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Translation

OR

Power supply installations for passenger stock

Installations pour l'alimentation en énergie électrique du matériel à voyageurs
Elektrische Energieversorgungseinrichtungen für Wagen der Reisezugwagenbauart

UNION INTERNATIONALE DES CHEMINS DE FER
INTERNATIONALER EISENBAHNVERBAND
INTERNATIONAL UNION OF RAILWAYS

Leaflet to be classified in Volumes:

V - Rolling Stock

IV - Operating

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1st edition, May 1930	First edition entitled: "Electric lighting - Carriages", numbered 51. The 3rd edition of this Leaflet was renumbered 550 in 1952.
9th edition, January 1994	with the current title and 1 Amendment.
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11th edition, January 2005	Editorial revision. Transfer of provisions on interference currents to UIC Leaflet 550-3. Addition of standards to the bibliography. Important: The points in this Leaflet have been renumbered in the new edition, so that, from point 7 onwards, the first digit of each point has been lowered by one (i.e. 8 becomes 7, 9 becomes 8, etc.). Please take account of this when using cross-references from other leaflets!

The person responsible for this leaflet is named in the UIC Code

Contents

Summary

This Leaflet applies to any passenger stock in generalised use in international traffic.

This Leaflet includes the general provisions with which power supply installations must comply, irrespective of their design.

The provisions for electrical switch cabinets on passenger stock are laid down in *UIC Leaflet 550-1*.

The conditions for type testing the power supply systems of passenger coaches are set out in *UIC Leaflet 550-2*.

The limit values for the effect on electrical installations outside passenger coaches are contained in *UIC Leaflet 550-3*.

1 - Principles

1.1 - Each coach shall be fitted with a train line as specified in *UIC Leaflet 552* (see Bibliography - page 34).

1.2 - Each coach shall be fitted with a storage battery and a battery charger in order to ensure that the lighting installations and other essential circuits continue to run should the power supply be cut.

1.3 - Electrical loads and in particular the converter equipment to be supplied with power from the train line, shall be so designed that any interference they may cause remains within the limits defined in *UIC Leaflet 550-3* (see Bibliography - page 34) so that they do not disrupt the operation of installations outside the vehicle.

1.4 - The equipment connected to the train line needs only to be designed for the nominal voltages at which train line can operate.

2 - Battery and battery chargers

2.1 - The nominal voltage of the battery and the d.c. circuit shall be 24 V. A voltage of 110 V is authorised for sleeping cars and dining cars.

The tolerances on the voltage shall correspond to the provisions of standard *EN 50155* (see Bibliography - page 34).

2.2 - Converters which take their power from the train line shall be used as battery chargers.

2.3 - The battery chargers which charge coach batteries for long periods when the vehicle is stationary must be designed to preclude any possibility of the battery becoming overcharged thus creating the risk of an explosion.

2.4 - The battery charge voltage shall be regulated in accordance with the temperature of the battery.

2.5 - As a safety measure, the capacity of the battery shall be such that at least the provisions of point 2.6.2 should be observed during an interruption of the battery charge.

When assessing the capacity of the battery account should be taken of loss of battery capacity due to natural ageing and the operation of the vehicle at low external temperatures according to the climatic zones stipulated in *UIC Leaflet 553, Appendix 3* (see Bibliography - page 34).

2.6 - In order to save the energy stored in vehicle batteries and allow the important units to operate for as long as possible when there is no battery charge, the following measures should be applied:

2.6.1 - The various units shall be progressively disconnected depending on the importance of their function by a minimum voltage relay.

2.6.2 - If there is no battery charge, battery consumption shall be reduced to a minimum in order to guarantee the following functions:

- the emergency lighting as specified in *UIC Leaflet 555*
- the starting of the power supply equipment as soon as the high voltage supply resumes as specified in Point 3 - page 5
- the electromagnetic brake as specified in Leaflet *UIC Leaflet 541-06*
- the electronic wheel slide protection as specified in *UIC Leaflet 541-05* minimum 5 hours
- the control of the doors as specified in *UIC Leaflet 560* minimum 5 hours
- the public address system as specified in *UIC Leaflet 568*
- the data transmission equipment as specified in *UIC Leaflet 556* minimum 5 hours
- the emergency ventilation as specified in *UIC Leaflet 553*
- other important control and monitoring systems (for example control of the WCs and fire warning system).

2.7 - The main circuit of the on-board d.c. system shall be protected on both its poles. It must be possible to cut secondary circuits on both poles with current monitoring carried out at least on the positive pole.

2.8 - The on-board d.c. system should be insulated from the vehicle earth.

It is recommended that the on-board d.c. system be insulated from the vehicle earth by means of an appropriate device. Any insulation defects should be signalled in accordance with *UIC Leaflet 550-1* (see Bibliography - page 34).

3 - Connection of the electrical power supply after a prolonged period of immobilisation without power

O **3.1 -** When vehicles are equipped for central supply from the train line through corresponding power-supplying installations, they must be able, even after a prolonged period of immobilisation with no external power supply, to restart and provide sufficient energy for all equipment as soon as HT power is restored to the train line.

3.2 - The requisite power may be available from any of the following sources:

- directly from the HT line or,
- from the coach battery or,
- from an auxiliary battery.

O **3.3 -** If batteries are the energy source, they must be able to provide the necessary power for 5 successive restarts.

O **3.4 -** The auxiliary battery shall only be used to restart the power supply equipment and shall not be connected to the coach circuits.

4 - Electrical loads connected to the train line

4.1 - Electrical loads connected to the train line shall be designed to operate satisfactorily within the voltage range of between U_{max2} and U_{min1} as set out in Appendix B - page 23 and shown in *UIC Leaflet 600* (see Bibliography - page 34).

4.2 - Possible distortion of the waveform should be taken into account. In the case of alternating current, the ratio between the root-mean-square value and the peak value may be 1:2. In the case of a d.c. voltage, this is a unidirectional three phase current without smoothing.

4.3 - The equipment may stop working when the voltage is outside the U_{min2}-U_{max2A} range; however, the equipment should start up again once the voltage has returned to the U_{max2}-U_{min1} range.

4.4 - For hauled stock supplied with electrical power by diesel tractive units or generator vans through the train line, the conditions to be met regarding voltage and frequency are those set out in *UIC Leaflet 626* (see Bibliography - page 34).

4.5 - Railways may require that coaches be suitable for running in accordance with *UIC Leaflet 626*, when the coaches concerned are worked on lines where the operating conditions so dictate.

4.6 - Nominal voltage of 1 500 V:

4.6.1 - It is recommended that frequency variations of between 16 and 52 Hz should be taken into account.

4.6.2 - Railways may require that coaches be suitable for working with frequency variations of between 16 and 52 Hz if the train line is energised through the electrical power generators in diesel tractive units.

4.7 - Railways may require that with a nominal voltage of 1 000 V coaches be suitable for working with frequency variations of between 21 and 23 Hz, if the train line is energised through the electrical power generators in diesel tractive units.

4.8 - Current-consuming equipment connected to the train line must adapt automatically to the different voltages.

4.9 - Each vehicle shall be fitted with an isolating and earthing switch that allows all equipment connected to the train line to be disconnected on load with one single action. The position of this device shall be marked as shown in Appendix D - page 26. The disconnection and earthing equipment shall be operated by means of a Berne key as specified in *RIC, Plate 3* (see Bibliography - page 34).

Other technical and design requirements that apply to the disconnection and earthing equipment are given in point 16 - page 19.

4.10 - Each vehicle shall be fitted with a switch in the electrical cabinet as shown in *UIC Leaflet 550-1* that enables all the electrical equipment to be disconnected from the train line in a single operation. This switch shall have a danger sign as shown in Appendix E - page 27.

O **4.11 -** Breaks of short duration, resulting from loss of pantograph contact, shall not lead to a power cut or to switching of the equipment.

O **4.12 -** Electrical equipment in a coach which causes current peaks on connection and is connected to the train line, must be designed in such a way that, when the train line is energised, the appliances concerned are not all activated simultaneously in all coaches but at different times.

O **4.13 -** When a current-consuming appliance is switched on, the first current semi-wave must not exceed 180 A for a sinusoidal voltage of 1 000 V and 16 2/3 Hz. However, the purely inductive part must not be higher than 40 A.

O **4.14 -** Regardless of the train line's nominal voltage, the inrush current of all static converters of a coach connected to the train line must not exceed 180 A.

O **4.15 -** Power factor λ:

4.15.1 - Power transformers in coaches should be reactionless, from the point of view of reactive power via the train line.

4.15.2 - When the train line is supplied by an electric tractive unit which has a sinusoidal voltage shape, the power factor λ, based on the maximum power allowable for a coach according to point 5 - page 8, shall not be less than 0,85 t.

4.15.3 - If the train line is supplied by a diesel locomotive or a generator van with a trapezoidal or rectangular voltage shape, the power factor λ shall not be less than 0,9 up to 20% of the nominal rating of the power transformation installation as specified in point 5 and shall not be less than 0,95 for a higher power.

O **4.16 -** If the train line is supplied by a diesel locomotive or generator vans with a trapezoidal or rectangular voltage shape, the design of the transformers connected directly to the train line shall comply with the following conditions:

- the magnetising current must not exceed 0,8 A,
- the working point on the characteristic magnetisation curve shall not exceed 50% of the saturation induction,
- the ohmic resistance of the primary winding should be between 1 and 2 Ω.

O **4.17 -** Electrical equipment connected to the train line must not have a capacitive effect.

O **4.18 -** Electronic power devices in coaches supplied by transformers connected directly to the train line (e.g. battery chargers, converters and inverters) shall not have a controlled or semi-controlled input stage.

5 - Permissible energy consumption of a coach and of a trainset

5.1 - The provisions relating to the power drawn by a vehicle from the train line are defined from the dimensions in *UIC Leaflet 567* (see Bibliography - page 34).

5.2 - The permissible energy consumption of a coach S_W shall not exceed the values shown in Appendix C.1 - page 24. The energy consumption is mainly influenced by the external temperature and the thermal insulation of the coach.

5.2.1 - Continuous operation: this is the situation when coaches have reached a steady state, where temperatures in the passenger compartments have attained their theoretical levels and the equipment is functioning within the range of values set.

5.2.2 - Start-up: this is the situation when the temperatures inside the passenger compartments have not yet reached their theoretical levels. The vehicles are still in a preheating or precooling phase; the batteries are almost flat. For a period of one hour after the train line has been energised, the energy absorbed may exceed by 10% that attained in continuous operation.

5.2.3 - The mean power absorbed by a coach is obtained by dividing the energy consumption in any given period by that same period.

5.3 - The maximum power absorbed by a coach corresponds to the sum of the powers of all the electric loads connected to the train line. The ratio between the mean power and the maximum power of a coach can be 1 : 1,1.

5.4 - The current taken by the power supply equipment from the train line shall not exceed the current allowed at U_n for $U < U_n$ (U_n = Nominal voltage in accordance with Appendix B - page 23).

5.5 - The average power of the electrical equipment in the dining car galley, taken from the train line, shall not exceed 50 kVA.

5.6 - The power for the pressure ventilation equipment of coaches with fans, taken from the train line, shall not exceed 10 kVA.

5.7 - The energy consumption on the train line of coaches whose dimensions differ from those specified in *UIC Leaflet 567* (e.g. double decker coaches), may be different to point 5.2, provided the conditions laid down in point 5.8.2 are complied with.

5.8 - The maximum permissible power absorbed by a 15 coach trainset S_Z, including a dining car, can be calculated from points 5.1 to 5.6. It is shown, as a function of the external temperature, in Appendix C.2 - page 25.

5.8.1 - For continuous operation and start-up, the definitions given in points 5.2.1 and 5.2.2 shall apply.

5.8.2 - The maximum permissible power absorbed by a trainset, as specified in Appendix C.2, shall remain the same regardless of the dimensions of the coaches. This limit must be heeded when forming train consists with coaches as per point 5.7.

6 - Voltage peaks on the train line

6.1 - Definition of voltage peaks: voltage peaks may be superimposed on the nominal voltages as specified in point 4.1 - page 6 and Appendix B - page 23 with their voltage tolerances. Their shape and duration may be as follows:

6.1.1 - Low voltage peaks with a slow increase but of a duration greater than 20 ms.

6.1.2 - Recurring voltage peaks, in the case of alternating voltages, of a duration greater than 20 ms.

6.1.3 - Very high level voltage peaks, non-recurring, lasting less than 20 ms for a period exceeding 20 ms.

6.2 - Appendices F.1 - page 28 to F.4 - page 31 show the maximum permissible values for voltage peaks in terms of time (logarithmic scale) for the different nominal voltages. The voltage values of U_{max1} to U_{max4} are also included. The peak values permissible for alternating voltages are also given in Appendices F.3 - page 30 and F.4.

6.3 - The limit values U_{max1} to U_{max4} are listed in the form of a table in Appendix F.5 - page 32 (see Appendix B - page 23).

6.4 - Energy content of the voltage peaks: to be added later.

7 - Protective fuses for nominal voltages up to 600 V

7.1 - The battery shall be protected on both its poles by fuses placed in 1 or 2 boxes located near the battery compartment which shall be easily accessible from the side of the coach.

7.2 - The different current-consuming equipment of the on-board d.c. circuit should be protected in line with point 2.7 - page 4.

7.3 - The various a.c. circuits feeding the different current-consuming equipment (e.g. air conditioning, cleaning sockets, etc.) shall be protected on all poles by fuses or automatic circuit breakers in order to avoid defects affecting the other circuits and to reduce the risk of fire.

Three phase motors must be protected in such a way that the 3 phases cut out simultaneously in the event of failure.

8 - Fuses for nominal voltages of 1 000 V and above

8.1 - The RUs are left free to use whatever types of fuses (or similar devices fulfilling the same role) that they wish. They will be called fuses hereafter.

O **8.2 -** The requirements specified below are to ensure that the fuses work well. This shall be demonstrated by the type test specified in Appendix A - page 20.

O **8.3 -** The fuses serve to protect against absolute short circuits, that is to say when the short-circuit current is more than 5 I_n.

Currents of between 1,5 and 5 I_n are a very critical zone for the correct breaking of the current. Fuses which are intended to operate below 5 I_n must be specially designed and are not covered by these provisions.

O **8.4 -** The nominal rating of the fuses shall be chosen in such a way that the protection of the electrical installations against short circuits is also guaranteed when the fuses are used under several voltages in accordance with Appendix B - page 23. In these cases the peak currents resulting from the switching on of the loads shall not have negative effects on the behaviour.

O **8.5 -** The fuses shall break the current without noise, without the projection of sparks and without the production of smoke and shall not explode.

8.6 - It is recommended that fuses for d.c. should not be fitted with indicators to show whether they are fused.

8.7 - Fuses need only be dimensioned for the nominal voltages for which the electrical power supply of a vehicle is designed. The principle whereby the type test for the d.c. voltage also includes that for the a.c. voltage and the type test for a higher voltage includes that for a lower voltage should be applied.

9 - Protection against indirect contact with installations under high voltage

O **9.1 -** All the accessible, non-live metallic parts of equipment whose electrical part is connected to the train line shall be earthed to the vehicle in a reliable manner.

O **9.2 -** The metallic parts shall be connected to the vehicle earth with a copper cable with a minimum cross section of 4 mm^2.

O **9.3 -** The earthing bar to protect electrical installations with U ≥ 1000 V shall, over the shortest distance, be metallically connected to the vehicle earth by two flexible connections made of copper with a minimum cross-section of 10 mm^2.

O **9.4 -** All the fixed cables in which current normally passes at voltages ≥ 1 000 V shall be protected by their location or by an appropriate sheath against mechanical damage. Metallic sheaths shall be connected to earth.

O **9.5 -** All equipment that must be kept away from unauthorised persons must be protected or locked with the aid of the square female key specified in *RIC, Plate 3* and/or with the aid of a special tool (for example: size 10 male hexagonal key).

9.6 - Earthing contacts:

O **9.6.1 -** The vehicle axle boxes shall be fitted with electric insulation in order to allow the current from loads connected to the train line to flow to the rail without damage to the bearings.

O **9.6.2 -** In order to short circuit the insulation, the following should be fitted on each bogie at least:

- one axle box with an earth contact through which the return current can flow, and
- on each of the other boxes not fitted with an earthing contact, a shunt of a protective resistance of 40 and 100 M Ω.

9.6.3 - It is recommended that the earthing contacts be fitted on the end axles.

O **9.6.4 -** Appendix G - page 33 shows the basic diagram.

10 - Test voltages

10.1 - The choice of test voltage for the insulation tests during the starting procedure is left to each railway but the high voltage electrical equipment connected to the train line must be able to withstand an r.m.s. alternating voltage of at least 2 U_n + 1 000 V, U_n being the nominal voltage defined in point 4.1 - page 6.

10.2 - To avoid damage, the power electronic components shall be protected by short circuiting of their connections and the electronic control units shall be disconnected before the test. The test requirements shall be specified by the railways.

10.3 - For the repeat tests, the high voltage electronic equipment connected to the train line shall be tested with 0,7 x (2 U_n + 1 000 V).

10.4 - The electronic and inductive loads shall no longer be subjected to additional insulation tests with the complete installation. If necessary they shall be tested as isolated units in accordance with the special instructions laid down by the railways and shall only be subjected in the complete installation to a service test at the maximum service voltage.

10.5 - The test durations shall be as follows:

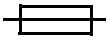
- 120 seconds for 1 000 V a.c.
- 60 seconds for 1 500 V a.c. or d.c.
- 30 seconds for 3 000 V d.c.

o 11 - Distribution and control panels - Equipment cases

11.1 - The electrical equipment cases of coaches shall be designed and fitted out as specified in *UIC Leaflet 550-1*.

11.2 - The control panel and the equipment panel with the other control and switching devices shall be fitted in the electrical cabinet and be easily accessible. The cabinet shall have a sufficient number of doors. To assist operation and maintenance, the doors of the cabinet shall be easily removable. Parts of the equipment that are at a greater voltage than the permissible contact voltage shall be protected against accidental contacts, without, however, hindering the visual monitoring of these units.

11.3 - If a fuse is housed in a box which is not easily accessible, this box shall be marked with the nominal current rating of the fuse.

11.4 - Battery fuse boxes shall be marked with the symbol  .

11.5 - The equipment cases fitted under the body shall have at least the level of protection IP 54 according to *IEC 60529* (see Bibliography - page 34).

11.6 - All the distribution and control panels of the coach and the equipment cases under the body in which the voltage is greater than 50 V a.c. or 110 V d.c. shall be marked by a danger sign that is at least 80 mm long and carries the wording "ATTENTION DANGEROUS ELECTRICAL VOLTAGE" as specified in *ISO 3864* (see Bibliography - page 34).

12 - Provisions for other electrical loads

O **12.1 -** A 230 V 50 Hz socket shall be provided in toilets and washrooms for electric shavers in accordance with *UIC Leaflet 563* (see Bibliography - page 34). The voltage may be sinusoidal or trapezoidal. The circuit shall be designed so that it cannot supply more than 25 VA, so as not to damage faulty equipment (short circuit) or supply equipment of too high a power. Normal operation must be restored automatically as soon as the defective contact ceases. As a safety measure, sockets shall be provided with a "protective circuit breaker".

O **12.2 -** Each coach shall be fitted with two 16A 230 V 50 Hz sockets of type 1 in accordance with standards *EN 60309-1* and *-2* (see Bibliography - page 34) into which electrical cleaning appliances can be plugged. These sockets should be supplied with a.c. 230 V 50Hz with a rectangular voltage shape as specified in *EN 50160* (see Bibliography - page 34). The total connected load of the two sockets shall be at least 2,0 kVA, and it should be possible to take this power from any socket. Allowance shall also be made for current peaks.

12.2.1 - The power need only be available at the sockets when the train line is energised.

12.2.2 - When coaches are in service, sockets located in the passenger area shall be de-energised or shall receive equivalent selective protection, in the form of a differential protective circuit for example.

12.2.3 - Socket locations shall be chosen in accordance with *UIC Leaflets 567-1 and 567-2* (see Bibliography - page 34).

12.3 - It is recommended that vehicles fitted with 230 V 50 Hz sockets (sinusoidal voltage) for use by passengers should have a maximum power of 150 VA, for example for supplying portable computers. The total power of these sockets shall not exceed 2,0 kVA.

O **12.3.1 -** The power supply circuits for the socket should be equipped with a residual current monitoring device with a maximum response threshold of 30 mA.

12.3.2 - The power need only be available at the sockets when the train line is energised.

O **12.4 -** Sockets that are accessible to passengers and are live during operation shall be fitted with "Shutters" (child protection) as specified in *IEC 60884-2-5* (see Bibliography - page 34).

13 - Spares

13.1 - Each coach shall be provided with one spare fuse for high-voltage circuits and two fuses for low-voltage circuits, for each size used.

13.2 - The fuses shall, where possible, be located in the cupboard for spare equipment accessible by means of the square socket key (Berne key) shown in *RIC, Plate 3*. If they are placed elsewhere, their location shall be specified on a notice displayed in this cupboard.

13.3 - The cupboard containing the spare fuses must be marked "spares cupboard" in all the languages specified by the *RIC*.

13.4 - The racks containing the spare fuses shall be marked with the nominal rating of the fuses.

14 - Markings

See *UIC Leaflet 552, point 7*.

o 15 - Operating instructions - Explanatory notes and diagrams

15.1 - A notice in several languages giving operating instructions, together with the notice concerning lighting and heating or air conditioning installations, shall be placed on the inside of the electrical cabinet door.

15.2 - The following information shall be placed in the electrical cabinet so that any fault may be identified and the necessary action taken for correction:

- a diagram indicating the layout of the main components;
- a basic circuit diagram;
- a short explanatory note giving information for repairs.
- an explanation of the fault codes for the type 1 or 2 man/machine interfaces specified in *UIC Leaflet 557* (see Bibliography - page 34) with indications for emergency repairs.

o 16 - Safety measures to be taken to protect staff working on high voltage installations

16.1 - It shall be possible to disconnect all the loads of a vehicle from the train line safely by operating an isolating and earthing device.

16.2 - The break between the train line and the HT installations shall be visible.

16.3 - The HT installation disconnected from the train line is automatically earthed after the isolating and earthing device has opened. If there are any condensers these shall also be automatically earthed. The earthing of these condensers is sufficient if there is a mechanical system to ensure that the part of the installation not earthed cannot be made live.

16.4 - It must not be possible to open the equipment cases with HT components which can be opened without using a tool until after disconnection of the installation from the train line as specified in point 16.1. Similarly it shall only be possible to re-energise the equipment once these cases have been closed again.

16.5 - Before the opening of the isolating and earthing device, the control circuits shall automatically be broken in such a way that they disconnect the load.

16.6 - If the load is not switched off by the contactors as a result of a fault (contacts welded for example) some protection measures shall be provided. This can be done by one of the following methods:

- the isolating and earthing device shall also be designed to break the load,
- the arc caused when the isolating and earthing device opens melts a fuse in an earlier part of the circuit,
- it shall not be possible for the isolating and earthing device to be opened.

16.7 - The connections of the electrical cables to the isolating and earthing device shall be designed in such a way that there can be no possibility of them being wrongly connected.

16.8 - The isolating and earthing device must be able to be locked in the "cut off" position with padlocks by staff who are working on the installation.

16.9 - Before any work is carried out on the high voltage lines, it is necessary to ensure that there is no voltage on any of the parts. Equipment-internal bus bars shall be earthed.

Appendix A - Test conditions for the type tests of high voltage fuses for nominal voltages of 1 000 V and above

A.1 - Scope

These conditions apply to the fuses that protect the electrical installations of coaches working at nominal voltages $U_n \geq 1\,000$ V against short circuits.

A.2 - Definition

The nominal rating of a fuse is the current at which the fuse overheats and cuts off the short circuit current.

A.3 - Type tests

A.3.1 - Each test shall be carried out on 3 fuses.

A.3.2 - Before the tests, the temperature of the fuses shall be brought to the equilibrium temperature with a current equal to 1,1 times the nominal rating.

A.3.3 - The test voltage shall be U_{max} of U_n each time. The risk of incorrect shut-off of the current exists in particular for direct current and increases with it.

A.3.4 - Type test for 3 000 V d.c.

A.3.4.1 - The test voltage shall be $3\,900\ V^{+100V}_{-0V}$

A.3.4.2 - Test rig

- The test circuits shall be supplied from a sub-station:
- test circuit of 1,2 Ω and 13 mH:
  - short circuit test
- test circuit of 2,4 Ω and 39 mH:
  - short circuit test
- test circuit with 39 mH:
  - cut-off test with a current of 5 I_n
  - cut-off test with a current of 10 I_n

A.3.4.3 - Measurement of the transient recovery voltage

- The transient recovery voltage shall be measured for a period of 100 ms after extinction of the electric arc and shall be shown on an oscillogram,
- It shall be maintained, after the current is cut off, for a period of 30 seconds for fuses containing no organic matter, and for 3 minutes for fuses of other designs. It is acceptable to change the source of voltage after 15 seconds, provided that the interruption is not more than 0,1 s.

A.3.4.4 - After the voltage has been cut off (according to point A.3.4.3), the resistance between the terminals shall be measured with at least 2 500 V for 3 minutes. The resistance shall be at least 1 M Ω.

A.3.4.5 - The transient recovery voltage shall not be greater, for fuses

with $I_n \geq 6$ A, than 12 kV and
with $I_n \leq 6$ A, than 16 kV.

A.3.5 - Type test for 1 500 V d.c.

A.3.5.1 - The test voltage shall be 1 950 V^{+50V}_{-0V}

A.3.5.2 - Test rig

- The test circuits shall be supplied from a sub-station:
- test circuit of 0,4 Ω and 11 mH:
  - short circuit test
- test circuit of 0,7 Ω and 21 mH:
  - short circuit test
- test circuit with 21 mH
  - cut-off test with a current of 5 I_n
  - cut-off test with a current of 10 I_n.

A.3.5.3 - Test as in point A.3.4.3.

A.3.5.4 - Test as in point A.3.4.4.

A.3.5.5 - The transient recovery voltage shall not be greater than 6 kV.

A.3.6 - Type test with a.c. voltage

A.3.6.1 - The test voltage shall be:

1 740 V, 50 Hz^{+50V}_{-0V} for fuses designed for U_n = 1 500 V
and
1 200 V, 50 Hz^{+50V}_{-0V} for fuses designed for U_n = 1 000 V.

A.3.6.2 - The tests shall be carried out according to the rules laid down in *EN 60282* (see Bibliography - page 34) (high voltage fuses) taking into account the values that are specified for railway operation.

A.4 - Assessment of the tests

The test is considered as satisfactory if:

- the fuse correctly cut off the current and no release of harmful gas or smoke was observed,
- the body of the fuse had no unacceptable damage and could be removed from the supports as a single piece. Slight damage, such as thermal cracks or changes of colour, are acceptable,
- the temperature remained below a given value, such that the fuses did not suffer any change which might have made their removal difficult or dangerous.

Appendix B - Voltages for equipment connected to the train line

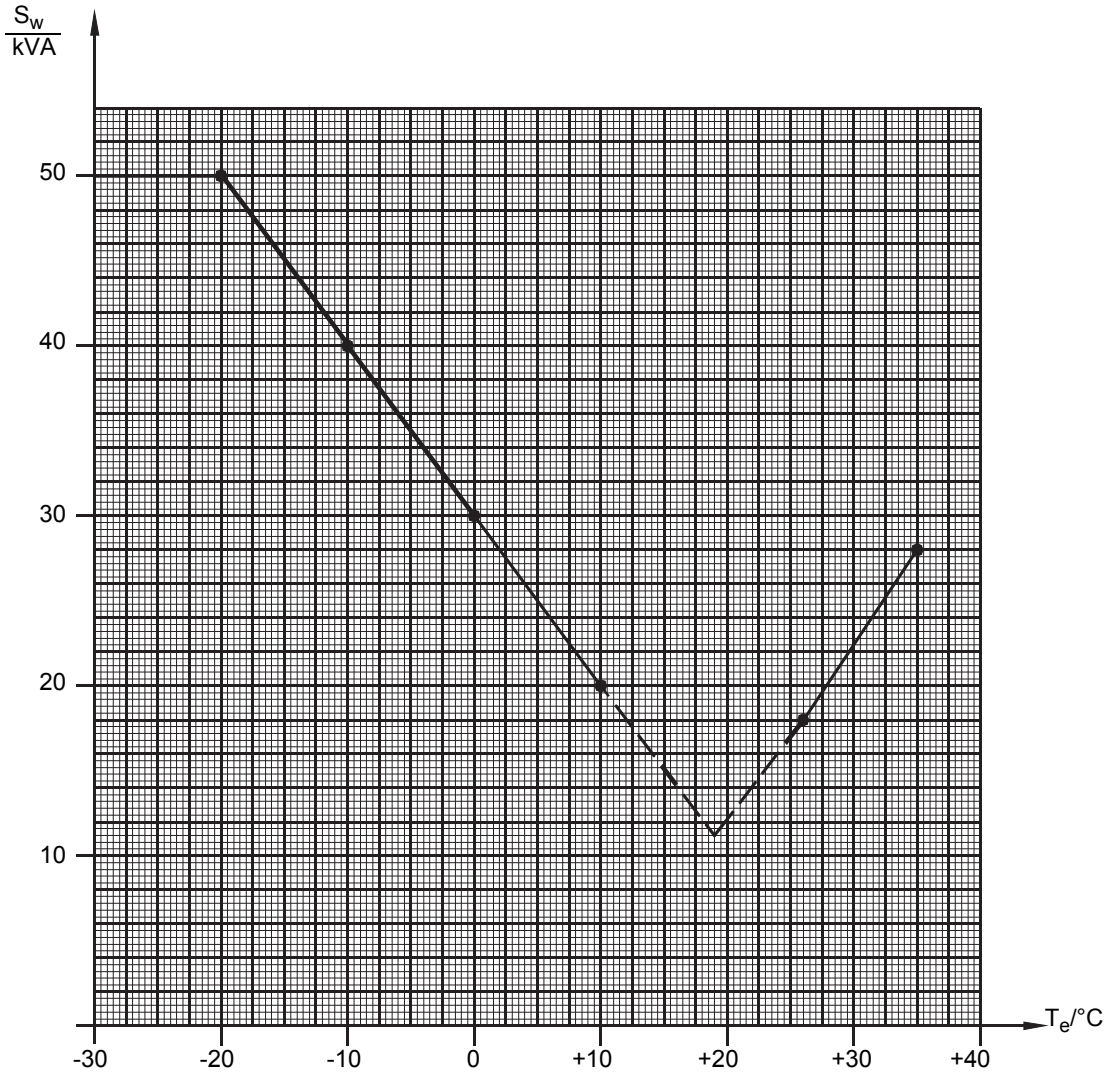
Transformation ratio of the transformer windings for the train line on traction units as specified in *UIC Leaflet 600* when idle.

Voltage on train line < U_n		**Nominal voltage U_n/V**	**Voltage on train line > U_n**		**Upper cut-off voltage**
For a max. period of 10 min	Possible on permanent basis	**Nominal frequency**	Possible on permanent basis	For a max. period of 5 min	
U_{min2} (V)	U_{min1} (V)	f_n (Hz)	U_{max1} (V)	U_{max2} (V)	U_{max2A} (V)
700	800	1 000; 16 2/3, 22, 50	1 150	1 200	1 250
1 050	1 140	1 500; 50	1 650	1 740	1 860
900	1 000	1 500	1 800	1 950	2 050
1 800	2 000	3 000	3 600	3 900	4 050

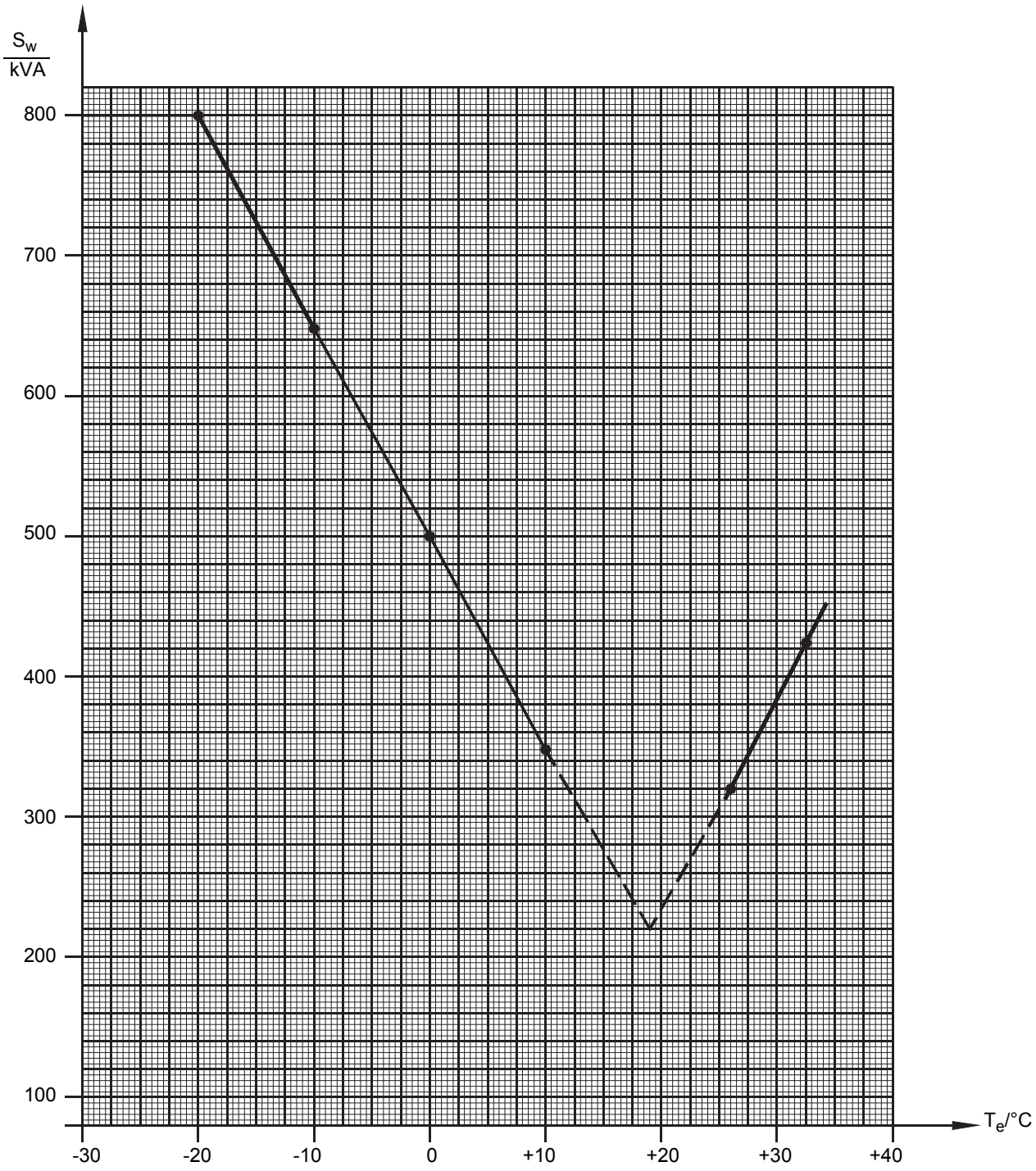
Nominal frequency f_n/Hz	Mandatory	Frequency tolerance generally recommended, mandatory with points 4.6.2 and 4.7
16 2/3	16 - 17,5	- -
22		21 - 23
50	48 - 52	16 - 52

Appendix C - Maximum permissible power that can be taken continuously from the train line depending on the outside temperature T_e

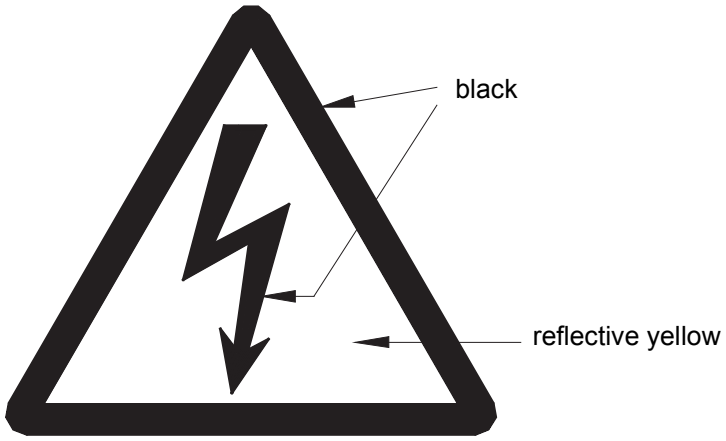
o C.1 - Maximum power S_w that can by taken by a coach

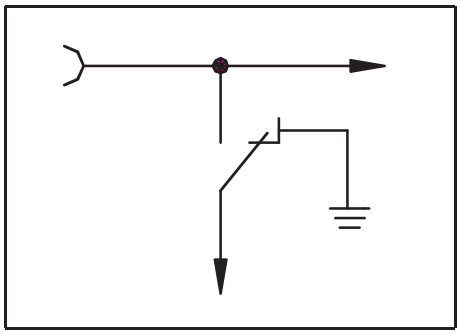


C.2 - Maximum power S_z that can by taken by a trainset



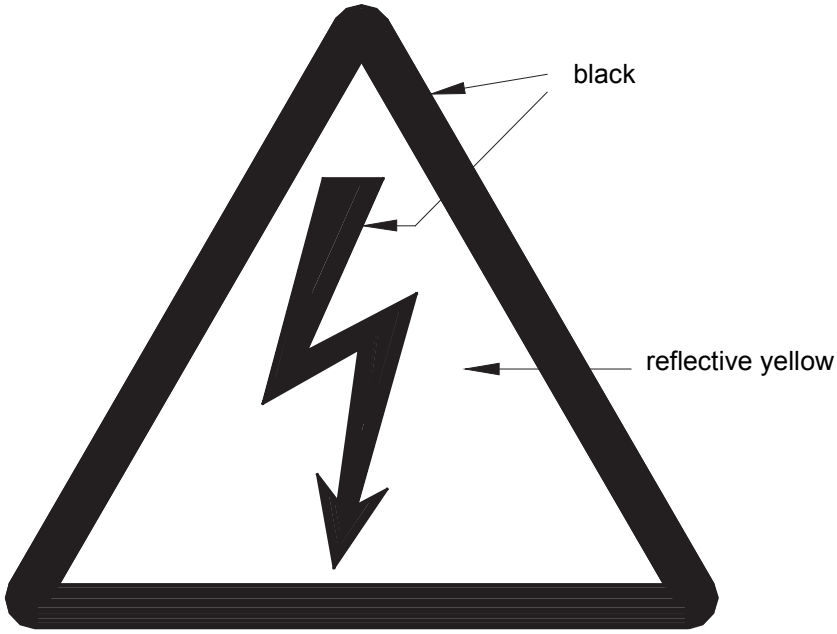
Appendix D - Marking of the isolating and earthing device





The size of the warning sign must be adapted to the size of the switch.

Appendix E - Sign for the main voltage circuit breaker

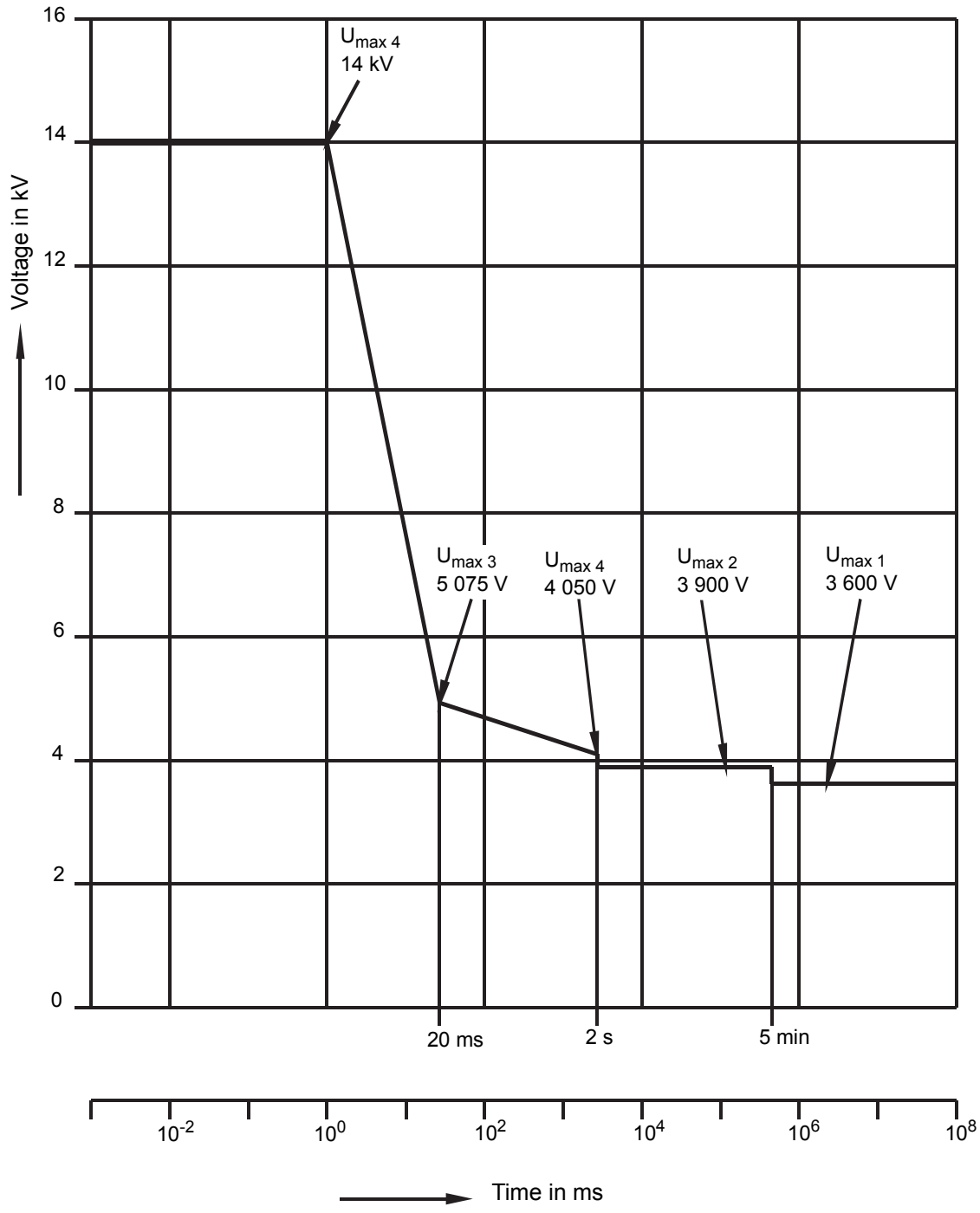


The size of the warning sign must be adapted to that of the switch.

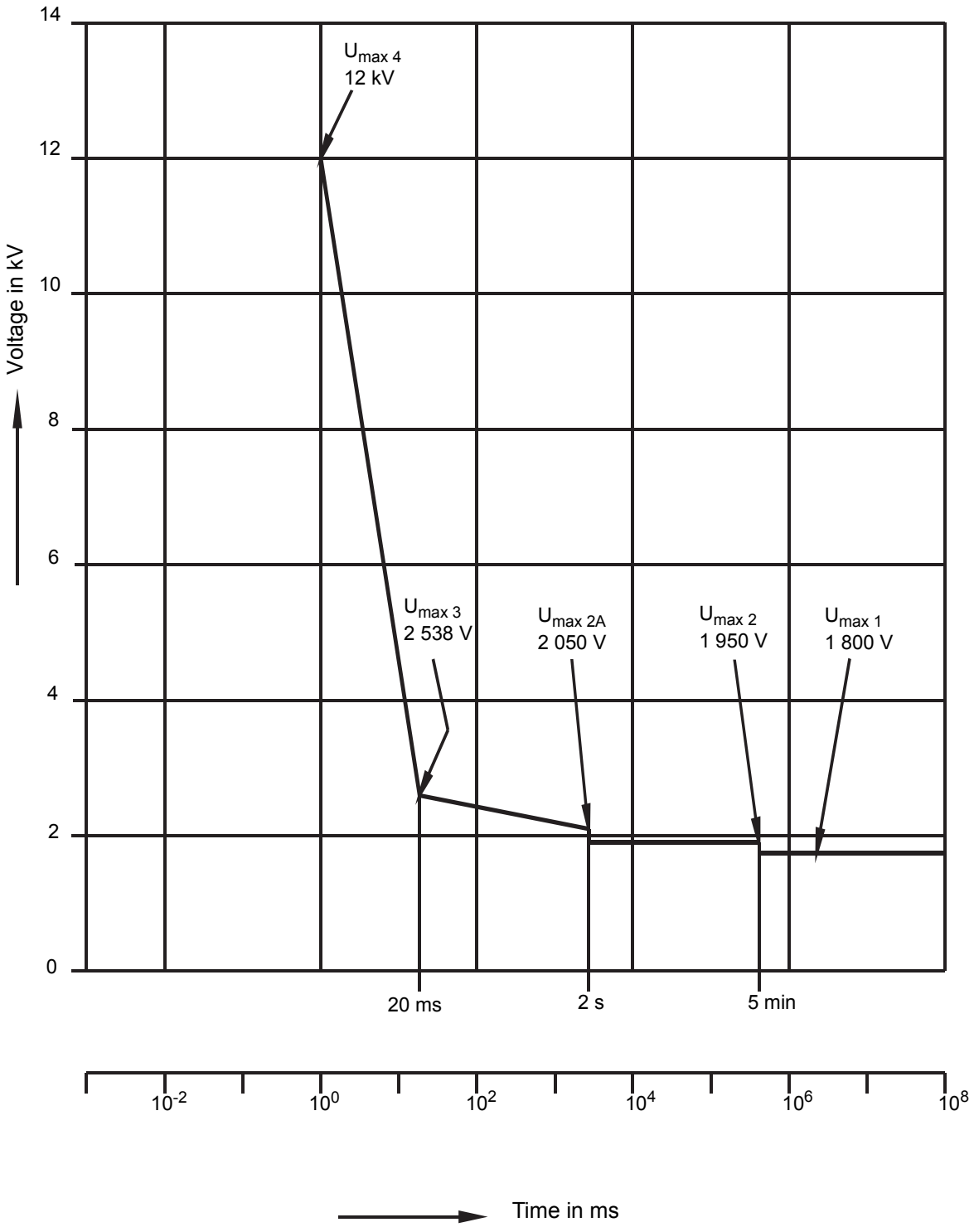
The "off" and "on" positions must be identified by "0" and "1".

Appendix F - Limit values for voltage peaks from the train line

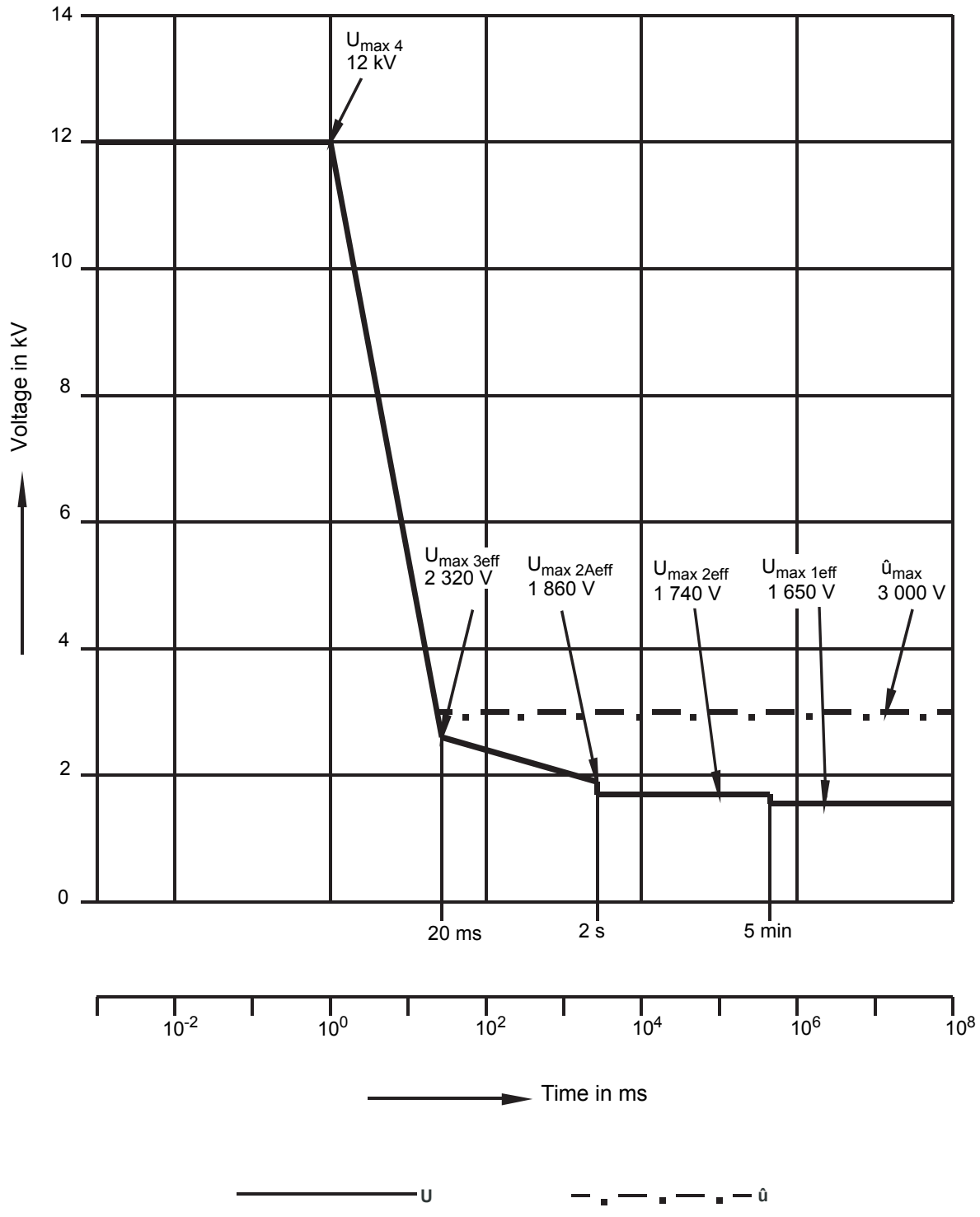
o F.1 - Limit values for 3 000 V d.c.



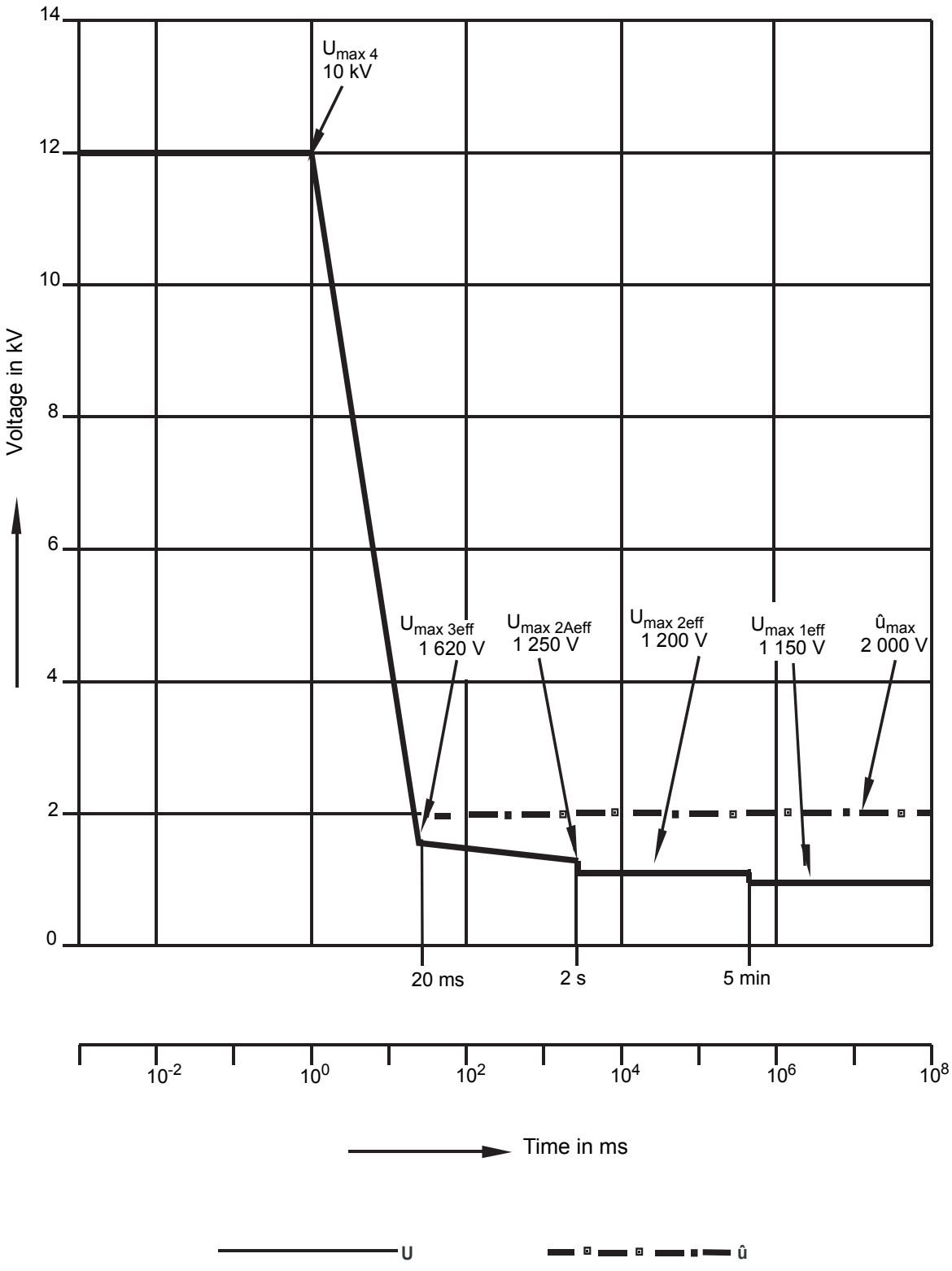
o F.2 - Limit values for 1 500 V d.c.



o F.3 - Limit values for 1 500 V 50 Hz



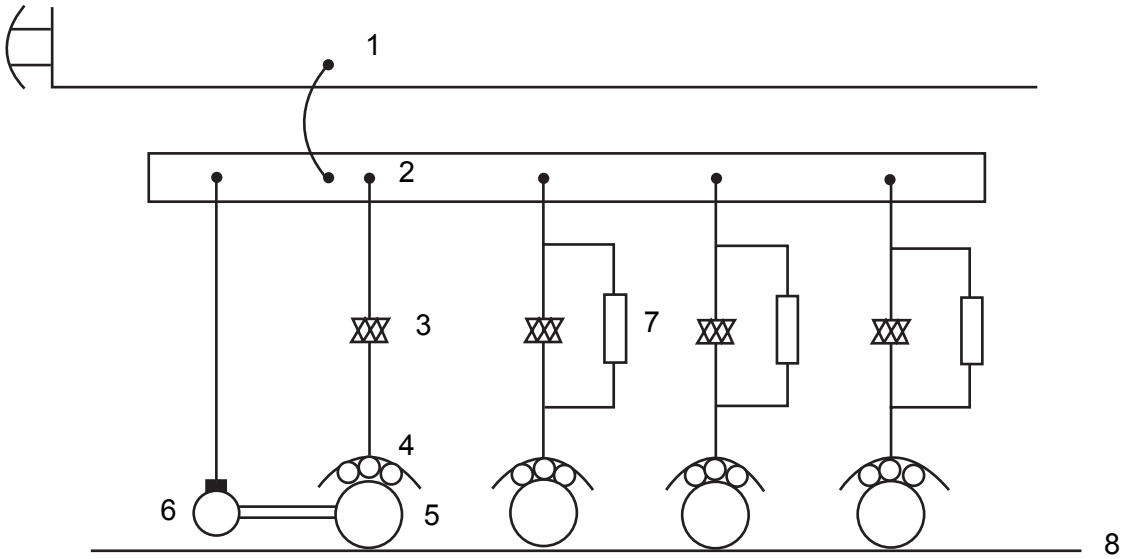
o F.4 - Limit values for 1 000 V 16 2/3 Hz



F.5 - Limit values for nominal voltages

U nominal (V)	U_{max1} (V)	U_{max2} (V)	U_{max2A} (V)	U_{max3} (V)	U_{max4} (kV)	û (V)
1 000 16 2/3Hz	1 150 r.m.s.	1 200 r.m.s.	1 250 r.m.s.	1 620	10	2 000
1 500 50Hz	1 650 r.m.s.	1 740 r.m.s.	1 860 r.m.s.	2 320	12	3 000
1 500 d.c.	1 800	1 950	2 050	2 538	12	
3 000 d.c.	3 600	3 900	4 050	5 075	14	

Appendix G - Layout of protective resistances and earthing contact on bogies



1 - Vehicle body
2 - Bogie
3 - Box isulation
4 - Axle-box
5 - Axle
6 - Earthing contact
7 - Protective resistance
8 - Rail

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Warning

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