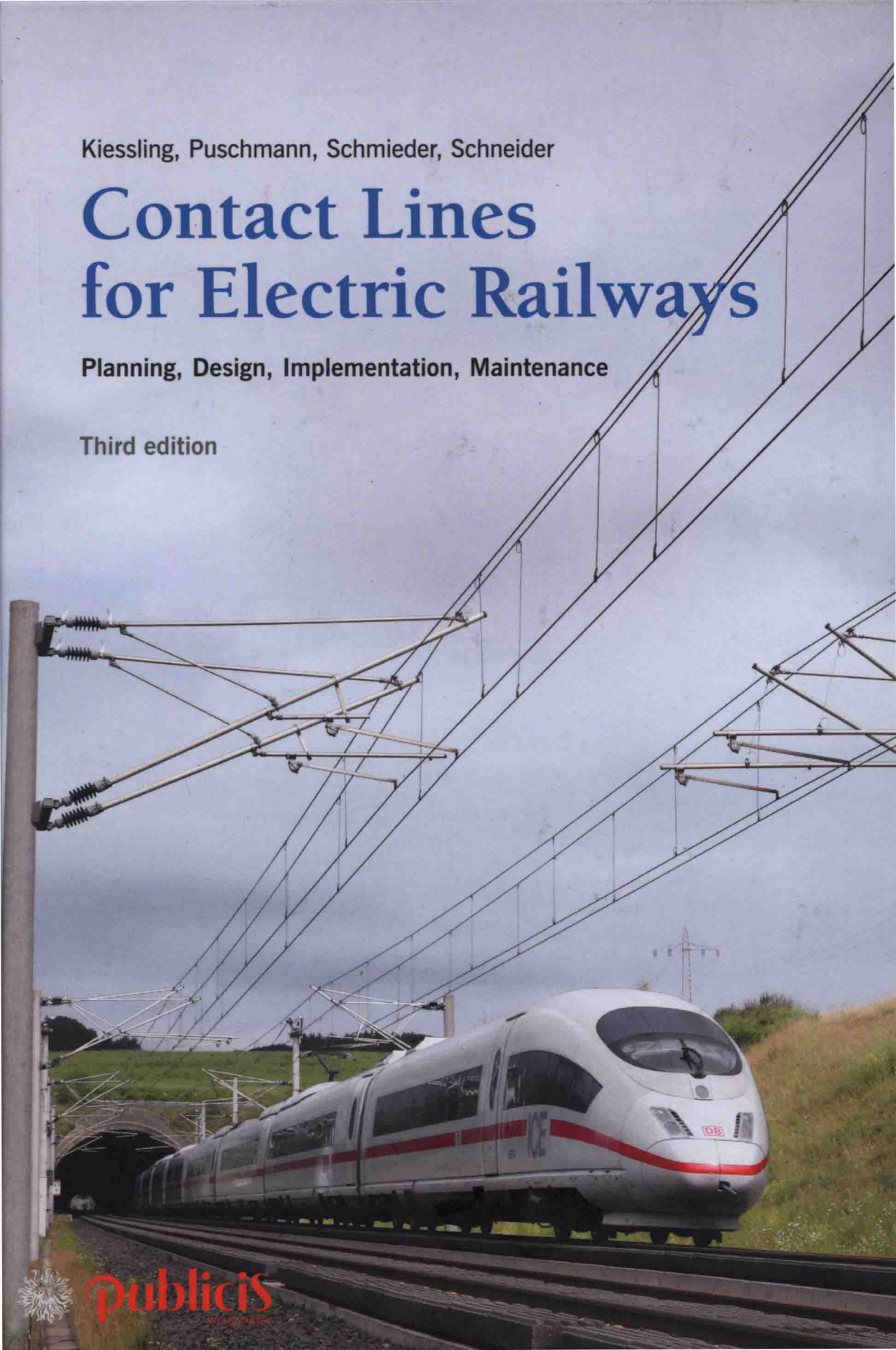


Kiessling, Puschmann, Schmieder, Schneider

Contact Lines for Electric Railways

Planning, Design, Implementation, Maintenance

Third edition



publicis

Kiessling, Puschmann, Schmieder, Schneider

Contact Lines for Electric Railways

Electric traction is the most favourable type of power supply for electric railways from both an ecological and an economic perspective. In the case of urban mass transit and high-speed trains it is the only possible type of traction. Its reliability largely depends on contact lines, which must operate in all climatic conditions with as high availability and as little maintenance as possible. Extreme demands arise when overhead contact lines are required to provide reliable and safe power transmission to traction vehicles travelling at speeds in excess of 250 km/h.

The authors have used their worldwide experience to provide comprehensive descriptions of configuration, mechanical and electrical design, installation, operation and maintenance of contact lines for local and long-distance transportation systems, including high-speed lines.

In this book, railway company professionals and manufacturers of contact line systems, students and those embarking on a career in this field will find practical guidance in the planning and implementation of systems, product descriptions, specifications and technical data, including standards and other regulations. Special emphasis is laid on the interaction of the individual components of power supply, especially between contact lines and pantographs. Since large sections of the book are dedicated to system aspects, consultant engineers can also use it as a basis for designing systems and interfaces to other subsystems of electric railway engineering. The contents of the book are rounded off by examples of running systems.

Contents

Power supply systems • Requirements and specifications • Contact line types and designs • Rating of overhead contact lines • Currents and voltages • Current return circuit and earthing • Thermal rating of conductors • Electromagnetic interferences • Line protection and fault location • Interaction of pantograph and overhead contact line • Components • Project design • Cross-span structures, poles and foundations • Designs for special applications • Construction, acceptance and commissioning • Examples of running systems from many countries • Management and maintenance

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Contact Lines for Electric Railways

Third edition

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Contact Lines for Electric Railways

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Cover photo:

Overhead contact line type Siemens Sicat H1.0 and ICE 3 train on the high-speed line Frankfurt am Main to Cologne. The photo is presented with kind permission of Deutsche Bahn.

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Design
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Maintenance

by Friedrich Kiessling, Rainer Puschmann,
Axel Schmieder and Egid Schneider

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Foreword to the third English Edition

The book "Contact Lines for Electric Railways" has attained the status of a standard text book for contact line engineering worldwide. As it is some years since the second edition went out of print, Siemens AG, Mobility Division, Rail Electrification, and SPL Powerlines Group GmbH are pleased to present this completely revised English edition to the international audience. We are confident that this work will meet the requirements of engineers in railway operating entities, contracting and engineering companies, as well as supervising bodies. It has also been designed as a teaching and learning aid.

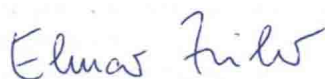
As noted in Werner Breitling's Foreword to the second English edition, contact lines are an essential component of electric traction supply systems. They are the interface between the fixed installations and moving energy consumers that are the electric traction units. Contact line design needs to be adapted to the technical and operational requirements of individual electric railway systems, including low-voltage DC systems or medium-voltage AC systems. It is a valuable resource from tramway applications running at relatively low speeds to high-speed trains in a plethora of climatic environments and topographic conditions, including in the open, in long tunnels under the sea or through mountains. The importance of the overhead contact line as a basis for ecologically beneficial transport of persons and goods continues to grow.

The structure and contents of this book reflects the authors objectives and considers all aspects of contact lines:

- an overview of different kinds of power supply systems feeding electrically driven trains
- an introduction to the development of energy transmission to railways from the beginnings up to today's high-speed traffic
- the electrical and mechanical aspects including theoretical considerations, electric and mechanical calculations and design of flexible overhead contact lines and rigid contact rails
- the theory of interaction between contact lines and pantographs, especially at high speeds and its verification by measurements
- necessary measures to protect passengers and the public from electrical dangers
- detailed descriptions and examples of components
- comprehensive presentation of contact line planning
- construction and maintenance of contact lines
- examples describe various possibilities for achieving required solutions
- relevant IEC and Cenelec standards that have replaced former national standards are listed in an Annex

The authors are active or former employees of Siemens AG, Rail Electrification, or of Powerlines Group GmbH, formed out of the former Siemens contact line activities in Austria and Germany. The authors describe the technology represented by both companies and the contents of the book describes international state-of-the-art technology. The presented examples demonstrate the potential of both companies. The authors conceived the book and prepared the draft under their own initiative. Siemens AG and Powerlines Group GmbH supported its

drafting and printing. As the responsible executives of these entities, we are pleased that the revised third English edition has been completed. We hope this edition has similar success as its predecessors.



Erlangen/Wolkersdorf,
October 2017

Dr.-Ing. Elmar Zeiler
Head of Rail Electrification
Siemens AG, Mobility Division



Mag. Gerhard Ehringer
Chief Executive Officer
Powerlines Group GmbH

Preface to the first English edition

The first edition of "Fahrleitungen elektrischer Bahnen" (Contact Lines for Electric Railways) was published in German in 1997 by B.G. Teubner-Verlag Stuttgart. The first edition was out of print quickly, so a second, revised edition was published in 1999. The co-authors of this book, Professor Dr. sc Anatoli Ignatjewitsch Gukow and Dr. sc. Peter Schmidt, died unexpectedly in 1999 and 2000, respectively. Both had essential roles in the production of the German edition.

There were no comparable works available and the book enjoyed wide distribution and attracted great interest, even in non-German-speaking countries instigating the need for translations in other languages.

Prior to the first English edition, substantial parts of the book were revised and adapted to include international overhead contact line designs. The revisions were based on international standards as published by IEC and EN.

Advice and comments from readers were also incorporated. More attention was paid to 50 Hz railways and local public transportation systems. New calculation methods, up-to-date examples of completed electrification projects and recently developed overhead contact line components have also been included.

The aims of the book are explained in the preface to the first edition, which also appears in this edition. The world-wide spread of high-speed railway systems, the need to ensure inter operability and the expansion of local public traffic systems are intensifying the demands made on electric railways, the qualifications of staff involved and supporting documentation. So, this edition especially aims to describe the theoretical principles underlying overhead contact lines and to offer possible solutions for their application, whilst taking current international developments in this complex field into consideration. At the same time, the book is intended as a co-operative contribution with projects carried out in parts of the world where German is not spoken.

The authors would like to thank the Transportation Systems Electrification Department of Siemens AG and especially the heads of this department, Dr. Werner Kruckow and Peter Schraut, who supported the preparation of the English edition. Beat Furrer of Furrer & Frey AG, Bern, Switzerland sponsored the preparation of the manuscript. The authors also thank the publishing company for its excellent technical facilities. Thanks are extended to Gernot Hirsinger for preparing the translation as well as Bela Jozsa, Norm Grady, Terry Wilkinson, John Allan and Jan Liddicut from Melbourne/Australia, who edited the English version and ensured that the complicated subject matter was understandable to English speaking readers. The authors thank Dr. Wilhelm Baldauf of Deutsche Bahn AG and Dr. Egid Schneider at Siemens AG, who supported them with contributions to certain sections of this revised edition, and Michael Schwarz for desk top editing.

The authors hope this book will promote co-operation amongst colleagues working in this field in as many countries as possible, and that it will contribute to their mutual technical understanding. They look forward to readers' comments and their advice on the content and design of the book.

Preface to the second English edition

The first English edition of this book was based on the second German version printed in 1998 and published in 2001. This first English edition was well accepted by railway companies, manufactures, contractors, consultants and at universities and encouraged translations into Chinese in 2003 and Spanish in 2008. Meanwhile the English edition sold out so the publisher commissioned the authors to prepare a revised edition of the book to be published in 2009.

The authors of the first English edition invited Egid Schneider from Siemens AG to participate as co-author. He accepted the offer and revised the chapters dealing with electrical aspects of contact line systems. Like the first English edition, this book addresses the requirements of an international audience so the individual chapters of the first edition were revised and enlarged. The design of contact lines has been affected by the European Directives on Interoperability and the related Technical Specifications. These documents initiated the preparation and issuing of several new European Standards which have also been considered in this new edition.

Since 2001, new high-speed rail networks have been introduced in a number of countries and others enlarged. In Europe high-speed operation commenced in Austria, the Netherlands and Switzerland. The networks in France, Germany, Italy and Spain were extended. In China, high-speed lines designed for commercial speeds of 350 km/h were commissioned. In Switzerland, a new tunnel, through the Alps, designed for high speed operation was finished and put into service. For these applications, contact lines were designed anew and or adapted from previous designs. Examples of new lines, new materials and components that were introduced to the market are dealt with in the text.

To present a comprehensive book on the subject matter the authors needed and received assistance and support from professional partners. In this context the authors would like to thank

- Jörg Schneppendahl and Roland Edel, Siemens AG, Erlangen, Railway Electrification, Johannes Emmelheinz and Daniel Leckel, Siemens AG, Erlangen, Railway Maintenance for sponsoring the revision and publication of the book,
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- Bela Jozsa who was assisted by Terry Wilkinson, Norm Grady and Jan Liddicut of Melbourne/Australia, who checked the draft and ensured that the complicated subject matter would be understood by English speaking readers,
- Christian Courtois, Paris, Hans-Herbert Meyer, Bergheim, Albrecht Brodkorb and Wieland Burkert, Erlangen, for their contributions,
- those readers who commented on errors and proposed amendments,
- Michael Schwarz and Jörg Unglaub, Erlangen, who took care of the desk top editing.

The authors hope that the revised new edition meets the requirements of people world wide who are active in the contact line business world wide. The authors welcome comments on the contents and usefulness of this book.

Erlangen, March 2009

Friedrich Kiessling, Rainer Puschmann, Axel Schmieder, Egid Schneider

Preface to the third English edition

The second English edition of this book was printed in 2009. It was based on the first English edition published in 2001 and followed by Chinese and Spanish editions published in 2004 and 2008, respectively. The Spanish version drafted mainly by Tomas Vega will be followed by a Russian edition currently in preparation. All editions have been well received by the international electrification community. A third German edition was published in 2014 by Publicis Publishing, Erlangen as a Siemens technical book as were the two previous English editions. The second English edition has been sold out for some years, so the publisher and the electrification entities Siemens and SPL Powerlines asked the authors to write a new English edition for the international market. All the authors responsible for the 2009 edition were able and willing to contribute to this third English edition.

Like the previous editions the book meets the requirements of an international audience. Compared with the previous edition, there are 17 chapters instead of 14 with subjects including contact line protection, components, implemented installations, management and maintenance dealt with in separate chapters. Chapters 1 to 8 deal with basic aspects of contact line design, chapters 9 to 14 are devoted to design and planning and chapters 15 to 17 are dedicated to installation, worked examples, management and maintenance.

With the publication of directive 96/49/EC in 1996, the replacement of national standards by European Cenelec or international IEC standards commenced. Since then, standards relevant to contact lines have been in continuous development. Since the publication of our last edition, the contact line standard EN 50119 has been amended twice, in 2009 and 2013. Currently EN 50119 is under revision and a new version will be published in 2019. Based on EN 50119 a new version of IEC 60913 was published in 2013. Also the EN 50122 and IEC 62128 standard series dealing with protective provisions and safety during maintenance in fixed installations have been revised. Because of lead times involved, any book needs to be drafted well in advance of printing and it is not feasible to always consider the most recent changes in the standards. Therefore, this edition is based mainly on standards published in the first half of 2017.

Since the last edition, remarkable progress has been made in electrically powered railways. In China, several new high-speed lines have been added to the worlds largest high-speed network, whilst in Europe, in countries such as The Netherlands, Spain and Turkey the high-speed network was been greatly extended. In Switzerland, the Gotthard Base Tunnel was completed and commercial services begun. In Austria, in the Vienna area, railway traffic was restructured with a new Central station and a tunnel under the Vienna forest. In Denmark, the electrification of a 1 300 km long network commenced, with the first section being commissioned in 2017. In Germany, the high-speed Leipzig–Erfurt line was commissioned as an important link between Berlin and Munich. In the UK the Great Western and Midland Main lines are under construction.

More and more cities are extending existing tram lines, metro systems, city railways and trolley bus networks utilising new materials for the overhead contact lines.

For all these lines modified or new contact line designs were required. Information on these projects can be found in the book.

To be able to prepare and present a complex book on a technical subject such as this, the authors required personal and financial assistance from professional partners. In this regard the authors would like to thank:

- Dr.-Ing. Elmar Zeiler, Siemens AG, Mobility Division, Rail Electrification Segment, Erlangen, and Magister Gerhard Ehringer, Powerlines Group GmbH, Wolkersdorf, for sponsoring the preparation and printing of this third edition of the book
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- Dr. Gerhard Seitzfuder, Publicis Publishing; Erlangen, for the excellent production of the book including four-colour printing
- all readers who commented on errors and proposed amendments
- Bela Jozsa as principal editor and his co-editors Jan Liddicut, Norm Grady and Terry Wilkinson, all from Australia, who checked the draft and ensured that the difficult subject would be understood by the English speaking audience
- Michael Schwarz, Erlangen, and Thomas Nickel, Forchheim, who took care of the desktop publishing

The authors hope that, as with previous editions, this book will fill the needs of professionals worldwide, practicing in the contact line industry. The authors also welcome any recommendations for improvements and comments on errors.

Potsdam, Igensdorf,
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October 2017

*Friedrich Kießling, Rainer Puschmann,
Axel Schmieder, Egid Schneider*

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