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Railway applications — Generic system architectures for onboard electric auxiliary power systems

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National foreword

This Draft for Development is the UK implementation of CLC/TS 50534:2010.

The UK participation in its preparation was entrusted by Technical Committee GEL/9, Railway Electrotechnical Applications, to Subcommittee GEL/9/2, Railway Electrotechnical Applications - Rolling stock.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This Draft for Development was published under the authority of the Standards Policy and Strategy Committee on 30 June 2010.

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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

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CLC/TS 50534

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English version

Railway applications - Generic system architectures for onboard electric auxiliary power systems

Applications ferroviaires - Architectures des systèmes génériques pour le système d'alimentation en énergie embarqué de véhicules ferroviaires

Bahnanwendungen - Generische Systemarchitekturen für elektrische Bordnetze zur Hilfsbetriebeversorgung

This Technical Specification was approved by CENELEC on 2010-03-26.

CENELEC members are required to announce the existence of this TS in the same way as for an EN and to make the TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Management Centre: Avenue Marnix 17, B - 1000 Brussels

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Foreword

This Technical Specification was prepared by SC 9XB, Electromechanical material on board rolling stock, of Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways.

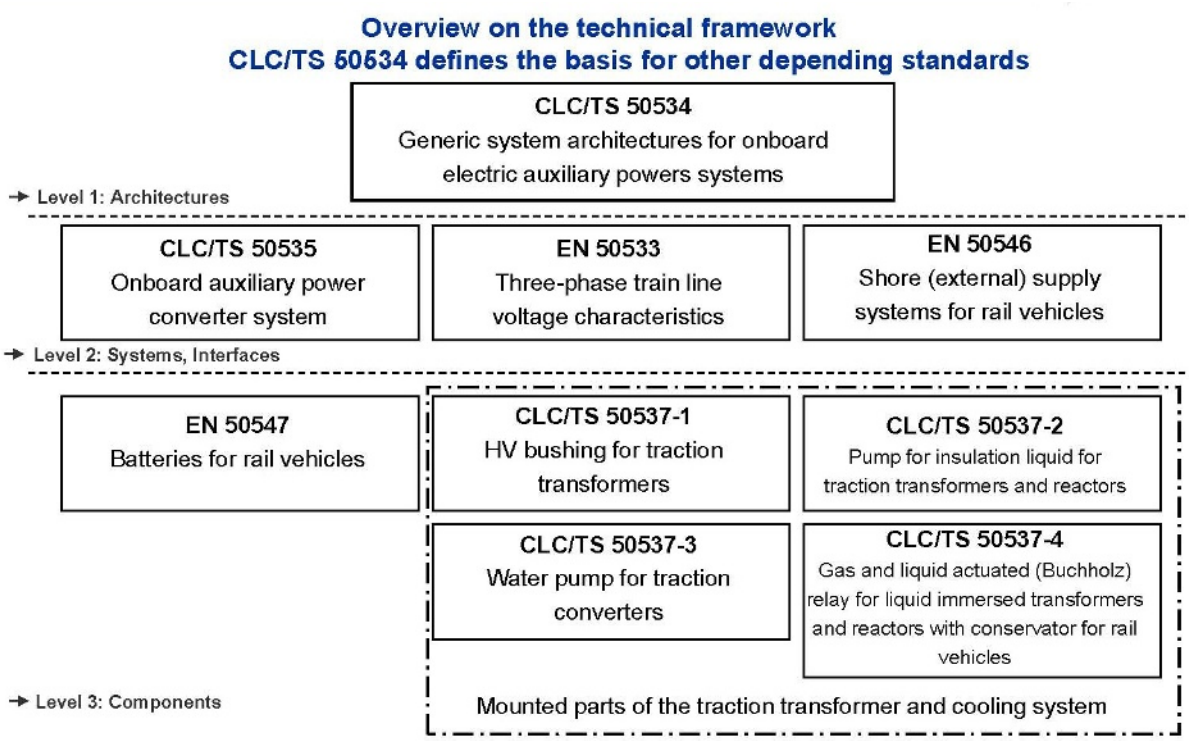
It was circulated for voting in accordance with the Internal Regulations, Part 2, Subclause 11.3.3.3 and was accepted as a CENELEC Technical Specification on 2010-03-26.

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

The following date was fixed:

– latest date by which the existence of the CLC/TS has to be announced at national level (doa) 2010-09-26

This standardization project was derived from the EU-funded Research project MODTRAIN (MODPOWER). It is part of a series of standards, referring to each other. The hierarchy of the standards is intended to be as follows:



Annexes defined to be normative belong to the content of this Technical Specification; annexes defined as informative are used only for information.

Annex A is classified as normative and Annex B is classified as informative.

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Introduction

This Technical Specification defines characteristics and interfaces for electric onboard power supply systems. The following European Standards and Technical Specifications refer to the defined target energy supply system in this present Technical Specification:

CLC/TS 50535	Railway applications – Onboard auxiliary power converter systems *(Auxiliary converter interfaces applicable for the different options defined in the target system architectures)*
EN 50533 [1)]	Railway applications – Three-phase train line voltage characteristics *(Characteristics of the voltage system used for auxiliary power supply)*
EN 50546 [2)]	Railway applications – Shore (external) supply system for rail vehicles *(Interface description of the shore supply including protection functions)*
EN 50547 [2)]	Railway applications – Batteries for rail vehicles *(Standardized batteries for rail vehicles and charging characteristics)*
CLC/TS 50537 (series)	Railway applications – Mounted parts of the traction transformer and cooling system *(Standardized products used in conjunction with traction transformers and traction cooling systems)*

CLC/TS 50534 has to be understood as a basic document of a set of hierarchically structured specifications. This set of European Standards and Technical Specifications defines a consistent technical framework beginning on an architectural level, followed by standards belonging to important system interfaces and concluding this hierarchy with Technical Specifications on component level. The diagram in the foreword points up these different system integration levels and shows the dependencies between the documents.

One main objective of this standardisation initiative is to simplify the cooperation between concerned railway stakeholders in charge of operating onboard auxiliary power systems, designing systems able to cope with the operational requirements and stakeholders manufacturing auxiliary power system components, which provide the requested services.

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1) At draft stage.

2) Under development.

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1 Scope

This Technical Specification defines characteristics and interfaces for electric onboard power supply systems. It applies to locomotive hauled passenger trains and electric multiple units with distributed power as well as trains with concentrated power for main-line application.

The objective of this Technical Specification is to define target systems, as regards the following interfaces and characteristics in order to enable further standardisation:

- interface between traction system and auxiliary power supply system;
- train line type: voltage, frequency and number of poles;
- interface between auxiliary power supply system and battery system;
- interface of the auxiliary power supply system as well as the low voltage grid to a shore supply (stationary workshop supply or external supply);
- supply concepts for essential loads e.g. HVAC systems and battery chargers;
- redundancy concept within the supply systems;
- auxiliary load control and protection strategy at train level.

Described system and interface characteristics define the technical basis for dependent European Standards and Technical Specifications. The introduction of this Technical Specification shows this dependency to adjacent documents.

Starting from a generic functional description of electric onboard energy supply systems structured in line with EN 15380-4 and a description of the related vehicle concepts, generic system architectures are derived, which are illustrated by examples of consistent sets of system designs showing interfaces and dependencies among concerned subsystems.

Relevant train configuration and concerned energy supply subsystems in scope of this Technical Specification are defined in Clause 4.

2 Normative references

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

CLC/TS 50535		*Railway applications – Onboard auxiliary power converter systems*
EN 50125-1	1999	*Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*
EN 15380-4	3)	*Railway applications – Environmental conditions for equipment – Part 1: Equipment on board rolling stock*
EN 50153	2002	*Railway applications – Rolling stock – Protective provisions relating to electrical hazards*
EN 50155	2007	*Railway applications – Electronic equipment used on rolling stock*
EN 50533	3)	*Railway applications – Three-phase train line voltage characteristics*

3) At draft stage.

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EN 60077-1	2002	*Railway applications – Electric equipment for rolling stock – Part 1: General service conditions and general rules* (IEC 60077-1:1999, mod.)
EN 60077-2	2002	*Railway applications – Electric equipment for rolling stock – Part 2: Electrotechnical components – General rules* (IEC 60077-2:1999, mod.)
EN 60310	2004	*Railway applications – Traction transformers and inductors on board rolling stock* (IEC 60310:2004)
EN 60349-2	2001	*Railway applications – Rotating electrical machines for rail and road vehicles – Part 2: Electronic converter-fed alternating current motors* (IEC 60349-2:1993, mod.)
EN 61287-1	2006	*Railway applications – Power convertors installed on board rolling stock – Part 1: Characteristics and test methods* (IEC 61287-1:2005)
IEC 60038	2002 [4)]	*IEC standard voltages*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
trainset
fixed formation that can only be reconfigured within a workshop environment

3.1.2
Electrical Multiple Units (EMU)
trainsets where all vehicles are capable of carrying payload. EMUs in scope of this Technical Specification belong to the main line sector. Light rail vehicles and metros are excluded from the scope of this Technical Specification

3.1.3
train section
functional and potentially independent subset of the electric system. It contains propulsion and auxiliary power equipments together with auxiliary loads and batteries

3.1.4
power head
traction vehicle of the trainset with a single driver's cab at one end, which is not capable of carrying payload

3.1.5
locomotive
traction vehicle that is not capable of carrying a payload and has the ability to uncouple in normal operation from a train and operate independently

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4) IEC 60038:2002 (Ed. 6.2) combines IEC 60038:1983 (Ed. 6) + A1:1994 + A2:1997. It is superseded by IEC 60038:2009 (Ed. 7), *IEC standard voltages*.

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3.1.6
locomotive hauled passenger trains
trains which consist of one or more locomotive and several coaches coupled to the locomotive to build a complete train. In contrast to EMUs the number of coaches and the position of the locomotive can be changed while in operation and in a short time without the need of a workshop and specific tools

3.1.7
system architectures
system architectures describe basic designs of systems consisting of several subsystems and functions. The description is precise in concern of essential interfaces and functions. The internal design of the subsystems itself is not part of the architecture description

3.1.8
auxiliary power supply systems
onboard subsystem, which transforms converts and distributes electric energy for traction auxiliary loads and comfort loads. In most applications the low voltage supply system is fed by the auxiliary power system. Refer to 3.5

3.1.9
low voltage supply systems
LV-DC system
low voltage supply system encompasses DC voltage supplies for control units, lighting and other loads, which need an uninterruptible, and highly available electric energy supply. In most applications, the low voltage supply system is fed by the auxiliary power supply system and supported e.g. by a rechargeable battery

3.1.10
traction auxiliary loads
loads installed in subsystems, which are needed for the operation of the traction system and driving operation of the train or locomotive. Pumps and fans in cooling systems for traction components are representative examples of this load group. Compared to other auxiliary loads (comfort loads) a high availability is required

3.1.11
comfort loads
loads connected to the auxiliary power supply system, which are used for the provision of a comfortable environment e.g. in the passenger coach interior, vestibule or other compartments for passengers and train crew. Compared to traction auxiliary loads the requested availability for comfort loads is lower and a reduced performance in degraded mode might be accepted

3.1.12
HVAC unit
facility installed in coaches or locomotives used for heating, ventilation and air conditioning

3.1.13
Battery Charger (BC)
power electronic converter (AC-DC or DC-DC) used to supply low voltage loads and to charge rechargeable batteries in the low voltage grid

3.1.14
power train line
electric energy distribution facility (e.g. bus bars, cables) used for the distribution of auxiliary power in a train and coaches

3.1.15
linear load
loads with a linear dependency between supply voltage and current producing negligible harmonic content compared to rated values, e.g. heating resistors and induction motors are regarded as linear loads

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3.1.16
non-linear load
in contrast to linear loads non-linear loads generate significant harmonic current or voltage content. These kinds of loads connected to a supply system with significant internal impedance will produce significant harmonic voltages, e.g. uncontrolled rectifiers and active front-end converters belong to this load group

3.1.17
unbalanced load
loads which will cause unsymmetrical phase currents, i.e. currents that have different amplitudes and/or phase angles in the three phases of a 3 AC supply system. Single phase loads connected to a 3 AC system are a representative example of unbalanced loads

3.1.18
3 AC voltage system
three-phase a.c. voltage systems involving three or four wire (including neutral wire) distribution

3.1.19
1 AC voltage system
single phase a.c. voltage systems

3.1.20
3 AC FF train line voltage systems
voltage systems applied in conjunction with 3 AC power train lines using fixed frequency and consequently fixed voltage amplitude (3 AC 400 V 50 Hz or 3 AC 480 V 60 Hz in accordance with IEC 60038)

3.1.21
3 AC VF train line voltage systems
voltage systems applied in conjunction with 3 AC power train lines using variable frequency and consequently variable voltage amplitude. Variation of frequency and voltage is used e.g. for power control and noise reduction purposes

3.1.22
RIC train line
power train line in accordance with the voltage systems defined in Annex A, mainly used as a single pole train line in locomotive hauled passenger trains

3.1.23
auxiliary converter intermediate circuit voltage
DC Link Auxiliary (DCLA)
intermediate circuit voltage in a voltage range of typically 600 V to 800 V used in auxiliary converters e.g. with 3 AC FF output

3.1.24
traction converter intermediate circuit voltage
DC Link Traction (DCLT)
intermediate circuit voltage of the traction converter

3.1.25
Train Line Interconnection (TLI)
electric interface between adjacent power train line sections, being supplied by different converter units. The TLI can either be a solid through connection or a contactor. The contactor will be opened or closed dependent on the auxiliary power supply systems status. During normal operation, the contactor will be open whereas in a case of a failed auxiliary converter the contactor will be closed in order to supply adjacent train sections

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3.2 Abbreviations

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

3 AC Three-phase Alternative Current or voltage

BC Battery Charger

DC Direct Current

DCLA DC Link Auxiliary

DCLT DC Link Traction

EMU Electrical Multiple Units

FF Fixed Frequency

HVAC Heating, Ventilation and Air Conditioning

LV-DC Low voltage supply system

RIC Regolamento Internazionale delle Carrozze

TLI Train Line Interconnection

VF Variable Frequency

4 General conditions

4.1 Vehicle concepts

The generic system architectures in the scope of this Technical Specification refer to three different train classes used for passenger transport (Figure 1). System architectures for energy supply systems have to be designed with respect to quantitative auxiliary power requirements and depending load characteristics in order to fulfil specific design aspects. Some examples of power ratings for auxiliary loads are given in Table B.2. Specific values used on trains depend on e.g. motorisation in conjunction with the used cooling system (e.g. natural-cooled, forced-air-cooled, and water-cooled) for traction components, climate (HVAC units design) as well as number and type of other comfort loads installed on the train.

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