DEUTSCHE NORM

August 2020

DIN EN IEC 61158-6-12

ICS 35.100.70; 35.160

Ersatz für
DIN EN 61158-6-12:2015-09
Siehe Anwendungsbeginn

Industrielle Kommunikationsnetze – Feldbusse – Teil 6-12: Protokollspezifikation des Application Layer (Anwendungsschicht) – Typ 12-Elemente (IEC 61158-6-12:2019); Englische Fassung EN IEC 61158-6-12:2019, nur auf CD-ROM

Industrial communication networks –
Fieldbus specifications –
Part 6-12: Application layer protocol specification – Type 12 elements
(IEC 61158-6-12:2019);
German version EN IEC 61158-6-12:2019, only on CD-ROM

Réseaux de communication industriels –
Spécifications des bus de terrain –
Partie 6-12: Spécification du protocole de la couche application – Eléments de type 12
(IEC 61158-6-12:2019);
Version anglaise EN IEC 61158-6-12:2019, seulement en CD-ROM

Gesamtumfang 154 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2019-07-25 angenommene Europäische Norm als DIN-Norm ist 2020-08-01.

Für DIN EN 61158-6-12:2015-09 besteht eine Übergangsfrist bis 2022-07-25.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61158-600:2017-12.

Dieser Entwurf betrifft auch die Normen DIN EN IEC 61158-6-2:2020-08, DIN EN IEC 61158-6-3:2020-08, DIN EN IEC 61158-6-4:2020-08, DIN EN IEC 61158-6-10:2020-08, DIN EN IEC 61158-6-19:2020-08, DIN EN IEC 61158-6-21:2020-08, DIN EN IEC 61158-6-23:2020-08, DIN EN IEC 61158-6-25:2020-08 und DIN EN IEC 61158-6-26:2020-08.

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.

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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 61158-6-12 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt und Abschnitt 3 (außer Unterabschnitte 3.4, 3.5 und 3.6), 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 durch den Data-Link Layer der einzelnen Typen zur Verfügung gestellt werden.

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Änderungen

Gegenüber DIN EN 61158-6-12:2015-09 wurden folgende Änderungen vorgenommen:

a) technische Korrekturen;

b) redaktionelle Verbesserungen zur Klarstellung.

Frühere Ausgaben

DIN V 19245-1: 1988-01
DIN 19245-1: 1991-04
DIN 19245-2: 1991-04
DIN EN 50170/1: 1997-07
DIN EN 50170/2: 1997-07
DIN EN 50170/3: 1997-07
DIN EN 50254: 1999-07
DIN EN 50170/A2: 2000-08
DIN EN 50170/A1: 2002-11
DIN EN 50170/A3: 2002-11
DIN EN 61158-6: 2005-05
DIN EN 61158-6-12: 2008-09, 2013-03, 2015-09

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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

Dieser Teil von IEC 61158 gehört zu einer Normenreihe, die zur Erleichterung der Verbindung von Komponenten von Automatisierungssystemen erstellt wurde. Er ist mit anderen Normen der Reihe verbunden, wie durch das in IEC 61158-1 beschriebene „dreischichtige“ Feldbus-Referenzmodell definiert.

Das Anwendungsprotokoll stellt den Anwendungsdienst bereit, indem es die Dienste nutzt, die über die Datenverbindung oder eine andere unmittelbar darunter liegende Schicht verfügbar sind. Das vorrangige Ziel dieses Dokuments ist es, eine Reihe von Regeln für die Kommunikation zu erstellen, die sich auf die Verfahren beziehen, die von den Peer Application Entities (AE) zum Zeitpunkt der Kommunikation durchzuführen sind. Diese Regeln für die Kommunikation sollen eine stabile Grundlage für die Weiterentwicklung bilden, damit sie einer Vielzahl von Zwecken dienen können:

- als Leitfaden für Implementierer und Konstrukteure;
- zur Verwendung bei der Prüfung und Beschaffung von Ausrüstung;
- als Teil einer Vereinbarung über die Zulassung von Systemen in der offenen Systemumgebung;
- als eine Erweiterung des Verständnisses von zeitkritischer Kommunikation innerhalb der OSI.

Dieses Dokument befasst sich insbesondere mit der Kommunikation und dem Zusammenwirken von Sensoren, Effektoren und anderen Automatisierungsgeräten. Durch die Verwendung dieses Dokuments zusammen mit anderen Normen, die innerhalb der OSI- oder Feldbus-Referenzmodelle vorhanden sind, können andernfalls inkompatible Systeme in beliebiger Kombination zusammenarbeiten.

1 Anwendungsbereich

1.1 Allgemeines

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

Dieser Teil der IEC 61158 legt allgemeine Elemente für grundlegende zeitkritische und nicht zeitkritische Messaging-Kommunikationen zwischen Anwendungsprogrammen in einem Automatisierungsumfeld und für Typ-12-Feldbusse 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 das nach außen erkennbare Verhalten, das durch die verschiedenen Typen des Feldbus Application Layer bereitgestellt wird, hinsichtlich

a) der abstrakten Syntax, die die zwischen kommunizierenden Anwendungsinstanzen übermittelten Application Layer-Protokolldateneinheiten definiert,

b) der Übertragungssyntax, die die zwischen kommunizierenden Anwendungsinstanzen übermittelten Application Layer-Protokolldateneinheiten definiert,

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c) des Anwendungskontextzustandsautomaten, der das zwischen kommunizierenden Anwendungsinstanzen erkennbare Anwendungsdienstverhalten definiert; und

d) der Anwendungsbeziehungszustandsautomaten, die das zwischen kommunizierenden Anwendungsinstanzen erkennbare Kommunikationsverhalten definieren.

Der Zweck dieses Dokuments ist es, das Protokoll zu definieren, das bereitgestellt wird, um

a) die Drahtdarstellung der in IEC 61158-5-12 definierten Dienstprimitive zu definieren und

b) das nach außen erkennbare Verhalten zu definieren, das im Zusammenhang mit der entsprechenden Übertragung steht.

Dieses Dokument legt das Protokoll des IEC-Feldbus Application Layer in Übereinstimmung mit dem OSI-Basisreferenzmodell (ISO/IEC 7498) 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 anfragende und antwortende Anwendungen mit diesen vorzunehmen haben. Die Verhaltensaspekte der Anwendungen sind nicht festgelegt, nur eine Definition von welchen 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 Dienste zur Unterstützung 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 Syntax und das Verhalten des Application Layer-Protokolls, das die in IEC 61158-5-12 definierten Application Layer-Dienste übermittelt, festzulegen.

Ein Nebenziel ist es, Migrationspfade von zuvor bestehenden industriellen Kommunikationsprotokollen bereitzustellen. Es ist dieses letztgenannte Ziel, das zu der Vielfalt von in Unterteilen von IEC 61158-6 genormten Protokollen führt.

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 dieser Application Layer-Protokollspezifikation erreicht.

3 Begriffe, Symbole, Abkürzungen und Vereinbarungen

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe, Symbole, Abkürzungen und Vereinbarungen.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- IEC Electropedia: verfügbar unter http://www.electropedia.org/
- ISO Online Browsing Platform: verfügbar unter http://www.iso.org/obp

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3.1 Begriffe für Referenzmodell

Dieses Dokument basiert zum Teil auf den in ISO/IEC 7498-1 und ISO/IEC 7498-3 entwickelten Konzepten und verwendet die folgenden darin definierten Begriffe:

3.1.1	**entsprechende (N)-Instanzen (en: correspondent (N)-entities)** **entsprechende AL-Instanzen (en: correspondent AL-entities) (N=7)**	[ISO/IEC 7498-1]
3.1.2	**(N)-Instanz (en: (N)-entity)** **AL-Instanz (en: AL-entity) (N=7)**	[ISO/IEC 7498-1]
3.1.3	**(N)-Schicht (en: (N)-layer)** **AL-Schicht (en: AL-layer) (N=7)**	[ISO/IEC 7498-1]
3.1.4	**Schichtenmanagement (en: layer-management)**	[ISO/IEC 7498-1]
3.1.5	**Peer-Instanzen (en: peer-entities)**	[ISO/IEC 7498-1]
3.1.6	**Primitivname (en: primitive name)**	[ISO/IEC 7498-3]
3.1.7	**AL-Protokoll (en: AL-protocol)**	[ISO/IEC 7498-1]
3.1.8	**AL-Protokolldateneinheiten (en: AL-protocol-data-unit)**	[ISO/IEC 7498-1]
3.1.9	**Rücksetzen (en: reset)**	[ISO/IEC 7498-1]
3.1.10	**Routing (en: routing)**	[ISO/IEC 7498-1]
3.1.11	**Segmentieren (en: segmenting)**	[ISO/IEC 7498-1]
3.1.12	**(N)-Dienst (en: (N)-service)** **AL-Dienst (en: AL-service) (N=7)**	[ISO/IEC 7498-1]
3.1.13	**AL-Dienstdateneinheiten (en: AL-service-data-unit)**	[ISO/IEC 7498-1]
3.1.14	**AL-Simplex-Übertragung (en: AL-simplex-transmission)**	[ISO/IEC 7498-1]
3.1.15	**AL-Subsystem (en: AL-subsystem)**	[ISO/IEC 7498-1]
3.1.16	**Systemmanagement (en: systems-management)**	[ISO/IEC 7498-1]
3.1.17	**AL-Benutzerdaten (en: AL-user-data)**	[ISO/IEC 7498-1]

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3.2 Begriffe für Dienstvereinbarung

Dieses Dokument verwendet auch die folgenden in ISO/IEC 10731 definierten Begriffe, da sie auf den Data-Link Layer anwendbar sind:

3.2.1 Empfänger (en: acceptor)

3.2.2 asymmetrischer Dienst (en: asymmetrical service)

3.2.3 bestätigen (Primitv) (en: confirm (primitive));
Anforderer.liefern (Primitiv) (en: requestor.deliver (primitive))

3.2.4 liefern (Primitiv)

3.2.5 AL-Dienstprimitiv (en: AL-service-primitive);
Primitiv (en: primitive)

3.2.6 AL-Dienstanbieter (en: AL-service-provider)

3.2.7 AL-Dienstnutzer (en: AL-service-user)

3.2.8 anzeigen (Primitiv) (en: indication (primitive));
Empfänger.liefern (Primitiv) (en: acceptor.deliver (primitive))

3.2.9 anfordern (Primitiv) (en: request (primitive));
Anforderer.zustellen (Primitiv) (en: requestor.submit (primitive))

3.2.10 Anforderer (en: requestor)

3.2.11 Antwort (Primitiv) (en: response (primitive));
Empfänger.zustellen (Primitiv) (en: acceptor.submit (primitive))

3.2.12 zustellen (Primitiv) (en: submit (primitive))

3.2.13 symmetrischer Dienst (en: symmetrical service)

3.3 Definitionen für Application Layer

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.3.1
Anwendung
(en: application)
Funktion oder Datenstruktur, für die Daten konsumiert oder produziert werden

3.3.2
Anwendungsobjekte
(en: application objects)
mehrere Objektklassen, die zur Laufzeit für einen Nachrichtenaustausch im Netzwerk und innerhalb des Netzwerkgerätes sorgen und diesen verwalten

3.3.3
Anwendungsprozess
(en: application process)
Teil einer verteilten Anwendung in einem Netzwerk, der sich auf einem Gerät befindet und eindeutig adressiert wird

3.3.4
Anwendungsbeziehung
(en: application relationship)
kooperative Verbindung zwischen zwei oder mehr Aufrufen von Anwendungsinstanzen zum Zweck des Informationsaustausches und der Koordination des gemeinsamen Betriebs

Anmerkung 1 zum Begriff: Diese Beziehung wird entweder durch den Austausch von Protokolldateneinheiten der Anwendung oder als Ergebnis von Vorkonfigurationsaktivitäten aktiviert.

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3.3.5
Attribut
(en: attribute)
Beschreibung eines von außen sichtbaren Merkmals oder einer von außen sichtbaren Eigenschaft eines Objekts

Anmerkung 1 zum Begriff: Die Attribute eines Objekts enthalten Informationen zu veränderlichen Teilen eines Objekts. Üblicherweise stellen sie Statusinformationen bereit oder steuern den Betrieb eines Objekts. Attribute können auch das Verhalten eines Objekts beeinflussen. Attribute werden in Klassenattribute und Instanzattribute unterteilt.

3.3.6
asis-Slave
(en: basic slave)
Slave-Gerät, das nur die physische Adressierung von Daten unterstützt

3.3.7
Verhalten
(en: behavior)
Angabe, wie ein Objekt auf bestimmte Ereignisse reagiert

3.3.8
Bit
(en: bit)
Informationseinheit, die aus einer 1 oder einer 0 besteht

Anmerkung 1 zum Begriff: Dies ist die kleinste Dateneinheit, die übertragen werden kann.

3.3.9
Kanal
(en: channel)
Darstellung eines einzelnen physischen oder logischen Verwaltungsobjekts eines Slaves zum Steuern der Datenübermittlung

3.3.10
Client
(en: client)
<Objekt>, das die Dienste eines anderen (Server-)Objekts zur Ausführung einer Aufgabe nutzt

3.3.11
Client
(en: client)
Initiator einer <Nachricht>, auf die ein Server reagiert

3.3.12
Uhrensynchronisation
(en: clock synchronization)
Darstellung einer Abfolge von Interaktionen zur Synchronisation der Uhren aller Zeitempfänger mittels eines Zeit-Masters

3.3.13
Kommunikationsobjekt
(en: communication object)
Komponente, die zur Laufzeit für einen Nachrichtenaustausch im Netzwerk sorgt und diesen verwaltet

3.3.14
Verbindung
(en: connection)
logische Verknüpfung zwischen zwei Anwendungsobjekten in demselben Gerät oder in unterschiedlichen Geräten

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3.3.15
konsumieren
(en: consume)
Vorgang des Empfangs von Daten von einem Provider

3.3.16
Konsument
(en: consumer)
Knoten oder Senke, der/die Daten von einem Provider empfängt

3.3.17
Übertragungspfad
(en: conveyance path)
unidirektionaler Strom von APDU über eine Anwendungsbeziehung

3.3.18
zyklisch
(en: cyclic)
Ereignisse, die sich regelmäßig wiederholen

3.3.19
Daten
(en: data)
allgemeine Bezeichnung für jegliche über einen Feldbus übertragene Informationen

3.3.20
Datenkonsistenz
(en: data consistency)
Einrichtung für die kohärente Übertragung des Eingabe- oder Ausgabedatenobjekts zwischen Client und Server und für den kohärenten Zugriff auf das Eingabe- oder Ausgabedatenobjekt innerhalb von Client und Server

3.3.21
Datentyp
(en: data type)
Beziehung zwischen den Werten und der Codierung für Daten dieses Typs

3.3.22
Datentypobjekt
(en: data type object)
Eintrag im Objektverzeichnis, der einen Datentyp angibt

3.3.23
Standard-Gateway
(en: default gateway)
Gerät mit mindestens zwei Schnittstellen in zwei verschiedenen IP-Subnetzen, das als Router für ein Subnetz agiert

3.3.24
Gerät
(en: device)
an den Feldbus angeschlossene physische Instanz, die aus mindestens einem Kommunikationselement (dem Netzwerkelement) besteht und die ein Steuerungselement und/oder ein Abschlusselement (Wandler, Aktuator usw.) enthalten darf

3.3.25
Geräteprofil
(en: device profile)
Zusammenstellung geräteabhängiger Informationen und Funktionalitäten zur Bereitstellung von Konsistenz zwischen ähnlichen Geräten desselben Gerätetyps

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3.3.26
Diagnose-Informationen
(en: diagnosis information)
alle Daten, die serverseitig für Wartungszwecke verfügbar sind

3.3.27
verteilte Uhren
(en: distributed clocks)
Methode zur Synchronisierung von Slaves und zur Aufrechterhaltung einer globalen Zeitbasis

3.3.28
Fehler
(en: error)
Nichtübereinstimmung zwischen einem berechneten, beobachteten oder gemessenen Wert oder Zustand und dem festgelegten oder theoretisch richtigen Wert oder Zustand

3.3.29
Fehlerklasse
(en: error class)
allgemeine Gruppierung für zugehörige Fehlerdefinitionen und entsprechende Fehlercodes

3.3.30
Fehlercode
(en: error code)
Kennzeichnung eines bestimmten Fehlertyps innerhalb einer Fehlerklasse

3.3.31
Ereignis
(en: event)
Vorgang einer Änderung von Zuständen

3.3.32
Speicherverwaltungseinheit des Feldbusses
(en: fieldbus memory management unit)
Funktion, die eine oder mehrere Korrespondenzen zwischen logischen Adressen und dem physischen Speicher aufbaut

3.3.33
Instanz der Speicherverwaltungseinheit des Feldbusses
(en: fieldbus memory management unit entity)
einzelnes Element der Speicherverwaltungseinheit des Feldbusses: eine Entsprechung zwischen einem kohärenten logischen Adressraum und einem kohärenten physischen Speicherort

3.3.34
Rahmen
(en: frame)
umgangssprachliches Synonym für DLPDU

3.3.35
Full-Slave
(en: full slave)
Slave-Gerät, das sowohl die physische als auch die logische Adressierung von Daten unterstützt

3.3.36
Index
(en: index)
Adresse eines Objekts innerhalb eines Anwendungsprozesses

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3.3.37
Schnittstelle
(en: interface)
gemeinsam genutzte Grenze zwischen zwei funktionalen Einheiten, die durch funktionale Merkmale, Signalmerkmale oder andere Merkmale, soweit zutreffend, festgelegt ist

3.3.38
Little-Endian
(en: little endian)
Datendarstellung von Multi-Oktett-Feldern, wobei das am wenigsten signifikante Oktett zuerst übertragen wird

3.3.39
Master
(en: master)
Gerät, das die Datenübertragung auf dem Netzwerk steuert und den Medienzugriff der Slave-Stationen durch Senden von Nachrichten veranlasst und das die Schnittstelle zum Steuerungssystem darstellt

3.3.40
Zuordnung
(en: mapping)
Verbindung zwischen zwei Objekten derart, dass ein Objekt ein Teil des anderen Objekts ist

3.3.41
Zuordnungsparameter
(en: mapping parameters)
Satz von Werten, der die Verbindung zwischen Anwendungsobjekten und Prozessdatenobjekten festlegt

3.3.42
Medium
(en: medium)
Kabel, Lichtwellenleiter oder andere Einrichtung, wodurch Kommunikationssignale zwischen zwei oder mehr Punkten übertragen werden

Anmerkung 1 zum Begriff: „Medien“ ist die Pluralform von „Medium“.

3.3.43
Nachricht
(en: message)
geordnete Folge von Oktetten für die Übermittlung von Informationen

Anmerkung 1 zum Begriff: Üblicherweise für die Übermittlung von Informationen zwischen Peers auf dem Application Layer verwendet.

3.3.44
Netzwerk
(en: network)
Menge von Knoten, die über ein bestimmtes Kommunikationsmedium miteinander verbunden sind, einschließlich jeglicher zwischengeschalteter Repeater, Bridges, Router und Gateways unterer Schichten

3.3.45
Knoten
(en: node)
a) einzelne DL-Instanz, wie sie auf einem lokalen Verbindungszweig existiert

b) Endpunkt eines Verbindungszweigs in einem Netzwerk oder Punkt, an dem zwei oder mehrere Verbindungszweige aufeinandertreffen

[QUELLE: IEC 61158-2, für Option b) mit einigen Wortlautanpassungen]

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3.3.46
Objekt
(en: object)
abstrakte Darstellung einer bestimmten Komponente innerhalb eines Gerätes

Anmerkung 1 zum Begriff: Ein Objekt kann sein:

a) eine abstrakte Darstellung des Vermögens eines Gerätes. Objekte können aus einigen oder aus allen der folgenden Komponenten bestehen:

   1) Daten (Informationen, die sich im Laufe der Zeit ändern),

   2) Konfiguration (Parameter für das Verhalten),

   3) Methoden (Dinge, die mithilfe der Daten und der Konfiguration durchgeführt werden können);

b) eine Zusammenstellung zugehöriger Daten (in Form von Variablen) und Methoden (Prozeduren) für den Betrieb mit diesen Daten, die eine klar definierte Schnittstelle und ein klar definiertes Verhalten aufweisen.

3.3.47
Objektverzeichnis
(en: object dictionary)
Datenstruktur, die von Index und Subindex adressiert wird und Beschreibungen von Datentypobjekten, Kommunikationsobjekten und Anwendungsobjekten enthält

3.3.48
Prozessdaten
(en: process data)
Zusammenstellung von Anwendungsobjekten, die zum Zweck der Messung und Steuerung zyklisch oder azyklisch übertragen werden

3.3.49
Prozessdatenobjekt
(en: process data object)
Struktur, die durch Zuordnungsparameter beschrieben wird und eine oder mehrere Prozessdateneninstanzen enthält

3.3.50
Produzent
(en: producer)
Knoten oder Quelle, der/die Daten an einen oder viele Konsumenten sendet

3.3.51
Ressource
(en: resource)
Verarbeitungs- oder Informationsfähigkeit

3.3.52
Segment
(en: segment)
Zusammenstellung von einem realen Master und einem oder mehreren Slaves

3.3.53
Server
(en: server)
Objekt, das einem anderen (Client-)Objekt Dienste bereitstellt

3.3.54
Dienst
(en: service)
Operation oder Funktion, die ein Objekt und/oder eine Objektklasse auf Anforderung eines anderen Objekts und/oder einer anderen Objektklasse hin ausführt

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3.3.55
Slave
(en: slave)
DL-Instanz, die nur nach Initiierung durch den vorausgehenden Slave oder den Master auf das Medium zugreift

3.3.56
Subindex
(en: subindex)
untergeordnete Adresse eines Objekts innerhalb des Objektverzeichnisses

3.3.57
Sync-Manager
(en: sync manager)
Zusammenstellung von Steuerelementen zur Koordinierung des Zugriffs auf gleichzeitig verwendete Objekte

3.3.58
Sync-Manager-Kanal
(en: sync manager channel)
einzelne Steuerelemente zur Koordinierung des Zugriffs auf gleichzeitig verwendete Objekte

3.3.59
Switch
(en: switch)
MAC-Bridge, wie in IEEE 802.1D definiert

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61158-6-12

August 2019

ICS 25.040.40; 35.100.70; 35.110

Supersedes EN 61158-6-12:2014 and all of its amendments and corrigenda (if any)

English Version

Industrial communication networks - Fieldbus specifications - Part 6-12: Application layer protocol specification - Type 12 elements (IEC 61158-6-12:2019)

Réseaux de communication industriels - Spécifications des bus de terrain - Partie 6-12: Spécification du protocole de la couche application - Eléments de type 12 (IEC 61158-6-12:2019)

Industrielle Kommunikationsnetze - Feldbusse - Teil 6-12: Protokollspezifikation des Application Layer (Anwendungsschicht) - Typ 12-Elemente (IEC 61158-6-12:2019)

This European Standard was approved by CENELEC on 2019-07-25. 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, 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/948/FDIS, future edition 4 of IEC 61158-6-12, 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 61158-6-12:2019.

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) 2020-04-25
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-07-25

This document supersedes EN 61158-6-12:2014 and all of its amendments and corrigenda (if any).

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 61158-6-12:2019 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 61131-3	NOTE	Harmonized as EN 61131-3.
IEC 61158-1:2019	NOTE	Harmonized as EN IEC 61158-1:2019 (not modified).
IEC 61158-4-12	NOTE	Harmonized as EN IEC 61158-4-12.
IEC 61784-1	NOTE	Harmonized as EN IEC 61784-1.
IEC 61784-2	NOTE	Harmonized as EN IEC 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 61158-3-12	-	Industrial communication networks - Fieldbus specifications - Part 3-12: Data-link layer service definition - Type 12 elements	EN IEC 61158-3-12	-
IEC 61158-5-12	-	Industrial communication networks - Fieldbus specifications - Part 5-12: Application layer service definition - Type 12 elements	EN IEC 61158-5-12	-
IEC 61158-6	series	Industrial communication networks - Fieldbus specifications - Part 6: Application layer protocol specification		-
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic reference model: The basic model		-
ISO/IEC 7498-3	-	Information technology - Open Systems Interconnection - Basic reference model: Naming and addressing		-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application layer structure		-
ISO/IEC 9899	-	Information technology – Programming languages – C		-
ISO/IEC 10731	-	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services		-
IEEE Std 802.1D	-	IEEE standard for Local and metropolitan area networks – Common specifications – Media access control (MAC) Bridges		
IEEE Std 802.1Q	-	IEEE standard for Local and metropolitan area networks – Bridges and Bridged Networks		
IETF RFC 768	-	User Datagram Protocol	-	-
IETF RFC 791	-	Internet protocol darpa internet program protocol specification		-
IETF RFC 826	-	Ethernet Address Resolution Protocol: Or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware		-
ISO/IEC/IEEE 60559	-	Information technology - Microprocessor Systems - Floating-Point arithmetic		-
ISO/IEC/IEEE 8802-3	-	Standard for Ethernet	-	-

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

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-12: Application layer protocol specification – Type 12 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 behavior provided by the different Types of the fieldbus Application Layer in terms of

a) the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,
b) the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,
c) the application context state machine defining the application service behavior visible between communicating application entities; and
d) the application relationship state machines defining the communication behavior visible between communicating application entities; and.

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

a) define the wire-representation of the service primitives defined in IEC 61158-5-12, and
b) define the externally visible behavior associated with their transfer.

This document specifies the protocol of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) 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; only a definition of what requests and responses they can send/receive is specified. This permits greater flexibility to the FAL users in

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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 syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-12.

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 subparts of IEC 61158-6.

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 the application layer service definition standard. Instead, conformance is achieved through implementation of this application layer protocol specification.

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 61158-3-12, *Industrial communication networks – Fieldbus specifications – Part 3-12: Data-link layer service definition – Type 12 elements*

IEC 61158-5-12, *Industrial communication networks – Fieldbus specifications – Part 5-12: Application layer service definition – Type 12 elements*

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

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

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC/IEEE 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

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

ISO/IEC 9899, *Information technology – Programming languages – C*

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

ISO/IEC/IEEE 60559, *Information technology – Microprocessor Systems – Floating-Point arithmetic*

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IEEE Std 802.1D, *IEEE standard for Local and metropolitan area networks – Common specifications – Media access control (MAC) Bridges;* available at http://www.ieee.org [viewed 2018-09-11]

IEEE Std 802.1Q, *IEEE standard for Local and metropolitan area networks – Bridges and Bridged Networks;* available at http://www.ieee.org [viewed 2018-09-11]

IETF RFC 768, *User Datagram Protocol*; available at http://www.ietf.org [viewed 2018-09-11]

IETF RFC 791, *Internet Protocol darpa internet program protocol specification;* available at http://www.ietf.org [viewed 2018-09-11]

IETF RFC 826, *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware;* available at http://www.ietf.org [viewed 2018-09-11]

3 Terms, definitions, symbols, abbreviations 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 Reference model terms and definitions

This document is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein:

3.1.1	**correspondent (N)-entities** **correspondent AL-entities (N=7)**	[ISO/IEC 7498-1]
3.1.2	**(N)-entity** **AL-entity (N=7)**	[ISO/IEC 7498-1]
3.1.3	**(N)-layer** **AL-layer (N=7)**	[ISO/IEC 7498-1]
3.1.4	**layer-management**	[ISO/IEC 7498-1]
3.1.5	**peer-entities**	[ISO/IEC 7498-1]
3.1.6	**primitive name**	[ISO/IEC 7498-3]
3.1.7	**AL-protocol**	[ISO/IEC 7498-1]
3.1.8	**AL-protocol-data-unit**	[ISO/IEC 7498-1]
3.1.9	**Reset**	[ISO/IEC 7498-1]
3.1.10	**routing**	[ISO/IEC 7498-1]
3.1.11	**segmenting**	[ISO/IEC 7498-1]
3.1.12	**(N)-service** **AL-service (N=7)**	[ISO/IEC 7498-1]
3.1.13	**AL-service-data-unit**	[ISO/IEC 7498-1]
3.1.14	**AL-simplex-transmission**	[ISO/IEC 7498-1]
3.1.15	**AL-subsystem**	[ISO/IEC 7498-1]
3.1.16	**systems-management**	[ISO/IEC 7498-1]

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3.1.17 AL-user-data [ISO/IEC 7498-1]

3.2 Service convention terms and definitions

This document also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

3.2.1 acceptor

3.2.2 asymmetrical service

3.2.3 confirm (primitive); requestor.deliver (primitive)

3.2.4 deliver (primitive)

3.2.5 AL-service-primitive; primitive

3.2.6 AL-service-provider

3.2.7 AL-service-user

3.2.8 indication (primitive); acceptor.deliver (primitive)

3.2.9 request (primitive); requestor.submit (primitive)

3.2.10 requestor

3.2.11 response (primitive); acceptor.submit (primitive)

3.2.12 submit (primitive)

3.2.13 symmetrical service

3.3 Application layer definitions

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

3.3.1
application
function or data structure for which data is consumed or produced

3.3.2
application objects
multiple object classes that manage and provide a run time exchange of messages across the network and within the network device

3.3.3
application process
part of a distributed application on a network, which is located on one device and unambiguously addressed

3.3.4
application relationship
cooperative association between two or more application-entity-invocations for the purpose of exchange of information and coordination of their joint operation

Note 1 to entry: This relationship is activated either by the exchange of application-protocol-data-units or as a result of preconfiguration activities.

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3.3.5
attribute
description of an externally visible characteristic or feature of an object

Note 1 to entry: The attributes of an object contain information about variable portions of an object. Typically, they provide status information or govern the operation of an object. Attributes may also affect the behavior of an object. Attributes are divided into class attributes and instance attributes.

3.3.6
basic slave
slave device that supports only physical addressing of data

3.3.7
behavior
indication of how an object responds to particular events

3.3.8
bit
unit of information consisting of a 1 or a 0

Note 1 to entry: This is the smallest data unit that can be transmitted.

3.3.9
channel
representation of a single physical or logical management object of a slave to control conveyance of data

3.3.10
client
<object> object which uses the services of another (server) object to perform a task

3.3.11
client
<message> initiator of a message to which a server reacts

3.3.12
clock synchroization
representation of a sequence of interactions to synchronize the clocks of all time receivers by a time master

3.3.13
communication object
component that manages and provides a run time exchange of messages across the network

3.3.14
connection
logical binding between two application objects within the same or different devices

3.3.15
consume
act of receiving data from a provider

3.3.16
consumer
node or sink receiving data from a provider

3.3.17
conveyance path
unidirectional flow of APDUs across an application relationship

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3.3.18
cyclic
events which repeat in a regular and repetitive manner

3.3.19
data
generic term used to refer to any information carried over a fieldbus

3.3.20
data consistency
means for coherent transmission and access of the input- or output-data object between and within client and server

3.3.21
data type
relation between values and encoding for data of that type

3.3.22
data type object
entry in the object dictionary indicating a data type

3.3.23
default gateway
device with at least two interfaces in two different IP subnets acting as router for a subnet

3.3.24
device
physical entity connected to the fieldbus composed of at least one communication element (the network element) and which may have a control element and/or a final element (transducer, actuator, etc.)

3.3.25
device profile
collection of device dependent information and functionality providing consistency between similar devices of the same device type

3.3.26
diagnosis information
all data available at the server for maintenance purposes

3.3.27
distributed clocks
method to synchronize slaves and maintain a global time base

3.3.28
error
discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

3.3.29
error class
general grouping for related error definitions and corresponding error codes

3.3.30
error code
identification of a specific type of error within an error class

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3.3.31
event
instance of a change of conditions

3.3.32
fieldbus memory management unit
function that establishes one or several correspondences between logical addresses and physical memory

3.3.33
fieldbus memory management unit entity
single element of the fieldbus memory management unit: one correspondence between a coherent logical address space and a coherent physical memory location

3.3.34
frame
denigrated synonym for DLPDU

3.3.35
full slave
slave device that supports both physical and logical addressing of data

3.3.36
index
address of an object within an application process

3.3.37
interface
shared boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics as appropriate

3.3.38
little endian
data representation of multi-octet fields where the least significant octet is transmitted first.

3.3.39
master
device that controls the data transfer on the network and initiates the media access of the slaves by sending messages and that constitutes the interface to the control system

3.3.40
mapping
correspondence between two objects in that way that one object is part of the other object

3.3.41
mapping parameters
set of values defining the correspondence between application objects and process data objects

3.3.42
medium
cable, optical fibre or other means by which communication signals are transmitted between two or more points

Note 1 to entry: Media is the plural of medium.

3.3.43
message
ordered series of octets intended to convey information

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Note 1 to entry: Normally used to convey information between peers at the application layer.

3.3.44
network
set of nodes connected by some type of communication medium, including any intervening repeaters, bridges, routers and lower-layer gateways

3.3.45
node
a) single DL-entity as it appears on one local link

b) end-point of a link in a network or a point at which two or more links meet

[SOURCE: IEC 61158-2, for option b), with some wording adjustment]

3.3.46
object
abstract representation of a particular component within a device

Note 1 to entry: An object can be

a) an abstract representation of the capabilities of a device. Objects can be composed of any or all of the following components:
   1) data (information which changes with time),
   2) configuration (parameters for behavior),
   3) methods (things that can be done using data and configuration);

b) a collection of related data (in the form of variables) and methods (procedures) for operating on that data that have clearly defined interface and behavior.

3.3.47
object dictionary
data structure addressed by Index and Sub-index that contains description of data type objects, communication objects and application objects

3.3.48
process data
collection of application objects designated to be transferred cyclically or acyclically for the purpose of measurement and control

3.3.49
process data object
structure described by mapping parameters containing one or several process data entities

3.3.50
producer
node or source sending data to one or many consumers

3.3.51
resource
processing or information capability

3.3.52
segment
collection of one real master with one or more slaves

3.3.53
server
object which provides services to another (client) object

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3.3.54
service
operation or function than an object and/or object class performs upon request from another object and/or object class

3.3.55
slave
DL-entity accessing the medium only after being initiated by the preceding slave or the master

3.3.56
subindex
sub-address of an object within the object dictionary

3.3.57
sync manager
collection of control elements to coordinate access to concurrently used objects

3.3.58
sync manager channel
single control elements to coordinate access to concurrently used objects

3.3.59
switch
MAC bridge as defined in IEEE 802.1D

3.4 Common symbols and abbreviations

AL-	Application layer (as a prefix)
ALE	AL-entity (the local active instance of the application layer)
AL	AL-layer
APDU	AL-protocol-data-unit
ALM	AL-management
ALME	AL-management Entity (the local active instance of AL-management)
ALMS	AL-management service
ALS	AL-service
ALSDU	AL-service-data-unit
DL	Data-link-layer
FIFO	First-in first-out (queuing method)
OSI	Open systems interconnection
PhL	Ph-layer
QoS	Quality of service

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3.5 Additional symbols and abbreviations

AoE	Automation Device Specification (ADS) over Type 12
ASE	Application service element
AR	Application relationship
CAN	Controller Area Network
CiA	CAN in Automation
CoE	CAN application protocol over Type 12 services
CSMA/CD	Carrier sense multiple access with collision detection
DC	Distributed clocks
DNS	Domain name system (server for name resolution in IP networks)
E²PROM	Electrically erasable programmable read only memory
EoE	Ethernet tunneled over Type 12 services
ESC	Type 12 slave controller
FCS	Frame check sequence
FMMU	Fieldbus memory management unit
FoE	File access with Type 12 services
HDR	Header
ID	Identifier
IETF	Internet engineering rask force
IP	Internet protocol
LAN	Local area network
MAC	Medium access control
OD	Object dictionary
PDI	Physical device internal interface (a set of elements that allows access to DL services from the AL)
PDO	Process data object
RAM	Random access memory
Rx	Receive
SDO	Service data object
SII	slave information interface
SM	Synchronization manager
SoE	Servo drive profile with Type 12 services
SyncM	Synchronization manager
TCP	Transmission control protocol
Tx	Transmit
UDP	User datagram protocol (IETF RFC 768)
VoE	Profile specific services
WKC	Working counter

3.6 Conventions

3.6.1 General concept

The services are specified in IEC 61158-5-12. The service specification defines the services that are provided by the Type 12 DL. The mapping of these services to ISO/IEC/IEEE 8802-3 is described in this document.

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

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3.6.2 Convention for the encoding of reserved bits and octets

The term "reserved" may be used to describe bits in octets or whole octets. All bits or octets that are reserved should be set to zero at the sending side and shall not be tested at the receiving side except it is explicitly stated or if the reserved bits or octets are checked by a state machine.

The term "reserved" may also be used to indicate that certain values within the range of a parameter are reserved for future extensions. In this case the reserved values should not be used at the sending side and shall not be tested at the receiving side except it is explicitly stated or if the reserved values are check by a state machine.

3.6.3 Conventions for the common codings of specific field octets

APDUs may contain specific fields that carry information in a primitive and condensed way. These fields shall be coded in the order according to Figure 1.

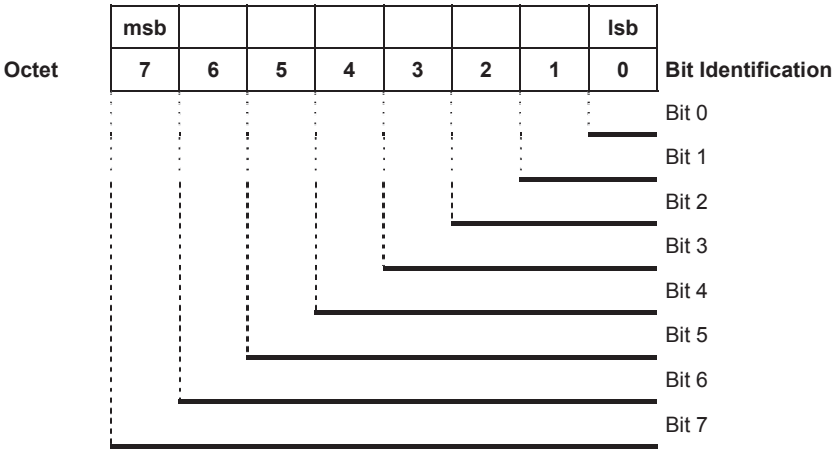


Figure 1 – Common structure of specific fields

Bits may be grouped as group of bits. Each bit or group of bits shall be addressed by its Bit Identification (e.g. Bit 0, Bit 1 to 4). The position within the octet shall be according to the figure above. Alias names may be used for each bit or group of bits or they may be marked as reserved. The grouping of individual bits shall be in ascending order without gaps. The values for a group of bits may be represented as binary, decimal or hexadecimal values. This value shall only be valid for the grouped bits and can only represent the whole octet if all 8 bits are grouped. Decimal or hexadecimal values shall be transferred in binary values so that the bit with the highest number of the group represents the msb concerning the grouped bits.

EXAMPLE Description and relation for the specific field octet

Bit 0: reserved.

Bit 1-3: Reason_Code The decimal value 2 for the Reason_Code means general error.

Bit 4-7: shall always set to one.

The octet that is constructed according to the description above looks as follows:

(msb) Bit 7 = 1,

Bit 6 = 1,

Bit 5 = 1,

Bit 4 = 1,

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Bit 3 = 0,

Bit 2 = 1,

Bit 1 = 0,

(lsb) Bit 0 = 0.

This bit combination has an octet value representation of 0xf4.

3.6.4 Abstract syntax conventions

The AL syntax elements related to PDU structure are described as shown in the example of Table 1.

Frame part denotes the element that will be replaced by this reproduction.

Data field is the name of the elements.

Data Type denotes the type of the terminal symbol.

Value/Description contains the constant value or the meaning of the parameter.

Table 1 – PDU element description example

Frame part	Data Field	Data Type	Value/Description
CoE Header	Number	Unsigned9	0x00
	Reserved	Unsigned3	0x00
	Service	Unsigned4	0x02: SDO Request
SDO	Size Indicator	Unsigned1	0x00: size of Data (1..4) unspecified 0x01: size of Data in Data Set Size specified
	Transfer Type	Unsigned1	0x01: Expedited transfer
	Data Set Size	Unsigned2	0x00: 4 Octet Data 0x01: 3 Octet Data 0x02: 2 Octet Data 0x03: 1 Octet Data
	Complete Access	Unsigned1	0x00
	Command Specifier	Unsigned3	0x01: Initiate Download Request

The informational attribute types are described in C language notations (see ISO/IEC 9899) as shown in Figure 2. BYTE and WORD are elements of type unsigned char and unsigned short.

```
typedef struct
{
  Unsigned8     Type;
  Unsigned8     Revision;
  Unsigned16    Build;
  Unsigned8     NoOfSuppFmmuChannels;
  Unsigned8     NoOfSuppSyncManChannels;
  Unsigned8     RamSize;
  Unsigned8     Reserved1;
  unsigned      FmmuBitOperationNotSupp:  1;
  unsigned      Reserved2:                7;
  unsigned      Reserved3:                8;
} TDLINFORMATION;
```

Figure 2 – Type description example

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The attributes of an object are described in a form as shown in Table 2.

Subindex describes a single element of the object.

Description denotes a name string for this attribute.

Data Type denotes the type of this element.

M/O/C indicates whether the attribute is mandatory (M), optional (O) or depends upon setting of other attributes (C).

Access type shows the access right to this element. R means read access right, W means write access right. It can be extended showing the AL state where the access right applies.

PDO Mapping denotes the possibility to map this attribute to TxPDO or RxPDO or to indicate that this parameter is not mappable.

Value contains the constant value and/or the meaning of the parameter.

Table 2 – Example attribute description

Sub-Index	Description	Data type	M/O/C	Access	PDO Mapping	Value
0	Number of entries	UNSIGNED8	M	R	No	4
1	Vendor ID	UNSIGNED32	M	R	No	Assigned uniquely by ETG
2	Product Code	UNSIGNED32	M	R	No	Assigned uniquely by Vendor
3	Revision Number	UNSIGNED32	M	R	No	Assigned uniquely by Vendor
4	Serial Number	UNSIGNED32	M	R	No	assigned uniquely for this device by Vendor

3.6.5 State machine conventions

The protocol sequences are described by means of State Machines.

In state diagrams states are represented as boxes and state transitions are shown as arrows. Names of states and transitions of the state diagram correspond to the names in the textual listing of the state transitions.

The textual listing of the state transitions is structured as follows, see also Table 3.

– The first column contains the name of the transition.
– The second column defines the current state.
– The third column contains an optional event followed by Conditions starting with a “/” as first line character and finally followed by the Actions starting with a “=>” as first line character.
– The last column contains the next state.

If the event occurs and the conditions are fulfilled the transition fires, i.e. the actions are executed and the next state is entered.

The layout of a Machine description is shown in Table 3. The meaning of the elements of a State Machine Description is shown in Table 4.

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Table 3 – State machine description elements

#	Current state	Event /Condition => Action	Next state

Table 4 – Description of state machine elements

Description element	Meaning
Current state Next state	name of the given states.
#	name or number of the state transition.
Event	name or description of the event.
/Condition	boolean expression. The preceding "\" is not part of the condition.
=> Action	list of assignments and service or function invocations. The preceding "=>" is not part of the action.

The conventions used in the state machines are shown in Table 5.

Table 5 – Conventions used in state machines

Convention	Meaning
=	value of an item on the left is replaced by value of an item on the right. If an item on the right is a parameter, it comes from the primitive shown as an input event.
axx	a parameter name if a is a letter. EXAMPLE Identifier = reason means value of a 'reason' parameter is assigned to a parameter called 'Identifier.'
"xxx"	indicates fixed visible string. EXAMPLE Identifier = "abc" means value "abc" is assigned to a parameter named 'Identifier.'
nnn	if all elements are digits, the item represents a numerical constant shown in decimal representation.
0xnn	if all elements nn are digits, the item represents a numerical constant shown in hexadecimal representation.
==	a logical condition to indicate an item on the left is equal to an item on the right.
<	a logical condition to indicate an item on the left is less than the item on the right.
>	a logical condition to indicate an item on the left is greater than the item on the right.
!=	a logical condition to indicate an item on the left is not equal to an item on the right.
&&	logical "AND"
||	logical "OR"
!	logical "NOT"
+ – * /	arithmetic operators
;	separator of expressions

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Readers are strongly recommended to refer to the subclauses for the attribute definitions, the local functions and the FDL-PDU definitions to understand protocol machines. It is assumed that readers have sufficient knowledge of these definitions and they are used without further explanations.

Further constructs as defined in C language notation (see ISO/IEC 9899) can be used to describe conditions and actions.

4 Application layer protocol specification

4.1 Operating principle

Type 12 is a Real Time Ethernet technology that aims to maximize the utilization of the full duplex Ethernet bandwidth. Medium access control employs the master/slave principle, where the master node (typically the control system) sends the Ethernet frames to the slave nodes, which extract data from and insert data into these frames.

From an Ethernet point of view, a Type 12 segment is a single Ethernet device, which receives and sends ISO/IEC/IEEE 8802-3 Ethernet frames. However, this Ethernet device is not limited to a single Ethernet controller with a downstream microprocessor, but may consist of a large number of slave devices. These process the incoming frames directly and extract the relevant user data or insert data and transfer the frame to the next slave device. The last slave device within the segment sends the fully processed frame back, so that it is returned by the first slave device to the master as response frame.

This procedure utilizes the full duplex mode of Ethernet: both communication directions are operated independently. Direct communication without a switch between a master device and a Type 12 segment consisting of one or several slave devices may be established.

Industrial communication systems have to meet different requirements in terms of the data transmission characteristics. Parameter data is transferred acyclically and in large quantities, whereby the timing requirements are relatively non-critical, and the transmission is usually triggered by the control system. Diagnostic data is also transferred acyclically and event-driven, but the timing requirements are more demanding, and the transmission is usually triggered by a peripheral device.

Process data, on the other hand, is typically transferred cyclically with different cycle times. The timing requirements are most stringent for process data communication. Type 12 supports a variety of services and protocols to meet these differing requirements.

4.2 Node reference model

4.2.1 Mapping onto OSI basic reference model

Type 12 is described using the principles, methodology and model of ISO/IEC 7498-1. The OSI model provides a layered approach to communications standards, whereby the layers can be developed and modified independently. The Type 12 specification defines functionality from top to bottom of a full OSI stack, and some functions for the users of the stack. Functions of the intermediate OSI layers, layers 3 – 6, are consolidated into either the Type 12 Data Link layer or the Type 12 Application layer. Likewise, features common to users of the Fieldbus Application Layer may be provided by the Type 12 Application layer to simplify user operation, as noted in Figure 3.

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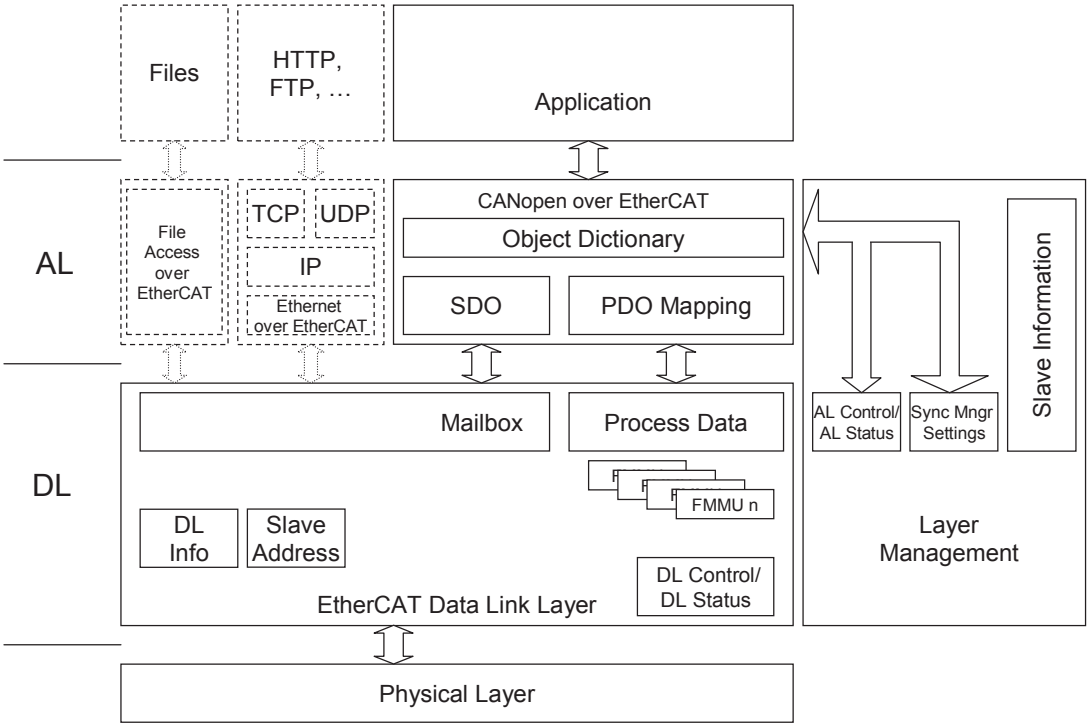


Figure 3 – Slave Node Reference Model

4.2.2 Data Link Layer features

The data link layer provides basic time critical support for data communications among devices. The term “time-critical” is used to describe applications having 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.

The data link layer has the task to compute, compare and generate the frame check sequence and provide communications by extracting data from and/or including data into the Ethernet frame. This is done depending on the data link layer parameters which are stored at pre-defined memory locations. The application data is made available to the application layer in physical memory, either in a mailbox configuration or within the process data section.

Additionally, some data structures in the Data Link layer will be used to allow a coordination of the interaction between master and slave such as AL Control, Status and Event and Sync manager settings.

4.2.3 Application Layer structure

The Application Layer consists of the following elements.

- A real time entity (mandatory)
- An entity that deals with TCP/UDP/IP and related protocols (optional)
- A file access utility (optional)
- A Management unit (mandatory)

The Application Layer uses the services provided by the Type 12 Data Link Layer to convey the Application Layer service data.

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5 FAL syntax description

5.1 Coding principles

Application layer uses DL objects as defined in IEC 61158-4-12.

5.2 Data types and encoding rules

5.2.1 General description of data types and encoding rules

The format of this data and its meaning have to be known by the producer and consumer(s) to be able to exchange meaningful data. This specification models this by the concept of data types.

The encoding rules define the representation of values of data types and the transfer syntax for the representations. Values are represented as bit sequences. Bit sequences are transferred in sequences of octets (bytes). For numerical data types the encoding is little endian style as shown in Table 6.

The data types and encoding rules shall be valid for the DL services and protocols as well as for the AL services and protocols specified. The encoding rules for the Ethernet frame are specified in ISO/IEC/IEEE 8802-3. The DLSDU of Ethernet is an octet string. The transmission order within octets depends upon MAC and PhL encoding rules.

5.2.2 Encoding of a Boolean value

a) The encoding of a Boolean value shall be primitive. The ContentsOctets shall consist of a single octet.

b) If the Boolean value is FALSE, the ContentsOctets shall be 0 (zero). If the Boolean value is TRUE, the ContentsOctets shall be 0xff.

5.2.3 Encoding of a Time Of Day with and without date indication value

a) The encoding of a Time Of Day with and without date indication value shall be primitive.

b) The ContentsOctets shall be equal in value to the octets in the data value, as shown in Figure 4.

bits	7	6	5	4	3	2	1	0	
octets									
1	0	0	0	0	2^{27}	2^{26}	2^{25}	2^{24}	number of
2	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	milliseconds
3	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	since
4	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	midnight
5	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	number of days since 1984-01-01
6	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	only with date indication
	msb								

Figure 4 – Encoding of Time of Day value

5.2.4 Encoding of a Time Difference with and without date indication value

a) The encoding of a Time Difference with and without date indication value shall be primitive.

b) The ContentsOctets shall be equal in value to the octets in the data value, as shown in Figure 5.

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bits	7	6	5	4	3	2	1	0	
octets									
1	2^{31}	2^{30}	2^{29}	2^{28}	2^{27}	2^{26}	2^{25}	2^{24}	
2	2^{23}	2^{22}	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	milliseconds
3	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	
4	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	
5	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	days
6	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	only with date indication
	msb								

Figure 5 – Encoding of Time Difference value

5.2.5 Transfer syntax for bit sequences

For transmission a bit sequence is reordered into a sequence of octets. Hexadecimal notation is used for octets as specified in ISO/IEC 9899. Let $b = b_0 ... b_{n-1}$ be a bit sequence. Denote k a non-negative integer such that $8(k-1) < n \leq 8k$. Then b is transferred in k octets assembled as shown in Table 6. The bits b_i, $i \geq n$ of the highest numbered octet are do not care bits.

Octet 1 is transmitted first and octet k is transmitted last. Hence the bit sequence is transferred as follows across the network (transmission order within an octet is determined by ISO/IEC/IEEE 8802-3):

$b_7, b_6, ..., b_0, b_{15}, ..., b_8, ...$

Table 6 – Transfer Syntax for bit sequences

octet number	1.	2.	k.
	b_7 .. b_0	b_{15} .. b_8	b_{8k-1} .. b_{8k-8}

EXAMPLE

Bit 9	...	Bit 0
10b	0001b	1100b
0x2	0x1	0xC
		= 0x21C

The bit sequence b = b_0 .. b_9 = 0011 1000 01_b represents an Unsigned10 with the value 0x21C and is transferred in two octets: first 0x1C and then 0x02.

5.2.6 Encoding of a Unsigned Integer value

Data of basic data type Unsignedn has values in the non-negative integers. The value range is 0, ..., 2^n-1. The data is represented as bit sequences of length n. The bit sequence

$b = b_0 ... b_{n-1}$

is assigned the value

$\text{Unsignedn}(b) = b_{n-1} \times 2^{n-1} + ... + b_1 \times 2^1 + b_0 \times 2^0$

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The bit sequence starts on the left with the least significant byte (Octet).

EXAMPLE The value 266 = 0x10A with data type Unsigned16 is transferred in two octets, first 0x0A and then 0x01.

The Unsignedn data types are transferred as specified in Table 7. Unsigned data types as Unsigned1 to Unsigned7 and Unsigned 9 to Unsigned15 will be used too. In this case the next element will start at the first free bit position as denoted in 3.6.3.

Table 7 – Transfer syntax for data type Unsignedn

octet number	1.	2.	3.	4.	5.	6.	7.	8.
Unsigned8	b7..b0							
Unsigned16	b7..b0	b15..b8						
Unsigned32	b7..b0	b15..b8	b23..b16	b31..b24				
Unsigned64	b7..b0	b15..b8	b23..b16	b31..b24	b39..b32	b47..b40	b55..b48	b63..b56

BYTE is used as UNSIGNED8, WORD is used as UNSIGNED16.

5.2.7 Encoding of a Signed Integer value

Data of basic data type Integern has values in the integers. The value range is from -2^{n-1} to $2^{n-1}-1$. The data is represented as bit sequences of length n. The bit sequence

$$b = b_0 \,..\, b_{n-1}$$

is assigned the value

$$\text{Integern}(b) = b_{n-2} \times 2^{n-2} + ...+ b_1 \times 2^1 + b_0 \times 2^0 \qquad \text{if } b_{n-1} = 0$$

and, performing two's complement arithmetic,

$$\text{Integern}(b) = -\text{Integern}(\hat{}b) - 1 \text{ if } b_{n-1} = 1$$

NOTE The bit sequence starts on the left with the least significant bit.

EXAMPLE The value –266 = 0xFEF6 with data type Integer16 is transferred in two octets, first 0xF6 and then 0xFE.

The Integern data types are transferred as specified in Table 8. Integer data types as Integer1 to Integer7 and Integer9 to Integer15 will be used too. In this case the next element will start at the first free bit position as denoted in 3.6.3.

Table 8 – Transfer syntax for data type Integern

octet number	1.	2.	3.	4.	5.	6.	7.	8.
Integer8	b7..b0							
Integer16	b7..b0	b15..b8						
Integer32	b7..b0	b15..b8	b23..b16	b31..b24				
Integer64	b7..b0	b15..b8	b23..b16	b31..b24	b39..b32	b47..b40	b55..b48	b63..b56

5.2.8 Encoding of a Floating Point value

Float32::= OCTET STRING SIZE (4) -- ISO/IEC/IEEE 60559 Single precision

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Float64::= OCTET STRING SIZE (8) -- ISO/IEC/IEEE 60559 Double precision

5.2.9 Encoding of a Visible String value

a) The encoding of a variable length VisibleString value shall be primitive.

b) There is no Length field and no termination symbol; the length is encoded implicitly.

c) The ContentsOctets shall be a sequence of octets. The leftmost string element is encoded in the first octet, followed by the second octet, followed by each octet in turn up to and including the last octet as rightmost of the ContentsOctets.

5.2.10 Encoding of a Unicode String value

a) The encoding of a variable length UnicodeString value shall be primitive.

b) There is no Length field; the length is encoded implicitly.

c) The ContentsOctets shall be a sequence of unsigned integer. The leftmost string element is encoded in the first unsigned integer, followed by the second unsigned integer, followed by each unsigned integer in turn up to and including the last unsigned integer as rightmost of the ContentsOctets.

5.2.11 Encoding of an Octet String value

a) The encoding of a variable length OctetString value shall be primitive.

b) There is no Length field; the length is encoded implicitly.

c) The ContentsOctets shall be a sequence of octets. The leftmost string element is encoded in the first octet, followed by second octet, followed by each octet in turn up to and including the last octet as rightmost of the ContentsOctets.

5.2.12 Encoding of GUID

Data of basic data type GUID (Globally Unique Identifier) is a unique reference number used as an identifier. The value of a GUID is stored as a 128-bit integer.

5.3 AR coding

5.3.1 AL Control Request (Indication)

The attribute types of AL Control Request are described in Figure 6.

```
typedef struct
{
  unsigned          State:            4;
  unsigned          Acknowledge:      1;
  unsigned          IdRequest:        1;
  unsigned          Reserved:         2;
  unsigned          ApplSpecific:     8;
} TALCONTROL;
```

Figure 6 – AL Control Request structure

The AL Control Request is mapped to a DL write service to the DL-user control register object R1 and R2 as specified in IEC 61158-4-12. The AL Control Request coding is specified in Table 9.

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Table 9 – AL Control Description

Parameter	DL-user Register	Data Type	Value
State	R1	Unsigned4	1: Init 2: Pre-Operational 3: Bootstrap 4: Safe-Operational 8: Operational
Acknowledge	R1	Unsigned1	0: Parameter Change of the AL Status Register will be unchanged 1: Parameter Change of the AL Status Register will be reset
IdRequest	R1	Unsigned1	0: ID is not requested 1: Request of ID
Reserved	R1	Unsigned2	shall be zero
Reserved	R2	Unsigned8	

5.3.2 AL Control Response (Confirmation)

The AL Control Response is mapped to a DL read service to the DL-user status register object and register R4, R5 and R6 as specified in IEC 61158-4-12. The attribute types of AL Control Response are described in Figure 7.

```
typedef struct
{
  unsigned          State:            4;
  unsigned          Change:           1;
  unsigned          IdLoaded:         1;
  unsigned          Reserved1:        2;
  unsigned          ApplSpecific:     8;
  unsigned          Reserved2:       16;
  unsigned          AlStatusCode:    16;
} TALSTATUSE;
```

Figure 7 – AL Control Response structure

The AL Control Response coding is specified in Table 10.

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Table 10 – AL Control Response

Parameter	DL-user Register	Data Type	Value
State	R3	Unsigned4	1: Init 2: Pre-Operational 3: Bootstrap 4: Safe-Operational 8: Operational
Change	R3	Unsigned1	0: State transition successful 1: State transition not successful
IdLoaded	R3	Unsigned1	0: Value in R6 does not represent ID 1: Value in R6 represents ID
Reserved	R3	Unsigned2	shall be zero
Reserved	R4	Unsigned8	
Reserved	R5	Unsigned16	
AL Status Code	R6	Unsigned16	see Table 11

Table 11 – AL Status Codes

Code	Description	Current state (or state change)	Resulting state
0x0000	No error	Any	Current state
0x0001	Unspecified error	Any	I + E, P + E, S + E
0x0002	No Memory	Any	I + E, P + E, S + E
0x0003	Invalid Device Setup	P -> S	P + E
0x0005	Reserved due to compatibility reasons		
0x0011	Invalid requested state change	I -> S, I -> O, P -> O O -> B, S -> B, P -> B	I + E, P + E, S + E
0x0012	Unknown requested state	Any	I + E, P + E, S + E
0x0013	Bootstrap not supported	I -> B	I + E
0x0014	No valid firmware	I -> P	I + E
0x0015	Invalid mailbox configuration	I -> B	I + E
0x0016	Invalid mailbox configuration	I -> P	I + E
0x0017	Invalid sync manager configuration	P -> S, S -> O	Current state + E
0x0018	No valid inputs available	O, S -> O	S + E
0x0019	No valid outputs	S, O, S -> O	S + E
0x001A	Synchronization error	O, S -> O	S + E
0x001B	Sync manager watchdog	O, S	S + E
0x001C	Invalid Sync Manager Types	O, S, P -> S	S + E
0x001D	Invalid Output Configuration	O, S, P -> S	P + E
0x001E	Invalid Input Configuration	O, S, P -> S	P + E
0x001F	Invalid Watchdog Configuration	O, S, P -> S	P + E
0x0020	Slave needs cold start	Any	I + E, P + E, S + E
0x0021	Slave needs INIT	B, P, S, O	I + E, P + E, S + E

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Code	Description	Current state (or state change)	Resulting state
0x0022	Slave needs PREOP	S, O	S + E, O + E
0x0023	Slave needs SAFEOP	O	O + E
0x0024	Invalid Input Mapping	P -> S	P + E
0x0025	Invalid Output Mapping	P -> S	P + E
0x0026	Inconsistent Settings	P -> S	P + E
0x0027	FreeRun not supported	P -> S	P + E
0x0028	SyncMode not supported	P -> S	P + E
0x0029	FreeRun needs 3Buffer Mode	P -> S	P + E
0x002A	Background Watchdog	S, O	P + E
0x002B	No Valid Inputs and Outputs	O, S -> O	S + E
0x002C	Fatal Sync Error	O	S + E
0x002D	No Sync Error	O, S, P -> S	S + E
0x0030	Invalid DC SYNC Configuration	O, S -> O, P -> S	P + E, S + E
0x0031	Invalid DC Latch Configuration	O, S -> O, P -> S	P + E, S + E
0x0032	PLL Error	O, S -> O	S + E
0x0033	DC Sync IO Error	O, S -> O	S + E
0x0034	DC Sync Timeout Error	O, S -> O	S + E
0x0035	DC Invalid Sync Cycle Time	P -> S	P + E
0x0036	DC Sync0 Cycle Time	P -> S	P + E
0x0037	DC Sync1 Cycle Time	P -> S	P + E
0x0041	MBX_AOE	B, P, S, O	I + E, P + E, S + E
0x0042	MBX_EOE	B, P, S, O	I + E, P + E, S + E
0x0043	MBX_COE	B, P, S, O	I + E, P + E, S + E
0x0044	MBX_FOE	B, P, S, O	I + E, P + E, S + E
0x0045	MBX_SOE	B, P, S, O	I + E, P + E, S + E
0x004F	MBX_VOE	B, P, S, O	I + E, P + E, S + E
0x0050	EEPROM no access	Any	I + E, P + E, S + E
0x0051	EEPROM Error	Any	I + E, P + E, S + E
0x0060	Slave restarted locally	Any	I
0x0061	Device Identification value updated	P	P + E
0x0062 …0x00EF	Reserved		
0x00F0	Application controller available	I	I + E
other codes < 0x8000	reserved		
0x8000 – 0xFFFF	Vendor specific		

5.3.3 AL State Changed

The AL State Changed is mapped to a DL read service to the AL Status and AL Status Code object. The attribute types of AL State Changed are described in Figure 8.

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