Irish Standard
I.S. EN 61158-6-21:2012

Industrial communication networks - Fieldbus specifications - Part 6-21: Application layer protocol specification - Type 21 elements (IEC 61158-6 -21:2010 (EQV))

I.S. EN 61158-6-21:2012

Incorporating amendments/corrigenda issued since publication:

The National Standards Authority of Ireland (NSAI) produces the following categories of formal documents:

I.S. xxx: Irish Standard – national specification based on the consensus of an expert panel and subject to public consultation.

S.R. xxx: Standard Recommendation - recommendation based on the consensus of an expert panel and subject to public consultation.

SWiFT xxx: A rapidly developed recommendatory document based on the consensus of the participants of an NSAI workshop.

This document replaces:	*This document is based on:* EN 61158-6-21:2012	*Published:* 22 June, 2012

This document was published
under the authority of the NSAI and comes into effect on:

28 June, 2012

ICS number:
25.040.40
35.100.70
35.110

NSAI
1 Swift Square,
Northwood, Santry
Dublin 9

T +353 1 807 3800
F +353 1 807 3838
E standards@nsai.ie

W NSAI.ie

Sales:
T +353 1 857 6730
F +353 1 857 6729
W standards.ie

Údarás um Chaighdeáin Náisiúnta na hÉireann

I.S. EN 61158-6-21:2012

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61158-6-21

June 2012

ICS 25.040.40; 35.100.70; 35.110

English version

Industrial communication networks - Fieldbus specifications - Part 6-21: Application layer protocol specification - Type 21 elements

(IEC 61158-6-21:2010)

Réseaux de communication industriels - Spécifications des bus de terrain - Partie 6-21: Spécification des protocoles des couches d'application - Eléments de type 21 (CEI 61158-6-21:2010)

Industrielle Kommunikationsnetze - Feldbusse - Teil 6-21: Protokollspezifikation des Application Layer (Anwendungsschicht) - Typ 21-Elemente (IEC 61158-6-21:2010)

This European Standard was approved by CENELEC on 2012-03-28. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, 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, Turkey and the United Kingdom.

CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

Ref. No. EN 61158-6-21:2012 E

Foreword

The text of document 65C/607/FDIS, future edition 1 of IEC 61158-6-21, 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 approved by CENELEC as EN 61158-6-21:2012.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-12-28
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2015-03-28

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61158-6-21:2010 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/TR 61158-1:2010	NOTE	Harmonized as CLC/TR 61158-1:2010 (not modified).
IEC 61784-2:2010	NOTE	Harmonized as EN 61784-2:2010 (not modified).

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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.

Publication	Year	Title	EN/HD	Year
IEC 61158-3-21	2010	Industrial communication networks - Fieldbus specifications - Part 3-21: Data-link layer service definition - Type 21 elements	EN 61158-3-21	2012
IEC 61158-4-21	2010	Industrial communication networks - Fieldbus specifications - Part 4-21: Data-link layer protocol specification - Type 21 elements	EN 61158-4-21	2012
IEC 61158-5-21	2010	Industrial communication networks - Fieldbus specifications - Part 5-21: Application layer service definition - Type 21 elements	EN 61158-5-21	2012
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model	-	-
ISO/IEC 8822	-	Information technology - Open Systems Interconnection - Presentation service definition	-	-
ISO/IEC 8824-1	-	Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation	-	-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application Layer structure	-	-
ISO/IEC 9899	-	Programming Languages - C	-	-
ISO/IEC 10731	1994	Information technology - Open Systems Interconnection - Basic reference model - Conventions for the definition of OSI services	-	-
IEEE 754	2008	Binary floating-point arithmetic	-	-

This page is intentionally left BLANK.

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
1.1 General 8
1.2 Overview 8
1.3 Specifications 9
1.4 Conformance 9
2 Normative references 9
3 Terms, definitions, symbols, abbreviations, and conventions 10
3.1 Terms and definitions from other ISO/IEC standards 10
3.2 Other terms and definitions 10
3.3 Abbreviations and symbols 16
3.4 Conventions 17
4 FAL syntax description 19
4.1 General 19
4.2 FAL-AR PDU abstract syntax 19
4.3 Abstract syntax of PDU body 20
4.4 Protocol data units (PDUs) for application service elements (ASEs) 21
5 Transfer Syntax 24
5.1 Overview of encoding 24
5.2 APDU header encoding 25
5.3 APDU body encoding 26
5.4 Encoding of Data types 26
6 FAL protocol state machines 30
7 AP context state machine 32
8 FAL service protocol machine 32
8.1 General 32
8.2 Common parameters of the primitives 32
8.3 AP ASE protocol machine 32
8.4 Service data object ASE protocol machine (SDOM) 36
8.5 Process data object ASE protocol machine (PDOM) 40
9 AR protocol machine 41
9.1 General 41
9.2 Point-to-point user-triggered confirmed client/server AREP (PTC-AR) ARPM 42
9.3 Multipoint network-scheduled unconfirmed publisher/subscriber AREP (MSU-AR) ARPM 44
9.4 Multipoint user-triggered unconfirmed publisher/subscriber AREP (MTU-AR) ARPM 47
10 DLL mapping protocol machine 49
10.1 Primitive definitions 49
10.2 DMPM state machine 50
Bibliography 51

Figure 1 – Common structure of specific fields 17
Figure 2 – APDU overview 25

Figure 3 – Type field 25
Figure 4 – Encoding of Time of Day value 29
Figure 5 – Encoding of Time Difference value 30
Figure 6 – Primitives exchanged between protocol machines 31
Figure 7 – State transition diagram of APAM 34
Figure 8 – State transition diagram of SDOM 37
Figure 9 – State transition diagram of PDOM 40
Figure 10 – State transition diagram of PTC-ARPM 43
Figure 11 – State transition diagram of MSU-ARPM 46
Figure 12 – State transition diagram of MTU-ARPM 48
Figure 13 – State transition diagram of DMPM 50

Table 1 – Conventions used for AE state machine definitions 18
Table 2 – Status code for the confirmed response primitive 21
Table 3 – Encoding of FalArHeader field 25
Table 4 – Transfer Syntax for bit sequences 26
Table 5 – Transfer syntax for data type UNSIGNEDn 27
Table 6 – Transfer syntax for data type INTEGERn 28
Table 7 – Primitives exchanged between FAL-user and APAM 33
Table 8 – Parameters used with primitives exchanged FAL-user and APAM 34
Table 9 – APAM state table – Sender transitions 34
Table 10 – APAM state table – Receiver transitions 35
Table 11 – Functions used by the APAM 35
Table 12 – Primitives exchanged between FAL-user and SDOM 36
Table 13 – Parameters used with primitives exchanged FAL-user and SDOM 37
Table 14 – SDOM state table – Sender transitions 38
Table 15 – SDOM state table – Receiver transitions 39
Table 16 – Functions used by the SDOM 39
Table 17 – Primitives exchanged between FAL-user and PDOM 40
Table 18 – Parameters used with primitives exchanged between FAL-user and PDOM 40
Table 19 – PDOM state table – Sender transitions 41
Table 20 – PDOM state table – Receiver transitions 41
Table 21 – Functions used by the SDOM 41
Table 22 – Primitives issued by user to PTC-ARPM 42
Table 23 – Primitives issued by PTC-ARPM to user 42
Table 24 – PTC-ARPM state table – sender transactions 43
Table 25 – PTC-ARPM state table – receiver transactions 44
Table 26 – Function BuildFAL-PDU 44
Table 27 – Primitives issued by user to ARPM 44
Table 28 – Primitives issued by ARPM to user 44
Table 29 – MSU-ARPM state table – sender transactions 46
Table 30 – MSU-ARPM state table – receiver transactions 46
Table 31 – Function BuildFAL-PDU 46

Table 32 – Primitives issued by user to ARPM 47
Table 33 – Primitives issued by ARPM to user 47
Table 34 – MTU-ARPM state table – sender transactions 48
Table 35 – MTU-ARPM state table – receiver transactions 48
Table 36 – Function BuildFAL-PDU 49
Table 37 – Primitives issued by ARPM to DMPM 49
Table 38 – Primitives issued by DMPM to ARPM 49
Table 39 – Primitives issued by DMPM to DLL 49
Table 40 – Primitives issued by DLL to DMPM 49
Table 41 – DMPM state table – sender transactions 50
Table 42 – DMPM state table – receiver transactions 50

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-21: Application layer protocol specification – Type 21 elements

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 itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
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.

NOTE 1 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 IEC 61784 series. Use of the various protocol types in other combinations may require permission of their respective intellectual-property-right holders.

International Standard IEC 61158-6-21 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

This standard cancels and replaces IEC/PAS 62573 published in 2008. This first edition constitutes a technical revision

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

FDIS	Report on voting
65C/607/FDIS	65C/621/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 ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61158 series, published under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

NOTE 2 The revision of this standard will be synchronized with the other parts of the IEC 61158 series.

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 implementers and designers;
- for use in the testing and procurement of equipment;
- as part of an agreement for the admission 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 6-21: Application layer protocol specification – Type 21 elements

1 Scope

1.1 General

This standard 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 61158-1:2010.

This standard contains material specific to the Type 21 communication protocol.

1.2 Overview

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, as well as material specific to Type 21. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions must to be completed with some defined level of certainty. Failure to complete specified actions within the required time risks the failure of the applications requesting the actions, with attendant risk to equipment, plant, and possibly human life.

This standard defines interactions between remote applications. It also defines the externally visible behavior provided by the Type 21 application layer in terms of:

a) the formal abstract syntax defining the application layer protocol data units (APDUs) conveyed between communicating application entities;

b) the transfer syntax defining encoding rules that are applied to the APDUs;

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:

a) describe the wire-representation of the service primitives defined in IEC 61158-5-21:2010;

b) describe the externally visible behavior associated with their transfer.

This standard defines the protocol of the Type 21 application layer in conformance with the OSI Basic Reference Model (ISO/IEC 7498) and the OSI application layer structure (ISO/IEC 9545).

1.3 Specifications

The principal objective of this standard is to specify the syntax and behavior of the application layer protocol that conveys the Type 21 application layer services.

A secondary objective is to provide migration paths from previously existing industrial communications protocols.

1.4 Conformance

This standard does not restrict individual implementations or products, nor does it constrain the implementations of application layer entities in industrial automation systems. Conformance is achieved through implementation of this application layer protocol specification.

2 Normative references

The following referenced documents are essential for the application of this document. For dated references, only the cited edition applies. For undated references, the latest edition of the document (including any amendments) applies,.

IEC 61158-3-21:2010 [1] , *Industrial communication networks – Fieldbus specifications – Part 3-21: Data-link layer service definition – Type 21 elements*

IEC 61158-4-21:2010[1], *Industrial communication networks – Fieldbus specifications – Part 4-21: Data-link layer protocol specification – Type 21 elements*

IEC 61158-5-21:2010[1], *Industrial communication networks – Fieldbus specifications – Part 5-21: Application layer service definition – Type 21 elements*

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

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

ISO/IEC 8824-1, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

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

ISO/IEC 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

ISO/IEC 9899, *Programming Languages – C*

IEEE 754-2008, *IEEE Standard for Binary Floating-Point Arithmetic*

---

[1] To be published.