

© Copyright SEK. Reproduction in any form without permission is prohibited.

Industriell processtyrning – Fältbuss – Del 6-8: Specifikation av protokoll i applikationsskiktet – Delar i fältbuss, Typ 8

*Industrial communication networks –
Fieldbus specifications –
Part 6-8: Application layer protocol specification –
Type 8 elements*

Som svensk standard gäller europastandarden EN 61158-6-8:2008. Den svenska standarden innehåller den officiella engelska språkversionen av EN 61158-6-8:2008.

Nationellt förord

Europastandarden EN 61158-6-8:2008

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61158-6-8, First edition, 2007 - Industrial communication networks - Fieldbus specifications - Part 6-8: Application layer protocol specification - Type 8 elements**

utarbetad inom International Electrotechnical Commission, IEC.

Denna standard, och de andra delarna i serien SS-EN 61158-6, ersätter SS-EN 61158-6, utgåva 1, 2004.

Tidigare fastställd svensk standard SS-EN 61158-6, utgåva 1, 2004, gäller ej fr o m 2011-02-01.

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a säkerhet, prestanda, dokumentation, utförande och skötsel av elprodukter, elanläggningar och metoder. Genom att utforma sådana standarder blir säkerhetskraven tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English version

**Industrial communication networks -
Fieldbus specifications -
Part 6-8: Application layer protocol specification -
Type 8 elements
(IEC 61158-6-8:2007)**

Réseaux de communication industriels -
Spécifications des bus de terrain -
Partie 6-8: Spécification des services
des couches d'application -
Éléments de type 8
(CEI 61158-6-8:2007)

Industrielle Kommunikationsnetze -
Feldbusse -
Teil 6-8: Protokollspezifikation
des Application Layer
(Anwendungsschicht) -
Typ 8-Elemente
(IEC 61158-6-8:2007)

This European Standard was approved by CENELEC on 2008-02-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 65C/476/FDIS, future edition 1 of IEC 61158-6-8, prepared by SC 65C, Industrial networks, of IEC TC 65, Industrial-process measurement, control and automation, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61158-6-8 on 2008-02-01.

This and the other parts of the EN 61158-6 series supersede EN 61158-6:2004.

With respect to EN 61158-6:2004 the following changes were made:

- deletion of Type 6 fieldbus for lack of market relevance;
- addition of new fieldbus types;
- partition into multiple parts numbered 6-2, 6-3, ...6-20.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2008-11-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2011-02-01

NOTE Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in type combinations as specified explicitly in the EN 61784 series. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

IEC and CENELEC draw attention to the fact that it is claimed that compliance with this standard may involve the use of patents as follows, where the [xx] notation indicates the holder of the patent right:

Type 8:

DE 197 39 297 C2	[PxC]	"Automatisierungssystem und Steuervorrichtung zur transparenten Kommunikation zwischen verschiedenen Netzwerken."
US 2002/0042845 A1	[PxC]	"Automation System and connecting Apparatus for the Transparent Communication between two Networks."

IEC and CENELEC take no position concerning the evidence, validity and scope of these patent rights.

The holders of these patent rights have assured IEC that they are willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holders of these patent rights are registered with IEC. Information may be obtained from:

[PxC]: Phoenix Contact GmbH & Co. KG
Intellectual Property Licenses & Standards
Flachsmarktstr. 8
D-32825 Blomberg,
Germany

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights other than those identified above. IEC and CENELEC shall not be held responsible for identifying any or all such patent rights.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61158-6-8:2007 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61784-1	NOTE Harmonized as EN 61784-1:2008 (not modified).
IEC 61784-2	NOTE Harmonized as EN 61784-2:2008 (not modified).
ISO/IEC 9506-2	NOTE Harmonized as EN 29506-2:1993 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60559	- ¹⁾	Binary floating-point arithmetic for microprocessor systems	HD 592 S1	1991 ²⁾
IEC 61158-3-8	- ¹⁾	Industrial communication networks - Fieldbus specifications - Part 3-8: Data-link layer service definition - Type 8 elements	EN 61158-3-8	2008 ²⁾
IEC 61158-4-8	- ¹⁾	Industrial communication networks - Fieldbus specifications - Part 4-8: Data-link layer protocol specification - Type 8 elements	EN 61158-4-8	2008 ²⁾
IEC 61158-5-8	- ¹⁾	Industrial communication networks - Fieldbus specifications - Part 5-8: Application layer service definition - Type 8 elements	EN 61158-5-8	2008 ²⁾
ISO/IEC 7498	Series	Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model	EN ISO/IEC 7498	Series
ISO/IEC 8822	- ¹⁾	Information technology - Open Systems Interconnection - Presentation service definition	-	-
ISO/IEC 8824-2	- ¹⁾	Information technology - Abstract Syntax Notation One (ASN.1): Information object specification	-	-
ISO/IEC 8825-1	- ¹⁾	Information technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)	-	-
ISO/IEC 9545	- ¹⁾	Information technology - Open Systems Interconnection - Application Layer structure	-	-

¹⁾ Undated reference.

²⁾ Valid edition at date of issue.

CONTENTS

INTRODUCTION.....	8
1 Scope.....	9
1.1 General.....	9
1.2 Specifications.....	9
1.3 Conformance.....	9
2 Normative references	10
3 Terms and definitions	10
3.1 ISO/IEC 7498-1 terms	10
3.9 ISO/IEC 8822 terms	11
3.11 ISO/IEC 9545 terms	11
3.16 ISO/IEC 8824 terms	11
3.37 ISO/IEC 8825 terms	12
3.40 Terms and definitions from IEC 61158-5-8.....	12
3.47 Other terms and definitions	12
4 FAL syntax description	13
4.1 FAL-AR PDU abstract syntax	13
4.2 Abstract syntax of PDUBody.....	16
4.3 Type definitions for ASEs	20
4.4 Object definitions	23
4.5 Abstract syntax of Data types.....	25
5 Transfer syntax	26
5.1 Peripherals encoding rules (PER).....	26
5.2 Encoding of APDU types	26
5.3 Encoding of tagged type values.....	28
5.4 Encoding of simple values.....	29
6 Protocol machine overview	35
7 AP-context state machine	35
7.1 Primitive definitions	35
7.2 State machine description	36
7.3 AP to AP-context initiation state transitions	37
7.4 Functions	48
8 FAL service protocol machine (FSPM).....	51
8.1 Summary.....	51
8.2 Primitive definitions	51
8.3 FSPM state tables	53
9 Application relationship protocol machines (ARPMs)	56
9.1 Queued user-triggered bidirectional-flow control (QUB-FC) ARPM	56
9.2 Buffered network-scheduled unidirectional (BNU) ARPM	78
9.3 Queued user-triggered bidirectional – transparent mode (QUB-TM) ARPM.....	86
10 DLL mapping protocol machine	90
10.1 Overview	90
10.2 Primitive definitions	91
10.3 DMPM state machine	94
Bibliography.....	101

Figure 1 – APDU overview	26
Figure 2 – APDU header	26
Figure 3 – PDU with type extension	26
Figure 4 – PDU with address extension	27
Figure 5 – PDU with type and length extension	27
Figure 6 – Example of an Establish-Request PDU.....	27
Figure 7 – Encoding of a PRIVATE tagged value	28
Figure 8 – Encoding of a context specific tagged value	28
Figure 9 – Identification information fields.....	28
Figure 10 – ID-info for tag 0 .. 14 , length entry 0 .. 6.....	29
Figure 11 – ID-info for tag 15 .. 255 , length entry 0 .. 6.....	29
Figure 12 – ID-info for tag 0 .. 14 , length entry 7 .. 255.....	29
Figure 13 – ID-info for tag 15 .. 255 , length entry 7 .. 255.....	29
Figure 14 – Encoding of Boolean value TRUE.....	29
Figure 15 – Encoding of Boolean value FALSE	29
Figure 16 – Encoding of Strings	30
Figure 17 – Encoding of BinaryDate value	31
Figure 18 – Encoding of BinaryDate2000 value.....	31
Figure 19 – Encoding of Time-of-day value	32
Figure 20 – Encoding of Time-difference value	32
Figure 21 – Encoding of Time value	33
Figure 22 – Example for an Object definition.....	34
Figure 23 – Primitives exchanged between protocol machines	35
Figure 24 – AP to AP-context initiation state machine	37
Figure 25 – State transition diagram of FSPM.....	53
Figure 26 – State transition diagram of QUB-FC ARPM	59
Figure 27 – State transition diagram of the BNU ARPM	81
Figure 28 – State transition diagram of QUB-TM AREP.....	88
Figure 29 – State transition diagram of DMPM	94
Table 1 – Primitives issued by FAL-user to AP-context	35
Table 2 – Primitives issued by AP-context to FAL-user	36
Table 3 – AP-context state machine sender transactions	37
Table 4 – AP-context state machine receiver transactions	41
Table 5 – Function ResetArep.....	49
Table 6 – Function ApContextTest	49
Table 7 – Function ServicesSupportedTest.....	49
Table 8 – Function ApExplicitConnection	49
Table 9 – Function ImmediateAcknowledge	49
Table 10 – Function ConfirmedServiceCheck.....	49
Table 11 – Function UnconfirmedServiceCheck	49
Table 12 – Function ArServiceCheck	50

Table 13 – Function ArFspmService	50
Table 14 – Function ArAcceeSupported	50
Table 15 – Function MaxFalPduLengthTest	50
Table 16 – Function NegotiateOutstandingServices	50
Table 17 – Function RequestedServicesSupportedTest	51
Table 18 – Function IndicatedServicesSupportedTest	51
Table 19 – Function InvokeldExistent	51
Table 20 – Function SameService.....	51
Table 21 – Primitives issued by AP-context to FSPM	52
Table 22 – Primitives issued by FSPM to AP-context	52
Table 23 – FSPM state table – sender transactions	53
Table 24 – FSPM state table – receiver transactions	55
Table 25 – Function SelectArep	55
Table 26 – Primitives issued by FSPM to ARPM	56
Table 27 – Primitives issued by ARPM to FSPM	56
Table 28 – Parameters used with primitives exchanged between FSPM and ARPM	57
Table 29 – QUB-FC ARPM states	59
Table 30 – QUB-FC ARPM state table – sender transactions	60
Table 31 – QUB-FC ARPM state table – receiver transactions	65
Table 32 – Function GetArepId ()	76
Table 33 – Function BuildFAL-PDU	76
Table 34 – Function FAL_Pdu_Type	77
Table 35 – Function AREPContextCheck().....	77
Table 36 – Function AbortIdentifier	77
Table 37 – Function AbortReason	77
Table 38 – Function AbortDetail.....	77
Table 39 – Function StartTimer.....	78
Table 40 – Function StopTimer	78
Table 41 – Function ResetCounters	78
Table 42 – Function IncrementCounter	78
Table 43 – Function DecrementCounter	78
Table 44 – Function GetCounterValue	78
Table 45 – Primitives issued by FSPM to ARPM	79
Table 46 – Primitives issued by ARPM to FSPM	79
Table 47 – Parameters used with primitives exchanged between FSPM and ARPM	79
Table 48 – BNU ARPM states	81
Table 49 – BNU ARPM state table – sender transactions	81
Table 50 – BNU ARPM state table – receiver transactions	82
Table 51 – Function GetArepId ()	85
Table 52 – Function BuildFAL-PDU	85
Table 53 – Function FAL_Pdu_Type	85
Table 54 – Function AbortIdentifier	85
Table 55 – Function AbortReason	85

Table 56 – Function AbortDetail.....	85
Table 57 – Primitives issued by FAL to ARPM	86
Table 58 – Primitives issued by ARPM to FAL	86
Table 59 – Parameters used with primitives exchanged between FAL and ARPM	86
Table 60 – QUB-TM ARPM states	88
Table 61 – QUB-TM state table - sender transactions	88
Table 62 – QUB-TM state table - receiver transactions	89
Table 63 – Function GetArepId ().....	89
Table 64 – Function BuildFAL-PDU.....	89
Table 65 – Function FAL_Pdu_Type	89
Table 66 – Function ResetCounters	90
Table 67 – Function IncrementCounter	90
Table 68 – Function DecrementCounter	90
Table 69 – Function GetCounterValue	90
Table 70 – Primitives issued by ARPM to DMPM	91
Table 71 – Primitives issued by DMPM to ARPM	92
Table 72 – Parameters used with primitives exchanged between ARPM and DMPM	93
Table 73 – Primitives exchanged between data-link layer and DMPM	93
Table 74 – DMPM state descriptions.....	94
Table 75 – DMPM state table – sender transactions	94
Table 76 – DMPM state table – receiver transactions.....	98
Table 77 – Function PickArep	99
Table 78 – Function FindAREP	99
Table 79 – Function SelectNextArep	99
Table 80 – Function ArepRole.....	100
Table 81 – Function FalArHeader	100
Table 82 – Function AddUcsPduHeader.....	100
Table 83 – Function RemoveUcsPduHeader	100
Table 84 – Function DILinkStatus	100

INTRODUCTION

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC/TR 61158-1.

The application protocol provides the application service by making use of the services available from the data-link or other immediately lower layer. The primary aim of this standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer application entities (AEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

- as a guide for implementors and designers;
- for use in the testing and procurement of equipment;
- as part of an agreement for the admittance of systems into the open systems environment;
- as a refinement to the understanding of time-critical communications within OSI.

This standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-8: Application layer protocol specification – Type 8 elements

1 Scope

1.1 General

The fieldbus application layer (FAL) provides user programs with a means to access the fieldbus communication environment. In this respect, the FAL can be viewed as a “window between corresponding application programs.”

This standard provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment and material specific to Type 8 fieldbus. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This standard specifies interactions between remote applications and defines the externally visible behavior provided by the Type 8 fieldbus application layer in terms of

- a) the formal abstract syntax defining the application layer protocol data units conveyed between communicating application entities;
- b) the transfer syntax defining encoding rules that are applied to the application layer protocol data units;
- c) the application context state machine defining the application service behavior visible between communicating application entities;
- d) the application relationship state machines defining the communication behavior visible between communicating application entities.

The purpose of this standard is to define the protocol provided to

- 1) define the wire-representation of the service primitives defined in IEC 61158-5-8, and
- 2) define the externally visible behavior associated with their transfer.

This standard specifies the protocol of the Type 8 fieldbus application layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) and the OSI application layer structure (ISO/IEC 9545).

1.2 Specifications

The principal objective of this standard is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-8.

A secondary objective is to provide migration paths from previously-existing industrial communications protocols. It is this latter objective which gives rise to the diversity of protocols standardized in the IEC 61158-6 series.

1.3 Conformance

This standard does not specify individual implementations or products, nor does it constrain the implementations of application layer entities within industrial automation systems.

Conformance is achieved through implementation of this application layer protocol specification.

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 60559, *Binary floating-point arithmetic for microprocessor systems*

IEC 61158-3-8, *Industrial communication networks – Fieldbus specifications – Part 3-8: Data-link layer service definition – Type 8 elements*

IEC 61158-4-8, *Industrial communication networks – Fieldbus specifications – Part 4-8: Data-link layer protocol specification – Type 8 elements*

IEC 61158-5-8, *Industrial communication networks – Fieldbus specifications – Part 5-8: Application layer service definition – Type 8 elements*

ISO/IEC 7498 (all parts), *Information technology – Open Systems Interconnection – Basic Reference Model*

ISO/IEC 8822, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8824, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1)*

ISO/IEC 8825, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 9545, *Information technology – Open Systems Interconnection – Application Layer structure*

1 [REDACTED]

[REDACTED]

2 [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]