



LOVAG
TEST INSTRUCTION IEC/EN 60439-2 Ed. 3.1

CONDITIONS FOR TESTING LOW VOLTAGE SWITCHGEAR AND CONTROLGEAR

PARTICULAR REQUIREMENTS FOR BUSBAR
TRUNKING SYSTEMS (BUSWAYS)

This test instruction is based on the following standards:

General **Requirements:**

IEC 60439-1 Ed. 4.0(1999) + A1(2004)

EN 60439-1(1999) + A1(2004)

Specific Requirements:

IEC 60439-2 Ed. 3.0 (2000) + **A1(2005)**

EN 60439-2 (2000) + **A1(2005)**

It complies with this standard in all respects, and provides additional information ensuring a suitable degree of repeatability of the tests between the different test stations.

S. Manganaro 
Chairman of LOVAG Technical Committee

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Author: ACAE

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The test instruction consist of pages dated as shown in the following check list:

Page	Date
1 to 15	2006-06-30

Remark:

Modifications from the document LTI IEC/EN 60439-2 Ed. 3.0 are yellow highlighted

PREAMBLE

For convenience in the use of this test instruction, the paragraphs are numbered according to the clauses in the Standard

All references to the clauses of **General Requirements : IEC 60439-1 (1999) + A1(2004)** are preceded by the letter "**G**" and written in bold characters.

Tests must be carried out according to the standard; the test instruction only adds a few specific details.

Procedure for certification of an homogeneous series of busbar trunking systems

The series shall be considered "homogeneous" when:

- The enclosure has same size and dimensions.
- The conductors have the same distance between the phases or are assembled in a single pack
- The busbar carrying insulators and/or the insulating sheath, are identical in form, material and dimensions. The distance should be the same or smaller
- The protection circuit is identical.

Verification of temperature-rise limits (clause 8.2.1)

The series product to be tested is that with the maximum dissipated energy.

Verification of short-circuit withstand strength (clause 8.2.3)

Assuming that the whole series has the same rated values, the series samples to be tested are:

- a) Test of short-time withstand current
The series product having the maximum current density
- b) Test of peak withstand current
The series product with the minimum withstand cross section, which usually is that having busbars with minimum thickness

1. GENERAL

Refer both to standard and G1

2. DEFINITIONS

Refer to standard and G2

2.1.1.2 Partially type-tested LV switchgear and controlgear assembly (PTTA)

It is applicable only for tap-off units.

3. CLASSIFICATION OF ASSEMBLIES

Refer to standard and G3

4. ELECTRICAL CHARACTERISTICS OF ASSEMBLIES

Refer to standard and G4

5. INFORMATION TO BE GIVEN REGARDING THE ASSEMBLY

Refer to standard and G5

6. SERVICE CONDITIONS

Refer to standard and G6

7. DESIGN AND CONSTRUCTION

Refer to standard and G7

7.3 Temperature rise

Attention is drawn to the Note at the end of the first paragraph which states that:

“The temperature rise of an element or part is the difference between the temperature of this element or part measured in accordance with Sub-clause **G8.2.1.5** and the ambient air temperature outside the ASSEMBLY.”

i.e. External Ambient

The note in TABLE 2 for Built-in components states that the temperature rise for built-in components will be:

'In accordance with the relevant product standard requirements for the individual components, or, in accordance with the component manufacturer's instructions, taking into consideration the temperature in the ASSEMBLY'.

The relevant requirements for the individual component shall be the relevant international standard for the component. Alternatively the temperature rise limits may be based on the data given in the manufacturer instructions

Where the terminals of the built-in component are also the terminals for external insulated conductors, the over-temperatures (limiting values and measured actual values) refer to the ambient temperature outside the busbar trunking system.

Where applicable, the allowable temperature rise of built-in components and bus-bars, conductors and insulating materials etc shall be specified by the manufacturer and detailed in the test report.

The note 4 of the table 2 in **G7.3** was replaced by the following note:

Unless otherwise specified, in the case of external surfaces of enclosures of busbar trunking systems which are accessible but do not need to be touched during normal operation, an increase in the temperature-rise limits by 25 K is permissible for metal surfaces and by 15 K for insulating surfaces.

G7.5**Short-circuit protection and short-circuit withstand strength.****G7.5.4****Coordination of short-circuit protective devices. (SCPD'S)**

If the test circuit incorporates SCPDs, the report shall detail the SCPDs used for test i.e. manufacturer's name and reference, rated current, rated voltage and type of device. In addition, the short-circuit rating of the SCPD shall be stated where this differs from that of the associated connection of the bus-bar trunking system.

8.**TEST SPECIFICATIONS****8.1****Classification of tests**

Refer to standard and **G8.1**

8.1.1 Type tests (see Sub-Clause 8.2)

Refer to standard

8.2 Type tests

Refer to standard

8.2.1 Verification of temperature-rise limits

Refer to the preamble of this document for testing an homogeneous series of bus-bar trunking systems

8.2.1.2 Arrangement of the bus-bar trunking system

Refer to standard

The bus-bar trunking system shall be arranged as in normal use and as stated by the manufacturer. For a bus-bar trunking system intended to be mounted with its main longitudinal axis in the vertical plane, then it shall be tested in this configuration.

If the bus-bar trunking system can be used in either horizontal or vertical orientations, it is permissible to test both using suitable connections, (to determine rating factor k_2).

In any event, the attitude e.g. horizontal or vertical of the test shall form part of the description in the test report.

8.2.1.3 Temperature-rise test using current on all apparatus.

Refer to standard

The positions at which measurements are made and the method of temperature measurement shall be detailed in the test report.

a) Busbar trunking unit

Temperature rises of conductors and corresponding parts of the enclosure shall be recorded and checked with thermocouples located in the centre of each busbar trunking unit and adjacent joints and shall comply with the values of IEC 60439-1, table 3, including note 4 of this standard.

b) Tap-off unit

A temperature-rise test shall be performed on each type and size of tap-off unit, with a tap-off unit having the maximum rating (I_n) in that type and size.

The tap-off unit shall be fitted to a busbar trunking, arranged as in 8.2.1.3 a), having a rating of not less than twice the rating (I_n) of the tap-off unit (or the nearest available)

8.2.1.8 Termal cycling test.

8.2.1.8.1 **General**

Plug-in tap-off units shall be submitted to a thermal cycling test.

NOTE A plug-in tap-off unit is considered to be one in which the contact force is developed by the deflection of a spring member in the bus-bar trunking system; for the purpose of this requirement a disc spring is not considered to be a spring member.

8.2.1.8.2 **Test sample**

Refer to standard

8.2.1.8.3 **Conditioning**

Table 1A gives the number on cycles of insertion and removal of the plug-in unit to be carried out without load current

8.2.1.8.4 **Test procedure**

The rated current of the tap-off unit is applied until the temperatures have stabilised.

The temperatures as specified for the temperature-rise test are recorded. The current is switched off and the sample allowed to return to room temperature.

The sample is then subjected to two successive sequences of current cycling. Each sequence consists of 42 cycles.

For each duty cycle see the reference.

The temperature is measured at the end of the 42nd 'ON' period and at the end of the 84th "ON" period.

8.2.1.8.5 **Results to be obtained**

The temperatures taken after the 84th cycle shall not be more than 5 K higher than

- a) the temperatures recorded at the end of the stabilisation run, and
- b) the temperatures recorded at the end of the 42nd 'ON' period.

G8.2.2 **Verification of dielectric properties**

Refer to **G8.2.2**

8.2.3 **Verification of the short-circuit withstand strength**

Refer to standard

8.2.3.2.1 **Test arrangements**

Refer to standard

The specification requires the Bus-bar trunking system to be set up as in normal use. This means that the bus-bar trunking system shall be set up as far as is practical with due regard to normal service conditions and as stated by the manufacturer. The test arrangement shall be clearly detailed in the test report by appropriate means e.g. description, photograph(s) or both.

The tests shall be carried out on a bus-bar trunking system as detailed in Sub-Clause 8.2.3.2.1, the bus-bar trunking system comprising at least two straight trunking units connected to at least one bus-bar trunking feeder unit such that the total length of the Bus-bar trunking system does not exceed 6m.

A greater length than 6 m may be used in which case the actual test current must be equal to the rated short-time withstand current or the peak withstand current, as applicable.

Where tests are required on variations of sections e.g. elbows or angles, these variations may be included in the tests on the straight sections provided the overall length does not exceed 6m for rated short-time and peak withstand current tests only. These variations may also be tested individually connected to a straight section and its associated feeder unit.

For tests on outgoing circuits these shall be placed as near to the incoming feeder unit as consistent with the design of the bus-bar trunking system.

G8.2.3.2.2

Performance of the test: General

Refer to **G8.2.3.2.2** and sub-clause **G7.5.4** of this test instruction.

G8.2.3.2.3

Testing of the main circuits

Refer to **G8.2.3.2.3**

The requirements of Sub-clause **G7.5.5.1.2** are considered to be fulfilled when the conductors including any joints in the conductors between the main bus-bars and the supply side of a single functional unit, including the connections to the unit, are adequately and individually insulated and/or adequately shrouded phase-to-phase and phase to earth.

For the test to Sub-clause **G8.2.3.2.3(c)** the standard requires the value of the short-circuit current to be the same as that for the main bars.

This shall be taken to relate to the magnitude of rms and peak currents including the associated duration, and to the bus-bars to which the interconnections are made, OR not withstanding the designations of Appendix D, Figure D2, Forms 1 to 4 of the **General Requirements: IEC 60439-1: 1999 + A1:2004.**

For the test to Sub-clause **G8.2.3.2.3(d)** the standard requires the value of test current to be 60% of the phase-to-phase current and to be also agreed between the manufacturer and user if different to this. For the purposes of testing the term 'phase current' shall be taken to mean the rated short-time withstand, rated prospective short-circuit withstand, rated conditional short-circuit or rated fused short-circuit current as applicable, assigned to the associated main bus-bars.

The relationship between the peak and rms current for the test to Sub-clause **G8.2.3.2.3(d)** shall be as in Table 4. The value of the rms test current, its peak and duration, shall be stated in the test report. The test applies to the main bus-bars, bus-bars, conductors connecting the bus-bars to the outgoing circuit and the outgoing circuits.

The standard, Sub-clause **G8.2.3.2.3(b)**, details the precise requirements for the positioning of the short-circuit point related to prospective short-circuit current tests on the main bus-bars, but does not make this reference for such tests on outgoing circuits (Sub-clause **G8.2.3.2.3(a)**) or interconnections (Sub-clause **G8.2.3.2.3(c)**).

For the purposes of testing, the connection requirements of Sub-clause **G8.2.3.2.3(b)** do not apply to the tests of Sub-clause **G8.2.3.2.3(a)** and **G8.2.3.2.3(c)**.

The distance from the calibration point to the relevant short-circuit point(s) shall, however, be detailed within the test report.

This may be in the form of a dimensioned diagrammatic representation of the main circuit(s) on page F439-2/03 "Configuration of the Assembly".

Tests on a neutral bar to Clause **G8.2.3.2.3(d)** shall not be included in a Certificate unless tests on the main bus-bar to Clause **G8.2.3.2.3(b)** are also included.

G8.2.3.2.4

Value and duration of the short-circuit current

Refer to **G8.2.3.2.4** and **G8.2.3.2.2**

The rated short-circuit currents or short-time withstand currents may be any recognized value provided the Certificate Front Sheet clearly indicates the associated peak factor which in turn must be at least that specified in Table V for the relevant short-circuit rating.

For ASSEMBLIES incorporating short-circuit protective devices, whether these be in the incoming circuit or elsewhere, the test voltage shall be applied for a time sufficiently long to enable the short-circuit protective device to operate to clear the fault and, in any case, for not less than 10 cycles.

For ASSEMBLIES not incorporating short-circuit protective devices the specified time may be any value provided this is a direct multiple of 0.05s and the requirements of Sub-clause **G8.2.3.2.3** are met.

The standard requires the rms value of the rated short-time withstand current to be determined from the oscillogram, For testing purposes the rated peak withstand current (see Sub-clause 4.4) shall also be determined from the oscillogram. Values determined thus shall be used to verify the assigned ratings.

Note 1 implies that a shorter or longer test period is permissible, in accordance with the formula $I^2t = \text{Constant}$; that the peak value may be less than the rated peak withstand current; that it is only necessary to attain the rms value of short-time withstand current in one phase and that the minimum period for such a test is 0.1s.

For testing purposes these options may be adopted providing the following criteria are met:

- a) The formula $I^2t = \text{Constant}$, is utilized for periods up to a maximum of 3s (see the note incorporated in Sub-clause **G7.5.2.1.2**).
- b) The peak value is not less than the rated peak withstand current.
- c) The average value of the three phase currents shall be not less than the rated value for at least 0.1s after current initiation and the current in any one phase does not deviate from this average value by more than 15% of the average over this period unless the deviation is caused by the equipment under test.
- d) The option is utilized for specified times in excess of 0.1s.

Note 2 permits the peak withstand current test and the short-time withstand test to be made separately under certain conditions.

For testing purposes this option may be adopted provided the following criteria are met:

- a) The laboratory has made reasonable effort to achieve the rated values during one and the same test.
- b) The time during which the short-circuit is applied for the peak withstand current test shall be not less than three cycles.
- c) All other requirements within the standard and this test instruction are complied with. The final paragraph of Sub-clause G8.2.3.2.4 requires the dynamic and thermal stresses to be verified with a prospective current at the supply side of the specified protective device. Clause **G8.2.3.2.2** details requirements for the positioning of the short-circuit and prospective current calibration points.

The calculated value of the prospective current, obtained during the proving test, shall be not less than the rated prospective short-circuit current, the test being performed at a supply voltage not less than 1.1 times the rated operational voltage of the bus-bar trunking system.

8.2.3.2.5

Results to be obtained

Refer to standard

Apparatus incorporated in the bus-bar trunking system and intended to provide isolation shall be checked for compliance with the conditions prescribed in the relevant specification.

The supporting insulating parts shall not show any significant signs of deterioration, i.e. the essential characteristics of the insulation remain such that the mechanical properties of the equipment satisfy the requirements of this standard.

Additionally after the test of Clause **G8.2.3.2.3(a)** and tests incorporating short-circuit protective devices, the tested equipment shall be capable of withstanding the dielectric test of Sub-clause 8.2.2, at a value of voltage from table 10 or as prescribed in the relevant standard for the protective device for the after-test conditions, as follows:

- 1) between all live parts and the enclosure.
- 2) between each pole and all other poles connected to the enclosure.

If tests 1 and 2 above are conducted, they shall be carried out with any fuses replaced and with any switching device closed.

In the case of distribution trunking, it shall be verified that the ability to add and remove a tap-off unit is not impaired. In this case the dielectric test of this subclause is made with tap-off units fitted to each available outlet.

G8.2.4

Verification of the effectiveness of the protective circuit.

G8.2.4.1

Verification of the effective connection between the exposed conductive parts of the ASSEMBLY and the protective circuit.

Refer to **G8.2.4.1**

According to Note 2 of Sub-clause **G8.2.4.3**, the resistance of the protective circuit under test, shall be measured, before and after each test ie. between the incoming terminal of the protective circuit and the outgoing terminal of the protective conductor of the circuit concerned.

Verification of the requirements of Clause **G8.2.4.1** on ASSEMBLIES coming within the requirements of Sub-clause **G8.2.3.2** shall not be included within a Certificate unless Verification of the short-circuit strength of the protective circuit by the test of Sub-clause **G8.2.4.2** is also included.

G8.2.4.2 Verification of the short-circuit strength of the protective circuit by test.

Refer to **G8.2.4.2**

G8.2.4.3 Results to be obtained

Refer to **G8.2.4.3**

After the test, check that no possible damage is liable to hinder the correct operation of the bus-bar trunking system, and measure again the resistance of the protective circuit using the same method and the same instruments as before the test.

The continuity and short-circuit withstand strength of the protective circuit, whether it consists of a separate conductor or the trunking enclosure, shall not be significantly impaired.

In the case of a tap-off unit this may be verified by measurements with a current of the order of the rated current of the tap-off unit.

In the case of a busbar trunking unit, following the test and after sufficient time for the bar to cool to ambient temperature, the resistance phase to PE is measured and shall not exceed by more than 10 % the value of **G8.2.4.1**.

Where the trunking enclosure is used as the protective conductor, sparks and localized heating at joints are permitted, provided that they do not impair the electrical continuity and provided adjacent flammable parts are not ignited.

G8.2.5 Verification of clearances and creepage distances.

Refer to **G8.2.5**

The standard requires that clearances and creepage distances comply with the values specified in Sub-clause **G7.1.2** which, in turn requires that the apparatus forming part of the bus-bar trunking system shall have distances complying with those specified in their relevant specifications.

Where the relevant specification details that such requirements are "under consideration" and a client requested verification to clause **G8.2.5** the following statement shall be made on the test report:

"Verification of the requirements of clause **G8.2.5** is not possible since the requirements of the relevant specification are 'under consideration'".

The test report may detail the minimum clearance and creepage distance measured before and after short-circuit tests.

In any event, verification of the clearance and creepage distance shall not be included within the test report without the inclusion of verification of clause **G8.2.2** - Dielectric properties and clause 8.2.3 - short circuit withstand strength.

G8.2.6 Verification of mechanical operation

Refer to **G8.2.6**

Verification of the requirements of clause **G8.2.6** shall be made by performing the prescribed tests.

8.2.7 Verification of degree of protection

Refer to standard and to **G8.2.7**

The standard permits unspecified adaptations to be made to the requirements of IEC Publication 60529 to suit the particular type of bus-bar trunking system.

For the purposes of Certification, adaptations to the requirements of IEC Publication 60529 are not permitted.

G8.2.8 EMC tests

Refer to **G8.2.8**.

If the bus-bar trunking system fulfills the requirements of **G7.10.2a)** and **G7.10.2b)** and/or **G7.10.3** then no testing is required.

G8.2.9 Verification of the resistance of insulating material to abnormal heat and fire (glow-wire test)

Refer to **G8.2.9**

8.2.10 Verification of structural strength.

Refer to standard

8.2.10.1 Verification of the structural strength with normal mechanical loads.

Refer to standard

8.2.10.2 Verification of the structural strength with heavy mechanical loads

Refer to standard

8.2.10.3 Verification of the structural strength with special mechanical loads.

Refer to standard

The results of these tests may be included in the test report provided one or both of the other structural tests to Sub-Clause 8.2.9 have been carried out.

8.2.10.4**Results to be obtained**

Refer to standard

After the tests, the clearances or creepage distances shall not be **lower** than those specified in IEC60439-1. The outgoing and incoming units shall be able to be easily inserted. Similarly, after disassembly, straight elements shall be able to be reinstalled without any difficulty.

Finally, the trunking unit shall successfully withstand the dielectric test according to paragraph 8.2.2 of IEC 60439-1.

8.2.11**Verification of the endurance of trunking systems with trolley type tap-off facilities.**

Refer to standard.

8.2.12**Verification of resistance to crushing.**

Refer to standard.

8.2.13**Verification of electrical characteristics of bus-bar trunking systems**

Refer to standard.

The preferred methods for calculations are as defined in Appendices N1 and N2.

8.2.14**Verification of resistance to flame-propagation**

Refer to standard.

These tests are only applicable if the manufacturer has classified the bus-bar trunking system as "Resistant to flame propagation". Otherwise no tests need be performed. (See clause 3 and clauses 7.1.1.4 to 7.1.1.7.)

8.2.15**Verification of fire **resistance** in building penetrations**

Refer to standard.

These tests are only applicable if the manufacturer has classified a component as a "Fire Barrier Unit". Otherwise no tests need be performed. (See clause 3 and clauses 7.1.1.4 to 7.1.1.7.)

Note that no tests have yet been defined for verification of "Circuit integrity under fire conditions" (Clause 7.1.1.6 and Annex L).

- Annex J** **Voltage drop of the System (informative)**
See standard.
- Annex K** **Method of determination of magnetic field in vicinity of bus bar trunking system. (informative)**
See standard.
- Annex L** **Verification of maintenance circuit integrity under fire conditions (informative)**
See standard.
- Annex M** **Test arrangement (see IEC 60332-3) (informative)**
See standard.
- Annex N** **Method of determination of the electrical characteristics of bus bar trunking systems by calculations from measurements (informative)**
See standard.
Although clause 4.9.2 and 8.2.13 state that the values are at I_n , N.2 indicates that measurements are made at I_{xx} , the "...r.m.s. single short time test current, equal to three times the value of I_n ..."
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