Werner Leonhard

Control of Electrical Drives

2nd Completely Revised and Enlarged Edition

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Preface

Electrical drives play an important role as electromechanical energy converters in transportation, material handling and most production processes. The ease of controlling electrical drives is an important aspect for meeting the increasing demands by the user with respect to flexibility and precision, caused by technological progress in industry as well as the need for energy conservation.

At the same time, the control of electrical drives has provided strong incentives to control engineering in general, leading to the development of new control structures and their introduction to other areas of control. This is due to the stringent operating conditions and widely varying specifications — a drive may alternately require control of torque, acceleration, speed or position — and the fact that most electric drives have — in contrast to chemical or thermal processes — well defined structures and consistent dynamic characteristics.

During the last few years the field of controlled electrical drives has undergone rapid expansion due mainly to the advances of semiconductors in the form of power electronics as well as analogue and digital signal electronics, eventually culminating in microelectronics and microprocessors. The introduction of electronically switched solid-state power converters has renewed the search for AC motor drives, not subject to the limitations of the mechanical commutator of DC drives; this has created new and difficult control problems. On the other hand, the fast response of electronic power switching devices and their limited overload capacity have made the inclusion of protective control functions essential. The present phase of evolution is likely to continue for many more years; a new steady-state is not yet in sight.

This book, in its original form published 1974 in German, was an outcome of lectures the author held for a number of years at the Technical University Braunschweig. In its updated English version it characterises the present state of the art without laying claim to complete coverage of the field. Many interesting details had to be omitted, which is not necessarily a disadvantage since details are often bound for early obsolescence. In selecting and presenting the material, didactic view points have also been considered.

A prerequisite for the reader is a basic knowledge of power electronics, electrical machines and control engineering, as taught in most under-graduate electrical engineering courses; for additional facts, recourse is made to special literature. However, the text should be sufficiently self contained to be useful

also for non-experts wishing to extend or refresh their knowledge of controlled electrical drives.

These drives consist of several parts, the electrical machine, the power converter, the control equipment and the mechanical load, all of which are dealt with in varying depths. A brief resume of mechanics and of thermal effects in electrical machines is presented in Chaps. 1 – 4 which would be skipped by the more experienced reader. Chaps. 5 – 9 deal with DC drives which have for over a century been the standard solution when controlled drives were required. This part of the text also contains an introduction to line-commutated converters as used for the supply of DC machines. AC drives are introduced in Chap.10, beginning with a general dynamic model of the symmetrical AC motor, valid in both the steady-state and transient condition. This is followed in Chap.11 by an overview of static converters to be employed for AC drives. The control aspects are discussed in Chaps. 12 – 14 with emphasis on high dynamic performance drives, where microprocessors are proving invaluable in disentangling the multivariate interactions present in AC machines. Chapter 15 finally describes some of the problems connected with the industrial application of drives. This cannot by any means cover the wide field of special situations with which the designer is confronted in practice but some more frequent features of drive system applications are explained there. It will become sufficiently clear that the design of a controlled drive, in particular at larger power ratings, cannot stop at the motor shaft but often entails an analysis of the whole electro-mechanical system.

In view of the fact that this book is an adaptation and extension of an application-orientated text in another language, there are inevitably problems with regard to symbols, the drawing of circuit diagrams etc. After thorough consultations with competent advisors and the publisher, a compromise solution was adopted, using symbols recommended by IEE wherever possible, but retaining the authors usage where confusion would otherwise arise with his readers at home. A list of the symbols is compiled following the table of contents. The underlying principle employed is that time varying quantities are usually denoted by lower case latin letters, while capital letters are applied to parameters, average quantities, phasors etc; greek letters are used predominantly for angles, angular frequencies etc. A certain amount of overlap is unavoidable, since the number of available symbols is limited. Also the bibliography still exhibits a strong continental bias, eventhough an attempt has been made to balance it with titles in english language. The list is certainly by no means complete but it contains the information readily available to the author. Direct references in the text have been used sparingly. Hopefully the readers are willing to accept these shortcomings with the necessary patience and understanding.

The author wishes to express his sincere gratitude to two English colleagues, R. M. Davis of Nottingham University and S. R. Bowes of the University of Bristol who have given help and encouragement to start the work of updating and translating the original German text and who have spent considerable time and effort in reviewing and improving the initial rough translation; without their

assistance the work could not have been completed. Anyone who has undertaken the task of smoothing the translation of a foreign text can appreciate how tedious and time-consuming this can be. Thanks are also due to the editors of this Springer Series, Prof. J. G. Kassakian and Prof. D. H. Naunin, and the publisher for their cooperation and continued encouragement.

Braunschweig, October 1984 Werner Leonhard

Preface to the 2nd edition

During the past 10 years the book on Control of Electrical Drives has found its way onto many desks in industry and universities all over the world, as the author has noticed on numerous occasions. After a reprinting in 1990 and 1992, where errors had been corrected and a few technical updates made, the book is now appearing in a second revised edition, again with the aim of offering to the readers perhaps not the latest little details but an updated general view at the field of controlled electrical drives, which are maintaining and extending their position as the most flexible source of controlled mechanical energy.

The bibliography has been considerably extended but in view of the continuous stream of high quality publications, particularly in the field of controlled AC drives, the list is still far from complete.

As those familiar with word processing will recognise, the text and figures are now produced as a data set on the computer. This would not have been possible without the expert help by Dipl.- Ing. Hendrik Klaassen, Dipl.- Math. Petra Heinrich, as well as Dr.-Ing. Rüdiger Reichow, Dipl.-Ing. Marcus Heller, Mrs. Jutta Stich and Mr. Stefan Brix, to whom the author wishes to express his sincere gratitude. The final layout remained the task of the publishers, whose patience and helpful cooperation is gratefully appreciated.

Braunschweig, May 1996 Werner Leonhard

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Bạn đang có trong tay thông tin cơ bản của một trong số những tài liệu có hàm lượng chất xám cao, với những thông tin vô cùng hữu ích cho quá trình học tập và nghiên cứu của bản thân bạn !

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