

INTERNATIONAL STANDARD



**Industrial communication networks – Profiles –
Part 3-13: Functional safety fieldbuses – Additional specifications for CPF 13**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00



IEC 61784-3-13

Edition 1.0 2010-06

INTERNATIONAL STANDARD



**Industrial communication networks – Profiles –
Part 3-13: Functional safety fieldbuses – Additional specifications for CPF 13**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XH**

ICS 25.040.40; 35.100.05

ISBN 978-2-88910-982-1

CONTENTS

FOREWORD.....	13
0 Introduction	15
0.1 General.....	15
0.2 Patent declaration	17
1 Scope.....	19
2 Normative references	19
3 Terms, definitions, symbols, abbreviated terms and conventions	20
3.1 Terms and definitions	20
3.1.1 Common terms and definitions	20
3.1.2 CPF 13: Additional terms and definitions	24
3.2 Symbols and abbreviated terms.....	25
3.2.1 Common symbols and abbreviated terms	25
3.2.2 CPF 13: Additional symbols and abbreviated terms	26
3.3 Conventions	27
3.3.1 Hexadecimal values.....	27
3.3.2 Binary values.....	27
3.3.3 Wildcard digits.....	27
3.3.4 Diagrams.....	27
4 Overview of FSCP 13/1 (Ethernet POWERLINK safety).....	27
4.1 Functional Safety Communication Profile 13/1.....	27
4.2 Technical overview.....	28
5 General	28
5.1 External documents providing specifications for the profile.....	28
5.2 Safety functional requirements	29
5.3 Safety measures	29
5.4 Safety communication layer structure	31
5.5 Relationships with FAL (and DLL, PhL)	32
5.5.1 General	32
5.5.2 Data types.....	32
6 Safety communication layer services.....	32
6.1 Modelling	32
6.1.1 Reference model	32
6.1.2 Communication model	33
6.1.3 Device roles and topology	34
6.2 Life cycle model	38
6.2.1 General	38
6.2.2 Concept, planning and implementation	38
6.2.3 Commissioning.....	39
6.2.4 Operation terms.....	40
6.2.5 Maintenance terms	42
6.3 Non safety communication layer.....	42
6.3.1 General	42
6.3.2 Requirements for data transport	42
6.3.3 Domain protection and separation	46
7 Safety communication layer protocol	46
7.1 Safety PDU format	46

7.1.1	General	46
7.1.2	Address field (ADR).....	48
7.1.3	PDU identification field (ID)	49
7.1.4	Length field (LE).....	50
7.1.5	Consecutive Time field (CT)	50
7.1.6	Payload data field (DB0 to DBn)	50
7.1.7	Cyclic Redundancy Check field (CRC-8 / CRC-16)	50
7.1.8	Time Request Address field (TADR)	50
7.1.9	Time Request Distinctive Number field (TR)	51
7.1.10	UDID of SCM coding (UDID of SCM)	51
7.2	Safety Process Data Objects (SPDO).....	51
7.2.1	General	51
7.2.2	SPDO telegram types	51
7.2.3	Data Only telegram.....	51
7.2.4	Data with Time Request telegram	52
7.2.5	Data with Time Response telegram	53
7.3	Safety Service Data Object (SSDO)	54
7.3.1	General	54
7.3.2	SSDO telegram types	54
7.3.3	SSDO services and protocols	55
7.3.4	SSDO Initiate Download	56
7.3.5	SSDO Segmented Download.....	57
7.3.6	SSDO Initiate Upload	58
7.3.7	SSDO Segmented Upload	59
7.3.8	SSDO Abort.....	60
7.4	Safety Network Management (SNMT).....	62
7.4.1	General	62
7.4.2	SNMT telegram types	62
7.4.3	SNMT services and protocols	62
7.5	Safety Object dictionary (SOD).....	75
7.5.1	General	75
7.5.2	Object dictionary entry definition.....	75
7.5.3	Data type entry specification.....	81
7.5.4	Object description.....	82
7.6	Safety related PDO mapping	117
7.6.1	General	117
7.6.2	Transmit SPDOs.....	118
7.6.3	Receive SPDOs.....	118
7.6.4	SPDO mapping parameter	118
7.6.5	SPDO mapping example.....	119
7.6.6	SPDO error handling	121
7.7	State and sequence diagrams	121
7.7.1	Safety Process Data Object (SPDO).....	121
7.7.2	Time synchronization and validation	125
7.7.3	Safety Service Data Object (SSDO).....	134
7.7.4	SOD access	136
7.7.5	Safety Network Management Object (SNMT).....	141
7.7.6	SN power up.....	143
7.7.7	SN power down	147

7.7.8	SN recovery after Restart / Error	147
7.7.9	SCM power up.....	147
7.7.10	Address verification	150
7.7.11	Commissioning mode	152
7.7.12	Handle single UDID mismatch	152
7.7.13	Activate SN	156
7.7.14	Device exchange	157
8	Safety communication layer management.....	157
8.1	General.....	157
8.2	Goals of parameterization	158
8.3	Initial configuration of a device	158
8.3.1	General	158
8.3.2	SD setup by only configuring the SCM.....	158
8.3.3	SD setup configuring each SN	159
8.4	Avoiding of parameterize the wrong device	159
8.5	Parameter check mechanism.....	159
9	System requirements.....	159
9.1	Indicators and switches	159
9.2	Installation guidelines.....	159
9.3	Safety function response time	159
9.4	Duration of demands	161
9.5	Constraints for calculation of system characteristics.....	161
9.5.1	General	161
9.5.2	Number of sinks limit	161
9.5.3	Message rate limit	161
9.5.4	Message payload limit	161
9.5.5	Residual error rate.....	161
9.6	Maintenance.....	161
9.6.1	Diagnostic information.....	161
9.6.2	Replacement of safety related devices	161
9.6.3	Modification.....	162
9.6.4	Machine part changing	162
9.6.5	Firmware update of safety related nodes	162
9.6.6	Machine check due to service interval	162
9.7	Safety manual	162
10	Assessment.....	162
10.1	General.....	162
10.2	CP 13/1 assessment	163
10.3	FSCP 13/1 conformance test.....	163
10.4	Approval of functional safety by competent assessment body.....	163
10.5	Summary.....	163
Annex A (informative) Additional information for functional safety communication profiles of CPF 13.....		164
A.1	Hash function calculation.....	164
A.2	Stochastic errors – general considerations	167
A.2.1	General.....	167
A.2.2	Error detection mechanisms	167
A.2.3	Calculations	169

A.3 Stochastic errors (case A)	169
A.3.1 General	169
A.3.2 Constraints	169
A.3.3 Residual error rate	169
A.3.4 Summary	170
A.4 Stochastic errors (case B)	170
A.4.1 General	170
A.4.2 Constraints	170
A.4.3 Bit error probability considerations	170
A.4.4 Residual error rate (payload 1—8)	171
A.4.5 Residual error rate (payload 9—254)	171
A.4.6 Summary	171
Annex B (informative) Information for assessment of the functional safety communication profiles of CPF 13	172
Bibliography	173
Table 1 – Communication errors and detection measures (cyclic)	29
Table 2 – Communication errors and detection measures (acyclic)	30
Table 3 – Device roles	35
Table 4 – PDU format	48
Table 5 – PDU identification field (ID)	49
Table 6 – Used ID field combinations	49
Table 7 – Request / response identification	49
Table 8 – Type of CRC depending on LE	50
Table 9 – SPDO telegram types (ID field, bits 2, 3 and 4)	51
Table 10 – Fields of SPDO_Data_Only telegram	52
Table 11 – Fields of SPDO_Data_with_Time_Request telegram	53
Table 12 – Fields of SPDO_Data_with_Time_Response telegram	53
Table 13 – SSSDO telegram types (ID field, bits 2, 3 and 4)	54
Table 14 – SOD Access Command (SACmd) – bit coding	54
Table 15 – Fields of Initiate Download SSSDO_Service_Request telegram	56
Table 16 – Fields of Initiate Download SSSDO_Service_Response telegram	57
Table 17 – Fields of Segmented Download SSSDO_Service_Request telegram	57
Table 18 – Fields of Segmented Download SSSDO_Service_Response telegram	58
Table 19 – Fields of Initiate Upload SSSDO_Service_Request telegram	58
Table 20 – Fields of Initiate Upload SSSDO_Service_Response telegram	59
Table 21 – Fields of Segmented Upload SSSDO_Service_Request telegram	60
Table 22 – Fields of Segmented Upload SSSDO_Service_Response telegram	60
Table 23 – Fields of Segmented Upload SSSDO_Service_Request telegram	60
Table 24 – Fields of Segmented Upload SSSDO_Service_Response telegram	61
Table 25 – SSSDO Abort codes	61
Table 26 – SNMT telegram types (ID field, bits 2, 3 and 4)	62
Table 27 – Fields of SNMT_Request_UDID telegram	63
Table 28 – Fields of SNMT_Response_UDID telegram	63

Table 29 – Fields of SNMT_Assign_SADR telegram	64
Table 30 – Fields of SNMT_SADR_Assigned telegram	65
Table 31 – Fields of SNMT_SN_reset_guarding_SCM telegram	65
Table 32 – SNMT request telegram types	66
Table 33 – SNMT response telegram types	66
Table 34 – Fields of SNMT_SN_set_to_PRE_OP telegram	66
Table 35 – Fields of SNMT_SN_status_PRE_OP telegram	67
Table 36 – Fields of SNMT_SN_set_to_OP telegram	68
Table 37 – Fields of SNMT_SN_status_OP telegram	68
Table 38 – Fields of SNMT_SN_busy telegram	68
Table 39 – Fields of SNMT_SN_FAIL telegram	69
Table 40 – SNMT_SN_FAIL Error Group values	69
Table 41 – SNMT_SN_FAIL Error Code values	69
Table 42 – Fields of SNMT_SN_ACK telegram	70
Table 43 – Fields of SNMT_SCM_set_to_STOP telegram	70
Table 44 – Fields of SNMT_SCM_set_to_OP telegram	71
Table 45 – Fields of SNMT_SCM_guard_SN telegram	72
Table 46 – Fields of SNMT_SN_status_OP/SNMT_SN_status_OP telegrams	72
Table 47 – Fields of SNMT_assign_additional_SADR telegram	73
Table 48 – Fields of SNMT_assigned_additional_SADR telegram	73
Table 49 – Fields of SNMT_assign_UDID_of_SCM telegram	74
Table 50 – Fields of SNMT_assigned_UDID_of_SCM telegram	74
Table 51 – Object type definition	75
Table 52 – Access attributes for data objects	77
Table 53 – SPDO mapping attributes for data objects	77
Table 54 – Basic data type object definition example	77
Table 55 – Compound data type object definition example	78
Table 56 – Sub index interpretation	78
Table 57 – NumberOfEntries sub index specification	79
Table 58 – RECORD type object sub index specification	79
Table 59 – ARRAY type object sub index specification	80
Table 60 – StructureOfObject encoding	80
Table 61 – Object dictionary data types	81
Table 62 – 0021h Compound data type description	82
Table 63 – 0021h Compound sub index descriptions	82
Table 64 – Standard objects	83
Table 65 – Common communication objects	83
Table 66 – Receive SPDO communication objects	83
Table 67 – Receive SPDO mapping objects	84
Table 68 – Transmit SPDO communication objects	84
Table 69 – Transmit SPDO mapping objects	84
Table 70 – SADR DVI list	84
Table 71 – Additional SADR list	85

Table 72 – SADR UDID list	85
Table 73 – Object 1001h Error Register	85
Table 74 – Object 1001h Error Register value interpretation	86
Table 75 – Object 1002h Manufacturer status register	86
Table 76 – Object 1003h Pre defined error field	87
Table 77 – Object 1003h sub index 00h	87
Table 78 – Object 1003h sub index 01h	87
Table 79 – Object 1003h sub index 02h to FDh	88
Table 80 – Object 100Ch Life Guarding	88
Table 81 – Object 100Ch sub index 00h	88
Table 82 – Object 100Ch sub index 01h	89
Table 83 – Object 100Ch sub index 02h	89
Table 84 – Object 100Dh Refresh Interval of Reset Guarding	90
Table 85 – Object 1018h Device Vendor Information	90
Table 86 – Object 1018h sub index 00h	90
Table 87 – Object 1018h sub index 01h	91
Table 88 – Object 1018h sub index 02h	91
Table 89 – Object 1018h sub index 03h	91
Table 90 – Object 1018h sub index 04h	92
Table 91 – Object 1018h sub index 05h	92
Table 92 – Object 1018h sub index 06h	92
Table 93 – Object 1018h sub index 07h	93
Table 94 – Structure of Revision Number	93
Table 95 – Object 1019h Unique Device ID	94
Table 96 – Object 101Ah Parameter Download	94
Table 97 – Object 101Bh SCM Parameters	95
Table 98 – Object 101Bh sub index 00h	95
Table 99 – Object 101Bh sub index 01h	95
Table 100 – Object 1200h Common Communication Parameter	96
Table 101 – Object 1200h sub index 00h	96
Table 102 – Object 1200h sub index 01h	96
Table 103 – Object 1200h sub index 02h	97
Table 104 – Object 1200h sub index 03h	97
Table 105 – Object 1200h sub index 04h	98
Table 106 – Object 1201h SSDO Communication Parameter	98
Table 107 – Object 1201h sub index 00h	98
Table 108 – Object 1201h sub index 01h	99
Table 109 – Object 1201h sub index 02h	99
Table 110 – Object 1202h SNMT Communication Parameter	99
Table 111 – Object 1202h sub index 00h	100
Table 112 – Object 1202h sub index 01h	100
Table 113 – Object 1202h sub index 02h	100
Table 114 – Object 1400h -- 17FEh RxSPDO Communication Parameter	101