DEUTSCHE NORM

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DIN EN IEC 61158-5-23

ICS 25.040.40; 35.100.70; 35.110

Ersatz für
DIN EN 61158-5-23:2015-08
Siehe Anwendungsbeginn

Industrielle Kommunikationsnetze – Feldbusse – Teil 5-23: Dienstfestlegungen des Application Layer (Anwendungsschicht) – Typ 23-Elemente (IEC 61158-5-23:2019); Englische Fassung EN IEC 61158-5-23:2019, nur auf CD-ROM

Industrial communication networks –
Fieldbus specifications –
Part 5-23: Application layer service definition – Type 23 elements
(IEC 61158-5-23:2019);
English version EN IEC 61158-5-23:2019, only on CD-ROM

Réseaux de communication industriels –
Spécifications des bus de terrain –
Partie 5-23: Définition des services de la couche application – Éléments de type 23
(IEC 61158-5-23:2019);
Version anglaise EN IEC 61158-5-23:2019, seulement en CD-ROM

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DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

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Full document details: DIN EN IEC 61158-5-23:2020-07

Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2019-05-23 angenommene Europäische Norm als DIN-Norm ist 2020-07-01.

Für DIN EN 61158-5-23:2015-08 besteht eine Übergangsfrist bis 2022-05-23.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61158-500:2017-12.

Dieser Entwurf betrifft auch die Normen DIN EN IEC 61158-5-2:2020-07, DIN EN IEC 61158-5-4:2020-07, DIN EN IEC 61158-5-10:2020-07, DIN EN IEC 61158-5-12:2020-07, DIN EN IEC 61158-5-19:2020-07, DIN EN IEC 61158-5-21:2020-07, DIN EN IEC 61158-5-25:2020-07 und DIN EN IEC 61158-5-26:2020-07.

Für dieses Dokument ist das nationale Arbeitsgremium K 956 „Industrielle Kommunikation“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 65C „Industrial networks“ erarbeitet.

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– geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf ein Dokument ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils aktuellste Ausgabe des in Bezug genommenen Dokuments.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe des Dokuments.

Der Zusammenhang der zitierten Dokumente mit den entsprechenden deutschen Dokumenten ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN IEC 61158-5-23 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt und Unterabschnitt 3.2, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Ein Feldbus ist ein digitaler serieller Datenbus für die Kommunikation zwischen Geräten der industriellen Automatisierungstechnik wie beispielsweise Messeinrichtungen, Stellgliedern, Reglern und speicherprogrammierbaren Steuerungen. Die Normen der Reihe DIN EN IEC 61158 legen eine Anzahl von Feldbus-Protokolltypen fest. Die vorliegende Norm legt die Dienste fest, die von einem Application Layer der einzelnen Typen zur Verfügung gestellt werden.

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Änderungen

Gegenüber DIN EN 61158-5-23:2015-08 wurden folgende Änderungen vorgenommen:

a) Ergänzung eines Attributes für die Master ID, siehe 3.2.10, 6.4.3, 6.4.4, und 6.4.5;

b) verschiedene redaktionelle und technische Verbesserungen.

Frühere Ausgaben

DIN EN 61158-5-23: 2015-08

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Nationaler Anhang NA
(informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung.

EINLEITUNG

Dieses Dokument ist Teil einer Reihe, die entwickelt wurde, um die Zusammenschaltung von Komponenten eines Automatisierungssystems zu erleichtern. Es steht im Zusammenhang mit den anderen Normen der Reihe, wie sie durch das in IEC 61158-1 beschriebene „Drei-Layer“ Feldbus-Referenzmodell definiert sind.

Der Anwendungsdienst wird durch das Anwendungsprotokoll bereitgestellt, welches die Dienste nutzt, die vom Data-Link Layer oder einer anderen unmittelbar darunter liegenden Schicht zur Verfügung stehen. Dieses Dokument definiert die Eigenschaften der Anwendungsdienste, die von Feldbusanwendungen und/oder dem Systemmanagement genutzt werden können.

In der gesamten Reihe von Feldbusnormen bezieht sich der Begriff „Service“ auf die abstrakte Fähigkeit, die eine Schicht des OSI-Basisreferenzmodells der unmittelbar darüber liegenden Schicht bietet. Demzufolge ist der in diesem Dokument definierte Dienst des Data-Link Layer ein konzeptioneller Architekturdienst, unabhängig vom Administrativen- und Implementierungsbereich.

1 Anwendungsbereich

1.1 Allgemeines

Der Feldbus Application Layer (FAL, en: Fieldbus Application Layer) stellt Anwendungsprogramme mit Mitteln zum Zugriff auf die Feldbuskommunikationsumgebung bereit. Insofern kann der FAL als ein „Fenster zwischen entsprechenden Anwendungsprogrammen“ angesehen werden.

Dieser Teil von IEC 61158 legt allgemeine Elemente für grundlegende zeitkritische und nicht zeitkritische Messaging-Kommunikationen zwischen Anwendungsprogrammen in einem Automatisierungsumfeld und für Typ-12-Feldbusse[N1] spezifisches Material fest. Der Begriff „zeitkritisch“ wird zum Angeben des Vorhandenseins eines Zeitfensters, in dem eine oder mehrere festgelegte Aktionen mit einem gewissen definierten Sicherheitsgrad abzuschließen sind, verwendet. Das Nichtabschließen festgelegter Aktionen in dem Zeitfenster riskiert den Ausfall der Anwendungen, die die Aktionen anfordern, zusammen mit einem begleitenden Risiko für Betriebsmittel, die Anlage und möglicherweise Menschenleben.

Diese internationale Norm definiert auf abstrakte Art und Weise den nach außen erkennbaren Dienst, der durch die verschiedenen Typen des Feldbus Application Layer bereitgestellt wird, hinsichtlich

a) eines abstrakten Modells zur Definition von Anwendungsressourcen (Objekten), die durch Benutzer mittels Verwendung des FAL-Dienstes manipuliert werden können,

b) der Aktivitäten und Ereignisse des Dienstprimitivs;

c) der Parameter, die jeder Aktivität und jedem Ereignis der Dienstprimitive zugeordnet sind, und der Form, die sie annehmen; und

d) des Zusammenhangs zwischen diesen Aktivitäten und Ereignissen und ihrer gültigen Sequenzen.

Der Zweck dieses Dokuments ist es, die Dienste zu definieren, die bereitgestellt werden an

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[N1] Nationale Fußnote: Das deutsche nationale Komitee weist daraufhin, dass in der zugrunde liegenden IEC 61158-5-23:2019 an dieser Stelle ein Schreibfehler vorhanden ist, hier sind die Typ-23-Felsbusse gemeint.

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a) den FAL-Benutzer an der Grenze zwischen dem Benutzer und dem Application Layer des Feldbus-Referenzmodells und

b) das Systemmanagement an der Grenze zwischen dem Application Layer und Systemmanagement des Feldbus-Referenzmodells.

Dieses Dokument legt die Struktur und die Dienste des IEC-Feldbus Application Layer in Übereinstimmung mit dem OSI-Basisreferenzmodell (ISO/IEC 7498-1) und der OSI-Anwendungsschichtstruktur (ISO/IEC 9545) fest.

FAL-Dienste und Protokolle werden durch FAL-Anwendungsinstanzen (AE, en: application entities), die in den Anwendungsprozessen enthalten sind, bereitgestellt. Die FAL-AE besteht aus einem Satz objektorientierter Anwendungsdienstelemente (ASE, en: Application Service Elements) und einer Einheit für Schichtenmanagement (LME, en: Layer Management Entity), die die AE verwaltet. Die ASE stellen Kommunikationsdienste bereit, die auf einem Satz zugehöriger Anwendungsprozessobjekt-(APO)-Klassen operieren. Eines der FAL-ASE ist ein Management-ASE, das einen gemeinsamen Satz von Diensten für die Verwaltung der Instanzen von FAL-Klassen bereitstellt.

Obwohl diese Dienste, aus dem Blickwinkel der Anwendung, beschreiben, wie Anfrage und Antwort ausgegeben und abgegeben werden, beinhalten sie keine Festlegung, was die anfragenden und antwortenden Anwendungen mit diesen vorzunehmen haben. Die Verhaltensaspekte der Anwendungen sind nicht festgelegt, nur eine Definition, welche Anfragen und Antworten diese senden/empfangen können, ist beschrieben. Dies erlaubt den FAL-Benutzern eine größere Flexibilität, um solch ein Objektverhalten zu standardisieren. Zusätzlich zu diesen Diensten sind in dieser Norm ebenfalls einige unterstützende Dienste festgelegt, um den Zugriff zum FAL bereitzustellen und somit bestimmte Aspekte des Betriebs zu steuern.

1.2 Spezifikationen

Das wesentliche Ziel dieses Dokuments ist es, die Merkmale konzeptioneller Application Layer-Dienste, die für zeitkritische Kommunikation geeignet sind, festzulegen und somit das OSI-Basisreferenzmodell beim Lenken der Entwicklung von Application Layer-Protokollen für zeitkritische Kommunikation zu ergänzen.

Ein Nebenziel ist es, Migrationspfade von zuvor bestehenden industriellen Kommunikationsprotokollen bereitzustellen. Es ist dieses letztgenannte Ziel, das zu der Vielfalt von Diensten, die als die verschiedenen Typen nach IEC 61158 genormt sind, und den entsprechenden Protokollen, die in Unterteilen von IEC 61158-6 genormt sind, führt.

Diese Spezifikation darf als Basis für formale Anwendungsprogrammierschnittstellen verwendet werden. Nichtsdestotrotz handelt es sich nicht um eine formale Programmierschnittstelle und eine solche Schnittstelle muss Fragen hinsichtlich der Implementierung, die nicht durch diese Spezifikation abgedeckt sind, behandeln, einschließlich

a) der Größen und der Oktett-Anordnung verschiedener Multi-Oktett-Dienstparameter und

b) der Korrelation gepaarter Anfrage- und Bestätigungsprimitive oder Anzeige- und Antwortprimitive.

1.3 Konformität

Dieses Dokument legt keine individuellen Implementierungen oder Produkte fest, noch beschränkt es die Implementierungen von Application Layer-Instanzen in industriellen Automatisierungssystemen.

Es gibt keine Betriebsmittelkonformität betreffend dieser Application Layer-Dienstdefinitionsnorm. Stattdessen wird Konformität durch Implementierung entsprechender Application Layer-Protokolle, die jeglichen in diesem Dokument definierten Typ von Application Layer-Diensten erfüllen, erreicht.

3.2 Zusätzliche Typ-23-Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.2.1
zyklische Übertragung
(en: cyclic transmission)
periodisch durchgeführte Übertragung zur Aktualisierung des Link-Gerätes

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3.2.2
intelligente Gerätestation
(en: intelligent device station)
Knoten, der die zyklische und transiente Übertragung von 1:n-Bitdaten und -Wortdaten mit der Master-Station sowie die transiente Übertragung mit Slave-Stationen, außer entfernten E/A-Stationen, ausführen kann und während der transienten Übertragung über Client- und Server-Funktionen verfügt

3.2.3
Link-Bit
(en: link bit)
auf dem Verbindungszweig weitergegebene Bitdaten, die von allen Knoten bei der zyklischen Übertragung gemeinsam genutzt werden und als ein in Biteinheiten organisierter gemeinsamer Speicher des n:n-Typs genutzt werden

3.2.4
Link-Gerät
(en: link device)
Link-Bit, Link-Wort, Link x und Link y oder RX, RY, RWr und RWw

3.2.5
Link-Wort
(en: link word)
auf dem Verbindungszweig eingetragene Zwei-Oktett-Dateneinheit, die von allen Knoten bei der zyklischen Übertragung gemeinsam genutzt wird und als Einheit von zwei Oktetten mit gemeinsamen Speicher des n:n-Typs verwendet wird

3.2.6
Link x
(en: link x)
auf dem Verbindungszweig empfangene Bit-Eingangsdaten, die von jedem Knoten bei der zyklischen Übertragung übermittelt werden und als gemeinsamer Eingangsspeicher für den 1:n-Typ verwendet werden

3.2.7
Link y
(en: link y)
Bit-Ausgangsdaten auf dem Verbindungszweig, die bei der zyklischen Übertragung an jeden Knoten gesendet werden und als gemeinsamer Ausgangsspeicher für den 1:n-Typ verwendet werden

3.2.8
lokale Station
(en: local station)
Knoten, der die zyklische und transiente Übertragung von n:n-Bitdaten und -Wortdaten mit der Master-Station und anderen lokalen Stationen sowie die transiente Übertragung mit Slave-Stationen, außer entfernten E/A-Stationen, ausführen kann und während der transienten Übertragung über Server- und Client-Funktionen verfügt

3.2.9
Steuerungsknoten
(en: management node)
Knoten, in dem Parameter festgelegt werden

3.2.10
Master-ID
(en: master ID)
Kennung, die die Knotennummer der Master-Station darstellt

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3.2.11
Master-Station
(en: master station)
Knoten, der über Steuerungsinformationen (Parameter) verfügt und die zyklische Übertragung regelt

3.2.12
Knoten
(en: node)
Element, das ein Netzwerk bildet und die Datenübertragung, den Empfang und den Transfer ausführt

3.2.13
Knoten-zu-Knoten-Prüfung
(en: node-to-node test)
Prüfung zwischen zwei Knoten auf der Physical Layer

3.2.14
normaler Knoten
(en: normal node)
anderer Knoten als ein Steuerungsknoten

3.2.15
entfernte Gerätestation
(en: remote device station)
Knoten, der die zyklische und transiente Übertragung von 1:n-Bitdaten und -Wortdaten mit der Master-Station sowie die transiente Übertragung mit Slave-Stationen, außer entfernten E/A-Stationen, ausführen kann und während der transienten Übertragung über Server-Funktionen verfügt

3.2.16
entfernte E/A-Station
(en: remote I/O station)
Knoten, der die zyklische Übertragung von 1:n-Bitdaten mit der Master-Station ausführen kann

3.2.17
reservierter Knoten
(en: reserve node)
Knoten, der noch nicht verbunden ist, aber in der Gesamtknotenzahl des Netzwerks enthalten ist und der keine zyklische Übertragung ausführt, aber von Anwendungen als normaler Knoten betrachtet wird

3.2.18
RX
entfernter Eingang aus der Sicht der Master-Station mit Bitdaten, die durch die zyklische Übertragung periodisch aktualisiert werden, vom Slave zum Master, oder in einer lokalen Station aus der Sicht der Master-Station RY der lokalen Station

3.2.19
RY
entfernter Ausgang aus der Sicht der Master-Station mit Bitdaten, die durch zyklische Übertragung periodisch aktualisiert werden, vom Master zum Slave, oder in einer lokalen Station aus der Sicht der Master-Station RX der lokalen Station

3.2.20
RWr
entferntes Register (Eingang) aus der Sicht der Master-Station mit Wortdaten, die durch zyklische Übertragung periodisch aktualisiert werden, vom Slave zum Master, oder in einer lokalen Station aus der Sicht der Master-Station RWw der lokalen Station

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3.2.21
RWw
entferntes Register (Ausgang) aus der Sicht der Master-Station mit Wortdaten, die durch zyklische Übertragung periodisch aktualisiert werden, vom Master zum Slave, oder in einer lokalen Station aus der Sicht der Master-Station RWr der lokalen Station

3.2.22
Slave-Station
(en: slave station)
anderer Knoten als die Master-Station

3.2.23
Station
(en: station)
Knoten eines Netzwerks

3.2.24
Synchronisationsmanager
(en: synchronization manager)
einzelner Knoten in der Rolle einer Master-Station je Netzwerk, der die Synchronisation steuert und die Synchronisationssteuerung an andere Knoten verteilt

3.2.25
transiente Übertragung
(en: transient transmission)
Übertragung, die auf jede Anforderung hin ausgeführt wird

3.2.26
Client-Funktion bei der transienten Übertragung
(en: transient transmission client function)
Funktion, die eine transiente Anforderung ausgibt

3.2.27
Server-Funktion bei der transienten Übertragung
(en: transient transmission server function)
Funktion, die eine transiente Anforderung empfängt und eine Antwort ausgibt

3.2.28
Übertragungssteuerungsmanager
(en: transmission control manager)
einzelner Knoten in der Rolle der Master-Station je Netzwerk, der die Tokenweitergabe steuert

3.2.29
Wort (
en: word)
Einheit, die Daten repräsentiert und 16 Bit lang ist

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61158-5-23

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English Version

Industrial communication networks - Fieldbus specifications - Part 5-23: Application layer service definition - Type 23 elements (IEC 61158-5-23:2019)

Réseaux de communication industriels - Spécifications des bus de terrain - Partie 5-23: Définition des services de la couche application - Éléments de type 23 (IEC 61158-5-23:2019)

Industrielle Kommunikationsnetze - Feldbusse - Teil 5-23: Dienstfestlegungen des Application Layer (Anwendungsschicht) - Typ 23-Elemente (IEC 61158-5-23:2019)

This European Standard was approved by CENELEC on 2019-05-23. 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 respons bility 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, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

The text of document 65C/947/FDIS, future edition 2 of IEC 61158-5-23, 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 IEC 61158-5-23:2019.

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) 2020-02-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-05-23

This document supersedes EN 61158-5-23:2014.

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

Endorsement notice

The text of the International Standard IEC 61158-5-23:2019 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
IEC 61784-2	NOTE	Harmonized as EN 61784-2

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61158-1	2019	Industrial communication networks - Fieldbus specifications - Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series	EN IEC 61158-1	2019
IEC 61158-6	series	Industrial communication networks - Fieldbus specifications - Part 6-9: Application layer protocol specification - Type 9 elements	EN 61158-6	series
ISO/IEC 646	-	Information technology; ISO 7-bit coded character set for information interchange	-	-
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	-	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-

Documents
Document Sharing Hub
Full document details: DIN EN IEC 61158-5-23:2020-07

CONTENTS

European foreword 2
Annex ZA (normative) Normative references to international publications with their corresponding European publications 3
INTRODUCTION 7
1 Scope 8
1.1 General 8
1.2 Specifications 9
1.3 Conformance 9
2 Normative references 9
3 Terms, definitions, symbols, abbreviated terms and conventions 10
3.1 Referenced terms and definitions 10
3.1.1 ISO/IEC 7498-1 terms 10
3.1.2 ISO/IEC 8822 terms 10
3.1.3 ISO/IEC 9545 terms 10
3.1.4 ISO/IEC 8824-1 terms 11
3.1.5 IEC 61158-1 terms 11
3.2 Additional Type 23 terms and definitions 11
3.3 Symbols and abbreviated terms 13
3.4 Conventions 14
3.4.1 General conventions 14
3.4.2 Conventions for class definitions 15
3.4.3 Conventions for service definitions 16
4 Concept 17
5 Data type ASE 18
5.1 Overview 18
5.2 Fixed length types 18
5.2.1 Bitstring types 18
5.2.2 Numeric types 19
6 Communication model specification 23
6.1 Communication model 23
6.1.1 General 23
6.1.2 Cyclic model n:n 23
6.1.3 Cyclic model 1:n 24
6.1.4 Transient model 24
6.2 ASE 25
6.2.1 Overview type C 25
6.2.2 Overview type F 25
6.2.3 Cyclic data ASE type C 25
6.2.4 Cyclic data ASE type F 32
6.2.5 Acyclic data ASE type C 37
6.2.6 Acyclic data ASE type F 43
6.2.7 Management ASE 56
6.2.8 Synchronization ASE 59
6.2.9 Measurement ASE 60
6.3 AR type C 61

Documents
Document Sharing Hub
Full document details: DIN EN IEC 61158-5-23:2020-07

6.3.1 Overview ... 61
6.3.2 Connection Control ... 62
6.3.3 Cyclic transmission type C ... 66
6.3.4 Acyclic transmission type C ... 68
6.3.5 Common parameter dist ... 70
6.4 AR type F ... 75
6.4.1 Overview ... 75
6.4.2 Channel control ... 75
6.4.3 Cyclic transmission type F ... 82
6.4.4 Acyclic transmission type F ... 84
6.4.5 Parameter dist ... 87
6.4.6 Synchronous trigger ... 90
6.4.7 Measurement transmission ... 91
Bibliography ... 94

Figure 1 – Cyclic model (n:n type distributed shared memory, unconfirmed push model) ... 24
Figure 2 – Cyclic model (1:n type distributed shared memory, unconfirmed push model) ... 24
Figure 3 – Transient model (Client server model) ... 24
Figure 4 – Transient model (Push model) ... 25
Figure 5 – Structure of ASE type C of FAL type 23 ... 25
Figure 6 – Structure of ASE type F of FAL Type 23 ... 25
Figure 7 – Structure of AR type C ... 62
Figure 8 – Structure of AR type F ... 75

Table 1 – Ld service parameters ... 27
Table 2 – Set service parameters ... 27
Table 3 – Reset service parameters ... 27
Table 4 – Read service parameters ... 28
Table 5 – Write service parameters ... 28
Table 6 – Ld service parameters ... 29
Table 7 – Set service parameters ... 30
Table 8 – Reset service parameters ... 30
Table 9 – Read service parameters ... 31
Table 10 – Write service parameters ... 31
Table 11 – Ld service parameters ... 33
Table 12 – Set service parameters ... 34
Table 13 – Reset service parameters ... 34
Table 14 – Read service parameters ... 35
Table 15 – Write service parameters ... 35
Table 16 – Get memory access info service parameters ... 38
Table 17 – Run service parameters ... 39
Table 18 – Stop service parameters ... 40
Table 19 – Read memory service parameters ... 41
Table 20 – Write memory service parameters ... 42

AVA Documents
Document Sharing Hub

Full document details: DIN EN IEC 61158-5-23:2020-07

Table 21 – Get memory access info service parameters 44
Table 22 – Run service parameters 45
Table 23 – Stop service parameters 46
Table 24 – Read memory service parameters 47
Table 25 – Write memory service parameters 48
Table 26 – Vendor command service parameters 49
Table 27 – Distribute node info service parameters 50
Table 28 – Get statistics service parameters 51
Table 29 – Get node info detail service parameters 53
Table 30 – AC data service parameters 55
Table 31 – AC data ND service parameters 56
Table 32 – Get attribute service parameters 57
Table 33 – Set attribute service parameters 58
Table 34 – Synchronization trigger service parameters 59
Table 35 – Start measurement service parameters 60
Table 36 – Get offset service parameters 61
Table 37 – Control cyclic service parameters 66
Table 38 – CT Update service parameters 67
Table 39 – AC Send service parameters 68
Table 40 – AC Param send service parameters 70
Table 41 – CPD Set service parameters 74
Table 42 – Control cyclic service parameters 82
Table 43 – CT Update service parameters 83
Table 44 – AC Send service parameters 84
Table 45 – AC Send ND service parameters 86
Table 46 – Synchronous trigger internal service parameters 90
Table 47 – Measure send service parameters 91
Table 48 – MeasureAck send service parameters 92
Table 49 – Offset send service parameters 92
Table 50 – Update send service parameters 93

Documents
Document Sharing Hub

Full document details: DIN EN IEC 61158-5-23:2020-07

INTRODUCTION

This document 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 61158-1.

The application service is provided by the application protocol making use of the services available from the data-link or other immediately lower layer. This document defines the application service characteristics that fieldbus applications and/or system management may exploit.

Throughout the set of fieldbus standards, the term “service” refers to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, the application layer service defined in this document is a conceptual architectural service, independent of administrative and implementation divisions.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-23: Application layer service definition – Type 23 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 part of IEC 61158 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 12 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 International Standard defines in an abstract way the externally visible service provided by the different Types of the fieldbus Application Layer in terms of

a) an abstract model for defining application resources (objects) capable of being manipulated by users via the use of the FAL service,
b) the primitive actions and events of the service;
c) the parameters associated with each primitive action and event, and the form which they take; and
d) the interrelationship between these actions and events, and their valid sequences.

The purpose of this document is to define the services provided to

a) the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
b) Systems Management at the boundary between the Application Layer and Systems Management of the Fieldbus Reference Model.

This document specifies the structure and services of the IEC Fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) and the OSI Application Layer Structure (ISO/IEC 9545).

FAL services and protocols are provided by FAL application-entities (AE) contained within the application processes. The FAL AE is composed of a set of object-oriented Application Service Elements (ASEs) and a Layer Management Entity (LME) that manages the AE. The ASEs provide communication services that operate on a set of related application process object (APO) classes. One of the FAL ASEs is a management ASE that provides a common set of services for the management of the instances of FAL classes.

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified;

Documents
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Full document details: DIN EN IEC 61158-5-23:2020-07

only a definition of what requests and responses they can send/receive is specified. This permits greater flexibility to the FAL users in standardizing such object behavior. In addition to these services, some supporting services are also defined in this document to provide access to the FAL to control certain aspects of its operation.

1.2 Specifications

The principal objective of this document is to specify the characteristics of conceptual application layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of application layer protocols for time-critical communications.

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 services standardized as the various Types of IEC 61158, and the corresponding protocols standardized in subparts of IEC 61158-6.

This specification may be used as the basis for formal Application Programming-Interfaces. Nevertheless, it is not a formal programming interface, and any such interface will need to address implementation issues not covered by this specification, including

a) the sizes and octet ordering of various multi-octet service parameters, and

b) the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

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

There is no conformance of equipment to this application layer service definition standard. Instead, conformance is achieved through implementation of conforming application layer protocols that fulfill any given Type of application layer services as defined in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 All parts of the IEC 61158 series, as well as IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61158-1:2019, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-6 (all parts), *Industrial communication networks – Fieldbus specifications – Part 6: Application layer protocol specification*

ISO/IEC 646, *Information technology – ISO 7–bit coded character set for information interchange*

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*

AVA Documents
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Full document details: DIN EN IEC 61158-5-23:2020-07

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

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

3 Terms, definitions, symbols, abbreviated terms and conventions

For the purposes of this document, the following terms, definitions, symbols, abbreviations and conventions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Referenced terms and definitions

3.1.1 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms given in ISO/IEC 7498-1 apply:

a) application entity
b) application process
c) application protocol data unit
d) application service element
e) application entity invocation
f) application process invocation
g) application transaction
h) real open system
i) transfer syntax

3.1.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms given in ISO/IEC 8822 apply:

a) abstract syntax
b) presentation context

3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms given in ISO/IEC 9545 apply:

a) application-association
b) application-context
c) application context name
d) application-entity-invocation
e) application-entity-type
f) application-process-invocation
g) application-process-type
h) application-service-element
i) application control service element

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3.1.4 ISO/IEC 8824-1 terms

For the purposes of this document, the following terms given in ISO/IEC 8824-1 apply:

a) object identifier
b) type

3.1.5 IEC 61158-1 terms

For the purposes of this document, the following terms given in IEC 61158-1 apply:

a) DLL mapping protocol machine
b) fieldbus application layer
c) FAL service protocol machine
d) protocol data unit

3.2 Additional Type 23 terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.2.1
cyclic transmission
transmission that is performed periodically used for the link device update

3.2.2
intelligent device station
node capable of performing 1:n bit data and word data cyclic transmission and transient transmission with the master station, and transient transmission with slave stations, excluding remote I/O stations and having client functions and server functions during transient transmission

3.2.3
link bit
link relay bit data that are shared by all the nodes through the cyclic transmission and is used as one bit unit shared memory of the n:n type

3.2.4
link device
link bit, link word, link x and link y or RX, RY, RWr, and RWw

3.2.5
link word
link register two octet unit data that are shared by all the nodes through the cyclic transmission and is used as two octet unit shared memory of the n:n type

3.2.6
link x
link input received bit data that are transmitted from each node through the cyclic transmission and is used as an input shared memory of the 1:n type

3.2.7
link y
link output bit data that are sent to each node through the cyclic transmission and is used as an output shared memory of the 1:n type

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3.2.8
local station
node capable of performing n:n bit data and word data cyclic transmission and transient transmission with the master station and other local stations, and transient transmission with slave stations, excluding remote I/O stations and having server functions and client functions during transient transmission

3.2.9
management node
node in which parameters are set

3.2.10
master ID
ID that represents the node number of the master station

3.2.11
master station
node that has control information (parameters) and manages cyclic transmission

3.2.12
node
element that forms a network and performs data transmission, reception, and transfer

3.2.13
node-to-node test
physical layer test between two nodes

3.2.14
normal node
node other than a management node

3.2.15
remote device station
node capable of performing 1:n bit data and word data cyclic transmission and transient transmission with the master station, and transient transmission with slave stations, excluding remote I/O stations and having server functions during transient transmission

3.2.16
remote I/O station
node capable of performing 1:n bit data cyclic transmission with the master station

3.2.17
reserve node
node that is not yet connected, but counted in the total node number of the network not performing cyclic transmission, but always regarded as normal from applications

3.2.18
RX
remote input as viewed from the master station with bit data that are periodically updated by cyclic transmission, salve to master, or in local station as viewed from the master station is RY of the local station

3.2.19
RY
remote output as viewed from the master station with bit data that are periodically updated by cyclic transmission, master to salve, or in local station as viewed from the master station is RX of the local station

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3.2.20
RWr
remote register (input) as viewed from the master station with word data that are periodically updated by cyclic transmission, slave to master, or in local station as viewed from the master station is RWw of the local station

3.2.21
RWw
remote register (output) as viewed from the master station with word data that are periodically updated by cyclic transmission, master to slave, or in local station as viewed from the master station is RWr of the local station

3.2.22
slave station
node other than the master station

3.2.23
station
node of a network

3.2.24
synchronization manager
single node in a master station role per network that manages synchronization, distributing synchronization timing to other nodes

3.2.25
transient transmission
transmission that is performed upon each request

3.2.26
transient transmission client function
function that issues a transient request

3.2.27
transient transmission server function
function that receives a transient request and issues a response

3.2.28
transmission control manager
single node in a master station role per network that performs token passing management

3.2.29
word
unit representing data, 16 bits in length

3.3 Symbols and abbreviated terms

AE	Application Entity
AL	Application Layer
AP	Application Process
APDU	Application Protocol Data Unit
APO	Application Process Object
AR	Application Relationship
AREP	Application Relationship Endpoint
ASE	Application Service Element

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ASN.1	Abstract Syntax Notation 1
CRC	Cyclic Redundancy Check
DLL	Data-link Layer
DMPM	DLL Mapping Protocol Machine
FAL	Fieldbus Application Layer
FSPM	FAL Service Protocol Machine
LB	Link Bit
LSB	Least Significant Bit
LW	Link Word
LX	Link X
LY	Link Y
MSB	Most Significant Bit
OSI	Open Systems Interconnection
PDU	Protocol Data Unit

3.4 Conventions

3.4.1 General conventions

This document uses the descriptive conventions given in ISO/IEC 10731.

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

Service primitives, used to represent service user/service provider interactions (see ISO/IEC 10731), convey parameters that indicate information available in the user/provider interaction.

This document uses a tabular format to describe the component parameters of the service primitives. The parameters that apply to each group of service primitives are set out in tables throughout the remainder of this document. Each table consists of up to five columns, containing the name of the service parameter, and a column each for those primitives and parameter-transfer directions used by the service:

– the request primitive's input parameters;
– the indication primitive's output parameters;
– the response primitive's input parameters; and
– the confirm primitive's output parameters.

NOTE The request, indication, response and confirm primitives are also known as requestor.submit, acceptor.deliver, acceptor.submit, and requestor.deliver primitives, respectively (see ISO/IEC 10731).

One parameter (or part of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive and parameter direction specified in the column:

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Full document details: DIN EN IEC 61158-5-23:2020-07

M parameter is mandatory for the primitive.

U parameter is a User option, and may or may not be provided depending on the dynamic usage of the service-user. When not provided, a default value for the parameter is assumed.

C parameter is conditional upon other parameters or upon the environment of the service-user.

(blank) parameter is never present.

Some entries are further qualified by items in brackets. These may be a parameter-specific constraint:

(=) indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.

In any particular interface, not all parameters need be explicitly stated. Some may be implicitly associated with the primitive.

In the diagrams which illustrate these interfaces, dashed lines indicate cause-and-effect or time-sequence relationships, and wavy lines indicate that events are roughly contemporaneous.

3.4.2 Conventions for class definitions

Class definitions are defined using templates. Each template consists of a list of attributes and services for the class. The general form of the template is shown below:

FAL ASE:			**ASE Name**
CLASS:			**Class Name**
CLASS ID:			**#**
PARENT CLASS:			Parent Class Name
ATTRIBUTES:			
1	(o)	Key Attribute:	numeric identifier
2	(o)	Key Attribute:	name
3	(m)	Attr bute:	attribute name (values)
4	(m)	Attr bute:	attribute name (values)
4.1	(s)	Attr bute:	attribute name (values)
4.2	(s)	Attr bute:	attribute name (values)
4.3	(s)	Attr bute:	attribute name (values)
5	(c)	Constraint:	constraint expression
5.1	(m)	Attr bute:	attribute name (values)
5.2	(o)	Attr bute:	attribute name (values)
6	(m)	Attr bute:	attribute name (values)
6.1	(s)	Attr bute:	attribute name (values)
6.2	(s)	Attr bute:	attribute name (values)
SERVICES:			
1	(o)	OpsService:	service name
2	(c)	Constraint:	constraint expression
2.1	(o)	OpsService:	service name
3	(m)	MgtService:	service name

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Full document details: DIN EN IEC 61158-5-23:2020-07

a) The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.

b) The "CLASS:" entry is the name of the class being specified. All objects defined using this template will be an instance of this class. The class may be specified by this document, or by a user of this document.

c) The "CLASS ID:" entry is a number that identifies the class being specified. This number is unique within the FAL ASE that will provide the services for this class. When qualified by the identity of its FAL ASE, it unambiguously identifies the class within the scope of the FAL. The value "NULL" indicates that the class cannot be instantiated. Class IDs between 1 and 255 are reserved by this document to identify standardized classes. They have been assigned to maintain compatibility with existing national standards. CLASS IDs between 256 and 2048 are allocated for identifying user defined classes.

d) The "PARENT CLASS:" entry is the name of the parent class for the class being specified. All attributes defined for the parent class and inherited by it are inherited for the class being defined, and therefore do not have to be redefined in the template for this class.

NOTE The parent-class "TOP" indicates that the class being defined is an initial class definition. The parent class TOP is used as a starting point from which all other classes are defined. The use of TOP is reserved for classes defined by this document.

e) The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.

1) Each of the attribute entries contains a line number in column 1, a mandatory (m) / optional (o) / conditional (c) / selector (s) indicator in column 2, an attribute type label in column 3, a name or a conditional expression in column 4, and optionally a list of enumerated values in column 5. In the column following the list of values, the default value for the attribute may be specified.

2) Objects are normally identified by a numeric identifier or by an object name, or by both. In the class templates, these key attributes are defined under the key attribute.

3) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting is used to specify

i) fields of a structured attribute (4.1, 4.2, 4.3),

ii) attributes conditional on a constraint statement (5). Attributes may be mandatory (5.1) or optional (5.2) if the constraint is true. Not all optional attributes require constraint statements as does the attribute defined in (5.2),

iii) the selection fields of a choice type attribute (6.1 and 6.2).

f) The "SERVICES" label indicates that the following entries are services defined for the class.

1) An (m) in column 2 indicates that the service is mandatory for the class, while an (o) indicates that it is optional. A (c) in this column indicates that the service is conditional. When all services defined for a class are defined as optional, at least one has to be selected when an instance of the class is defined.

2) The label "OpsService" designates an operational service (1).

3) The label "MgtService" designates a management service (2).

4) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by a period. Nesting within the list of services is used to specify services conditional on a constraint statement.

3.4.3 Conventions for service definitions

3.4.3.1 General

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

3.4.3.2 Service parameters

Service primitives are used to represent service user/service provider interactions (ISO/IEC 10731). They convey parameters which indicate information available in the user/provider interaction. In any particular interface, not all parameters need be explicitly stated.

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The service specifications of this document use a tabular format to describe the component parameters of the ASE service primitives. The parameters which apply to each group of service primitives are set out in tables. Each table consists of up to five columns for the

a) parameter name,

b) request primitive, (transmitted from the sender)

c) indication primitive, (transmitted to the receiver)

d) response primitive, (transmitted from the receiver) and

e) confirm primitive (transmitted to the sender).

One parameter (or component of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive specified in the column:

M parameter is mandatory for the primitive.

U parameter is a User option, and may or may not be provided depending on dynamic usage of the service user. When not provided, a default value for the parameter is assumed.

C parameter is conditional upon other parameters or upon the environment of the service user.

— (blank) parameter is never present.

S parameter is a selected item.

Some entries are further qualified by items in brackets. These may be

1) a parameter-specific constraint:

   "(=)" indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.

2) an indication that some note applies to the entry:

   "(n)" indicates that the following note "n" contains additional information pertaining to the parameter and its use.

3.4.3.3 Service procedures

The procedures are defined in terms of:

– the interactions between application entities through the exchange of fieldbus Application Protocol Data Units, and

– the interactions between an application layer service provider and an application layer service user in the same system through the invocation of application layer service primitives.

These procedures are applicable to instances of communication between systems which support time-constrained communications services within the fieldbus application layer.

4 Concept

The basic concept of application layer services follows IEC 61158-1, Clause 9.

The FAL defined herein has two primary deployment models. A peer-level connection based controller network is identified throughout this FAL as type C. A master/slave oriented field network is identified throughout this FAL as type F. Both support a distributed memory model as well as client/server models.

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Full document details: DIN EN IEC 61158-5-23:2020-07

5 Data type ASE

5.1 Overview

The overview of the data type ASE follows of IEC 61158-1, Clause 10. The template is used to define the data type for the FAL.

5.2 Fixed length types

5.2.1 Bitstring types

5.2.1.1 BitString8

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	22
2	Data type name	=	Bitstring8
3	Format	=	Fixed length
4.1	Octet length	=	1

5.2.1.2 BitString16

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	23
2	Data type name	=	Bitstring16
3	Format	=	Fixed length
4.1	Octet length	=	2

5.2.1.3 BitString32

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	24
2	Data type name	=	Bitstring32
3	Format	=	Fixed length
4.1	Octet length	=	4

Documents
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Full document details: DIN EN IEC 61158-5-23:2020-07

5.2.2 Numeric types

5.2.2.1 Integer types

5.2.2.1.1 Integer8

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	2
2	Data type name	=	Integer8
3	Format	=	Fixed length
4.1	Octet length	=	1

This integer type is a two's complement binary number with a length of one octet.

5.2.2.1.2 Integer16

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	3
2	Data type name	=	Integer16
3	Format	=	Fixed length
4.1	Octet length	=	2

This integer type is a two's complement binary number with a length of two octets.

5.2.2.1.3 Integer32

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	4
2	Data type name	=	Integer32
3	Format	=	Fixed length
4.1	Octet length	=	4

This integer type is a two's complement binary number with a length of four octets.

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5.2.2.2 Unsigned types

5.2.2.2.1 Unsigned8

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	5
2	Data type name	=	Unsigned8
3	Format	=	Fixed length
4.1	Octet length	=	1

This type is a binary number with a length of one octet. No sign bit is included. The most significant bit of the most significant octet is always used as the most significant bit of the binary number.

5.2.2.2.2 Unsigned16

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	6
2	Data type name	=	Unsigned16
3	Format	=	Fixed length
4.1	Octet length	=	2

This type is a binary number with a length of two octets. No sign bit is included. The most significant bit of the most significant octet is always used as the most significant bit of the binary number.

5.2.2.2.3 Unsigned32

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	7
2	Data type name	=	Unsigned32
3	Format	=	Fixed length
4.1	Octet length	=	4

This type is a binary number with a length of four octets. No sign bit is included. The most significant bit of the most significant octet is always used as the most significant bit of the binary number.

Documents
Document Sharing Hub
Full document details: DIN EN IEC 61158-5-23:2020-07

5.2.2.3 OctetString character types

5.2.2.3.1 OctetString1

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	30
2	Data type name	=	OctetString1
3	Format	=	Fixed length
4.1	Octet length	=	1

This type is an OctetString with a length of one octet.

5.2.2.3.2 OctetString2

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	31
2	Data type name	=	OctetString2
3	Format	=	Fixed length
4.1	Octet length	=	2

This type is an OctetString with a length of two octets.

5.2.2.3.3 OctetString4

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	32
2	Data type name	=	OctetString4
3	Format	=	Fixed length
4.1	Octet length	=	4

This type is an OctetString with a length of four octets.

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5.2.2.3.4 OctetString8

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	33
2	Data type name	=	OctetString8
3	Format	=	Fixed length
4.1	Octet length	=	8

This type is an OctetString with a length of eight octets.

5.2.2.3.5 OctetString16

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	34
2	Data type name	=	OctetString16
3	Format	=	Fixed length
4.1	Octet length	=	16

This type is an OctetString with a length of 16 octets.

5.2.2.3.6 MACAddress

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	-
2	Data type name	=	MACAddress
3	Format	=	Fixed length
4.1	Octet length	=	6

This type is an OctetString with a length of 6 octets and represents a MAC address.

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5.2.2.4 Character String Type

5.2.2.4.1 OctetString

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	10
2	Data type name	=	OctetString
3	Format	=	string
4.1	Octet length	=	1 to n

This type is with a length of one to n octets. Octet 1 is referred to as the first octet.

5.2.2.4.2 VisibleString

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			Top
ATTRIBUTES:			
1	Data type numeric identifier	=	9
2	Data type name	=	VisibleString
3	Format	=	string
4.1	Octet length	=	1 to n

This type is defined as the ISO/IEC 646 string type.

6 Communication model specification

6.1 Communication model

6.1.1 General

Two types of communication models are used in FAL Type 23: The cyclic model and the transient model.

6.1.2 Cyclic model n:n

The n:n type distributed shared memory cyclic model is shown in Figure 1 and uses an unconfirmed push model performed periodically.

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