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NORME INTERNATIONALE

Railway applications – Rolling stock – Combined test method for traction systems

Applications ferroviaires – Matériel roulant – Méthode d'essais combinés pour systèmes de traction

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RAILWAY APPLICATIONS – ROLLING STOCK – COMBINED TEST METHOD FOR TRACTION SYSTEMS

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International Standard IEC 61377 has been prepared by IEC technical committee 9: Electrical equipment and systems for railways.

This edition cancels and replaces IEC 61377-1 (2006), IEC 61377-2 (2002) and IEC 61377-3 (2002). It constitutes a technical revision.

This edition includes the following main technical changes with regard to the previous editions: it includes updates as necessary in order to meet the current technical state of the art, to improve clarity and to create an edition that considers all types of motors part of a traction system.

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

FDIS	Report on voting
9/2078/FDIS	9/2113/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.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – ROLLING STOCK – COMBINED TEST METHOD FOR TRACTION SYSTEMS

1 Scope

This International Standard applies to the traction system consisting (when it applies) of traction motor(s), converter(s), traction control equipment including software, transformer, input filters, brake resistors, main circuit-breaker, cooling equipment, transducers, contactors, etc.

Figure 1 is just an overview and is not representative of all traction system architectures.

Current collector, mechanical braking systems and gearbox are not in the scope of this standard.

Types of motors applicable in this standard are asynchronous, or synchronous including permanent magnet (PMM), or direct current (DC).

The auxiliary converter(s) is (are) part of the scope when the auxiliary converter is enclosed within the traction converter. Otherwise, when the traction system feeds an auxiliary system outside the traction converter, the auxiliary system can be replaced by an equivalent load.

NOTE 1 Energy storage system is not considered in this standard since there is no specific type test standard for energy storage system.

NOTE 2 Auxiliary loads validation is not part of this standard.

NOTE 3 The gearbox can be part of test set-up, but it is not a part of traction system.

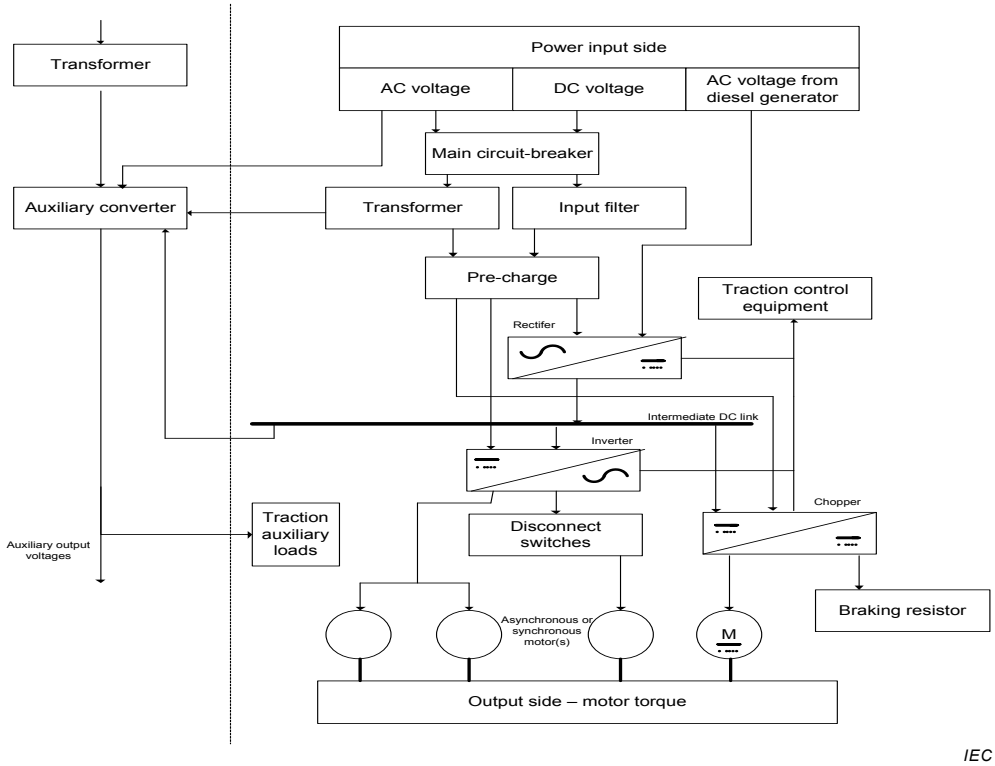

Figure 1 – Overview of traction system architecture

The objective of this standard is to specify the type test of a traction system, mainly comprising of:

– test of performance characteristics;
– test methods of verifying these performance characteristics.

This standard does not specify the type test of each individual component.

The traction system under test incorporates at least one complete traction conversion line (at least one traction converter and its related loads, one transformer in the case of AC supply or input filter in the case of DC supply). The representativeness of the traction system under test versus the actual traction system is agreed between the user and manufacturer.

Figure 2 gives one example of the relationship between the traction system under test and the whole traction system.

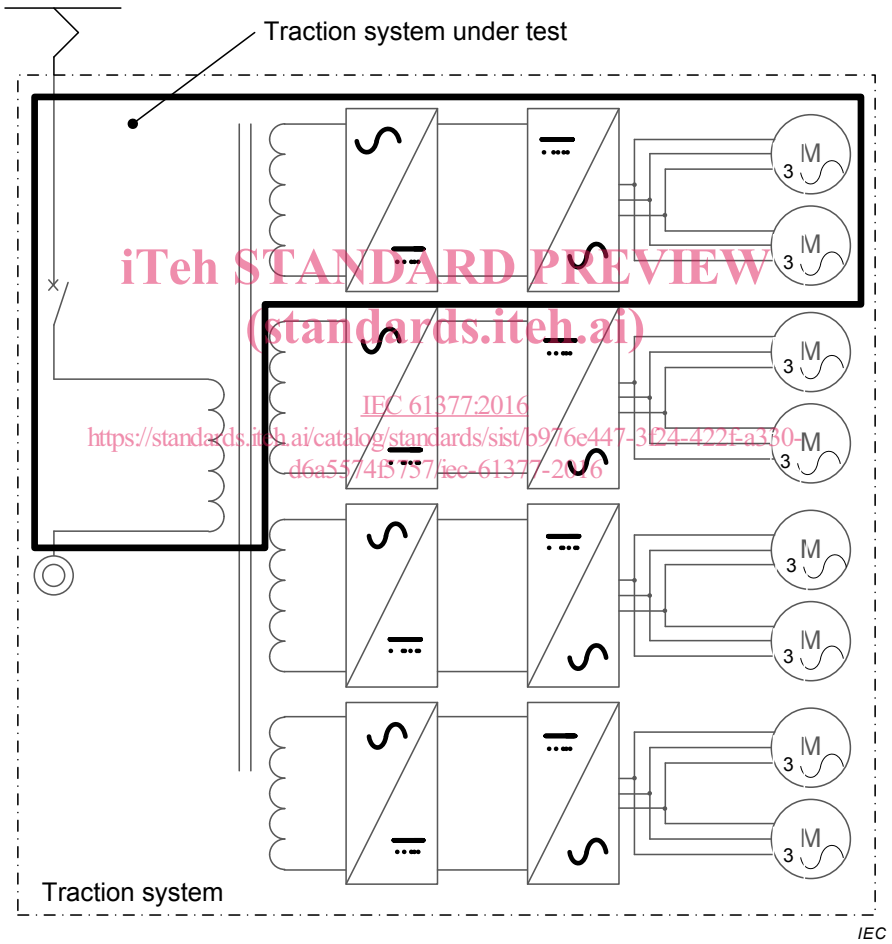

Figure 2 – Example of relationship between the “traction system under test” and the “traction system”

The traction system under test is equipped with components that are representative of the production series.

Deviations may be permitted by agreement between user and manufacturer, and are justified from an impact stand point in advance of the test. Using equivalent components or parts is permitted if no significant influence on the test result is expected.

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 60050 (all parts): *International Electrotechnical Vocabulary* (available at http://www.electropedia.org)

IEC 60349-1, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 1: Machines other than electronic converter-fed alternating current motors*

IEC 60349-2, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 2: Electronic converter-fed alternating current motors*

IEC TS 60349-3, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 3: Determination of the total losses of converter-fed alternating current motors by summation of the component losses*

IEC 60349-4, *Electric traction – Rotating electrical machines for rail and road vehicles – Part 4: Permanent magnet synchronous electrical machines connected to an electronic converter*

IEC 60850, *Railway applications – Supply voltages of traction systems*

IEC 61133, *Railway applications – Rolling stock – Testing of rolling stock on completion of construction and before entry into service*

IEC 61287-1, *Railway applications – Power converters installed on board rolling stock – Part 1: Characteristics and test methods*

IEC 62313, *Railway applications – Power supply and rolling stock – Technical criteria for the coordination between power supply (substation) and rolling stock*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-411, IEC 60050-551, IEC 60050-811, and the following apply:

3.1
traction system
system which provides traction torque, converting the input supply energy into mechanical energy in motoring and the mechanical energy into electrical or thermal energy in braking (if applicable), comprising of the entire conversion equipment located between the current collector (excluded) and the motor shaft(s) and including all associated auxiliary equipment needed to operate the system

3.2
traction system under test
representative traction system for combined test, according to Clause 1

3.3
component
constituent of traction system

3.4
user
organization which orders the traction system (see Figure 3)

Note 1 to entry: The user is normally an organization which operates the vehicle equipped with the traction system, unless the responsibility is delegated to a main contractor or consultant.

3.5
manufacturer
organization which has the technical responsibility for the supply of the traction system (see Figure 3)

Note 1 to entry: The manufacturer can be the supplier of one or more components of traction system, or of none of them.

3.6
supplier
organization which has the responsibility of one or more of the components

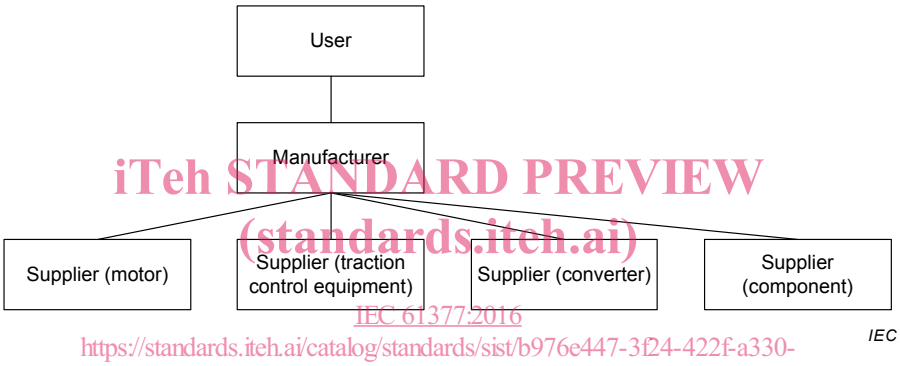

Figure 3 – Traction system – relationship between user, suppliers and manufacturer

3.7
duty
load to which the traction system is subjected, including motoring, coasting, and, if applicable, electrical braking

3.8
duty cycle
specified sequence of operation conditions, e.g. the speed and torque over the time on an elementary route

Note 1 to entry: Some examples of elementary route are:

- Main line train: route between two cities back and forth;
- Tramway: route between two stops;
- Metro: route between two stations.

Note 2 to entry: Typical duty cycle is defined as an agreement between the user and manufacturer.

3.9
route profile
repetition or combination of typical duty cycles in order to achieve steady temperature (repetitive peak temperatures over successive duty cycles are within a given tolerance) or to represent the daily operation of the vehicle

3.10
constant load
load applied at constant operating conditions (e.g. speed, voltage)

Note 1 to entry: Several loads can be specified.

3.11
route profile load
load based on route profile on which the traction system under test is operated

3.12
speed
motor speed in r/min

Note 1 to entry: Motor speed (r/min) is convertible from vehicle speed (km/h) based on specified wheel diameter and gear ratio.

3.13
maximum working speed
motor speed which corresponds to the maximum vehicle design speed at fully worn wheels or the minimum rolling diameter of rubber tyres

3.14
test plan
list of all tests to be undertaken by the manufacturer that includes the mandatory and optional tests to be agreed with the user

Note 1 to entry: In the test plan it is recommended to describe the components used in the traction system under test.

3.15
test specification
all information, requirements and parameters to be applied to carry out and assess the test, including e.g. scope of test, test objective, test conditions, test method, test procedure, evaluation method, measurements, acceptance criteria with tolerances

3.16
test result
final assessment of test

3.17
optional test
test that is not mandatory and subject to agreement between the user and manufacturer

4 Traction system characteristics

Traction system specifications shall, as a general rule, include characteristic curves. These curves are defined as the specified characteristics. They shall be plotted to the designed operating limits of each variable. They shall generally be drawn for the AC or DC supply voltage of the traction system at its specified nominal value. They may also be drawn for the lower and higher voltage of the supply of the traction system if agreed between the user and manufacturer.

These characteristics shall be drawn for a reference temperature of the motor (winding or magnet) and the design temperature of the parts of the converter, transformer and line filter, etc., expected by the supplier.

The reference temperature of the motor (winding or magnet) shall be according to the values as in IEC 60349 series or subject to agreement between the user and manufacturer.

The following characteristics are defined:

a) Specified characteristics: values defined in order to fulfil the user contractual requirements. They are the reference values for measurement and shall be validated on the test bench.

b) Internal characteristics: internal design values which shall be measured and used to prove the design but do not have an influence on the acceptance of the combined test, such as root-mean-square value of current/voltage of traction motor for example.

Provided that the measurement results are compliant with the specified characteristics, the test results remain valid, even if the internal characteristics are not exactly the same as the ones specified. The difference should be agreed between the user and manufacturer.

The set of specified characteristics on fixed operating points over the speed-torque curve, at given line voltages (according to IEC 60850 or otherwise specified if outside the scope of IEC 60850) and given wheel diameter is:

- torque versus speed;
- efficiency of the traction system versus speed at maximum torque reference along the curve.

Specified and internal characteristics can be measured during a speed sweep test or a test at constant speed .

NOTE 1 In the case of speed sweep the inertia mass of the motor rotor considerably influences measurement of the motor shaft torque.

The set of specified characteristics on the route profile at a specific line voltage is:

- torque reference value and speed versus time at the given wheel diameter;
- line current and voltage;
- all relevant peak temperatures (see Figure 4);
- input electrical energy consumption in kWh (integrated value over entire route profile).

NOTE 2 Specified and internal characteristics except those listed above are described in the following clauses for each test.

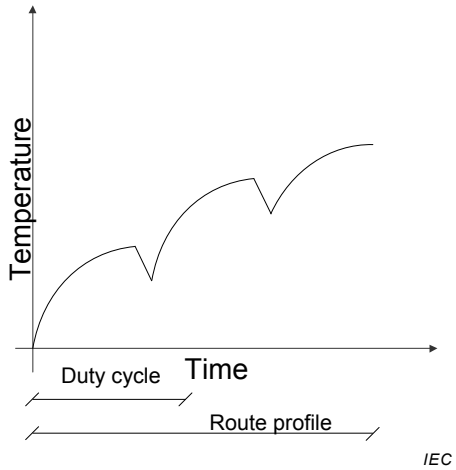

Figure 4 – Example of peak temperatures on route profile

5 General test requirements

The combined test gives the opportunity to run the components of the traction system under test with operating conditions close to service.