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Part 3-2: AC Traction Applications - Static frequency converter

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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IEC TC 9 : ELECTRICAL EQUIPMENT AND SYSTEMS FOR RAILWAYS	
SECRETARIAT: France	SECRETARY: Mr Denis MIGLIANICO
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	

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Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (See [AC/22/2007](#) or [NEW GUIDANCE DOC](#)).

TITLE:

Railway applications - Fixed installations – Electronic power converters – Part 3-2: AC Traction applications – Static frequency converter

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RAILWAY APPLICATIONS –
FIXED INSTALLATIONS –
ELECTRONIC POWER CONVERTERS****Part 3-2: AC traction application –
static frequency converter**

FOREWORD

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IEC 62590-3-2 has been prepared by of IEC technical committee 9: electrical equipment and systems for railways. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
9/XX/FDIS	9/XX/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at https://www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at <https://www.iec.ch/standardsdev/publications>.

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

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

INTRODUCTION

Static frequency converters for traction power supply differ from other converters for industrial use due to special electrical service conditions and due to the large range of load variation and the peculiar characteristics of the loads.

Specific requirements are needed for static frequency converter in addition to the requirements for converters for other industrial use.

Converter transformers for fixed installations of railway applications are covered by IEC 62695.

The series of IEC 62590 consists of the following parts:

IEC 62590-1 Railway applications – Fixed installations – Electronic Power Converters – Part 1: General requirements

IEC 62590-2-1 Railway applications – Fixed installations – Electronic Power Converters – Part 2-1: DC traction applications - Uncontrolled rectifiers

IEC 62590-2-2 Railway applications – Fixed installations – Electronic Power Converters – Part 2-2: DC traction applications – Controlled converters

IEC 62590-3-1 Railway applications – Fixed installations – Electronic power converters– Part 3-1: AC traction applications – Electronic power compensators

IEC 62590-3-2 Railway applications – Fixed installations – Electronic power converters – Part 3-2: AC traction applications – Static frequency converters

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – ELECTRONIC POWER CONVERTERS

Part 3-2: AC traction application – static frequency converter

1 Scope

This document specifies characteristics, requirements, and test methods for static frequency converters for AC electric traction power supply systems and railway transmission networks. Static frequency converters connect a 3AC power network with an AC electric traction power supply system or railway transmission network with a bidirectional load flow.

The main purpose of the SFC is:

- the power conversion between a 3AC and a 1AC system
- to establish an electric network
- operate at both systems independently with regard to the frequency
- to control phase angle and amplitude of the supply voltage
- to draw a balanced load from the 3AC system

This document applies to fixed installations of following electric traction power supply systems:

- railway networks,
- metropolitan transport networks including metros.

This document does not apply to:

- magnetic levitated transport systems

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60038, *IEC standard voltages*

IEC 60050, *International Electrotechnical Vocabulary*

IEC 60071-1, *Insulation co-ordination - Part 1: Definitions, principles and rules*

IEC 60364-1, *Erection of low voltage installations – Part 100: Fundamental principles, assessment of general characteristics, definitions*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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

IEC 61000-1-1, *Electromagnetic compatibility (EMC) – Part 1: General – Section 1: Application and interpretation of fundamental definitions and terms*

IEC 61000-3, *Electromagnetic compatibility (EMC) – Part 3: Limits*

IEC 61936-1, *Power installations exceeding 1 kV a.c. – Part 1: Common rules*

IEC 62236-1, *Railway applications - Electromagnetic compatibility - Part 1: General*

IEC 62236-2, *Railway applications - Electromagnetic compatibility - Part 2: Emission of the whole railway system to the outside world / Applies in conjunction with IEC 62236-1 (2018-02)*

IEC 62236-5, *Railway applications - Electromagnetic compatibility - Part 5: Emission and immunity of fixed power supply installations and apparatus / Applies in conjunction with IEC 62236-1 (2008-12)*

IEC 62278, *Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*

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

IEC 62497-1, *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distance for all electrical and electronic equipment*

IEC 62695, *Railway applications – Fixed installations – Traction transformers*

3 Terms, definitions, and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62590-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

Figures and illustrations including electric circuits within this document are based on the generator reference arrow system (GRAS) for defining the sign of electric power.

3.1.1 static frequency converter <for railways> SFC

electronic power converter for railway applications connecting a 3AC power network with an AC traction power supply system or railway transmission network of different voltage level, phase angle and/or frequency.

Note 1 to entry: The term static is used to distinguish semiconductor converters from rotating converters.

Note 2 to entry: The SFC is also called static phase converter (SPC) or electronic frequency converter (EFC).

Note 3 to entry: An AC traction system can also be an autotransformer system or 3AC traction system.

3.1.2**railway transmission network**

railway electric distribution network with particular installations, substations, lines or cables for the transmission and distribution of electric traction energy. The railway transmission network is connected to the 3AC power network and electric traction power supply system and operates with the same frequency as the electric traction power supply system.

Note 1 to entry: The system is not directly connected to the contact line system

Note 2 to entry: Can be considered as 1AC or 2AC system

3.1.3**network operation strategy**

defines and regulates the electrical operation and behaviour of the railway transmission network and/or electric traction power supply system.

3.1.4**supply voltage**

voltage at the interface point of the SFC to the connected network, 1AC or 3AC

Note 1 to entry: The interface point is normally the connection to a switchgear

3.1.5**network configuration**

defines the electric traction power supply system or railway transmission network topology and supply concept.

3.1.6**operation mode**

control status of the SFC defining the basic operating condition

EXAMPLE On, Off or VAR compensator mode are given in 5.5.2

3.1.7**converter substation**

traction substation equipped with one or more SFC

Note 1 to entry: A converter substation can also include other equipment like rotating converters.

EXAMPLE Traction substations (see IEC 60050 section 811-36-02), converter substation

3.1.8**stability of operation**

property of the operation of a system which implies that for a sufficiently small initial displacement from the rest position or for a sufficiently small disturbance the control variables remain within a sufficiently small neighbourhood of the rest position.

Note 1 to entry: see also IEC 60050 section 351-42-20 and 351-47-45

3.1.9**synchronized operation**

operation of equipment connected to the same network using the same frequency.

Note 1 to entry: The amplitude and the phase angle of a voltage can be used to control the load flow within a network.

3.1.10**single source mode**

one converter or converter substation is supplying a feeding section without other substations.

Note 1 to entry: In some countries also called island mode or island operation.

3.1.11**fault ride through**

the SFC shall continue operation and providing a current in case of a network fault without any interruption. The SFC may stop the operation after a user defined time period.

3.2 Abbreviations

G rotating machine operating as generator

HIL hardware in the loop

M rotating machine operating as motor

SFC static frequency converter

4 System configuration with SFC application**4.1 General**

Possible characteristics of the SFC application can be:

- Controlled exchange of active power between 3AC power network and electric traction power supply systems
- Independent control of reactive power in both electrical power networks
- If applicable, independent operation with different frequencies in both electric power networks
- Balanced operation in both electric power networks independent of number of phases including filtering of single-phase pulsating power.
- Different control functions and operation scenarios possible in alignment with the network configuration and operation strategy
- Improvement of power quality in both electric power networks by power factor control
- Improvement of power quality in both electric power networks by influencing of non-fundamental frequency components
- Block-wise controlled parallel operation with different equipment
- Controlled voltage for charging function of trains with onboard electric traction energy storages.

The SFC can either supply directly into the electric traction power supply system or into a railway transmission network. Figure 1 shows two examples for possible SFC applications.

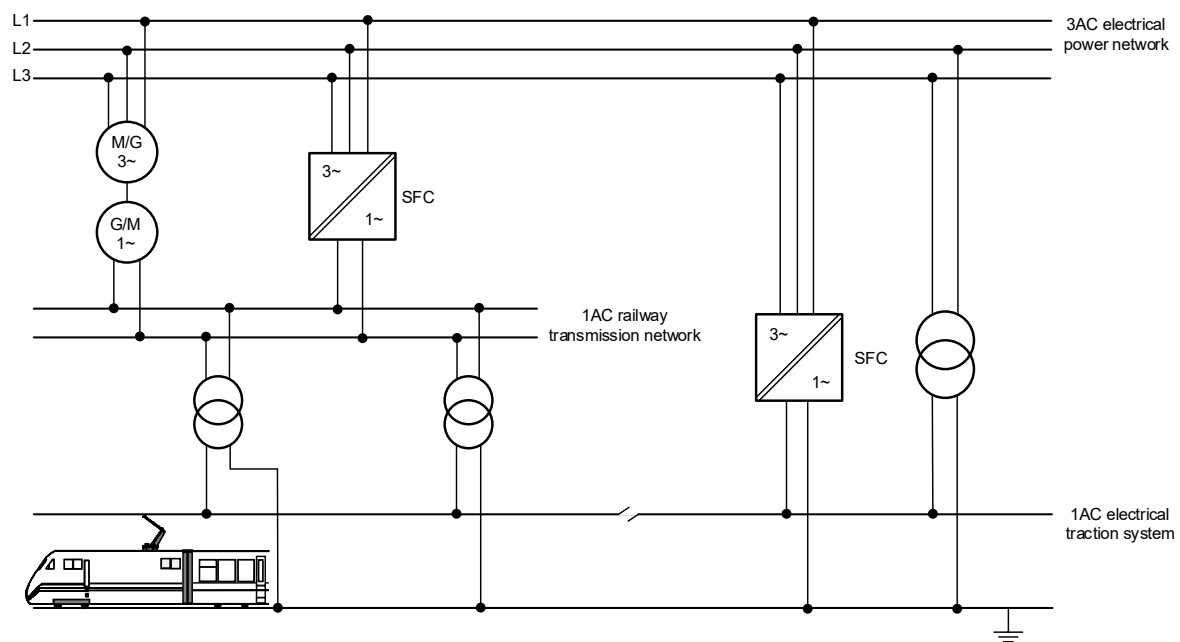


Figure 1 – Exemplary application of SFC in a railway transmission network and an electric traction power supply system

For each SFC application scenario different network configurations, network operation strategies and converter control functions can be applicable. The network configuration and network operation strategy are different for electric traction power supply systems and railway transmission networks. The network configuration and network operation strategy are also depending on the network topology and, if applicable, additional substations with interfaces to the 3AC power network. Railway electric transmission networks have in general a more meshed network topology. The choice of the network control strategy should be made under consideration of:

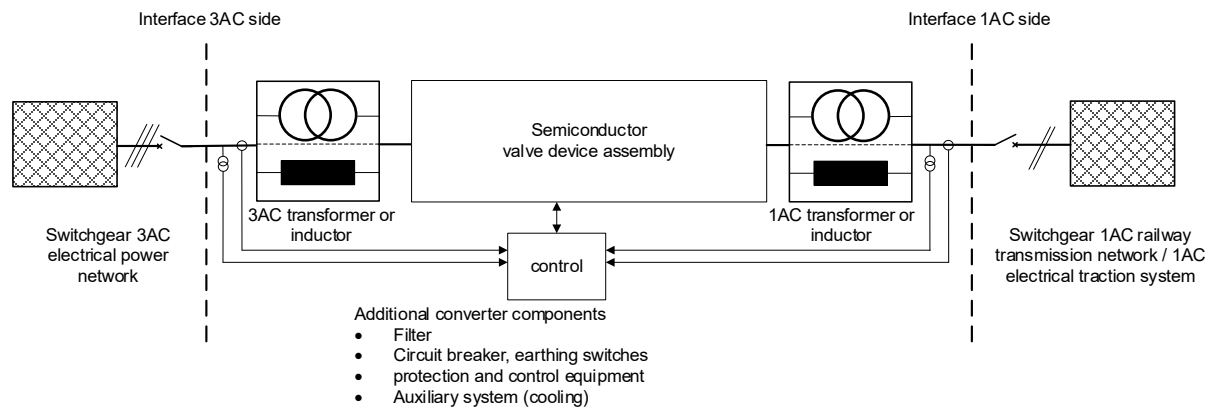
- network type and topology, network configuration
- targeted load distribution between substations
- type of additional substations with an interface to 3AC power network
- frequency decoupling between 3AC power network and electric traction power supply systems
- prevention of a parallel load flow between 3AC and 1AC
- degraded operation modes

Annex A provides an overview of network configurations with SFC application. Applicable converter control functions are described in Annex B. Details of the converter control function shall be upon agreement between the user and the manufacturer.

4.2 Components of an SFC

Static frequency converters need different components for their function. In Figure 2 the basic components of an SFC and the interfaces are shown.

189



190

Figure 2 – SFC components and interfaces

191 The main components within the scope of an SFC are:

- 192 • semiconductor valve device assemblies
- 193 • 3AC transformers and/or inductors
- 194 • 1AC transformers and/or inductors
- 195 • optional filters
- 196 • switching devices (earthing switches, circuit breaker)
- 197 • auxiliary system (e.g., cooling components)
- 198 • control components

199 Main parameters of the components are determined by the manufacturer of the SFC. For
 200 transformers of converters IEC 62695 is applicable. Auxiliaries are working mainly with low
 201 voltage, IEC 60364-1 and correlated standards are applicable.

202 At least one transformer shall be installed on either side of the SFC to ensure a galvanic
 203 isolation.

204 NOTE Some of the main components (e.g., switching devices) might not be in the scope of the SFC, but managed
 205 separately.

206 A converter substation can consist of one or more SFC as well as additional interfaces to the
 207 3AC power network, for example rotating converters or transformers. In case more than one
 208 SFC is connected to the same busbar, their parallel operation shall be aligned.

209 5 Design and integration

210 5.1 General

211 The SFC shall be designed to operate safely within the defined operational area of each
 212 network. The design of the SFC with regards to dimensioning, current carrying capacity, load
 213 profile and voltage immunity shall be done in respect to the weakest component. Individual
 214 components of the SFC can be designed using their individual characteristics.

215 NOTE e.g., transformer can be designed using their overload capability described in IEC 62695, different to the
 216 overload capability of semiconductor devices.