. There are three main groups of test suites:

- basic interconnection tests;
- capability tests;
- behavioural tests.

Physical layer testing requires manipulation of signal amplitude and signal timing. To reduce the effort of adapting existing generators, either frame or telegram generators, or creating ad-hoc frame generators, the idea for testing the electrical part of the physical layer is to use a test equipment derived from a reference medium attachment unit followed by a waveshaper. The waveshaper samples the signal coming from the test equipment and generates the required conditions to stimulate the IUT. See Figure 1.

The waveshaper shall sample the incoming bit sending out an outgoing bit:

- with the amplitude changed as required by the test;
- with the rise time changed as required by the test;
- with the fall time changed as required by the test;
- with the jitter as required by the test.

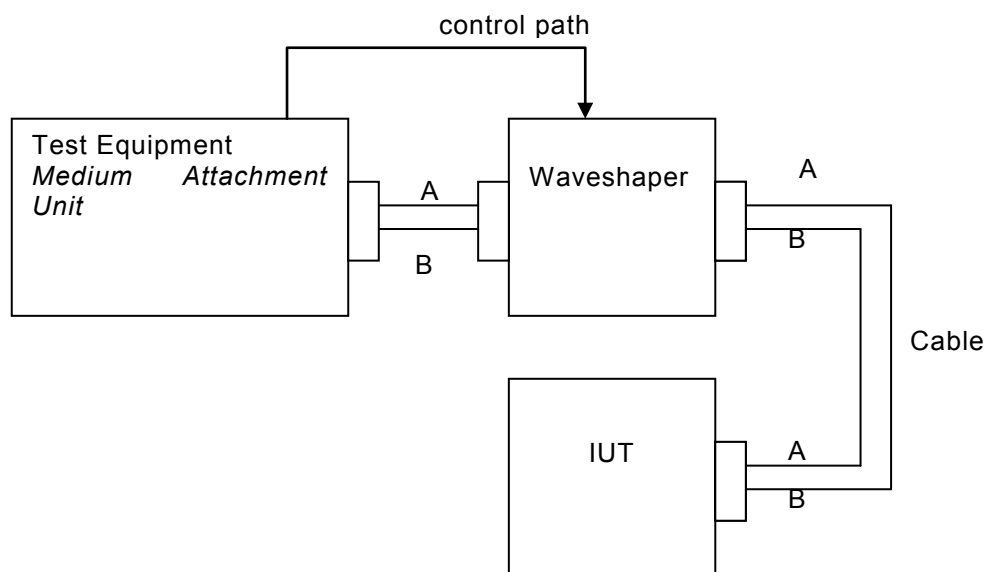


Figure 1 – Application of the waveshaper

5.2.1 Basic interconnection tests

The basic interconnection tests are a subset of the behavioural tests. The following two subclauses list the relevant clauses of the behavioural test that constitute the basic

interconnection tests in the case of an MVB device using respectively ESD and EMD attachment.

5.2.1.1 ESD basic interconnection tests

The following table lists the relevant clause to be applied to the ESD basic interconnection tests.

Table 6 – ESD basic interconnection tests

Subclause to be applied	
5.2.4.1	ESD test layout
5.2.4.2	ESD identification
5.2.4.3.2	ESD connector
5.2.6.1.1	Requirements
5.2.6.1.2.1	Device status protocol
5.2.6.1.2.8	Capabilities field
5.2.7.1	Simple test

5.2.1.2 EMD basic interconnection tests

The following table lists the relevant clause to be applied to the EMD basic interconnection tests.

Table 7 – EMD basic interconnection tests

Subclause to be applied	
5.2.5.1.1	Resistance test
5.2.5.1.4	Measurement of the signal waveform during transmission
5.2.5.1.5	Receiver behaviour test threshold set to 200 mV
5.2.6.1.1	Requirements
5.2.6.1.2.1	Device status protocol
5.2.6.1.2.8	Capabilities field
5.2.7.1	Simple test

5.2.2 Capability tests

The capability tests consist of activities:

- to check the consistency of the PICS against the declared values into the PICS themselves, as a preliminary filter before undertaking more in-depth and costly testing;
- to check that the capabilities of the IUT are consistent with the static conformance requirements specified by this standard and IEC 61375-3-1;
- to enable efficient selection of behaviour tests to be made for a particular IUT;

when taken together with behaviour tests, as a basis for claims of conformance.

Refer to Clause A.3 for the role of the IUT supplier and the Laboratory test to be played in this activities.

5.2.3 Behavioural tests

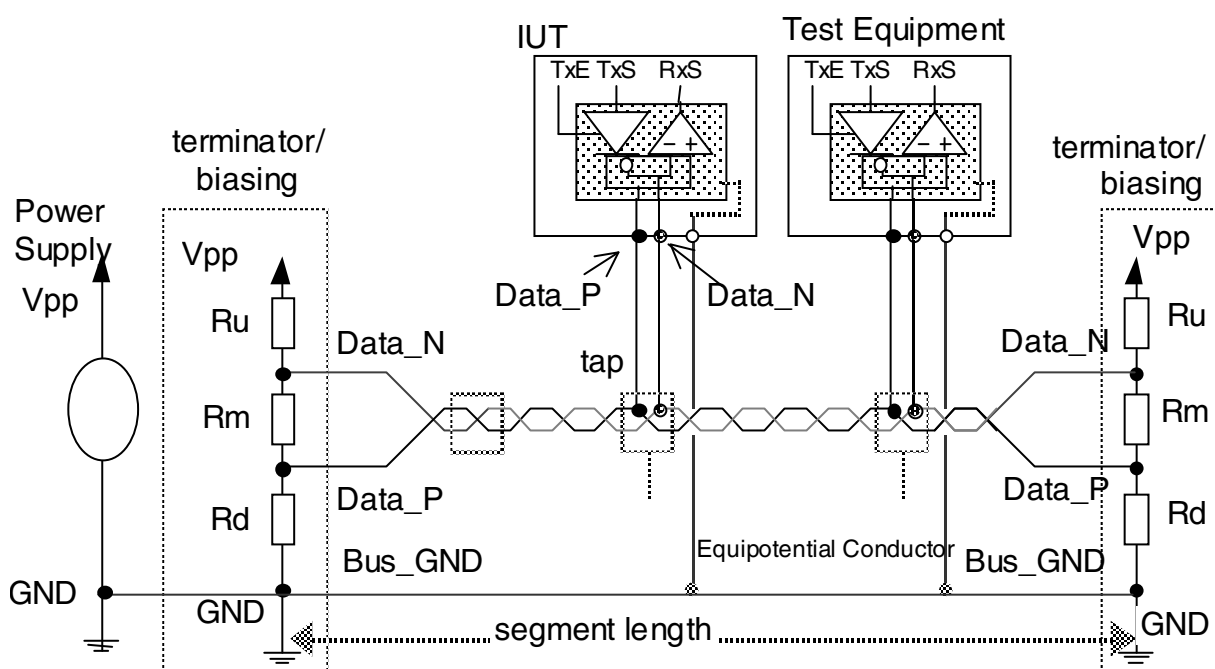
The behavioural test suites are sub-divided into the following test sequences.

5.2.4 Electrical short distance medium

5.2.4.1 ESD test layout

As shown in Figure 2 the ESD test layout consists of

- two conductors carrying the serial data;
- an equipotential conductor;
- two terminators biasing at each end;
- stubs to attach the devices participating on the network.



Components	Type	Value	Connections	Type	Value
Ru	Resistor	390 Ω 1 W	Vpp	Supply voltage	5,0 V 3,0 W
Rm	Resistor	150 Ω 1 W	GND	Reference voltage	0,0 V
Rd	Resistor	390 Ω 1 W			

Figure 2 – ESD test layout

5.2.4.2 ESD identification

ESD identification is to test the implementation of the requirement 4.4.2.1 of IEC 61375-3-1:

- verify that the two conductors of a line are named Data_P and Data_N;
- verify that the two conductors Data_P and Data_N are marked distinctly;
- verify that the equipotential conductor is named Bus_GND;
- verify that the equipotential conductor is marked distinctly.

5.2.4.3 ESD section specifications

5.2.4.3.1 ESD attachment backplane

This test is conditioned by 5.1.2.20.

Test the implementation of the requirement 4.4.5.1 of IEC 61375-3-1.

Verify that Line_A and/or Line_B through independent connection points, identified as shown in Figure 1 as:

- A.Data_P and A.Data_N; respectively;
- B.Data_P and B.Data_N.

5.2.4.3.2 ESD connector

Test the implementation of the requirement 4.4.5.2 of IEC 61375-3-1. The requirement in item j) states a minimum source current of 70,0 mA and a maximum current of 300,0 mA. This test checks for these values as minimum and maximum. A first assessment with no load is applied, then the minimum current is tested, following which the maximum. To assess the maximum current limitation, the value of 350 mA exceeding the maximum current of 16,6 % is chosen. This value, even if arbitrary, is 3 times the tolerance of current and voltage specified in IEC 61375-3-1.

Calculation for the minimum current: $5 \text{ V} / 70 \text{ mA} = 71,42 \Omega$

Calculation for the maximum current: $5 \text{ V} / 300 \text{ mA} = 16,6 \Omega$

Calculation for the overcurrent: $5 \text{ V} / 350 \text{ mA} = 14,28 \Omega$

The loads chosen from the E96 series, specified by IEC 60063, are respectively 71,5 Ω , 17,8 Ω , 14,3 Ω , the values fit near enough to the calculated values. Resistor power is chosen big enough to account for the derating.

- the connectors shall have the polarity and arrangement shown in Figure 4;
- measure $5,0 \text{ V} \pm 5 \%$ as in the following table;

Table 8 – Measurement idle

Measurement points	Result
Pin 8 to Pin 6	$5,0 \text{ V} \pm 5 \%$
Pin 9 to Pin 7	$5,0 \text{ V} \pm 5 \%$

- connect a load of 71,5 Ω 1 % 5 W between the couple of pins in the following table and measure the voltage across them. See item j), 4.4.5.2 of IEC 61375-3-1;

Table 9 – Measurement with load for minimum current

Measurement points	Result
Pin 8 to Pin 6	$5,0 \text{ V} \pm 5 \%$
Pin 9 to Pin 7	$5,0 \text{ V} \pm 5 \%$

- connect a load of 17,8 Ω 1 % 5 W between the couple of pins in the following table and measure the voltage across them;

Table 10 – Measurement with load for maximum current

Measurement points	Result
Pin 8 to Pin 6	$5,0 \text{ V} \pm 5 \%$
Pin 9 to Pin 7	$5,0 \text{ V} \pm 5 \%$

- e) connect a load of $14,3 \Omega \pm 1 \% 5 W$ between the couple of pins in the following table and measure the voltage across them.

Table 11 – Measurement with load for overcurrent

Measurement points	Result
Pin 8 to Pin 6	$\pm 50 \text{ mV}$
Pin 9 to Pin 7	$\pm 50 \text{ mV}$

5.2.4.3.3 ESD connector of the terminator

Test the implementation of the requirement 4.4.5.3 of IEC 61375-3-1.

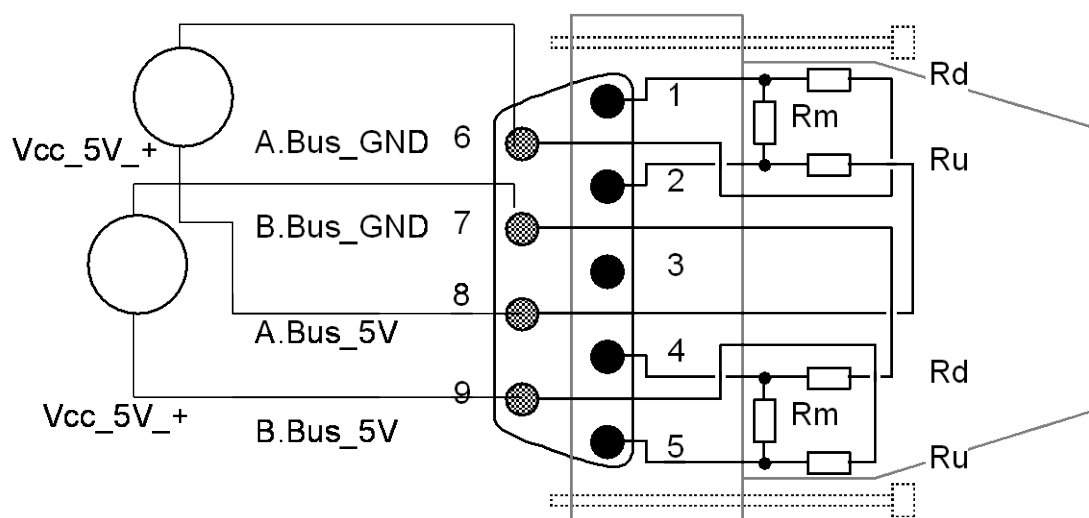


Figure 3 – ESD terminator connector test

The connector containing the terminator for ESD shall be tested as follows:

Connect a 5 V 1 W short-circuit protected power supply as in Figure 3.

Measure the voltages as:

Table 12 – ESD measurements pin to pin

Measurement points	Result
Pin 6 to Pin 1	$2 \text{ V} \pm 10 \%$
Pin 6 to Pin 2	$4,7 \text{ V} \pm 10 \%$
Pin 7 to Pin 4	$2 \text{ V} \pm 10 \%$
Pin 7 to Pin 5	$4,7 \text{ V} \pm 10 \%$

5.2.4.4 ESD Line_Unit test

5.2.4.4.1 ESD conventions

- The characteristics of each device are measured at the points where the line is attached to the device, Data_P, Data_N and Bus_GND.
- When measuring a transmitter, the circuit of the receiver is the normal receiving state.

- c) When measuring a receiver, the circuit of its transmitter is in a high impedance state.
- d) If the device is attached through connectors, these are included into the measurement.

5.2.4.4.2 ESD signal waveform

Test the implementation of the requirements 4.4.8.1 and 2.4.8.3 of IEC 61375-3-1.

With the test setup described in Figure 6:

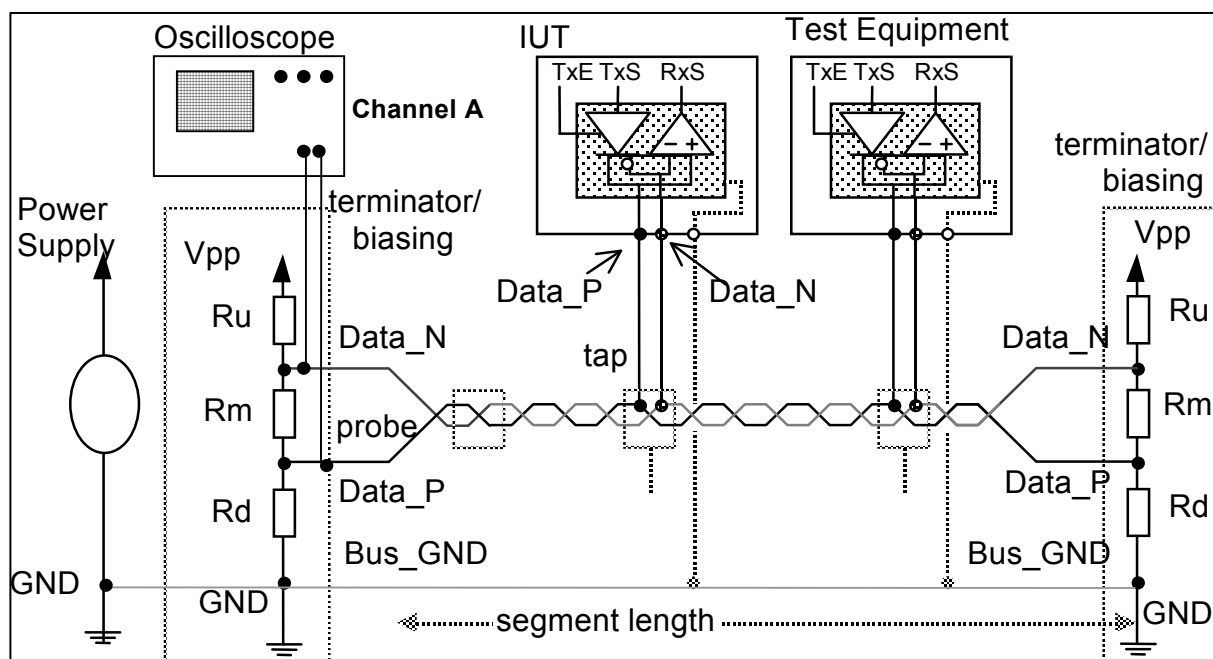


Figure 4 – ESD waveform measurement

- a) Using the oscilloscope in single shot acquisition and the arrangement of Figure 4, acquire a frame from the IUT.
- b) The rise time of the signal (10 % – 90 %) < 20,0 ns at 1,5 Mb/s.
- c) The level of the transmitted frame shall be a differential voltage two active levels:
 - HIGH, when the voltage difference (Data_P – Data_N) is within: $+1,5 \text{ V} < (U_p - U_n) < +5,0 \text{ V}$;
 - LOW, when the voltage difference (Data_P – Data_N) is within: $-1,5 \text{ V} > (U_p - U_n) > -5,0 \text{ V}$.
- d) The beginning level of transmitted frame shall be a differential voltage that is:
 - LOW, for at least $0,125 \mu\text{s} \pm 0,010 \mu\text{s}$.
- e) The end level of transmitted frame shall be a differential voltage that is:
 - LOW state for at least $0,125 \mu\text{s}$ and at most 1,0 BT.

5.2.4.4.3 ESD transmitter jitter

Send at least 100 frames, the jitter between two consecutive edges between Start_Bit and End_Delimiter shall not exceed 10,0 ns.

Using the digital storage oscilloscope the jitter measurement is accumulated (long-term jitter). This is defined to be the deviation of a rising (or falling) edge "n" cycles after the first rising (or falling) edge. The digital phosphor oscilloscope can measure 100 cycles of an incoming

frame sent by the IUT. The scope is set to delay by 100 μ s ($n \times$ period of BT). This is the long-term jitter performance of the frame over 100 cycles or 66 μ s. The value specified for the jitter is $\pm 10,0$ ns, the measured peak-to-peak jitter shall not exceed 3σ .

5.2.4.5 ESD receiver

5.2.4.5.1 Signal reception

This subclause tests the implementation of the requirement 4.4.9 of IEC 61375-3-1 and applies to its items a) and b). Item c) of 4.4.9 of IEC 61375-3-1 shall be guaranteed by the datasheet specification of the receiver and thus **not tested**.

The characteristics of the receiver are tested by applying a sequence of frames containing 256 random data bits in the data field, passed by a waveshape modifier. The waveshape modifier shall be able to

- a) sample the incoming bit and sending out an outgoing bit with the amplitude changed as required by the test;
- b) sample the incoming bit and sending out an outgoing bit with the rise time changed as required by the test;
- c) sample the incoming bit and sending out an outgoing bit with the fall time changed as required by the test;
- d) sample the incoming bit and sending out an outgoing bit with the jitter as required by the test:
 - 1) the amplitude of the outgoing signal from the waveshape modifier shall be set until the oscilloscope read a differential voltage of 250 mV p-p;
 - 2) verify that the IUT receives correctly all frames.

5.2.4.5.2 Input impedance

This subclause tests the implementation of the requirement 4.5.7.1 of IEC 61375-3-1.

The sequence is the following:

- a) attach the test fixture and waveform generator as shown in Figure 6;
- b) test both with the device not powered and with the device powered and not transmitting;
- c) set the generator to produce a 150¹ kHz sinusoid at about 5 V pp differential measured at V_i ;
- d) verify that the level is constant (± 2 %) from 150 kHz to 1 500 kHz;
- e) measure V_o (pp differential) with the generator set to 150 kHz;
- f) V_o should be greater than $V_i/2$ V. This verifies that the differential input resistance is greater than 12 k Ω ²;
- g) calculate the ratio V_o/V_i , if the ratio is $\geq 0,5$ the test passes.

5.2.5 Electrical middle distance medium

5.2.5.1 Measurement of terminating resistors

5.2.5.1.1 Resistance test

This test is intended to check the requirement 4.5.3 of IEC 61375-3-1.

¹ The lower frequency limit is 150 kHz.

² 12 k Ω is the specified minimum value of impedance.

This is a pure resistance test of the terminating resistors of MVB lines A and B, with the IUT switched off.

The resistance shall have the following value: 120 Ω range $\pm 10\%$.

5.2.5.1.2 Inductance test

This test is intended to check the requirement 4.5.3 of IEC 61375-3-1.

The inductance test of the terminating resistors is executed by connecting a sine-wave generator to the IUT and measuring the phase displacement between current and voltage.

Optionally, the inductance can be measured with an LCR meter.

The maximum permissible phase displacement is 0,087 rad in a frequency range between 0,5 and 2,0 BR.

5.2.5.1.3 Measurement of insertion loss

The characteristics of a device are measured at the connection points, where the cable is attached to the device, possibly through a connector, indicated in IEC 61375-3-1, 4.5.6.2 as:

- a) A1.Data_P, A1.Data_N, and
- b) A2.Data_P, A2.Data_N.

The output or the input signal of a device is the differential voltage ($U_p - U_n$) at the connection point.

For conformity testing, it is not necessary to access the Line_Unit interface, as shown in Figure 5. However, timing diagrams refer to the Line_Unit interface signals, especially TxS and RxS, to explain the specification.

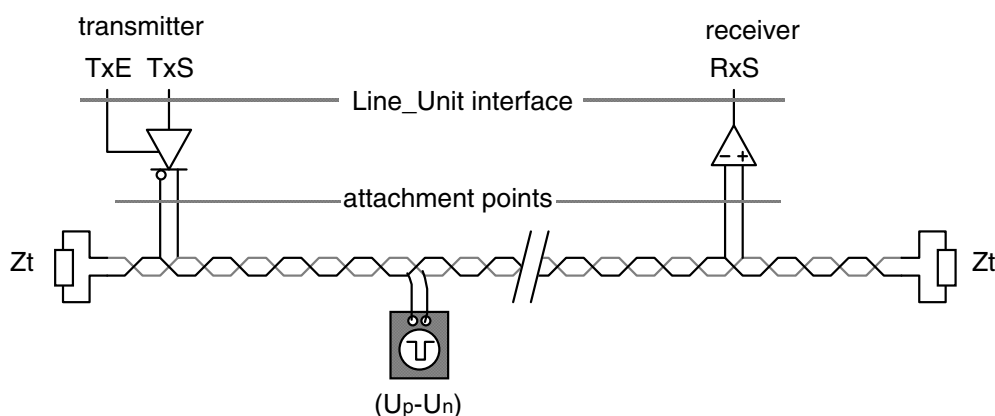


Figure 5 – Measurement of an EMD device

When measuring a transmitter, the circuit of the receiver is in the normal receiving state. When measuring a receiver, the circuit of its transmitter is in a high impedance state.

Insertion loss is measured by applying the sinusoidal signal of a generator (of internal impedance = Z_t) through 20,0 m of cable to the points A1.Data_P and A1.Data_N and by measuring the signal with a voltmeter (connected in parallel with an impedance Z_t) at the extremity of another 20,0 m of cable attached to the points A2.Data_P and A2.Data_N, or vice-versa, as shown in Figure 8.

The attenuation is defined as the ratio expressed in dB of two differential voltages:

- c) first voltage being set to 4,0 Vpp when the device is removed and the cable connectors coupled;
- d) a second voltage being measured when the device is inserted.

For this test, the measuring setup illustrated in Figure 8 is required.

One MVB connector of the IUT is connected to a terminating resistor via a 20 m MVB cable. The other MVB connector of the IUT is connected to a sine-wave generator (with an internal resistance $Z_t = 120 \Omega$) via a 20 m mVB cable. The amplitude of the signal output by the frequency generator is set to 4 V at the location of the voltmeter, without the IUT inserted.

The insertion loss is measured as the ratio between the voltage present at the location of the voltmeter in a setup without IUT with shorted cables (2×20 m MVB cable) (1)) and the voltage present with the IUT inserted (2).

With the IUT switched off or in normal operation, the maximum permissible loss at frequencies between 0,5 BR and 2,0 BR is 0,15 dB.

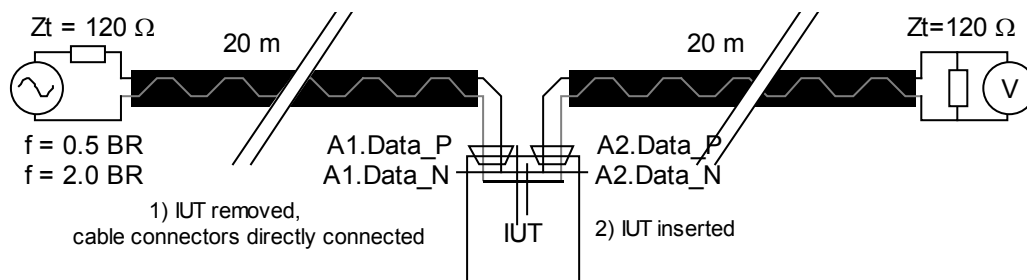


Figure 6 – Measurement of insertion loss

5.2.5.1.4 Measurement of the signal waveform during transmission

To approximate the loading of the transmitter with a cable and devices, four test circuits are specified, corresponding to four test cases:

- a) Light test circuit:
the light test circuit simulates a line where only one device is present, the value of the total resistive load is equal to $0,5 \pm 1 \%$ that of the terminator;
- b) Heavy test circuit:
the heavy test circuit simulates a fully loaded bus, the value of the total resistive load is equal to $0,42 \pm 1 \%$ of that of the terminator;
- c) Idling test circuit:
the idling test circuit simulates the behaviour of a 200,0 m cable without resistive consumers, the capacitors have a value of $150,0 \text{ pF} \pm 10 \%$ each, the resistors a value of $2,2 \Omega \pm 1 \%$;
- d) Short test circuit:
the short test circuit simulates a line failure, it consists only of a current measurement circuit.

These circuits are shown in Figure 7.

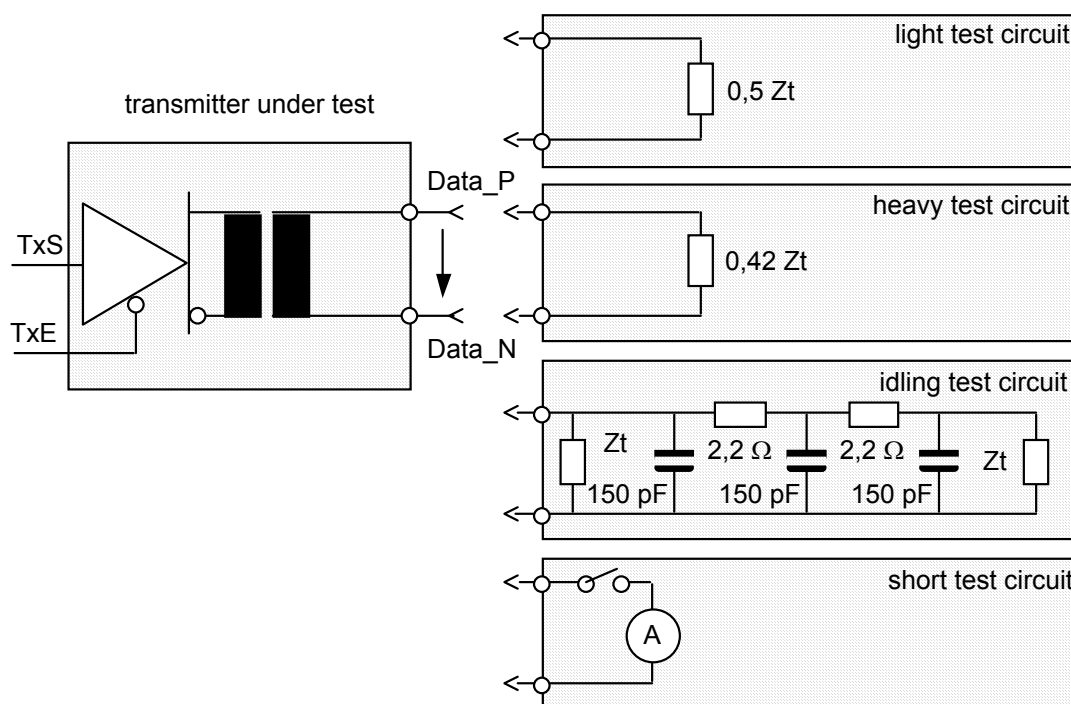


Figure 7 – EMD transmitter test circuits

The stationary amplitude is defined as the average amplitude of the output signal when transients settle.

This test is intended to check the requirements 4.5.9.1 and 4.5.9.3 of IEC 61375-3-1.

The waveform of the signals from the IUT during transmission is measured in three setups.

Due to the data encoding, the transmitter generates pulses which are either one bit in length (1,0 BT), a half-bit in length (0,5 BT) or one-and-a-half bits in length (1,5 BT): the operator shall choose one of these three pulses to synchronize upon.

By sending a master frame F_CODE4 subscribed by the IUT as source port, the TE authorises the IUT to send a slave frame: the differential output signal from the IUT (slave frame) is measured at the IUT for channels A and B by means of an oscilloscope. The sourced frame from the IUT data bits are a sequence of

- first 64 bits at "1";
- the second 64 bits at "0";
- the third 64 bits with the sequence "10" repeated 32 times;
- the fourth 64 bits with the sequence "01" repeated 32 times.

According to IEC 61375-3-1, it shall comply with 4.5.9.1, and particularly with the following list of requirements:

- e) the signal shall have a voltage level of $\pm 5,5$ V max. and $\pm 1,5$ V min. symmetrically to the zero line (see IEC 61375-3-1, 4.5.9.1);
- f) the difference between the steady-state amplitudes of two successive pulses shall not exceed 100 mV;
- g) the slew rate of the output signal shall be more than 15 mV/ns within 0,100 μ s of the zero-crossing (see IEC 61375-3-1, 4.5.9.1);

- h) The maximum jitter shall be limited to $\pm 2\%$. This jitter is defined as the actual time difference between two signal voltage zeroes in reference to an ideal interval of one Bit Time (see IEC 61375-3-1, 4.5.9.1);
- i) The overshoot of the output signal, defined as the ratio of the maximum amplitude to the stationary amplitude shall not exceed 10 % of its stationary amplitude.

As an option, in order to improve signal quality, the transmitter may use a technique called Pre-Emphasis. In such a case, the transmitter shall comply with the above-listed requirements except requirement i) that is replaced by the following requirements:

- j) the ratio of the Pre-Emphasis amplitude to the steady state amplitude shall be in the range from 165 % up to 235 %;
- k) the duration of the Pre-Emphasis pulse, measured from the front edge of the waveform, shall be maximum 330 ns;
- l) the difference between the positive and the negative stationary amplitude in two consecutive pulses shall not exceed 0,20 V.

The heavy load test fixture shall be disconnected. The light test circuit shall be placed at the connection point of IUT (where $Z_t = 120\ \Omega$), and the operator shall verify the same previous items (e), f), g), h), i)) with the new test circuit (see Figure 7).

The light test circuit shall be disconnected. The idling test circuit shall be placed at the connection point of IUT (see Figure 7).

The reply of IUT shall have the end delimiter with some characteristic:

- the voltage shall not exceed 200 mV (see IEC 61375-3-1, 4.5.9.3)

The voltage shall have dropped to less than 100 mV after 300 ns (see IEC 61375-3-1, 4.5.9.3).

The frame shall be closed with a "NL" symbol followed by a "NH" symbol (see IEC 61375-3-1, 6.1.6 and Manchester or Bi-phase-L encoding).

The output signal amplitude shall be greater than 4,5 V before the transmitter is disabled.

These points are verifiable on the IUT for channels A and B by means of an oscilloscope.

If the transmitter uses the pre-emphasis, the transmitter shall comply with the requirements e),f),g),h) and requirement i) which is replaced by the following requirements:

- m) the ratio of the pre-emphasis amplitude to the steady state amplitude shall be in the range from 165 % up to 235 %;
- n) the duration of the pre-emphasis pulse, measured from the front edge of the waveform, shall be 330 ns.

5.2.5.1.5 Receiver behaviour test threshold set to 200 mV

This test checks the requirement 4.5.10.1 of IEC 61375-3-1.

To test the receive behaviour of the IUT, it is necessary to find out at what maximum deviation of the received signal from the ideal signal the IUT can still correctly interpret the received data.

The IUT is connected to the TE via 20 m of MVB cable.

To generate such a non-ideal signal, the sender of the TE is provided with an additional attenuation resistor that reduces the amplitude of the master frames to 300 mV at the input of the IUT.

If the IUT has correctly received the master frame from the TE, it will acknowledge the reception by sending a slave frame. No slave frame may be lost.

5.2.5.1.6 Receiver behaviour test threshold set to 500 mV

This test checks the requirement 4.5.10.1 of IEC 61375-3-1 when the threshold of 500 mV is set.

To test the receiver behaviour of the IUT, it is necessary to find out at what maximum deviation of the received signal from the ideal signal the IUT can still correctly interpret the received data.

The IUT is connected to the TE via 20 m of MVB cable.

To generate such a non-ideal signal, the sender of the TE is provided with an additional attenuation resistor that reduces the amplitude of the master frames to 750 mV at the input of the IUT.

If the IUT has correctly received the master frame from the TE, it will acknowledge the reception by sending a slave frame. No slave frame may be lost.

5.2.6 Slave device status test suites

The slave device status test suite shall be executed in distinct phases depending of the capabilities of the IUT. The following phases are specified:

- a) common test;
- b) custom test;
- c) specific class test.

Phase 1 covers the tests that are common to all devices irrespectively to the capabilities.

Phase 2 covers the tests to be applied to devices that require customised test method having lacks of capabilities or characteristics (as an example a class one device is able to sink ports but not to source ports, consequently it is not able to answer at application level to incoming test data).

Phase 3 covers the tests that are specific of a certain MVB class.

5.2.6.1 Common test

This test applies to Classes 1, 2, 3, 4 and 5.

This test does not apply to Class 0.

5.2.6.1.1 Requirements

The IUT requirements and the test equipment requirement are specified by the following subclauses.

5.2.6.1.1.1 IUT requirement

The IUT supplier shall define:

- a) the physical address of the IUT;
- b) physical redundant capability;
- c) the T_ignore time of the device;
- d) the capabilities of the device (class of device);
- e) the configuration option to execute the automatic switchover when the device responds to a Device_Status_Response (LAT and ERD test). If the device is a class 1, this specification is not required ³;
- f) the procedure to produce a malfunction the IUT or a fault outside of the device without effect on the communication (SDD test).
- g) the procedure to force/unforce at least a Port of the IUT to the imposed value (FRC test). Not applicable to Class 1;
- h) the procedure to set the IUT not operative without effect on the communication and the procedure to return the IUT operative (DNR test).

5.2.6.1.1.2 Test equipment requirement

The test equipment shall provide a Class 4 or higher MVB device (master device) with the capability to connect both lines (LINE_A and LINE_B) or to connect to one single line (LINE_A or LINE_B).

The test equipment shall provide a Class 2 or higher MVB device with a manager interface (MGI) to send a WRITE_RESERVATION request message to IUT (see SER test in this standard).

NOTE The two above-mentioned devices might be the same device (master and slave).

5.2.6.1.2 Common test execution procedure

Test clauses presented hereinafter contain questions asking for proof, the relevant clause specifies the test to prove the compliance to the question.

5.2.6.1.2.1 Device status protocol

This test checks the requirement 8.4.2. of IEC 61375-3-1 summarised by the following question:

is a device replying with its Device_Status_Response ,when receiving a Master Frame with F_code = 15 (Device_Status_Request) and with its own address?

The test equipment shall send one or more Device_Status_Request.

The test passes if the IUT response is a Device_Status_Response (16 bits length response) for every Device_Status_Request.

The test shall be terminated when 10 Device_Status_Request are sent.

5.2.6.1.2.2 RLD and LAT

This test checks the requirements 8.4.1.2.4 of IEC 61375-3-1 summarised respectively by the following questions:

- is the RLD flag set if the Observed_Line is disturbed?

³ For class 1 devices, if a device responds to a Device_Status_Request with a Device_Status_Response (with RLD=0), the switchover is mandatory

- is the LAT flag asserted if the master frame of this telegram was received over Line_A, and negated if it was received over Line_B?

Using a lay-out without physical layer redundancy, the test equipment shall send a sequence of Device_Status_Request and read the status of the LAT and RLD flags in the Device_Status_Response sent back by IUT.

The test passes if the RLD flag is always set to 1 and if the LAT flag is always set to the same value.

The test shall be terminated when 10 Device_Status_Request are sent.

Using a lay-out with physical layer redundancy, the test equipment shall send a sequence of Device_Status_Request with the following sequence of status of line connection.

- At least a Device_Status_Request with either lines connected.
- At least a Device_Status_Request with only line A connected.
- At least a Device_Status_Request with either lines connected.
- At least a Device_Status_Request with only line B connected.

For any step it shall execute the following check (the test passes if):

- Step 1. All Device_Status_Responses in this step shall have RLD=0.
- Step 2. All Device_Status_Responses in this step shall have the LAT=1 and the RLD=1.
- Step 3. All Device_Status_Responses in this step shall have RLD=0. If the IUT is a class 1 device or if it has this configuration option set for the other class, the LAT bit shall change every time, or else it shall remain equal to 1.
- Step 4. All Device_Status_Responses in this step shall have the LAT=0 and the RLD=1.

5.2.6.1.2.3 SDD

This test checks the requirement 8.4.1.2.4 of IEC 61375-3-1 summarised by the following question:

Is the SDD flag set by a device malfunction (for instance: ROM or RAM checksum error) or a fault outside of the device (for instance: damaged sensors) and reset when the fault is removed?

The test sequence is the following:

- the tester shall execute the procedure to produce a malfunction of the IUT or a fault outside of the device without effect on the communication (see IUT requirement 6).

The test passes if, for every Device_Status_Request sent by the test equipment, then the IUT Device_Status_Response contain the SDD flag equal to 1.

The test shall be terminated when 10 Device_Status_Request are sent;

- the tester shall execute the procedure to remove the malfunction of the IUT or the fault outside of the device (see IUT requirement 6).

The test passes if, for every Device_Status_Request sent by the test equipment, then the IUT Device_Status_Response contains the SDD flag equal to 0.

The test shall be terminated if 10 Device_Status_Request are sent.

5.2.6.1.2.4 ERD flag (option)

This test checks the requirements 6.2.4.2 and 8.4.1.2.4 of IEC 61375-3-1 summarised respectively by the following question:

Is the ERD flag asserted if $T_ignore > T_reply_def$, negated otherwise?

The test equipment shall send more Device_Status_Request and relate the status of the ERD flag in the Device_Status_Response sent back by IUT to the T_ignore defined by the IUT supplier.

(pass criteria are to be defined)

The test shall be terminated when 10 Device_Status_Request are sent.

5.2.6.1.2.5 FRC flag

This test checks the requirement 8.4.1.2.4 of IEC 61375-3-1 summarised by the following question:

Is the FRC flag asserted if any port has been forced to an imposed value and negated if all ports attached to the MVB are in the unforced state?

The test equipment shall send a sequence of Device_Status_Request and read the status of the FRC flag in the Device_Status_Response sent back by IUT.

If the IUT is a Class 1 device, the test is passed when the flag FRC is always 0.

If the IUT is a class higher than 1, the test is passed when:

- the FRC flag is 1 if at least one port of the IUT is forced to an imposed value (see IUT requirement 7);
- the FRC flag is 0 if all ports of the IUT are unforced (see IUT requirement 7).

The test shall be terminated when 10 Device_Status_Request are sent.

5.2.6.1.2.6 DNR flag

This test checks the requirement 8.4.1.2.4 of IEC 61375-3-1 summarised by the following question:

Is the DNR flag asserted if the device is not operational (for instance application not running) but able to operate normally on the bus, and negated if the device is operational?

The test equipment shall send a sequence of Device_Status_Request and read the status of the FRC flag in the Device_Status_Response sent back by IUT.

The test is passed when:

- the flag is 1 if the IUT is not operational (see IUT requirement 8);
- the flag is 0 if the device is operational (see IUT requirement 8).

The test shall be terminated if 10 Device_Status_Request are sent.

5.2.6.1.2.7 SER flag

This test checks the requirement 8.4.1.2.4 of IEC 61375-3-1 summarised by the following question:

Is the SER flag set if the device has been reserved for exclusive use and reset when this exclusive use is lifted or timed-out?

If the IUT is a Class 1 device, the test equipment shall send a sequence of Device_Status_Request and read the status of the SER flag in the Device_Status_Response sent back by IUT. The test passes if the SER flag is always set to 0.

If the IUT is not a Class 1 device, the bus administrator of the test equipment shall send a sequence of Device_Status_Request to read the status of the SER flag in the Device_Status_Response sent back by IUT. The Class 2 stimulator device of the test equipment shall send a WRITE_RESERVATION request message to IUT with COMMAND field set to RESERVE, and after enough time (e.g. 1 s) it shall send a WRITE_RESERVATION request message to IUT with COMMAND field set to KEEPREL. The test passes if the SER flag is set to 1 after the first command, and if it is set to 0 after the second command.

5.2.6.1.2.8 Capabilities field

This test checks the requirement 8.4.1.2.2 of IEC 61375-3-1 summarised by the following questions:

- a) Is the SP bit set to "1" for special device and set to "0" for device with Device_Status and Process Data capability?
- b) Is the BA bit set to "1" for no special device with bus administrator capability and set to «0» for no special device without bus administrator capability?
- c) Is the GW bit set to "1" for no special device with gateway capability and set to «0» for no special device without gateway capability?
- d) Is the MD bit set to "1" for no special device with message data capability and set to «0» for no special device without message data capability?

The test equipment shall send one or more Device_Status_Request and relate the status of the capabilities field (SP, BA, GW and MD flags) in the Device_Status_Response sent back by IUT to the capabilities of the device (class of device) defined by the manufacturer.

The test shall be terminated if 10 Device_Status_Request are sent.

5.2.6.2 Custom test

This test shall be executed using a stimulator supplied by the manufacturer of IUT. Only the data logger shall be supplied by the test laboratory to test the IUT.

5.2.6.2.1 IUT requirement

The physical address of the IUT is required.

5.2.6.2.2 Test equipment requirement

The test equipment is partly supplied by the IUT supplier and this part is a stimulator that shall be capable of sending to the IUT all sink process data present in the Periodic_List of the IUT (master frame + slave frame) using the correct period for any one. Using an input of the stimulator shall be possible to avoid a sending of at least a single port.

Periodically the stimulator shall send a Device_Status_Response to check the Device_Status_Response sent by the IUT.

The test equipment is completed by a second part supplied by the test laboratory. This part is a data logger that shall be capable of latching and displaying the Device_Status_Response sent by the IUT.

5.2.6.2.3 Custom test procedure

This test checks the requirement 8.4.1.2.4 of IEC 61375-3-1 summarised by the following question:

Is the SSD flag set when the sink time supervision of any port is triggered and reset when all configured ports are operated normally?

The test procedure is the following:

- a) the stimulator shall send all sink process data published by the IUT using the correct period.

The test passes if, for every Device_Status_Request sent by the stimulator, the IUT Device_Status_Response contains the SSD flag equal to 0.

The test is terminated when 10 Device_Status_Request are sent;

- b) the stimulator shall not send all sink process data of the IUT using the correct period, but at least a sink process data shall be sent in a time greater than the sink time supervision.

The test passes if, for every Device_Status_Request sent by the stimulator, the IUT Device_Status_Response contains the SSD flag equal to 1.

The test is terminated when 10 Device_Status_Request are sent.

5.2.6.3 Specific class test

This test checks the Class_specific field of the Device_Status_Response of the IUT.

5.2.6.3.1 Class 1 device specific test

This test shall be applied to Class 1 IUT (no special device, no bus administrator capability, no Gateway capability, no message data capability).

The capabilities field is «0000».

5.2.6.3.1.1 IUT requirement

To run this test, the IUT supplier shall define the physical address of the IUT.

5.2.6.3.1.2 Test equipment requirement

The test equipment shall provide a MVB device with a bus administrator capability (master device).

5.2.6.3.1.3 Procedure

This test checks the requirement 8.4.1.2.3.1 of IEC 61375-3-1 that is summarised by the following questions:

Does a device of Class 1 respond with the "specific" field set to "0000"?

The test equipment shall send several Device_Status_Request to the IUT and verify that the status of the «specific» field in the Device_Status_Response responded from the IUT is always «0000».

The test is terminated when 10 Device_Status_Request are sent.

5.2.6.3.2 Bus administrator specific test

This test shall be applied to the IUT if it is a bus administrator capability device, i.e. no special device, bus administrator capability, independent of gateway capability, independent of message data capability.

The test procedure is sub-divided into the following phases:

- ACT flag;
- AX1 and AX0 bits;
- MAS flag.

5.2.6.3.2.1 IUT requirement

Using this test, the IUT manufacturer shall define:

- a) the physical address of the IUT;
- b) Actualisation_Key of the Periodic List;
- c) the procedure to set «configured» (in possession of a Bus_Configuration) and, optionally, the procedure to set «unconfigured» (only executes the Event_Round and the Devices_Scan) the MVB_Administrator object of the IUT.

5.2.6.3.2.2 Test equipment requirement

The test equipment shall provide a MVB device with bus administrator capability (master device) with modifiable Actualisation_Key.

Also the test equipment shall provide a data logger to read all Device_Status_Response sent from IUT.

It would be better if the two above-mentioned devices were the same device (master and slave).

5.2.6.3.2.3 AX1 and AX0 bits

This test checks the requirement 8.4.1.2.3.3 of IEC 61375-3-1 that is summarised by the following questions:

- a) Does the AX1 bit correspond to the second least significant bit of the Actualisation_Key of the Periodic List?
- b) Does the AX0 bit correspond to the least significant bit of the Actualisation_Key of the periodic list?

At start-up (bus inauguration) the test equipment shall take the mastership before the IUT (it may be necessary to turn on the test equipment before the IUT).

The bus administrator device of the test equipment shall send several Device_Status_Request to IUT and verify that the status of the AX0 and AX1 bits of the «specific» field in the Device_Status_Response matches the last two least significant bits of the Actualisation_Key in the periodic list defined by the manufacturer of the IUT.

The test is terminated when 10 Device_Status_Request are sent.

5.2.6.3.2.4 ACT flag

This test checks the requirement 8.4.1.2.3.3 of IEC 61375-3-1 that is summarised by the following question:

Is the ACT Bit set to 1 if the device is actualised (in possession of a Bus_Configuration) and set to 0 if the device is not actualised (only executes the Event_Round and the Devices_Scan)?

At start-up (bus inauguration) the test equipment shall take the mastership before the IUT (it may be necessary to turn on the test equipment before the IUT).

Then the bus administrator device of the test equipment shall send a sequence of Device_Status_Request to IUT and verify that when the IUT is «configured» (see IUT requirement 3) the status of the ACT of the «specific» field in the Device_Status_Response is set to 1, and when the IUT is «unconfigured» (see IUT requirement 3) the status of the ACT is set to 0.

The test is terminated when 10 Device_Status_Request are sent.

5.2.6.3.2.5 MAS flag

This test checks the requirement 8.4.1.2.3.3 of IEC 61375-3-1 that is summarised by the following question:

Is the MAS Bit set to 1 if the device is the current master and set to 0 if the device is not the current master?

To execute this test, the bus administrator device of the test equipment shall use the same Actualisation_Key of IUT and IUT shall be «configured».

At start-up (bus inauguration) the test equipment shall take the mastership before the IUT (it may be necessary to turn on the test equipment before the IUT).

In this status (phase 1) the bus administrator device of the test equipment shall send one or more Device_Status_Request to IUT.

Then the test equipment shall execute a mastership transfer procedure to set the IUT as master of the bus.

In this status (phase 2) the IUT shall send one or more Device_Status_Request to itself.

The test passes if during the phase 1 the MAS flag of Device_Status_Response of IUT is set to 0, and if during phase 1 MAS flag of Device_Status_Response of IUT is set to 1.

The test is terminated when 10 Device_Status_Request are sent.

5.2.6.3.3 Gateway specific test

This test shall apply to IUT if it is a device with gateway capability (no special device, no bus administrator capability, gateway capability, independent of message data capability).

The other bus connected to IUT can be WTB bus or other bus , nevertheless they are not involved in this test.

The test procedure is sub-divided into the following phases:

- STD flag;
- DYD flag.

5.2.6.3.3.1 IUT requirement

In order to run this test, the IUT manufacturer shall define:

- a) the physical address of the IUT;
- b) the procedure to set MVB bus of IUT in static disturbance status and the procedure to remove it and set back the IUT in normal condition;
- c) the procedure to set MVB bus of IUT in dynamic disturbance status and the procedure to remove it and set back the IUT in normal condition.

5.2.6.3.3.2 Test equipment requirement

The test equipment shall provide a MVB device with bus administrator capability (master device).

5.2.6.3.3.3 STD flag

This test checks the requirement 8.4.1.2.3.4 of IEC 61375-3-1 that is summarised by the following question:

Is the STD bit set to "1" to indicate a static disturbance (remote bus down)?

The test sequence is the following:

- a) the test shall execute the procedure to set the remote bus of the IUT in static disturbance state (see IUT requirement 2).
the test passes if, for every Device_Status_Request sent by the test equipment, the IUT Device_Status_Response contains the STD flag of the «specific» field equal to 1;
- b) the test shall execute the procedure to remove the static disturbance state from remote bus of the IUT (see IUT requirement 2).
The test passes if, for every Device_Status_Request sent by the test equipment, the IUT Device_Status_Response contains the STD flag of the «specific» field equal to 0.

5.2.6.3.4 DYD flag

This test is intended to check the requirement 8.4.1.2.3.4 of IEC 61375-3-1 that is summarised by the following question:

Is the DYD bit set to "1" to indicate a dynamic disturbance (e.g. train inauguration)?

- a) The test shall execute the procedure to set the remote bus of IUT in dynamic disturbance state (see IUT requirement 3).
The test pass if, for every Device_Status_Request sent by the test equipment, the IUT Device_Status_Response contains the DYD flag of the «specific» field equal to 1.
- b) The test shall execute the procedure to remove the dynamic disturbance state from the remote bus of the IUT (see IUT requirement 3).
The test passes if, for every Device_Status_Request sent by the test equipment, the IUT Device_Status_Response contains the DYD flag of the «specific» field equal to 0.

5.2.7 Process data test suites

To make easier the testing of process data capability without sacrificing the coverage, some confidence tests shall be applied to the IUT. A confidence test is not exhaustive nor fully covering all the possible cases referred to specification, nevertheless it gives the confidence that coverage is high enough to ensure conformance. The use of confidence tests has some advantages: fast execution, low cost, reduction error during test.