



IEC 61800-7-304

Edition 1.0 2007-11

# INTERNATIONAL STANDARD

---

**Adjustable speed electrical power drive systems –  
Part 7-304: Generic interface and use of profiles for power drive systems –  
Mapping of profile type 4 to network technologies**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE **XC**

---

ICS 29.200; 35.100.05

ISBN 2-8318-9383-6

## CONTENTS

FOREWORD.....	6
INTRODUCTION.....	8
1 Scope.....	11
2 Normative references .....	11
3 Terms, definitions and abbreviated terms .....	12
3.1 Terms and definitions .....	12
3.2 Abbreviated terms .....	17
4 General .....	17
5 Mapping to CP16/1 (SERCOS I) and CP16/2 (SERCOS II) .....	18
5.1 Reference to communication standards .....	18
5.2 Overview .....	18
5.3 Physical layer and topology.....	20
5.4 Synchronisation mechanism .....	21
5.4.1 General .....	21
5.4.2 Handling of command and feedback values .....	22
5.4.3 Position loop with fine interpolator .....	23
5.5 Telegram contents.....	24
5.5.1 General .....	24
5.5.2 Data block .....	25
5.5.3 Communication function group telegrams .....	25
5.5.4 Standard telegrams .....	26
5.5.5 Application telegrams .....	28
5.6 Non-cyclic data transfer.....	29
5.7 Real-time bits .....	29
5.7.1 Functions of Real time bits .....	29
5.7.2 Allocation of real-time bits .....	30
5.7.3 Possible cases .....	31
5.8 Signal control word and signal status word .....	33
5.9 Data container.....	34
5.10 Drive shutdown functions .....	36
5.11 Communication classes .....	37
5.11.1 General .....	37
5.11.2 Communication class A .....	38
5.11.3 Communication class B (Extended Functions) .....	41
5.11.4 Communication class C (Additional Functions) .....	42
5.11.5 Communication cycle time granularity.....	43
6 Mapping to CP16/3 (SERCOS III) .....	43
6.1 Reference to communication standards .....	43
6.2 Overview .....	43
6.3 Physical layer and topology.....	45
6.4 Synchronisation mechanism and telegram content .....	46
6.5 Non-cyclic data transfer.....	47
6.6 Real-time bits .....	47
6.7 Signal control word and signal status word .....	47
6.8 Data container.....	47

6.9	Drive shutdown functions .....	47
6.10	Communication classes .....	48
7	Mapping to EtherCAT .....	48
7.1	Reference to communication standards .....	48
7.2	Overview .....	48
7.3	SoE Synchronisation .....	49
7.3.1	General .....	49
7.3.2	CP16 Phase 0-2 .....	50
7.3.3	CP16 Phase 3-4 .....	50
7.4	SoE Application Layer Management .....	50
7.4.1	EtherCAT State Machine and IEC 61784 CPF 16 State Machine .....	50
7.4.2	Multiple Drives .....	51
7.4.3	IDN Usage .....	51
7.5	SoE Process Data Mapping .....	52
7.6	SoE Service Channel Services .....	55
7.6.1	Overview .....	55
7.6.2	SSC Read .....	55
7.6.3	SSC Write .....	60
7.6.4	SSC Procedure Commands .....	64
7.6.5	SSC Slave Info .....	66
7.7	SoE Coding General .....	67
7.8	SoE Protocol Data Unit Coding .....	69
7.8.1	SSC Read .....	69
7.8.2	SSC Write .....	72
7.8.3	Notify SSC Command Execution Request .....	76
7.8.4	SSC Slave Info .....	77
	Bibliography .....	79
	Figure 1 – Structure of IEC 61800-7 .....	10
	Figure 2 – Topology .....	21
	Figure 3 – Validity of command values and feedback acquisition time in the PDSs .....	22
	Figure 4 – Synchronisation of cycle times .....	23
	Figure 5 – Synchronisation of the control loops and the fine interpolator .....	23
	Figure 6 – AT configuration (example) .....	29
	Figure 7 – Function of the real-time bits .....	30
	Figure 8 – Allocation of IDN ≠ 0 to the real-time bits .....	31
	Figure 9 – Allocation of IDN = 0 to the real-time bits .....	32
	Figure 10 – Allocation of IDN ≠ 0 to the real-time bits .....	33
	Figure 11 – Configuration example of signal status word .....	34
	Figure 12 – Data container configuration without acknowledge (slave) .....	35
	Figure 13 – Data container configuration with acknowledge (slave) .....	36
	Figure 14 – Structure of Communication classes .....	37
	Figure 15 – Topology .....	45
	Figure 16 – Telegram sequence .....	46
	Figure 17 – General communication cycle .....	47

Figure 18 – ESM and IEC 61158-4-16 State Machine .....	51
Figure 19 – Successful SSC Read sequence .....	56
Figure 20 – Unsuccessful SSC Read sequence .....	56
Figure 21 – Successful SSC Fragmented Read sequence.....	57
Figure 22 – Successful SSC Write sequence .....	60
Figure 23 – Unsuccessful SSC Write sequence .....	61
Figure 24 – Successful SSC Fragmented Write sequence.....	61
Figure 25 – Successful SSC Procedure Command sequence.....	64
Figure 26 – Aborted SSC Procedure Command sequence .....	65
Figure 27 – Slave Info sequence.....	66
Table 1 – CP16/1 and CP16/2 feature summary.....	18
Table 2 – Number of PDSs per network (examples) .....	19
Table 3 – Communication Profile Interoperability within a network .....	20
Table 4 – Typical operation data for cyclic transmission.....	24
Table 5 – Typical data for non-cyclic transmission .....	25
Table 6 – IDN for choice and parameterisation of telegrams .....	26
Table 7 – Structure of standard telegram-0 .....	26
Table 8 – Structure of standard telegram-1 .....	26
Table 9 – Structure of standard telegram-2 .....	26
Table 10 – Structure of standard telegram-3 .....	27
Table 11 – Structure of standard telegram-4 .....	27
Table 12 – Structure of standard telegram-5 .....	27
Table 13 – Structure of standard telegram-6 .....	28
Table 14 – IDN for configuration of MDT .....	28
Table 15 – IDN for configuration of AT .....	28
Table 16 – IDN for real-time bits .....	29
Table 17 – Real-time bits assignment IDNs.....	30
Table 18 – IDN for configuring control and status words .....	33
Table 19 – Data containers IDN .....	34
Table 20 – Ring configuration – Timing.....	38
Table 21 – Ring configuration – Telegram configuration.....	39
Table 22 – Ring configuration – Phase run-up .....	39
Table 23 – Service channel protocol .....	39
Table 24 – Information & diagnostics .....	40
Table 25 – Communication class A settings .....	40
Table 26 – Ring configuration – Telegram configuration.....	41
Table 27 – Information & diagnostics .....	41
Table 28 – Real-time control bits .....	41
Table 29 – Real-time status bits.....	42
Table 30 – Communication class B settings .....	42
Table 31 – CP16/3 features summary .....	44
Table 32 – Number of PDSs per network (examples) .....	45

Table 33 – Synchronisation performance classes.....	47
Table 34 – EtherCAT feature summary .....	49
Table 35 – Number of PDSs per network (examples) .....	49
Table 36 – Obsolete IDNs.....	52
Table 37 – Changed IDNs.....	52
Table 38 – Status word of drive .....	53
Table 39 – Control word for drive .....	54
Table 40 – Mapping of SSC services to EtherCAT services.....	55
Table 41 – SSC Read Service.....	58
Table 42 – Read SSC Fragment Service.....	59
Table 43 – SSC Write Service.....	62
Table 44 – Write SSC Fragment Service .....	63
Table 45 – Notify SSC Command Execution Service.....	65
Table 46 – SSC Slave Info Service .....	67
Table 47 – SoE Mailbox Protocol .....	68
Table 48 – SSC Read Request .....	69
Table 49 – SSC Read Response.....	70
Table 50 – Read SSC Fragment Request.....	72
Table 51 – SSC Write Request .....	73
Table 52 – SSC Write Response.....	74
Table 53 – Write SSC Fragment Request.....	76
Table 54 – Notify SSC Command Execution Request.....	77
Table 55 – Slave Info Request.....	78

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –****Part 7-304: Generic interface and use  
of profiles for power drive systems –  
Mapping of profile type 4 to network technologies**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The International Standard IEC 61800-7-304 has been prepared by subcommittee SC 22G: Adjustable speed electric drive systems incorporating semiconductor power converters, of IEC technical committee TC 22: Power electronic systems and equipment.

The text of this standard is based on the following documents:

FDIS	Report on voting
22G/185/FDIS	22G/193/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61800 series, under the general title *Adjustable speed electrical power drive systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this publication may be issued at a later date.

## INTRODUCTION

The IEC 61800 series is intended to provide a common set of specifications for adjustable speed electrical power drive systems.

IEC 61800-7 describes a generic interface between control systems and power drive systems. This interface can be embedded in the control system. The control system itself can also be located in the drive (sometimes known as "smart drive" or "intelligent drive").

A variety of physical interfaces is available (analogue and digital inputs and outputs, serial and parallel interfaces, fieldbuses and networks). Profiles based on specific physical interfaces are already defined for some application areas (e.g. motion control) and some device classes (e.g. standard drives, positioner). The implementations of the associated drivers and application programmers interfaces are proprietary and vary widely.

IEC 61800-7 defines a set of common drive control functions, parameters, and state machines or description of sequences of operation to be mapped to the drive profiles.

IEC 61800-7 provides a way to access functions and data of a drive that is independent of the used drive profile and communication interface. The objective is a common drive model with generic functions and objects suitable to be mapped on different communication interfaces. This makes it possible to provide common implementations of motion control (or velocity control or drive control applications) in controllers without any specific knowledge of the drive implementation.

There are several reasons to define a generic interface:

### **For a drive device manufacturer**

- Less effort to support system integrators
- Less effort to describe drive functions because of common terminology
- The selection of drives does not depend on availability of specific support

### **For a control device manufacturer**

- No influence of bus technology
- Easy device integration
- Independent of a drive supplier

### **For a system integrator**

- Less integration effort for devices
- Only one understandable way of modeling
- Independent of bus technology

Much effort is needed to design a motion control application with several different drives and a specific control system. The tasks to implement the system software and to understand the functional description of the individual components may exhaust the project resources. In some cases, the drives do not share the same physical interface. Some control devices just support a single interface which will not be supported by a specific drive. On the other hand, the functions and data structures are often specified with incompatibilities. This requires the system integrator to write special interfaces for the application software and this should not be his responsibility.

Some applications need device exchangeability or integration of new devices in an existing configuration. They are faced with different incompatible solutions. The efforts to adopt a solution to a drive profile and to manufacturer specific extensions may be unacceptable. This will reduce the degree of freedom to select a device best suited for this application to the selection of the unit which will be available for a specific physical interface and supported by the controller.

IEC 61800-7-1 is divided into a generic part and several annexes as shown in Figure 1. The drive profile types for CiA 402<sup>1</sup>, CIP Motion<sup>TM2</sup>, PROFIdrive<sup>3</sup> and SERCOS interface<sup>TM4</sup> are mapped to the generic interface in the corresponding annex. The annexes have been submitted by open international network or fieldbus organizations which are responsible for the content of the related annex and use of the related trademarks.

The different profile types 1, 2, 3 and 4 are specified in IEC 61800-7-201, IEC 61800-7-202, IEC 61800-7-203 and IEC 61800-7-204.

This part of IEC 61800-7 specifies how the profile type 4 (SERCOS<sup>TM</sup>) is mapped to the network technologies SERCOS I, II, III and EtherCAT<sup>TM5</sup>.

IEC 61800-7-301, IEC 61800-7-302 and IEC 61800-7-303 specify how the profile types 1, 2 and 3 are mapped to different network technologies (such as CANopen<sup>6</sup>, EtherCAT<sup>TM</sup>, Ethernet Powerlink<sup>TM7</sup>, DeviceNet<sup>TM8</sup>, ControlNet<sup>TM9</sup>, EtherNet/IP<sup>TM10</sup>, PROFIBUS<sup>11</sup> and PROFINET<sup>12</sup>).

- 
- 1 CiA 402 is a trade name of CAN in Automation, e.V. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name CiA 402.
  - 2 CIP Motion<sup>TM</sup> is a trade name of Open DeviceNet Vendor Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name CIP Motion<sup>TM</sup>. Use of the trade name CIP Motion<sup>TM</sup> requires permission of Open DeviceNet Vendor Association, Inc.
  - 3 PROFIdrive is a trade name of PROFIBUS International. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name PROFIdrive. Use of the trade name PROFIdrive requires permission of PROFIBUS International.
  - 4 SERCOS<sup>TM</sup> and SERCOS interface<sup>TM</sup> are trade names of SERCOS International e.V. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade names SERCOS or SERCOS interface. Use of the trade names SERCOS and SERCOS interface requires permission of the trade name holder.
  - 5 EtherCAT<sup>TM</sup> is a trade name of Beckhoff, Verl. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name EtherCAT<sup>TM</sup>. Use of the trade name EtherCAT<sup>TM</sup> requires permission of the trade name holder.
  - 6 CANopen is an acronym for Controller Area Network *open* and is used to refer to EN 50325-4.
  - 7 Ethernet Powerlink<sup>TM</sup> is a trade name of B&R, control of trade name use is given to the non profit organization EPSG. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name Ethernet Powerlink<sup>TM</sup>. Use of the trade name Ethernet Powerlink<sup>TM</sup> requires permission of the trade name holder.
  - 8 DeviceNet<sup>TM</sup> is a trade name of Open DeviceNet Vendor Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name DeviceNet<sup>TM</sup>. Use of the trade name DeviceNet<sup>TM</sup> requires permission of Open DeviceNet Vendor Association, Inc.
  - 9 ControlNet<sup>TM</sup> is a trade name of ControlNet International, Ltd. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name ControlNet<sup>TM</sup>. Use of the trade name ControlNet<sup>TM</sup> requires permission of ControlNet International, Ltd.
  - 10 EtherNet/IP<sup>TM</sup> is a trade name of ControlNet International, Ltd. and Open DeviceNet Vendor Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trademark holder or any of its products. Compliance to this profile does not require use of the trade name EtherNet/IP<sup>TM</sup>. Use of the trade name EtherNet/IP<sup>TM</sup> requires permission of either ControlNet International, Ltd. or Open DeviceNet Vendor Association, Inc.
  - 11 PROFIBUS is a trade name of PROFIBUS International. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name PROFIBUS. Use of the trade name PROFIBUS requires permission of PROFIBUS International.
  - 12 PROFINET is a trade name of PROFIBUS International. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade name holder or any of its products. Compliance to this profile does not require use of the trade name PROFINET. Use of the trade name PROFINET requires permission of PROFIBUS International.

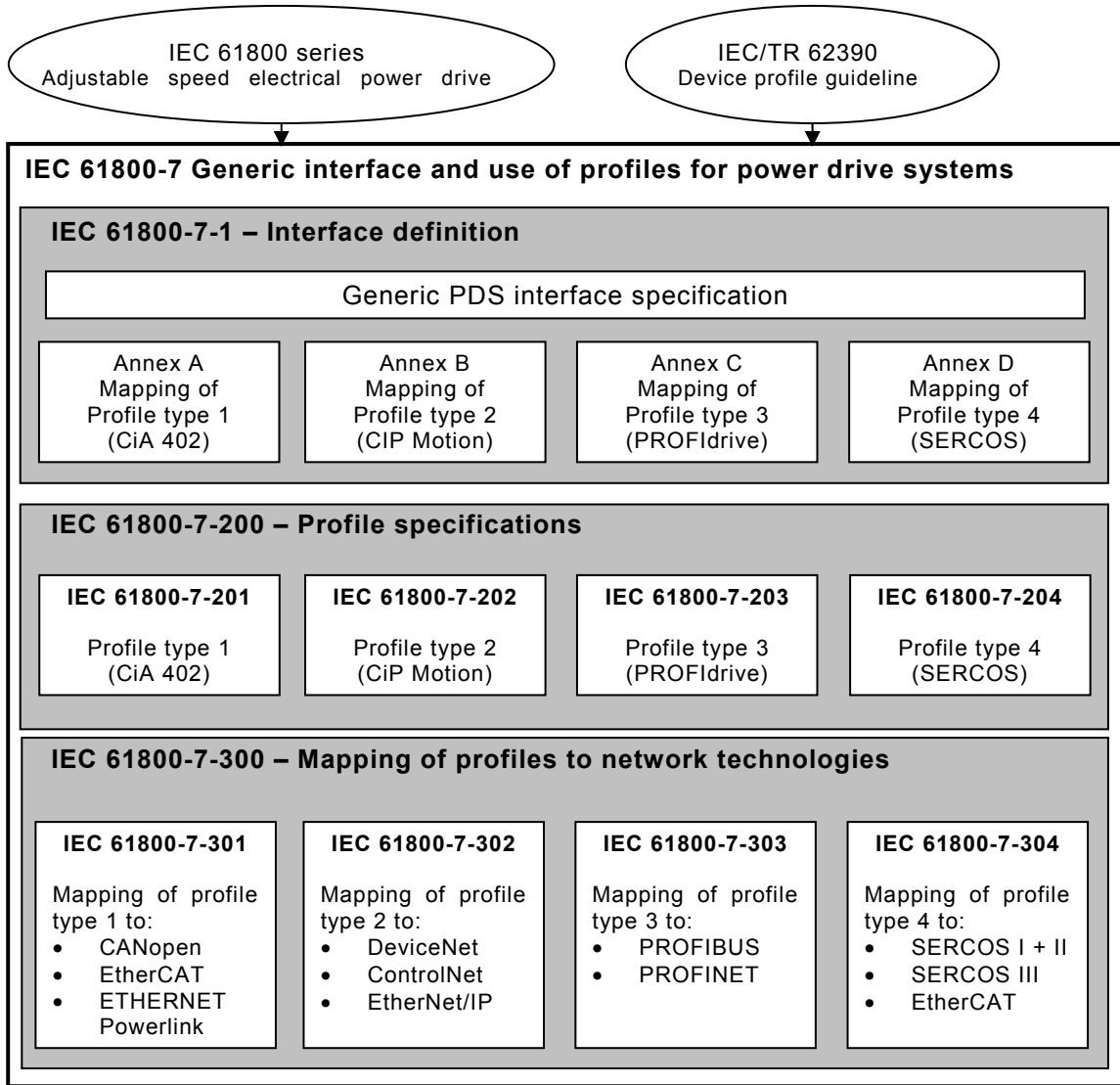


Figure 1 – Structure of IEC 61800-7

## **ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –**

### **Part 7-304: Generic interface and use of profiles for power drive systems – Mapping of profile type 4 to network technologies**

#### **1 Scope**

IEC 61800-7 specifies profiles for Power Drive Systems (PDS) and their mapping to existing communication systems by use of a generic interface model.

The functions specified in this part of IEC 61800-7 are not intended to ensure functional safety. This requires additional measures according to the relevant standards, agreements and laws.

This part of IEC 61800-7 specifies the mapping of the profile type 4 (SERCOS) specified in IEC 61800-7-204 onto different network technologies.

- SERCOS I / II, see Clause 5,
- SERCOS III, see Clause 6,
- EtherCAT, see Clause 7.

#### **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.

IEC 61158-2, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-4-16, *Industrial communication networks – Fieldbus specifications – Part 4-16: Data-link layer protocol specification – Type 16 elements*

IEC 61158-5-16, *Industrial communication networks – Fieldbus specifications – Part 5-16: Application layer service definition – Type 16 elements*

IEC 61158-6-16, *Industrial communication networks – Fieldbus specifications – Part 6-16: Application layer protocol specification – Type 16 elements*

IEC 61491:2002, *Electrical equipment of industrial machines – Serial data link for real-time communication between controls and drives*

IEC 61784-1, *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*

IEC 61784-2, *Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3*

IEC 61800-7 (all parts), *Adjustable speed electrical power drive systems – Generic interface and use of profiles for power drive systems*

IEC 61800-7-204, *Adjustable speed electrical power drive systems – Part 7-204: Generic interface and use of profiles for power drive systems – Profile type 4 specification*

ISO/IEC 8802-3:2000, *Information technology -Telecommunications and information exchange between systems - Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*