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DIN EN 61800-7-202:2008-11

Entwurf

Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 7-202: Generisches Interface und Nutzung von Profilen für Leistungsantriebssysteme (PDS) – Spezifikation von Profil-Typ 2 (IEC 22G/269/CDV:2014); Englische Fassung FprEN 61800-7-202:2014

Adjustable speed electrical power drive systems –
Part 7-202: Generic interface and use of profiles for power drive systems – Profile type 2 specification
(IEC 22G/269/CDV:2014);
English version FprEN 61800-7-202:2014

Entraînements électriques de puissance à vitesse variable –
Partie 7-202: Interface générique et utilisation de profils pour entraînements de puissance – Spécification de profil de type 2
(CEI 22G/269/CDV:2014);
Version anglaise FprEN 61800-7-202:2014

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2015-01-30 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfes besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal des DIN unter www.entwuerfe.din.de bzw. für Norm-Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de, sofern dort wiedergegeben;
- oder als Datei per E-Mail an dke@vde.com möglichst in Form einer Tabelle. Die Vorlage dieser Tabelle kann im Internet unter www.din.de/stellungnahme oder für Stellungnahmen zu Norm-Entwürfen der DKE unter www.dke.de/stellungnahme abgerufen werden;
- oder in Papierform an die DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE, Stresemannallee 15, 60596 Frankfurt am Main.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 256 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

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Nationales Vorwort

Die Englische Fassung des europäischen Dokuments FprEN 61800-7-202:2014 „Elektrische Leistungsantriebssysteme mit einstellbarer Drehzahl – Teil 7-202: Generisches Interface und Nutzung von Profilen für Leistungsantriebssysteme (PDS) – Spezifikation von Profil-Typ 2“ (Entwurf in der Umfrage) ist unverändert in diesen Norm-Entwurf übernommen worden.

Die Internationale Elektrotechnische Kommission (IEC) und das Europäische Komitee für Elektrotechnische Normung (CENELEC) haben vereinbart, dass ein auf IEC-Ebene erarbeiteter Entwurf für eine Internationale Norm zeitgleich (parallel) bei IEC und CENELEC zur Umfrage (CDV-Stadium) und Abstimmung als FDIS (en: Final Draft International Standard) bzw. Schluss-Entwurf für eine Europäische Norm gestellt wird, um eine Beschleunigung und Straffung der Normungsarbeit zu erreichen. Dem entsprechend ist das internationale Dokument IEC 22G/269/CDV:2014 „Adjustable speed electrical power drive systems – Part 7-202: Generic interface and use of profiles for power drive systems – Profile type 2 specification“ unverändert in den Entwurf FprEN 61800-7-202:2014 übernommen worden.

Das internationale Dokument wurde vom SC 22G „Adjustable speed electric drive systems incorporating semiconductor power converters“ der Internationalen Elektrotechnischen Kommission (IEC) erarbeitet.

Bei der Abstimmung zu dem Europäischen Schluss-Entwurf bei CENELEC und dem Internationalen Schluss-Entwurf bei IEC [Final Draft International Standard (FDIS)] sind jeweils nur „JA/NEIN“-Entscheidungen möglich, wobei „NEIN“-Entscheidungen fundiert begründet werden müssen. Dokumente, die bei CENELEC als Europäische Norm angenommen und ratifiziert werden, sind unverändert als Deutsche Normen zu übernehmen.

Für dieses Dokument ist das nationale Arbeitsgremium K 226 „Ausrüstung von Starkstromgeräten und -anlagen mit elektronischen Betriebsmitteln“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

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

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

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen 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 des vorliegenden Normentwurfs der englischen Sprache als Fachsprache bedienen, wird die englische Fassung der FprEN 61800-7-202 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt, und deren Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA des vorliegenden Normentwurfs hinzugefügt. Für viele der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Dieser Normentwurf steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Es ist vorgesehen, auch bei der entsprechenden zukünftigen Deutschen Norm auf die deutsche Sprachfassung zu verzichten und diese in der englischsprachigen Fassung zu veröffentlichen.

Es wird auf die Möglichkeit hingewiesen, dass einige Elemente dieses Dokuments Patentrechte berühren können. ISO [und/oder] IEC sind nicht dafür verantwortlich, einige oder alle diesbezüglichen Patentrechte zu identifizieren.

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Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

Änderungen

Gegenüber DIN EN 61800-7-202:2008-11 wurden folgende Änderungen vorgenommen:

a) Überarbeitung der Spezifikationen für das Antriebsprofil und die Antriebsachse;

b) redaktionelle Überarbeitung des gesamten Dokumentes.

Nationaler Anhang NA
(informativ)

Die deutschen Übersetzungen haben Empfehlungscharakter und können nur die ungefähre Begrifflichkeit in Deutsch wiedergeben. Unter Experten wird empfohlen, ausschließlich die englischen Fachbegriffe zu verwenden, um die Gefahr von Missverständnissen zu reduzieren.

1 Anwendungsbereich

IEC 61800-7 beschreibt Profile für Leistungsantriebssysteme (en: Power Drive Systems, PDS) und ihre Abbildung auf bestehende Kommunikationssysteme unter Verwendung eines generischen Schnittstellenmodells.

Es ist nicht Zweck der in diesem Teil der IEC 61800-7 beschriebenen Funktionen, funktionale Sicherheit zu gewährleisten. Dies erfordert zusätzliche Maßnahmen nach den maßgeblichen Normen, Vereinbarungen und Gesetzen.

Dieser Teil der IEC 61800-7 beschreibt den Profil-Typ 2 (CIP Motion™) für Leistungsantriebssysteme (PDS). Profil-Typ 2 kann auf verschiedene Technologien für Kommunikationsnetzwerke abgebildet werden.

3 Begriffe und Abkürzungen

3.1 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.1.1
Algorithmus
(en: algorithm)
vollständig bestimmte endliche Folge von Anweisungen, nach denen die Werte der Ausgangsgrößen aus den Werten der Eingangsgrößen berechnet werden können

[QUELLE: IEV 351-21-37]

3.1.2
Anwendung
(en: application)
funktionales Element der Software, spezifisch für die Problemlösung beim Messen und Steuern in industriellen Prozessen

Anmerkung 1 zum Begriff: Eine Anwendung kann über Ressourcen verteilt sein und kann mit anderen Anwendungen kommunizieren.

[QUELLE: IEC/TR 62390:2005, 3.1.2, modifiziert]

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3.1.3
Anwendungsmodus
(en: application mode)
Art der Anwendung, die von einem PDS angefordert werden kann

Anmerkung 1 zum Begriff: Die verschiedenen Anwendungsmodi spiegeln den Regelkreis für die Regelung des Drehmoments, der Geschwindigkeit, der Position oder andere Anwendungen, wie Referenzieren, wider.

3.1.4
Attribut
(en: attribute)
Eigenschaft oder Charakteristik einer Einheit

[QUELLE: IEC/TR 62390:2005, 3.1.3]

3.1.5
Achse
(en: axis)
logisches Element eines Bewegungssteuerungssystems, das eine bestimmte Form der Bewegung darstellt

Anmerkung 1 zum Begriff: Achsen können rotatorisch oder linear, physikalisch oder virtuell, gesteuert oder nur beobachtet sein.

Anmerkung 2 zum Begriff: Eine physikalische Achse kann eine oder mehrere der folgenden Komponenten einschließen: einen Bewegungssensor, eine Bewegungssteuerungsstruktur, einen Leistungsverstärker und einen Bewegungsaktor.

3.1.6
Busregler
(en: bus regulator)
jede Methode zur Begrenzung des Anstiegs der Zwischenkreisspannung, was bei Verringerung der Motorgeschwindigkeit auftreten kann

3.1.7
CIP Motion™[1]
(en: CIP Motion™)
Erweiterungen der CIP-Dienste und des CIP-Protokolls zur Unterstützung der Bewegungssteuerung über CIP-Netzwerke

3.1.8
CIP(-Motion)-Antrieb
(en: CIP (Motion) drive)
Antrieb, der mit der CIP(-Motion)-Spezifikation konform ist

3.1.9
CIP-Motion-Antriebsprofil
(en: CIP Motion drive profile)
Zusammenstellung von Objekten, die zur Implementierung eines CIP-Motion-Antriebsgerätes verwendet werden, welche das Bewegungsgerät-Achsenobjekt sowie standardmäßige Unterstützungsobjekte, wie das Identitätsobjekt (en: Identity Object) und das Zeitsynchronisationsobjekt (en: Time Sync Object), umfasst

[1] CIP Motion™ und CIP Sync™ sind Marken der Open DeviceNet Vendor Association, Inc. Diese Informationen sind zum Nutzen der Anwender dieser Internationalen Norm enthalten, stellen aber keine Bevorzugung des Inhabers der Marke oder seiner Produkte durch die IEC dar. Für die Konformität mit diesem Profil ist die Nutzung der Marken CIP Motion™ und CIP Sync™ nicht erforderlich. Die Nutzung der Marken CIP Motion™ und CIP Sync™ bedarf der Genehmigung der Open DeviceNet Vendor Association, Inc.

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3.1.10
CIP-Motion-E/A-Verbindung
(en: CIP Motion I/O connection)
periodische, bidirektionale (Klasse 1) CIP-Verbindung zwischen einer Steuerung und einem Antrieb, die als Teil der CIP-Motion-Spezifikation festgelegt ist

3.1.11
CIP Sync™[16]
(en: CIP Sync™)
Erweiterungen der CIP-Dienste und des CIP-Protokolls zur Einkapselung der Zeitsynchronisationsfunktionalität nach IEC 61588:2009 über ein CIP-Netzwerk (siehe Zeitsynchronisationsobjekt (en: Time Sync Object) in IEC 61158-5-2 und IEC 61158-6-2)

3.1.12
Klasse
(en: class)
Beschreibung einer Menge von Objekten, die dieselben Attribute, Operationen, Methoden, Beziehungen und Bedeutungen haben

[QUELLE: ISO/IEC 19501, modifiziert]

3.1.13
geschlossener Regelkreis
(en: closed loop)
Methoden zur Regelung, bei denen ein bestimmtes Rückführsignal zum Antrieb der tatsächlichen Dynamik des Motors verwendet wird, um die vorgegebene Dynamik durch einen Servovorgang abzugleichen

Anmerkung 1 zum Begriff: In den meisten Fällen gibt es ein tatsächliches Rückführgerät, welches dieses Signal bereitstellt; in einigen Fällen jedoch wird das Signal von der Motoransteuerung (d. h. einer sensorlosen Operation) abgeleitet.

3.1.14
Befehle
(en: commands)
Menge an Befehlen von dem Programm zur Steuerung der Anwendung an das PDS, um das Verhalten des PDS oder der funktionalen Elemente des PDS zu steuern

Anmerkung 1 zum Begriff: Das Verhalten wird durch Zustände oder Betriebsarten wiedergegeben.

Anmerkung 2 zum Begriff: Die verschiedenen Befehle können jeweils durch ein Bit dargestellt werden.

3.1.15
Leiten
(en: control)
zweckmäßige Maßnahmen an oder in einem Prozess, um vorgegebene Ziele zu erreichen

[QUELLE: IEV 351-21-29, modifiziert]

3.1.16
Steuergerät
(en: control device)
physikalische Einheit, die – innerhalb eines Moduls/einer Baugruppe oder eines Gerätes – ein Anwendungsprogramm zur Steuerung des PDS enthält

3.1.17
Stromrichter
(en: converter)
Gerät, das üblicherweise eingehenden Wechselstrom in ausgehenden Gleichstrom umformt

Anmerkung 1 zum Begriff: Ein Stromrichter wird gemeinhin auch als Stromversorgung des Antriebs bezeichnet. Im Zusammenhang mit einem Antriebssystem ist der Stromrichter für die Umformung eines AC-Netzanschlusses in einen DC-Zwischenkreis verantwortlich.

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3.1.18
zyklischer Datenblock
(en: cyclic data block)
Echtzeitdatenblock mit hoher Priorität, der über eine CIP-Motion-Verbindung regelmäßig übertragen wird

3.1.19
Datentyp
(en: data type)
Menge von Werten mit einer Menge zulässiger Operationen

[QUELLE: ISO/IEC 2382-15:1999, 15.04.01, modifiziert]

3.1.20
Gerät
(en: device)
Feldgerät
vernetzte unabhängige physikalische Einheit eines industriellen Automatisierungssystems, die fähig ist, spezifische Funktionen in einem bestimmten Kontext auszuführen und die durch ihre Schnittstellen begrenzt ist

[QUELLE: IEC 61499-1:2005, 3.30, modifiziert]

Einheit, die Steuerungs- und Regelfunktionen sowie Aktor- und/oder Sensorfunktionen ausführt und Schnittstellen zu anderen derartigen Einheiten innerhalb eines Automatisierungssystems hat

[QUELLE: ISO 15745-1:2003, 3.11]

3.1.21
Geräteprofil
(en: device profile)
Darstellung eines Gerätes bezüglich seiner Parameter, seiner Parametergruppen und seines Verhaltens nach einem Gerätemodell, das die Daten und das Verhalten des Gerätes beschreibt, wie es durch ein Netzwerk gesehen wird

Anmerkung 1 zum Begriff: Dies ist eine Definition aus IEC/TS 61915, die durch das Hinzufügen der funktionalen Gerätestruktur erweitert ist.

[QUELLE: IEC/TR 62390:2005, 3.1.9, modifiziert]

3.1.22
Antrieb
(en: drive)
Gerät, das zur Steuerung der Dynamik eines Motors vorgesehen ist

3.1.23
Ereignisdatenblock
(en: event data block)
Echtzeitdatenblock mit mittlerer Priorität, der über eine CIP-Motion-Verbindung nur dann übertragen wird, wenn ein festgelegtes Ereignis auftritt

Anmerkung 1 zum Begriff: Übergänge bei Registrierung und Markierungseinträgen sind typische Antriebsereignisse.

3.1.24
funktionales Element
(en: functional element)
Einheit von Software oder von Software, die mit Hardware kombiniert ist, fähig, eine festgelegte Funktion eines Gerätes zu erfüllen

Anmerkung 1 zum Begriff: Ein funktionales Element hat eine Schnittstelle zu anderen funktionalen Elementen und Funktionen.

Anmerkung 2 zum Begriff: Ein funktionales Element kann aus einem oder mehreren Funktionsbausteinen, Objekten oder Parameterlisten erstellt werden.

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[QUELLE: IEC/TR 62390:2005, 3.1.12]

3.1.25
Abrufen/Lesen
(en: get/read)
Operation, die den Empfang eines Attributwerts aus der Sicht der Steuerseite der Schnittstelle einschließt

3.1.26
Eingangsdaten
(en: input data)
Daten, die von einer externen Quelle in ein Gerät, eine Ressource oder ein funktionales Element übertragen werden

[QUELLE: IEC/TR 62390:2005, 3.1.14]

3.1.27
Schnittstelle
(en: interface)
Grenze zwischen zwei Einheiten, die durch funktionale Merkmale, Signal-Eigenschaften oder andere geeignete charakteristische Merkmale festgelegt ist

[QUELLE: IEV 351-21-35, modifiziert]

3.1.28
Wechselrichter
(en: inverter)
Gerät, das üblicherweise eingehenden Gleichstrom in ausgehenden Wechselstrom umformt

Anmerkung 1 zum Begriff: Ein Wechselrichter wird gemeinhin auch als Antriebsverstärker bezeichnet. Im Zusammenhang mit einem Antriebssystem ist der Wechselrichter für die Steuerung bzw. Regelung des Energieflussses vom Gleichstromszwischenkreis zu einem Wechselstrommotor verantwortlich.

3.1.29
Modell
(en: model)
mathematische oder physikalische Darstellung eines Systems oder Prozesses, die das System oder den Prozess aufgrund bekannter Gesetzmäßigkeiten, einer Identifikation oder getroffener Annahmen genügend genau abbildet

[QUELLE: IEV 351-21-36]

3.1.30
Bewegung
(en: motion)
jeder Aspekt der Dynamik einer Achse

Anmerkung 1 zum Begriff: Im Kontext dieses Teils der IEC 61800 ist dies nicht auf Servo-Antriebe begrenzt, sondern umfasst alle Formen der antriebsbasierten Motorsteuerung.

3.1.31
Bewegungsgerät-Achsenobjekt
(en: Motion Device Axis Object)
Objekt, das die Attribute, die Dienste und das Verhalten einer bewegungsgerätbasierten Achse entsprechend der CIP-Motion-Spezifikation festlegt

3.1.32
Bewegungssteuerungs-Achsenobjekt
(en: Motion Control Axis Object)
Objekt, das die Attribute, die Dienste und das Verhalten einer reglerbasierten Achse entsprechend der CIP-Motion-Spezifikation festlegt

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3.1.33
offener Regelkreis
(en: open loop)
Methoden zur Regelung, bei denen keine Rückführung angewendet wird, um die tatsächliche Dynamik des Motors zwingend an die vorgegebene Dynamik anzugleichen

BEISPIEL Beispiele für offene Regelkreise sind Schrittantriebe und Frequenzumrichter-Antriebe.

3.1.34
Betriebsart
(en: operating mode)
Kennzeichnung von Art und Umfang, wie der Mensch als Bediener in eine Leiteinrichtung eingreift

[QUELLE: IEV 351-31-01]

3.1.35
Ausgangsdaten
(en: output data)
Daten, die von einem Gerät, einer Ressource oder einem funktionalen Element in externe Systeme übertragen werden

[QUELLE: IEC/TR 62390:2005, 3.1.21]

3.1.36
Parameter
(en: parameter)
Datenelement, das Geräteinformationen darstellt, die aus einem Gerät gelesen oder in ein Gerät geschrieben werden können; z. B. durch ein Netzwerk oder ein lokales Bediengerät

Anmerkung 1 zum Begriff: Aus IEC/TS 61915, angepasst.

Anmerkung 2 zum Begriff: Ein Parameter ist typischerweise durch einen Parameternamen, einen Datentyp und eine Zugriffsrichtung gekennzeichnet.

[QUELLE: IEC/TR 62390:2005, 3.1.22, modifiziert]

3.1.37
Profil
(en: profile)
Darstellung einer PDS-Schnittstelle hinsichtlich ihrer Parameter, Parametergruppierung und ihres Verhaltens nach einem Kommunikations- und einem Geräteprofil

3.1.38
Dienstdatenblock
(en: service data block)
Echtzeitdatenblock mit niedriger Priorität in Verbindung mit einer Dienstnachricht von der Steuerung, der über eine CIP-Motion-Verbindung regelmäßig übertragen wird

Anmerkung 1 zum Begriff: Dienstdaten schließen Dienstanforderungsnachrichten ein, um auf Attribute von Bewegungsgerät-Achsenobjekten zuzugreifen oder verschiedene Antriebsdiagnosen durchzuführen.

3.1.39
Sollwert
(en: set-point)
(im Zusammenhang mit einem Gerät) Wert, der an den Antrieb gesendet wird, der zur direkten Regelung einiger Aspekte der Motordynamik verwendet wird, zu denen (unter anderem) die Position, die Geschwindigkeit, die Beschleunigung und der Drehmoment gehören

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3.1.40
Festlegen/Schreiben
(en: set/write)
Operation, die die Festlegung eines Attributs auf einen bestimmten Wert aus der Sicht der Steuerseite der Schnittstelle einschließt

3.1.41
Parallelregler
(en: shunt regulator)
spezielle Methode der Regelung des Gleichstromzwischenkreises, bei der der Gleichstromzwischenkreis über mit Widerstand zur Aufnahme der Verlustleistung verschaltet wird, um die Bremsenergie eines seine Geschwindigkeit verringernden Motors umzuwandeln

3.1.42
Zustand
(en: status)
Menge an Informationen von dem PDS an das Programm zur Steuerung der Anwendung, die den Zustand oder die Betriebsart des PDS oder eines funktionalen Elementes des PDS wiedergibt

Anmerkung 1 zum Begriff: Die verschiedenen Zustandsinformationen können jeweils mit einem Bit kodiert werden.

3.1.43
synchronisiert
(en: synchronised)
Zustand, in dem der Wert der lokalen Uhr des Antriebs auf die Master-Uhr der verteilten Systemzeit gebunden ist

Anmerkung 1 zum Begriff: Im synchronisierten Zustand können die Antriebsgeräte und Regeleinrichtungen Zeitstempel in Verbindung mit CIP-Motion-Verbindungsdaten verwenden.

3.1.44
Systemzeit
(en: System Time)
absoluter Zeitwert, wie in der CIP-Sync-Spezifikation festgelegt, im Kontext eines verteilten Systems, in dem alle Geräte über lokale Uhren verfügen, die mit einer gemeinsamen Master-Uhr synchronisiert werden

Anmerkung 1 zum Begriff: Im Zusammenhang mit CIP Motion entspricht die Systemzeit einem ganzzahligen 64-Bit-Wert in Nanosekunden mit einem Wert von 0 entsprechend dem Datum 01.01.1970.

3.1.45
thermisches Modell
(en: thermal model)
jeder Algorithmus, der das thermische Verhalten des entsprechenden Gerätes während des Betriebs zu modellieren versucht

3.1.46
Zeitabstand
(en: time offset)
Abstandswert der Systemzeit in Verbindung mit den CIP-Motion-Verbindungsdaten, der dem Quellgerät zugeordnet ist

Anmerkung 1 zum Begriff: Der Systemzeitabstand entspricht einem 64-Bit-Abstandswert, welcher der lokalen Uhr des Gerätes hinzugefügt wird, um die Systemzeit für dieses Gerät zu erzeugen.

3.1.47
Zeitstempel
(en: time stamp)
Stempelwert der Systemzeit in Verbindung mit den CIP-Motion-Verbindungsdaten, der den absoluten Zeitpunkt der Erfassung der zugehörigen Daten übermittelt oder auch zur Festlegung der Anwendung der zugehörigen Daten verwendet werden kann

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3.1.48
Typ
(en: type)
Hardware- oder Software-Element, das die gemeinsamen Attribute festlegt, die von allen Instanzen des Typs gemeinsam genutzt werden

[QUELLE: IEC/TR 62390:2005, 3.1.25]

3.1.49
Variable
(en: variable)
Software-Einheit, die jeweils verschiedene Werte zu einer Zeit annehmen kann

[QUELLE: IEC/TR 62390:2005, 3.1.27]

Anmerkung 1 zum Begriff: Die Werte sowohl einer Variablen als auch eines Parameters sind üblicherweise auf einen bestimmten Datentyp festgelegt.

3.1.50
Frequenzumrichter-Antrieb
VFD
(en: Variable Frequency Drive)
Klasse von Antriebsprodukten, die die Geschwindigkeit eines Motors, üblicherweise eines Induktionsmotors, über eine proportionale Beziehung zwischen der Antriebsausgangsspannung und der vorgegebenen Ausgangsfrequenz regeln

Anmerkung 1 zum Begriff: Frequenzumrichter-Antriebe werden deshalb manchmal als U/f-Antriebe bezeichnet.

3.1.51
Vektorantrieb
(en: vector drive)
Klasse von Antriebsprodukten, die die Dynamik eines Motors über einen geschlossen Regelkreis regeln, wobei (unter anderem) sowohl Drehmoment- als auch Fluss-Vektor-Komponenten des Statorstroms des Motors in Bezug auf den Fluss-Vektor des Rotors geregelt werden

3.2 Abkürzungen

Ack	Bestätigen (en: Acknowledge)
Act	Ist (en: Actual)
Blk	Block
CIP™	Common Industrial Protocol (siehe IEC 61158 Typ 2, IEC 61784-1 und IEC 61784-2 CPF 2)
Cmd	Befehl (en: Command)
Cyc	zyklisch (en: Cyclic)
HMI	Mensch-Maschine-Schnittstelle (en: Human Machine Interface)
ID	Kennzeichner (en: Identifier)
I/O	Eingang/Ausgang (en: Input/Output)
Opt.	optional
PDS	Leistungsantriebssystem (en: Power Drive System)
Req.	erforderlich (en: Required)

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RMS	Effektivwert (en: Root Mean Square)
RPM	Umdrehungen je Minute (en: Revolutions per minute)
Sync'd	synchronisiert (en: Synchronized)
TCP	Transmission Control Protocol (siehe RFC 793)
UDP	User Datagram Protocol (siehe RFC 768)
VFD	Frequenzumrichter-Antrieb (en: Variable Frequency Drive)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 7-202: Generic interface and use of profiles for power drive systems – Profile type 2 specification

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International Standard IEC 61800-7-202 has been prepared by subcommittee SC 22G: Adjustable speed electric drive systems incorporating semiconductor power converters, of IEC technical committee TC 22: Power electronic systems and equipment.

This second edition cancels and replaces the first edition published in 2007. This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below.

- Update of patent information
- New revision of the Drive Profile and Drive Axis specifications, with multiple clarifications and enhancements
- Miscellaneous editorial corrections

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

FDIS	Report on voting
22G/XX/FDIS	22G/XX/RVD

57
58 Full information on the voting for the approval of this standard can be found in the report on
59 voting indicated in the above table.

60 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

61 A list of all parts of the IEC 61800 series, under the general title *Adjustable speed electrical*
62 *power drive systems*, can be found on the IEC website.

63 The committee has decided that the contents of this publication will remain unchanged until
64 the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data
65 related to the specific publication. At this date, the publication will be

66 • reconfirmed;
67 • withdrawn;
68 • replaced by a revised edition, or
69 • amended.

70

71 The National Committees are requested to note that for this publication the stability date
72 is 2019.

73 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE
74 DELETED AT THE PUBLICATION STAGE.

75

76 **IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it**
77 **contains colours which are considered to be useful for the correct understanding of its**
78 **contents. Users should therefore print this document using a colour printer.**

79

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INTRODUCTION

0.1 General

The IEC 61800 series is intended to provide a common set of specifications for adjustable speed electrical power drive systems.

IEC 61800-7 describes a generic interface between control systems and power drive systems. This interface can be embedded in the control system. The control system itself can also be located in the drive (sometimes known as "smart drive" or "intelligent drive").

A variety of physical interfaces is available (analogue and digital inputs and outputs, serial and parallel interfaces, fieldbuses and networks). Profiles based on specific physical interfaces are already defined for some application areas (e.g. motion control) and some device classes (e.g. standard drives, positioner). The implementations of the associated drivers and application programmers interfaces are proprietary and vary widely.

IEC 61800-7 defines a set of common drive control functions, parameters, and state machines or description of sequences of operation to be mapped to the drive profiles.

IEC 61800-7 provides a way to access functions and data of a drive that is independent of the used drive profile and communication interface. The objective is a common drive model with generic functions and objects suitable to be mapped on different communication interfaces. This makes it possible to provide common implementations of motion control (or velocity control or drive control applications) in controllers without any specific knowledge of the drive implementation.

There are several reasons to define a generic interface:

For a drive device manufacturer

- Less effort to support system integrators
- Less effort to describe drive functions because of common terminology
- The selection of drives does not depend on availability of specific support

For a control device manufacturer

- No influence of bus technology
- Easy device integration
- Independent of a drive supplier

For a system integrator

- Less integration effort for devices
- Only one understandable way of modeling
- Independent of bus technology

Much effort is needed to design a motion control application with several different drives and a specific control system. The tasks to implement the system software and to understand the functional description of the individual components may exhaust the project resources. In some cases, the drives do not share the same physical interface. Some control devices just support a single interface which will not be supported by a specific drive. On the other hand, the functions and data structures are often specified with incompatibilities. This requires the system integrator to write special interfaces for the application software and this should not be his responsibility.

Some applications need device exchangeability or integration of new devices in an existing configuration. They are faced with different incompatible solutions. The efforts to adopt a solution to a drive profile and to manufacturer specific extensions may be unacceptable. This will reduce the degree of freedom to select a device best suited for this application to the selection of the unit which will be available for a specific physical interface and supported by the controller.

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126 IEC 61800-7-1 is divided into a generic part and several annexes as shown in Figure 1. The
127 drive profiles types for CiA® 402[1], CIP Motion™[2], PROFIdrive[3] and SERCOS®[4] are mapped
128 to the generic interface in the corresponding annex. The annexes have been submitted by
129 open international network or fieldbus organizations which are responsible for the content of
130 the related annex and use of the related trade marks.

131 This part of IEC 61800-7 specifies the profile type 2 (CIP Motion™).

132 The profile types 1, 3 and 4 are specified in IEC 61800-7-201, IEC 61800-7-203 and
133 IEC 61800-7-204.

134 IEC 61800-7-301, IEC 61800-7-302, IEC 61800-7-303 and IEC 61800-7-304 specify how the
135 profile types 1, 2, 3 and 4 are mapped to different network technologies (such as CANopen®[5],
136 CC-Link IE® Field Network[6], EPA™[7], EtherCAT®[8], Ethernet Powerlink™[9], DeviceNet™[10],
137 ControlNet™[11], EtherNet/IP™[12], PROFIBUS[13], PROFINET[14] and SERCOS®).

---

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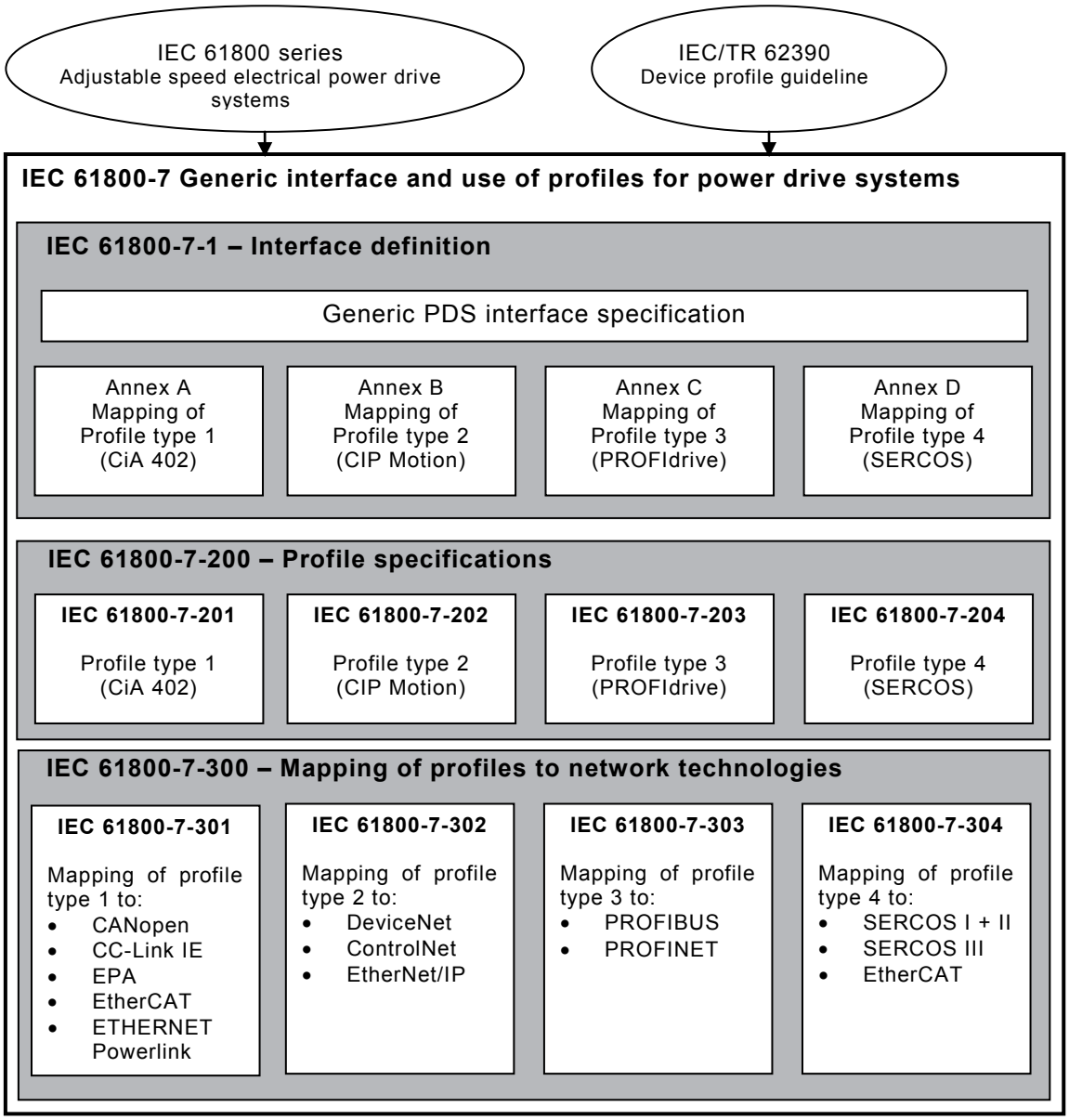


Figure 1 – Structure of IEC 61800-7

0.2 Patent declaration

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent concerning the following.

Publication / Application serial number	Holder	Title
US 7,983,769 EP 1659465	[RA]	Time stamped motion control network protocol that enables balanced single cycle timing and utilization of dynamic data structures

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ADJUSTABLE SPEED ELECTRICAL POWER DRIVE SYSTEMS –

Part 7-202: Generic interface and use of profiles for power drive systems – Profile type 2 specification

1 Scope

IEC 61800-7 specifies profiles for Power Drive Systems (PDS) and their mapping to existing communication systems by use of a generic interface model.

The functions specified in this part of IEC 61800-7 are not intended to ensure functional safety. This requires additional measures according to the relevant standards, agreements and laws.

This part of IEC 61800-7 specifies profile type 2 (CIP Motion™) for Power Drive Systems (PDS). Profile type 2 can be mapped onto different communication network technologies.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 61131-3, *Programmable controllers – Part 3: Programming languages*

IEC 61158-4-2:2014[15], *Industrial communication networks – Fieldbus specifications – Part 4-2: Data-link layer protocol specification – Type 2 elements*

IEC 61158-5-2:2014[15], *Industrial communication networks – Fieldbus specifications – Part 5-2: Application layer service definition – Type 2 elements*

IEC 61158-6-2:2014[15], *Industrial communication networks – Fieldbus specifications – Part 6-2: Application layer protocol specification – Type 2 elements*

IEC 61588:2009, *Precision clock synchronization protocol for networked measurement and control systems*

IEC 61800-7 (all parts), *Adjustable speed electrical power drive systems – Generic interface and use of profiles for power drive systems*

IEC 61800-7-1, *Adjustable speed electrical power drive systems – Part 7-1: Generic interface and use of profiles for power drive systems – Interface definition*

IEEE 802.1Q, *IEEE standards for local and metropolitan area networks – Virtual bridged local area networks*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

[15] To be published.

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3.1.1
algorithm
completely determined finite sequence of operations by which the values of the output data can be calculated from the values of the input data

[SOURCE: IEV 351-21-37]

3.1.2
application
software functional element specific to the solution of a problem in industrial-process measurement and control

Note 1 to entry: An application may be distributed among resources, and may communicate with other applications.

[SOURCE: IEC/TR 62390:2005, 3.1.2, modified]

3.1.3
application mode
type of application that can be requested from a PDS

Note 1 to entry: The different application modes reflect the control loop for torque control, velocity control, position control or other applications like homing.

3.1.4
attribute
property or characteristic of an entity

[SOURCE: IEC/TR 62390:2005, 3.1.3]

3.1.5
axis
logical element of a motion control system that exhibits some form of movement

Note 1 to entry: Axes can be rotary or linear, physical or virtual, controlled or simply observed.

Note 2 to entry: A physical axis may include one or more of the following components: a motion sensor, a motion control structure, a power amplifier, and a motion actuator.

3.1.6
bus regulator
any method used to limit the rise in DC bus voltage level that occurs when decelerating a motor

3.1.7
CIP Motion™ [16]
extensions to the CIP services and protocol to support motion control over CIP networks

3.1.8
CIP (Motion) drive
drive that complies with the CIP (Motion) specification

3.1.9
CIP Motion drive profile
collection of objects used to implement a CIP Motion drive device that includes the Motion Device Axis Object, as well as standard support objects like the Identity Object and the Time Sync Object

3.1.10
CIP Motion I/O connection
periodic bi-directional, class 1, CIP connection between a controller and a drive that is defined as part of the CIP Motion specification

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16 CIP Motion™ and CIP Sync™ are trade marks of Open DeviceNet Vendor Association, Inc. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by IEC of the trade mark holder or any of its products. Compliance to this profile does not require use of the trade marks CIP Motion™ or CIP Sync™. Use of the trade marks CIP Motion™ or CIP Sync™ requires permission of Open DeviceNet Vendor Association, Inc.

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3.1.11
CIP Sync™[16]
extensions to the CIP services and protocol to encapsulate IEC 61588:2009 time synchronisation functionality over a CIP Network (see Time Sync Object in IEC 61158-5-2 and IEC 61158-6-2)

3.1.12
class
description of a set of objects that share the same attributes, operations, methods, relationships, and semantics

[SOURCE: ISO/IEC 19501, modified]

3.1.13
closed loop
methods of control where there is a feedback signal of some kind that is used to drive the actual dynamics of the motor to match the commanded dynamics by servo action

Note 1 to entry: In most cases, there is a literal feedback device to provide this signal, but in some cases, the signal is derived from the motor excitation (i.e. sensorless operation).

3.1.14
commands
set of commands from the application control program to the PDS to control the behaviour of the PDS or functional elements of the PDS

Note 1 to entry: The behaviour is reflected by states or operating modes.

Note 2 to entry: The different commands may be represented by one bit each.

3.1.15
control
purposeful action on or in a process to meet specified objectives

[SOURCE: IEV 351-21-29, modified]

3.1.16
control device
physical unit that contains – in a module/subassembly or device – an application program to control the PDS

3.1.17
converter
device that generally converts AC input to DC output

Note 1 to entry: A converter is also commonly called the Drive Power Supply. In the context of a drive system, the converter is responsible for converting AC main input into DC bus power.

3.1.18
cyclic data block
high priority real-time data block that is transferred by a CIP Motion connection on a periodic basis

3.1.19
data type
set of values together with a set of permitted operations

[SOURCE: ISO/IEC 2382-15:1999, 15.04.01, modified]

3.1.20
device
field device
networked independent physical entity of an industrial automation system capable of performing specified functions in a particular context and delimited by its interfaces

[SOURCE: IEC 61499-1:2005, 3.30, modified]

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entity that performs control, actuating and/or sensing functions and interfaces to other such entities within an automation system

[SOURCE: ISO 15745-1:2003, 3.11]

3.1.21
device profile
representation of a device in terms of its parameters, parameter assemblies and behaviour according to a device model that describes the device's data and behaviour as viewed through a network

Note 1 to entry: This is a definition from IEC/TS 61915 which is extended by the addition of the device functional structure.

[SOURCE: IEC/TR 62390:2005, 3.19, modified]

3.1.22
drive
device designed to control the dynamics of a motor

3.1.23
event data block
medium priority real-time data block that is transferred by a CIP Motion connection only after a specified event occurs

Note 1 to entry: Registration and marker input transitions are typical drive events.

3.1.24
functional element
entity of software or software combined with hardware, capable of accomplishing a specified function of a device

Note 1 to entry: A functional element has an interface, associations to other functional elements and functions.

Note 2 to entry: A functional element can be made out of function block(s), object(s) or parameter list(s).

[SOURCE: IEC/TR 62390:2005, 3.1.12]

3.1.25
get/read
operation that involves the retrieving of an attribute value from the perspective of the controller side of the interface

3.1.26
input data
data transferred from an external source into a device, resource or functional element

[SOURCE: IEC/TR 62390:2005, 3.1.14]

3.1.27
interface
shared boundary between two entities defined by functional characteristics, signal characteristics, or other characteristics as appropriate

[SOURCE: IEV 351-21-35, modified]

3.1.28
inverter
device that generally converts DC input to AC output

Note 1 to entry: An inverter is also commonly called the Drive Amplifier. In the context of a drive system, the inverter is responsible for controlling the application of DC bus power to an AC motor.

3.1.29
model
mathematical or physical representation of a system or a process, based with sufficient precision upon known laws, identification or specified suppositions

[SOURCE: IEV 351-21-36]

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3.1.30
motion
any aspect of the dynamics of an axis

Note 1 to entry: In the context of this part of IEC 61800-7, it is not limited to servo drives but encompasses all forms of drive based motor control.

3.1.31
Motion Device Axis Object
object that defines the attributes, services, and behaviour of a motion device based axis according to the CIP Motion specification

3.1.32
Motion Control Axis Object
object that defines the attributes, services, and behaviour of a controller based axis according to the CIP Motion specification

3.1.33
open loop
methods of control where there is no application of feedback to force the actual motor dynamics to match the commanded dynamics

EXAMPLE Examples of open loop control are stepper drives and variable frequency drives.

3.1.34
operating mode
characterisation of the way and the extent to which the human operator intervenes in the control equipment

[SOURCE: IEV 351-31-01]

3.1.35
output data
data originating in a device, resource or functional element and transferred from them to external systems

[SOURCE: IEC/TR 62390:2005, 3.1.21]

3.1.36
parameter
data element that represents device information that can be read from or written to a device, for example through the network or a local HMI

Note 1 to entry: Adapted from IEC/TS 61915.

Note 2 to entry: A parameter is typically characterised by a parameter name, data type and access direction.

[SOURCE: IEC/TR 62390:2005, 3.1.22, modified]

3.1.37
profile
representation of a PDS interface in terms of its parameters, parameter assemblies and behaviour according to a communication profile and a device profile

3.1.38
service data block
lower priority real-time data block associated with a service message from the controller that is transferred by a CIP Motion connection on a periodic basis

Note 1 to entry: Service data includes service request messages to access Motion Device Axis Object attributes or perform various drive diagnostics.

3.1.39
set-point
(in the context of a device) value sent to the drive that is used to directly control some aspect of the motor dynamics, which includes (but is not limited to) position, velocity, acceleration, and torque

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3.1.40
set/write
operation that involves the setting of an attribute to a specified value from the perspective of the controller side of the interface

3.1.41
shunt regulator
specific bus regulator method that switches the DC bus across a power dissipating resistor to dissipate the regenerative power of a decelerating motor

3.1.42
status
set of information from the PDS to the application control program reflecting the state or mode of the PDS or a functional element of the PDS

Note 1 to entry: The different status information may be coded with one bit each.

3.1.43
synchronised
condition where the local clock value on the drive is locked onto the master clock of the distributed System Time

Note 1 to entry: When synchronised, the drive and controller devices may utilise time stamps associated with CIP Motion connection data.

3.1.44
System Time
absolute time value as defined in the CIP Sync specification in the context of a distributed time system where all devices have a local clock that is synchronised with a common master clock

Note 1 to entry: In the context of CIP Motion, System Time is a 64-bit integer value in units of nanoseconds with a value of 0 corresponding to the date 1970-01-01.

3.1.45
thermal model
any algorithm that attempts to model the thermal behaviour of the associated device during operation

3.1.46
time offset
System Time offset value associated with the CIP Motion connection data that is associated with source device

Note 1 to entry: The System Time offset is a 64-bit offset value that is added to a device's local clock to generate System Time for that device

3.1.47
time stamp
System Time stamp value associated with the CIP Motion connection data that conveys the absolute time when the associated data was captured, or that can also be used to determine when the associated data shall be applied

3.1.48
type
hardware or software element which specifies the common attributes shared by all instances of the type

[SOURCE: IEC/TR 62390:2005, 3.1.25]

3.1.49
variable
software entity that may take different values, one at a time

[SOURCE: IEC/TR 62390:2005, 3.1.27]

Note 1 to entry: The values of a variable as well as of a parameter are usually restricted to a certain data type.

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3.1.50
Variable Frequency Drive
VFD
class of drive products that seek to control the speed of a motor, typically an induction motor, through a proportional relationship between drive output voltage and commanded output frequency

Note 1 to entry: Variable Frequency Drives are therefore sometimes referred to as a Volts/Hertz drives.

3.1.51
vector drive
class of drive products that seek to control the dynamics of a motor via closed loop control which includes, but is not limited to, closed loop control of both torque and flux vector components of motor stator current relative to the rotor flux vector

3.2 Abbreviated terms

Ack	Acknowledge
Act	Actual
Blk	Block
CIP™	Common Industrial Protocol (see IEC 61158 Type 2, IEC 61784-1 and IEC 61784-2 CPF2)
Cmd	Command
Cyc	Cyclic
HMI	Human Machine Interface
ID	Identifier
I/O	Input/Output
Opt.	Optional
PDS	Power Drive System
Req.	Required
RMS	Root mean square
RPM	Revolutions per minute
Sync'd	Synchronized
TCP	Transmission Control Protocol (see RFC 793)
UDP	User Datagram Protocol (see RFC 768)
VFD	Variable Frequency Drive

4 General

4.1 General

A CIP Motion drive device controls the motion of one or more drive axes, typically consisting of a rotary or linear motor actuator and optional feedback devices. Each associated motor is driven by an associated drive power structure that is also part of the device. Motor control functionality supported by the CIP Motion drive device profile can be applied to a variety of motion actuators such as "open loop" Variable Frequency Drives or "closed loop" Vector Controlled Servo Drives. In either case, axis motion is controlled via a command reference that can be configured for position control, velocity control, acceleration control, or current/torque control. The CIP Motion drive device profile also supports use of additional drive feedback channels as master feedback sources.

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This CIP Motion drive profile specification and the associated Motion Device Axis Object specification define the interface, the specific attributes, and command behaviours required to support motion control when connected to a CIP Motion compliant controller through a CIP network.

Of the applicable CIP Networks, EtherNet/IP™ is the network of choice for high performance, synchronised multi-axis control. Other CIP networks such as ControlNet™ and DeviceNet™ could be applied to lower performance non-synchronised device applications such as simple variable frequency drives, velocity loop drives, and indexing drives.

4.2 Control modes

4.2.1 General

The Motion Device Axis Object covers the behavior of various motion control system devices that includes feedback devices and drive devices. For drive devices, the Motion Device Axis Object covers a wide range of drive types from simple variable frequency (V/Hz) drives, to sophisticated position control servo drives. Indeed, many commercial drive products have axes that can be configured to operate in any one of these different motion control modes depending on the specific application requirement.

IEC 61800-7-1 and this part of the IEC 61800-7 series are organised around the general philosophy that position control is the highest form of dynamic control. That is, position control implies velocity control, and velocity control implies acceleration control. Acceleration is related to torque or force by the inertia or mass of the load, respectively, acceleration control implies torque control. And finally, since motor torque or force is generally related to motor current by a torque or force constant, respectively, torque control implies current control. The torque or force constant can be a function of the motor magnets as in a Permanent Magnet motor, or the induced flux of an Induction motor.

Since acceleration, torque/force, and current are generally related by a constant, these terms are sometimes used interchangeably in the industry. For example IEC 61800-7-1 refers to a torque control loop rather than a current control loop. This specification attempts to differentiate between these control properties where applicable. This is particularly useful when the relationship between them is not static, such as when inertia/mass changes with position or time, or when the torque/force constant changes due to temperature change or motor flux variation.

4.2.2 Control methods

Within this basic control paradigm, there is latitude for different control methods, both closed loop and open loop. By closed loop, it is generally implied that there is a feedback signal that is used to drive the actual dynamics of the motor to match the commanded dynamics by servo action. In most cases, there is a literal feedback device to provide this signal, and in some cases, the signal is derived from the motor excitation (i.e. sensorless operation). By open loop, it is implied that there is no application of feedback to force the actual dynamics to match the commanded dynamics. While precision and performance are the hallmarks of closed loop control, simplicity and economy are the hallmarks of open loop control.

4.2.3 Control nomenclature

Finally, as evident in the description above, linear and rotary control applications can affect the control nomenclature. While rotary applications speak of Torque and Inertia, linear applications speak of Force and Mass. For the purposes of this part of the IEC 61800-7 series, when referring to rotary nomenclature, the defined behaviour can generally be applied to linear applications by substituting the terms, force for torque and mass for inertia. With that understanding, Figure 2 to Figure 8 follow the IEC 61800-7-1 nomenclature using torque rather than force without loss of generality.

4.2.4 Position Control

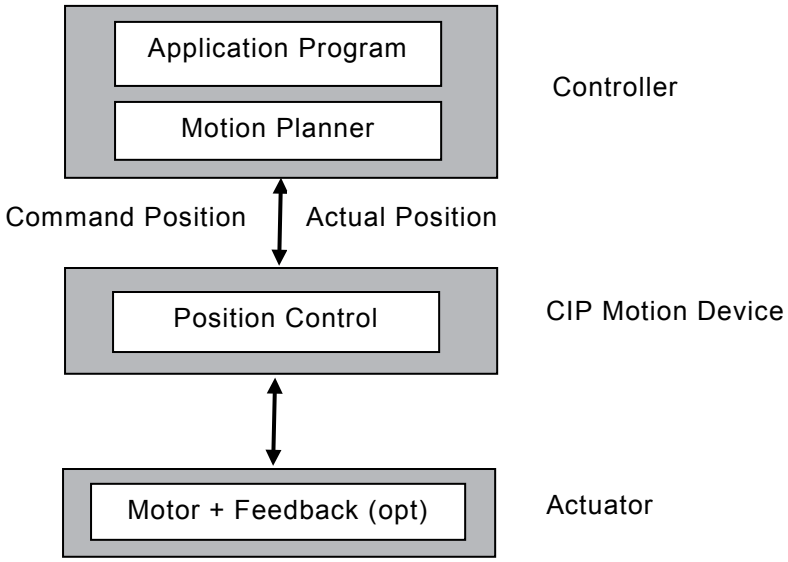
4.2.4.1 General concepts

In position control application mode, either the application control program (command execution function) or the motion planner (move trajectory control function) provide a set-point value to the CIP Motion device via the cyclic data connection. The position control method can be either open loop or closed loop.

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541 **4.2.4.2 Open Loop Position Control**

542 A device configured for open loop position control applies to a class of drive devices called
543 stepper drives. This type of drive is illustrated in Figure 2.



544

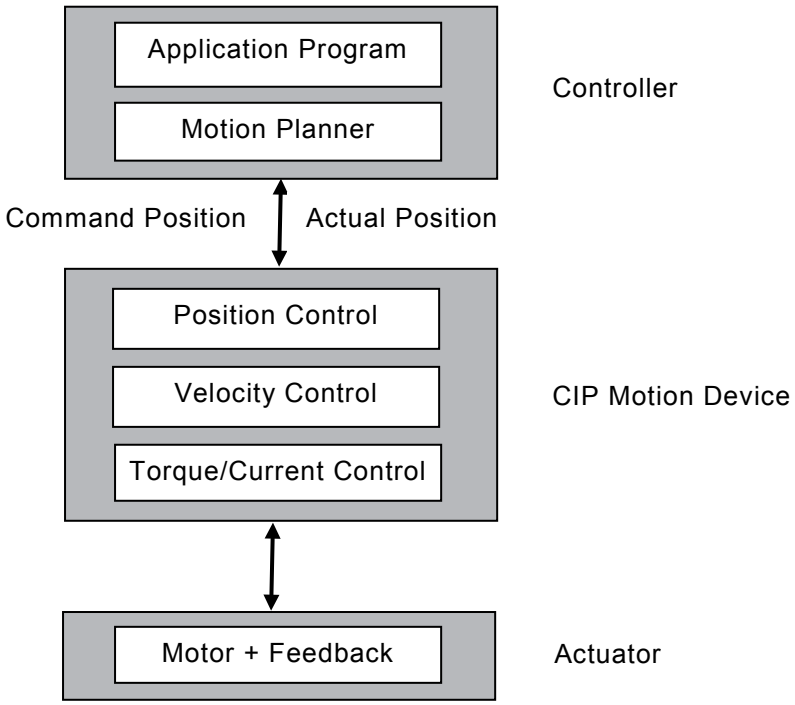
545 **Figure 2 – Open loop position control**

546 A feedback device for this configuration is optional. In the absence of a feedback device,
547 actual position can be estimated by the drive and returned to the controller.

548 **4.2.4.3 Closed Loop Position Control**

549 A motion control device configured for closed loop position control is traditionally referred to
550 as position loop drive or position servo drive. A position servo drive implies an inner velocity
551 and torque control loop as shown in Figure 3. The presence of the torque/current control loop
552 sometimes results in this kind of drive being referred to as a vector drive.

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553

554 **Figure 3 – Closed loop position control**

555 A feedback device for this configuration is generally required to achieve good positioning
556 accuracy. The feedback device may also be used to return Actual Velocity, and Actual
557 Acceleration data to the controller via the cyclic data connection.

558 In addition to Command Position, the controller can pass Command Velocity and Command
559 Acceleration for the purposes of forward control.

560 **4.2.5 Velocity Control**

561 **4.2.5.1 General concepts**

562 In velocity control application mode, the application control program and motion planner
563 provide a set-point value to the CIP Motion device via the cyclic data connection. The velocity
564 control method can be either open loop or closed loop.

565 **4.2.5.2 Open Loop Velocity Control**

566 A motion control device configured for open loop velocity control is traditionally referred to as
567 Variable Frequency, or V/Hz, or VFD, drive. This type of drive is illustrated in Figure 4.

568 A feedback device for this configuration is optional. In the absence of a feedback device,
569 actual velocity can be estimated by the drive and returned to the controller.

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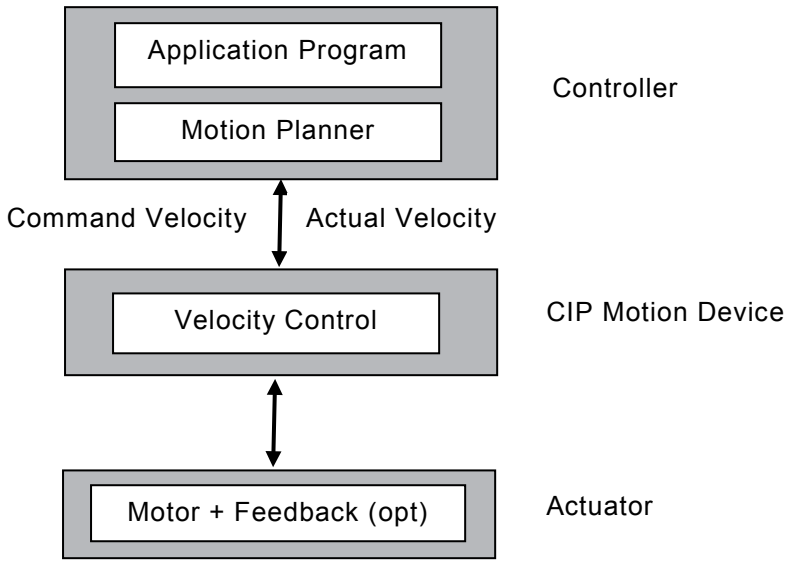


Figure 4 – Open loop velocity control

4.2.5.3 Closed Loop Velocity Control

A motion control device configured for closed loop velocity control is traditionally referred to as velocity loop drive or velocity servo drive. A closed loop velocity control drive implies an inner torque/current control loop (see Figure 5) and therefore is sometimes referred to as a vector drive.

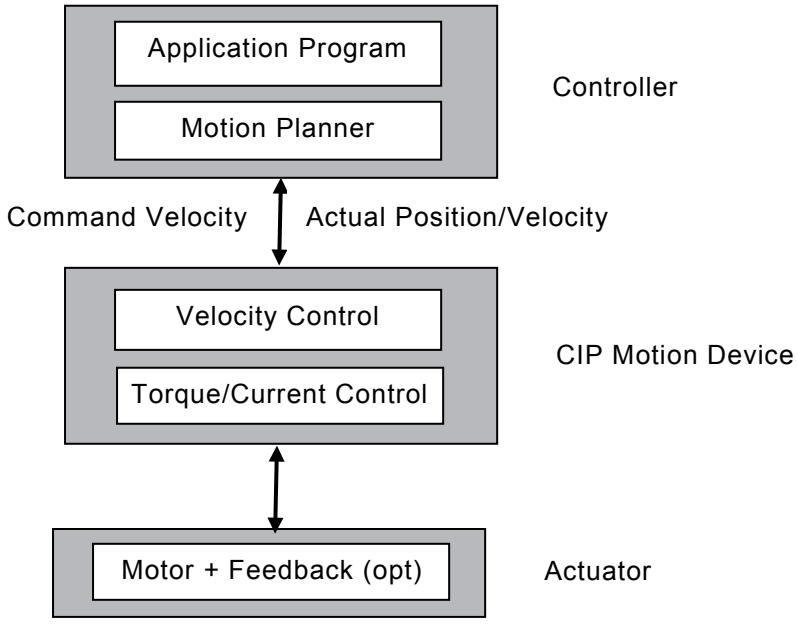


Figure 5 – Closed loop velocity control

A feedback device for the velocity loop drive configuration is optional. Tighter speed regulation is achieved when using a feedback device, particularly at low speed. When the feedback device is included, it may be used to return actual position, velocity, and acceleration data to the controller via the cyclic data connection. When the feedback device is not included, only estimated velocity can typically be returned to the controller.

In addition to Command Velocity, the controller can also pass Command Acceleration for the purposes of forward control.

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4.2.6 Acceleration Control

While neither a mainstream control mode in the industry nor mentioned in IEC 61800-7-1, the acceleration control mode is included here to complete the dynamic progression from velocity control to torque control and because the Motion Device Axis Object can support an Acceleration Command, potentially derived from the controller's motion planner. In the acceleration control mode, the application control program and motion planner provide acceleration set-point values to the CIP Motion device via the cyclic data connection. The drive converts the acceleration set-point into a torque command using the estimated system inertia. Acceleration control works in concert with the inner torque/current control loop as shown in Figure 6.

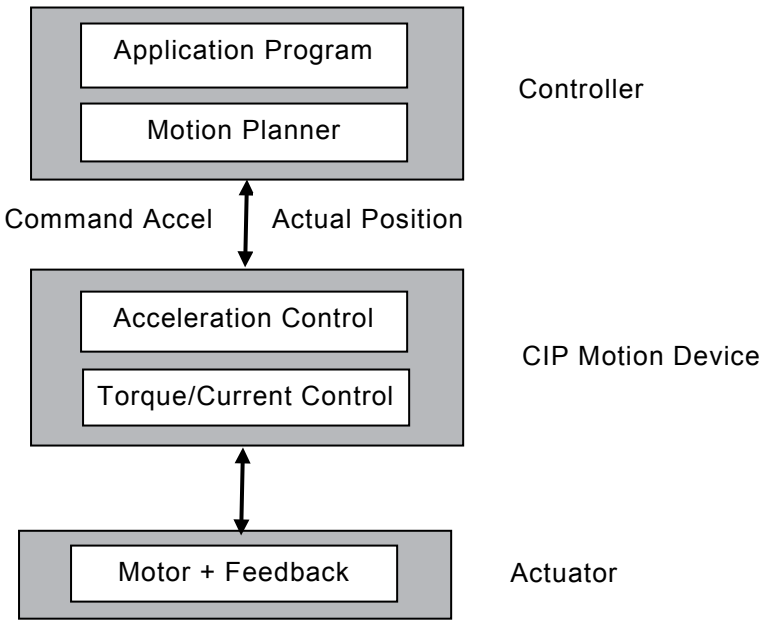


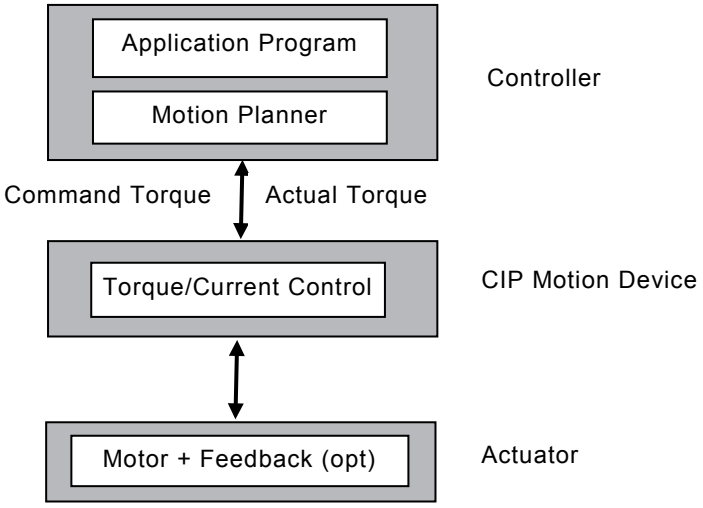
Figure 6 – Acceleration control

A feedback device for the acceleration control configuration is mandatory and may be used to return actual position, velocity, and acceleration data to the controller via the cyclic data connection.

4.2.7 Torque Control

In torque control application mode, the application control program or the motion planner provide torque set-point values to the device via the cyclic data connection (see Figure 7). Because motor current and motor torque are generally related by a torque constant, Kt, torque control is often synonymous with current control.

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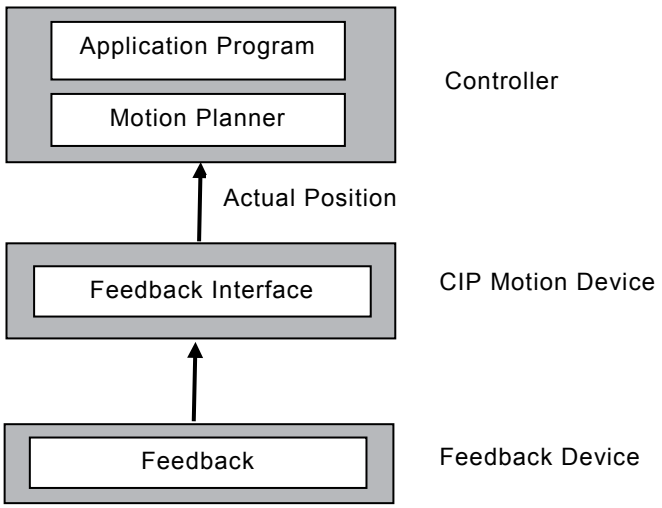
606

607 **Figure 7 – Torque control**

608 A position feedback device for this control mode is optional. If a feedback device is present, it
609 may be used to return actual position, velocity, and acceleration data to the controller via the
610 cyclic data connection.

611 **4.2.8 No Control**

612 The Motion Device Axis Object supports a “No Control” application mode. This configuration,
613 also referred to as “feedback only” or “master feedback”, can be of value when a particular
614 feedback channel in the CIP Motion drive device is to serve simply as a master feedback
615 source to the rest of the control system. This application mode can also be applied to CIP
616 Motion feedback devices. In this “No Control” configuration, no set-point value is supplied to
617 the CIP Motion device via the cyclic data connection, but actual position, velocity, and
618 acceleration can be supplied by the device to the controller via the cyclic data channel. The
619 No Control drive configuration is illustrated in Figure 8.



620

621 **Figure 8 – No control**

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5 Data types

5.1 Data type overview

Table 1 shows references of data types used in this profile and the related definitions.

Table 1 – Data types

Data Types used in CIP Motion	Reference to definition
BOOL	Boolean (see 5.3.1.1.2 of IEC 61158-5-2:2014)
SINT	Integer8 (see 5.3.1.4.2.2 of IEC 61158-5-2:2014)
INT	Integer16 (see 5.3.1.4.2.4 of IEC 61158-5-2:2014)
DINT	Integer32 (see 5.3.1.4.2.6 of IEC 61158-5-2:2014)
LINT	Integer64 (see 5.3.1.4.2.8 of IEC 61158-5-2:2014)
USINT	Unsigned8 (see 5.3.1.4.3.2 of IEC 61158-5-2:2014)
UINT	Unsigned16 (see 5.3.1.4.3.4 of IEC 61158-5-2:2014)
UDINT	Unsigned32 (see 5.3.1.4.3.6 of IEC 61158-5-2:2014)
ULINT	Unsigned64 (see 5.3.1.4.3.8 of IEC 61158-5-2:2014)
REAL	Float32 (see 5.3.1.4.1.2 of IEC 61158-5-2:2014)
LREAL	Float64 (see 5.3.1.4.1.4 of IEC 61158-5-2:2014)
SWORD/BYTE	Bitstring8 (see 5.3.1.2.2 of IEC 61158-5-2:2014)
WORD	Bitstring16 (see 5.3.1.2.4 of IEC 61158-5-2:2014)
DWORD	Bitstring32 (see 5.3.1.2.6 of IEC 61158-5-2:2014)
LWORD	Bitstring64 (see 5.3.1.2.8 of IEC 61158-5-2:2014)

5.2 Conventions

Hexadecimal numbers in this part of the IEC 61800-7 series may be represented by nn_{hex} (if their exact data type is not defined) or 0xnn, 0xnnnn (if their data type is specified).

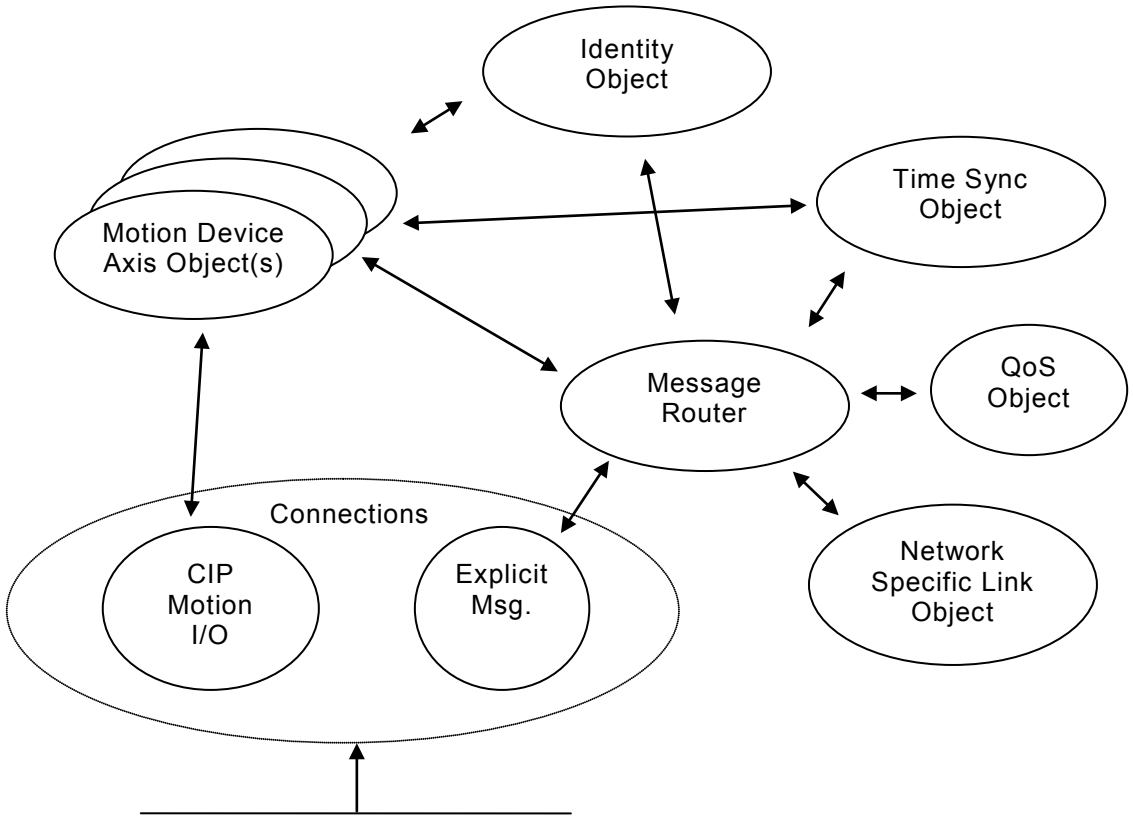
6 CIP Motion Drive Profile

6.1 Object model

6.1.1 Object overview

The object model in Figure 9 represents a CIP Motion drive device.

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634

635 **Figure 9 – Object Model for a CIP Motion drive**

636 Table 2 indicates:

637 • the object classes present in this device,

638 • whether or not the class is required,

639 • the number of instances present in each class.

640 **Table 2 – Objects present in a CIP Motion drive device**

Object class	Optional or Required	Number of instances
CIP common required objects	Required	See IEC 61158-5-2 and IEC 61158-6-2
Motion Device Axis Object (0x42)	Required	1 per axis
Time Sync Object (0x43)	Optional	1
QoS Object (0x48)	Conditional[a]	1
[a] Required for EtherNet/IP		

641

642 Refer to IEC 61158-5-2, IEC 61158-6-2 and 6.4.6.1 for more details about these objects.

643 **6.1.2 Object description**

644 The object model in Figure 9 shows the main functional components of the CIP Motion drive
645 device profile.

646 This object model also illustrates the use of multiple instances of a Motion Device Axis Object
647 to implement a multi-axis drive device. Each Motion Device Axis Object instance governs the
648 behavior of the associated drive axis. In this device profile, the term "drive axis" is
649 synonymous with a "Motion Device Axis Object instance".

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A single bi-directional I/O connection to the Motion Device Axis Object class instance provides a cyclic data path between the controller and each individual Motion Device Axis Object instance. This connection passes on a special data structure whose self-defining format can be used to transfer cyclic, event, and service related data.

An optional Time Sync Object is included in the object model to facilitate accurate time synchronization between CIP Motion controllers and drive devices for high performance motion control. For lower performance drives such as V/Hz or VFD drives, or simple velocity servo drives, the Time Sync Object is not necessary for drive operation.

A CIP Motion I/O connection is a standard, cyclic, bidirectional CIP I/O connection whose packets can vary in size, based on the formats outlined in 6.4.2.2.

6.2 How objects affect behaviour

The objects for this device affect the device's behavior as shown in Table 3.

Table 3 – Object effect on behavior

Object class	Effect on behavior
CIP common required objects	See IEC 61158-5-2 and IEC 61158-6-2
Motion Device Axis Object	Provides dynamic control interface to drive, motor, and feedback components that comprise an axis.
Time Sync Object	Provide absolute time synchronization services between devices on the control network.
QoS Object	Provides configuration information associated with Ethernet QoS (Quality of Service) function.

6.3 Defining object interfaces

Objects supported for the CIP Motion drive have the interfaces listed in Table 4.

Table 4 – Object interfaces

Object	Interface
CIP common required objects	See IEC 61158-5-2 and IEC 61158-6-2
Motion Device Axis Object	Message Router, CIP Motion I/O Connection, Time Sync Object, Identity Object
Time Sync Object	Message Router
QoS Object	Message Router

6.4 I/O Connection messages

6.4.1 General

The CIP Motion drive device profile supports a Transport Class 1 point-to-point bi-directional I/O connection between the controller and the Motion Device Axis Object class: this I/O connection is specifically referred to as the CIP Motion I/O connection.

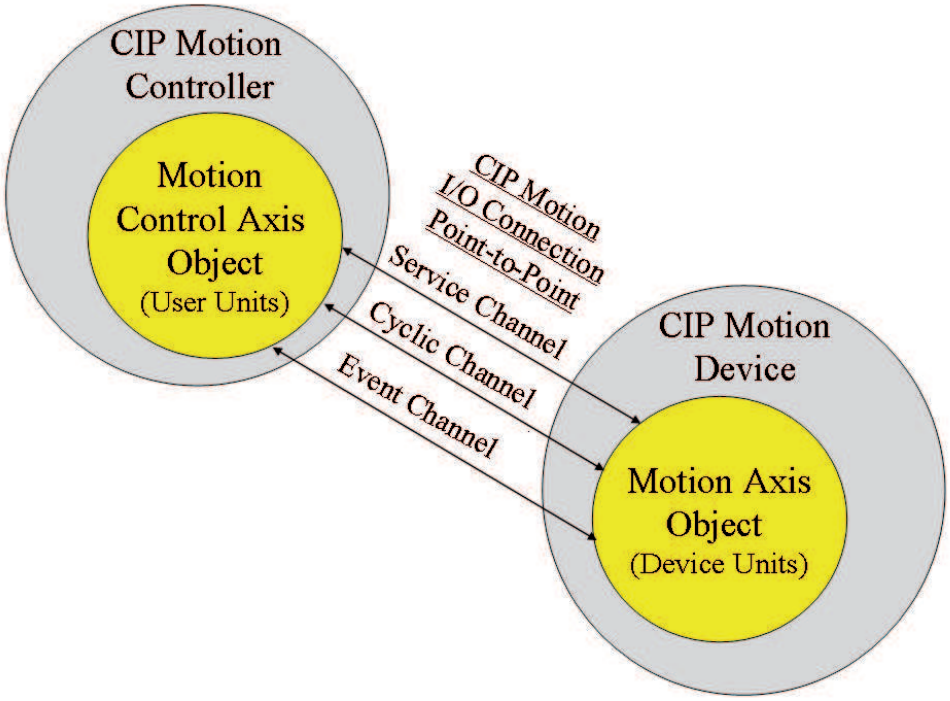
The Motion Device Axis Object distributes the data in this connection to each instantiated Motion Device Axis Object instance.

6.4.2 CIP Motion I/O connection

6.4.2.1 Overview

The following subclause specifies the CIP Motion I/O Connection format that includes the Controller-to-Device (C-to-D) Connection and the Device-to-Controller (D-to-C) Connection for bi-directional data transfer between a CIP Motion Controller and a CIP Motion Drive Device, as shown in Figure 10.

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681

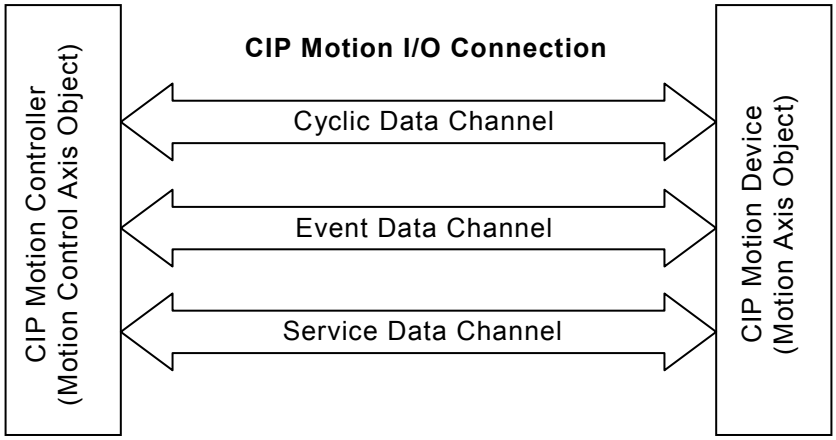
682 **Figure 10 – CIP Motion I/O connection model**

683 **6.4.2.2 CIP Motion I/O connection structure**

684 Both CIP Motion I/O connection data structures (Controller-to-Device and Device-to-
685 Controller) begin with a Connection Header followed by a Time Data block that typically
686 includes a 64-bit time stamp. The Time Data block is then followed by one or more Instance
687 Data Blocks for each axis supported by the drive node.

688 The size and contents of the Time Data Block and Instance Data Blocks vary dynamically as
689 determined by the associated headers. This ability to vary the contents of the data blocks
690 from update to update allows the drive and controller to only send data that has changed from
691 the last update, dramatically reducing the overall size of the typical CIP Motion connection
692 packet.

693 Each instance data block within the CIP Motion I/O connection packet consists of three sets of
694 data blocks associated with the cyclic, event, and service data channels. From the drive's
695 perspective, these three distinct data channels have different data processing priorities as
696 illustrated in Figure 11.



697

698 **Figure 11 – CIP Motion I/O Connection Channels**

699 The specific functionality of these three data channels is as follows:

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- Cyclic Data Channel – carries cyclic data blocks that are sampled or calculated every Controller Update Period and synchronised with other nodes in the motion control system through use of distributed System Time. Cyclic data is high priority data that shall be immediately processed and applied to the drive axis within one Device Update Period.
- Event Data Channel - carries event data associated with drive event(s) (e.g. registration, homing, etc.) that have occurred within the last Controller Update Period. Event data is medium priority and shall be processed and applied within one Controller Update Period.
- Service Data Channel – carries data associated with service requests to read or write attribute values of the Motion Device Axis Object as part of on-line configuration and diagnostic functionality, as well as service requests to affect Motion Device Axis Object behaviour as part of controller instruction execution. Service data has lowest priority and is typically buffered and processed as a background task. There is no guarantee that a service request will be processed within Controller Update Period.

Taken together, these three data channels provide a comprehensive controller to drive data connection solution for industrial motion control.

6.4.2.3 I/O connection formats

An overview of the CIP Motion I/O Connection format is shown in Figure 12 and Figure 13.

Not shown in these format figures is the encapsulation associated with the Class 1 Transport that includes a Sequence Count. For a detailed description of the Class 1 Transport header refer to IEC 61158-5-2 and IEC 61158-6-2. Multi-octet data in the CIP I/O Connection data structure follows standard little-endian octet-addressing rule. In the figures, octet ordering reads left to right. The gray banners in the figures are section labels and are not part of the actual connection data structure. Unless otherwise stated, data structure elements defined as “reserved” or marked with a hyphen, “-“, shall be set to zero (0).

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← 32-bit Word (octet 1 | octet 2 | octet 3 | octet 4) →

Controller-to-Device Connection Format
Connection Header
Time Data Block
Instance Data Blocks

Connection Header and Time Data Block			
Connection Format	Format Revision	Update ID	Node Control
Instance Count	-	Last Received ID	Time Data Set
Controller Time Stamp			
Controller Time Offset			

Instance Data Block
Instance Data Header
Cyclic Data Block
Cyclic Write Data Block
Event Data Block
Service Data Block

Instance Data Header			
Instance Num	-	Instance Blk Size	Cyclic Blk Size
Cyc. Cmd Blk Size	Cyc. Write Blk Size	Event Blk Size	Service Blk Size

Cyclic Data Block			
Control Mode	Feedback Mode	Axis Control	Control Status
Command Data Set	Actual Data Set	Status Data Set	Command Control
Cyclic Data			

Cyclic Write Data Block			
Cyclic Write Blk ID		Cyclic Read Blk ID	
Cyclic Write Data			

Event Data Block			
Event Checking Control			
Reg Data Set	Home Data Set	Watch Data Set	-
Registration Event Data			
Home Event Data			
Watch Event Data			
Event Ack. ID1	Event Ack. Status 1	Event Ack. ID2	Event Ack. Status 2
...			

Service Data Block			
Transaction ID	Service Code	-	-
Service Specific Request Data			

724 **Figure 12 – Controller-to-Device Connection Format (Connection Point 2)**

725

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← 32-bit Word (octet 1 | octet 2 | octet 3 | octet 4) →

Device-to-Controller Connection Format
Connection Header
Time Data Block
Instance Data Blocks

Connection Header and Time Data Block			
Connection Format	Format Revision	Update ID	Node Status
Instance Count	Node Faults/Alarms	Last Received ID	Time Data Set
Device Time Stamp			
Device Time Offset			
Lost Updates	Late Updates	-	
Timing Diagnostic Data			

Instance Data Block
Instance Data Header
Cyclic Data Block
Cyclic Read Data Block
Event Data Block
Service Data Block

Instance Data Header			
Instance Num	-	Instance Blk Size	Cyclic Blk Size
Cyc. Act. Blk Size	Cyc. Read Blk Size	Event Blk Size	Service Blk Size

Cyclic Data Block			
Control Mode	Feedback Mode	Axis Response	Response Status
-	Actual Data Set	Status Data Set	Axis State
Cyclic Data			

Cyclic Read Data Block			
Cyclic Write Blk ID	Cyclic Write Status	Cyclic Read Blk ID	Cyclic Read Status
Cyclic Read Data			

Event Data Block			
Event Checking Status			
Reg Data Ack	Home Data Ack	Watch Data Ack	-
Event ID	Event Status	Event Type	-
Event Position			
Event Time Stamp			
...			

Service Data Block			
Transaction ID	Service Code	General Status	Extended Status
Service Specific Response Data			

726 **Figure 13 – Device-to-Controller Connection Format (Connection Point 2)**

727 **6.4.3 Controller-to-Device connection**

728 **6.4.3.1 General**

729 To facilitate a detailed description of each of its constituent data elements, the CIP Motion
730 Controller-to-Device Connection is organised as shown in Figure 14.

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CIP Motion Controller-to-Device Connection Format
Connection Header
Time Data Block
Instance Data Blocks

Figure 14 – CIP Motion Controller-to-Device Connection Format

6.4.3.2 Controller-to-Device connection header

6.4.3.2.1 General structure

The Controller-to-Device Connection Header contains critical axis configuration information needed to parse the Instance Data Blocks. The fixed portion of the connection header is defined as shown in Figure 15.

Connection Header			
Connection Format	Format Revision	Update ID	Node Control

Figure 15 – Connection Header

- Connection Format: This enumerated byte determines the format of CIP Motion connection according to the definition in Figure 16.

Bit 7 Bit 0

Connection Format	
(Reserved)	Connection Type

Figure 16 – Connection Format

- Connection Type: This 4-bit enumeration defines the CIP Motion connection type as shown below. Valid values for a Controller-to-Device Connection are 2 for Fixed format and 6 for Variable format. Fixed connections have a fixed connection size during operation to support lower-performance CIP networks and are typically associated with a simple single axis drive device that does not support time synchronisation services. Variable connections allow the connection data structure to vary in size during operation and are targeted for high-performance drives and CIP networks like EtherNet/IP.

  0 = Reserved

  1 = Reserved

  2 = Fixed Controller-to-Device Connection

  3 = Fixed Device-to-Controller Connection

  4 = Reserved

  5 = Reserved

  6 = Variable Controller-to-Device Connection

  7 = Variable Device-to-Controller Connection

  8 to 15 = Reserved.

  The Connection Format is not only used by the device to correctly parse the Controller-to-Device connection data, but also by network diagnostic tools to display the individual elements of the data structure. If the device receives a Connection Format value that it cannot support, it generates a fault. In this case, the fault shall be Node Fault Error Code 4: Data Format Error. The Connection Format value shall not change for the life of the connection and, therefore, need only be checked by the device for the first received packet.

- Format Revision: This edition of IEC 61800-7-202 defines Format Revision 2. Devices utilizing this edition of IEC 61800-7-202 shall only recognize Format Revision 2; Format Revision 1 is therefore rendered obsolete. This value is incremented by 1 for every revision of the Controller-to-Device Connection format that impacts the interface. The Format Revision allows newer drives to support the connection formats generated by an older controller. It also allows older drives to recognise a newer connection format from a controller that it cannot support and to generate a fault. In this case, the fault shall be Node Fault Error Code 4: Data Format Error. Network diagnostic tools can also key off the Format Revision to know how to parse the connection data packet. At the time the I/O Connection is established, the Format Revision number is also indicated by the I/O Connection Point in the Application Path of the Forward_Open service (see 6.4). The

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Format Revision value shall not change for the life of the connection and, therefore, need only be checked by the device for the first received packet.

- Update ID: This cyclic transaction number is incremented every update period. The Update ID is like the CIP sequence count and is used by the drive to determine whether the connection buffer contains fresh data. In the case where the drive axis is not synchronised, or does not support time synchronisation services, the time stamp data is either not included or invalid, so the Update ID is the only way for the drive to detect new connection data. In this case, the Controller-to-Device Connection Update ID is applied to the next Device-to-Controller Connection Update ID.

  The Update ID also allows the drive to determine if an update has been lost. Any skip in the Update ID is an indication that an update packet has been lost during transmission. If the number of consecutive missed updates exceeds the value given by the class attribute, Controller Update Delay High Limit, the Control Connection Update Fault is indicated by the Node Faults class attribute of the Motion Device Axis Object. This fault can only be cleared by closing and opening the CIP Motion I/O connection. An optional Controller Update Delay Low Limit attribute is also available. If the number of consecutive missed updates exceeds the maximum value given by the class attribute, Controller Update Delay Low Limit, the Controller Connection Update Alarm is indicated by the Node Alarm class attribute of the Motion Device Axis Object. The alarm is cleared as soon as a fresh update is received.

- Node Control: This element is applied to the Motion Device Axis Object class attribute “Node Control”, which is used to control the state of the associated drive communications node. See 7.2.2.1 (Motion Device Axis Object) for details.

6.4.3.2.2 Fixed connection header

If the Connection Format is a Fixed Controller-to-Device Connection, the above header is immediately followed by the instance data block.

6.4.3.2.3 Variable connection header

If the Connection Format is a Variable Controller-to-Device Connection, then the connection header contains additional fields related to multi-axis drive addressing and time stamping, as shown in Figure 17.

Connection Header			
Connection Format	Format Revision	Update ID	Node Control
Instance Count	-	Last Received ID	Time Data Set
Controller Time Stamp			
Controller Time Offset			

Figure 17 – Connection Header

- Instance Count: This value reflects the number of instance data blocks present in the CIP Motion Controller-to-Device Connection data structure.

- Last Received ID: This is the Update ID of the last Device to Controller connection data block actually processed by the controller. The Last Received ID is used by the drive to determine if the data that was sent was processed successfully. For example, Fault Codes passed as part of the Device to Controller connections Status Data Block are sequenced into the controller’s fault log. It is recommended that the Last Received ID element be read by the device to determine if the last Fault Code was entered into the Fault Log, thus allowing the device to send the next Fault Code in the sequence.

- Time Data Set: This bit-mapped byte contains flags that determine the usage and format of the controller and drive timing information, as specified in Table 5. In general, the Time Data Set value sent by the controller in the Controller-to-Device Connection not only determines the contents of the Controller-to-Device Connection data block, but it also represents the requested Time Data Set to be sent by the drive in the Device-to-Controller Connection. The value of this element is transferred to the Motion Device Axis Object attribute “Time Data Set”.

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825 **Table 5 – Time Data Set**

Bit	Definition	Syntax
0	Time Stamp	0 = no time stamp 1 = time stamp included
1	Time Offset	0 = no time offset – use last offset 1 = time offset included
2	Update Diagnostics	0 = no update diagnostic data in D-to-C 1 = update diagnostic data in D-to-C
3	Time Diagnostics	0 = no time diagnostic data in D-to-C 1 = time diagnostic data in D-to-C
4 to 7	(Reserved)	

826

827 • Time Stamp – if this bit is set, the Controller Time Stamp is included in the Time Data
828 Set block. Setting this bit also instructs the drive to send Device Time Stamps back to
829 the controller in the Device-to-Controller connection in the next update. It also instructs
830 the drive to send the Device Time Offset if its value has changed since the last update.
831 If the device does not support time synchronization, the device simply returns a value
832 of zero for the Time Stamp and does not ever return a Time Offset.

833 • Time Offset – if this bit is set, the Controller Time Offset is included in the Time Data
834 Set block. This bit is only set when there is a change to the Controller Time Offset
835 value, a relatively infrequent occurrence. Note that this bit does NOT determine if the
836 drive sends its Device Time Offset in the next update. That is determined by the Time
837 Stamp bit and by whether or not the Device Time Offset has changed since the last
838 update.

839 • Update Diagnostics – although there is no data associated with this bit in the
840 Controller-to-Device connection header, the Update Diagnostic bit in the Controller-to-
841 Device connection instructs the drive to send Update Diagnostic data in the next
842 Device-to-Controller connection update, but only if one or more of the Update
843 Diagnostic values have changed since the last update. This Update Diagnostic data
844 includes the current number of Lost or Late Updates from the controller over the
845 Controller-to-Device Connection. Update Diagnostics apply to devices regardless of
846 the whether they support time synchronization.

847 • Time Diagnostics – although there is no data associated with this bit in the Controller-
848 to-Device connection header, the Time Diagnostic bit in the Controller-to-Device
849 connection instructs the drive to send Time Diagnostic data in the next Device-to-
850 Controller connection update. This Time Diagnostic data includes the Controller-to-
851 Device Data Received time stamp and the Device-to-Controller Data Transmit time
852 stamp. If the device does not support time synchronization, the device simply returns a
853 value of zero for the Time Diagnostic elements.

854

855 • Controller Time Offset: This element is included in the Connection Header if the Time
856 Offset bit is set in the Time Data Set element. The Controller Time Offset represents the
857 64-bit System Time Offset value associated with the Controller Time Stamp that follows.
858 The value of this element is transferred to the Motion Device Axis Object class attribute of
859 the same name. The Controller Time Offset value is used by the drive to determine if
860 System Time as defined in the controller is skewed relative to System Time in the drive.
861 Normally, System Time between the drive and the controller are closely matched at any
862 given time. But every few seconds, according to the IEC 61588:2009 based CIP Sync
863 protocol, the time master of the system can correct the System Time reference by a
864 significant amount of time, perhaps an hour. Indeed, even the master itself can change as
865 a higher quality time master is discovered by the system. These step changes to the
866 System Time reference propagate through to the various devices on the network in such a
867 way that the controller and the drive are running with skewed System Time values. The
868 Controller Time Offset value can be used together with the System Time Offset for the
869 drive to both determine if System Time between the drive and the controller is skewed and
870 if so, to compensate for the skew using the System Time Offset Compensation algorithm.

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The Controller Time Offset value changes relatively infrequently, i.e. as a result of a IEC 61588 driven Sync update, which typically occurs every second. Thus, it is recommended that the controller only load and send the Time Offset data if the value has changed. The drive need only parse the Controller Time Offset data if the associated Time Offset bit is set in the Time Data Set element, otherwise it continues to use the last Controller Time Offset received.

- Controller Time Stamp: This element is included in the Connection Header if the Time Stamp bit is set in the Time Data Set element. The Controller Time Stamp represents the 64-bit System Time value at the beginning of the Controller Update Period when the controller's update timer event occurred. In other words the Controller Time Stamp marks, in absolute time, the beginning of the current CIP Motion connection cycle. The value of this time stamp is calculated by the controller as the sum of the controller's local clock value when update timer event occurred and the controller's System Time Offset value. The Controller Time Stamp is therefore directly associated with the command data contained in the connection. The value of this element, when read, is transferred to the Motion Device Axis Object class attribute Controller Time Stamp. Taken together with the Controller Update Period, established by the RPI of the Forward_Open service, and the Command Target Update (discussed later), the drive has all the information it needs compute command interpolation polynomials to correct command data values for differences between the drive and controller update timing. These differences can occur when the Controller Update Period is not an integer multiple of the Device Update Period or when the drive updates are phase shifted relative to the controller.

  When the connection is synchronized, the Controller Time Stamp can be used by the drive along with the Controller Update Period to check for missed or late updates. If the difference between the last Controller Time Stamp and the current local Device Time Stamp exceeds the maximum value given by,

  Max Fault Delay = Controller Update Delay High Limit × Controller Update Period,

  The Control Connection Update Fault is indicated by the Node Faults class attribute of the Motion Device Axis Object. An optional Controller Update Delay Low Limit attribute is also available. If the difference between the last Controller Time Stamp and the current local Device Time Stamp exceeds the maximum value given by,

  Max Alarm Delay = Controller Update Delay Low Limit × Controller Update Period,

  the Controller Connection Update Alarm is indicated by the Node Alarm class attribute of the Motion Device Axis Object.

  If either the Controller Time Offset or the Device Time Offset values have changed since the last update, System Time Offset Compensation shall be applied to the Controller Time Stamp. See 6.4.6.7 for details. If the time offsets have not changed, the typical case, the Controller Time Stamp can be directly applied to the Motion Device Axis Object.

6.4.3.3 Instance data blocks

6.4.3.3.1 General structure

After the Connection Header are one or more Instance Data Blocks as determined by the above Instance Count. The Instance Data Block has the basic structure shown in Figure 18.

Instance Data Block
Instance Data Header
Cyclic Data Block
Event Data Block
Service Data Block

Figure 18 – Instance Data Block

6.4.3.3.2 Instance data header

The Instance Data Header contains critical axis configuration information needed to parse and apply the data contained in the three data channels (see Figure 19). This header is only included in the Variable Connection format to accommodate multi-axis drive applications. Information within the header can be used by the drive communications interface to copy the individual data blocks into separate fixed memory locations for processing.

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If configured for a Fixed Connection format, only the Cyclic Data Block for a single axis instance is supported so there is no need for any information to specify instance number or block sizing. The Instance Data Header is therefore not included.

Instance Data Header			
Instance Num	-	Instance Blk Size	Cyclic Blk Size
Cyc. Cmd. Blk Size	Cyc. Write Blk Size	Event Blk Size	Service Blk Size

Figure 19 – Instance Data Header

- Instance Number: This is the number that identifies the specific Motion Device Axis Object instance the following instance data block applies to. Motion Device Axis Object instances are created as a contiguous series of instance numbers starting with instance 1. Within the connection data structure, the Instance Numbers for each consecutive instance data block shall be an ordinal sequence, i.e. 0, 1, 2, 3, etc.

  NOTE Instance 0 is defined as the class instance and is typically only used during initialization to configure class attributes of the Motion Device Axis Object via the Service Data Block. Otherwise, the instance data block sequence starts with instance 1.

  Thus, in theory, up to 255 axis instances can be serviced by the CIP Motion I/O Connection. The instance numbers sequence of the Controller-to-Device connection determines the instance number sequence of the subsequent Device-to-Controller connection.

- Instance Block Size: This value represents the size of the Instance Data Block in 32-bit words including the header. The Instance Block Size is useful when the drive wants to directly access the next instance data block without having to add the sizes of the cyclic, event, and service blocks. If the Instance Block Size for the Controller-to-Device Connection is zero, i.e. no Instance Data Block, then the Instance Block Size for the following Device-to-Controller Connection shall also be zero.

- Cyclic Block Size: This value represents the size to the Cyclic Data Block in 32-bit word units including the header.

  NOTE For instance 0, the class instance, the Cyclic Block Size is 0 indicating that there is no Cyclic Data Block.

- Cyclic Command Block Size: This value represents the size to the Cyclic Command Data Block in 32-bit word units including the header. A Cyclic Command Block Size of 0 indicates that there is no Cyclic Command Data for the drive to process.

- Cyclic Write Block Size: This value represents the size to the Cyclic Write Data Block in 32-bit word units including the header. A Cyclic Write Block Size of 0 indicates that there is no Cyclic Write data currently configured for transfer to the drive and therefore there is no Cyclic Write Block included for the drive to process.

- Event Block Size: This value represents the size to the Event Data Block in 32-bit word units including the header. If the Event Block Size for the Controller-to-Device Connection is zero, there is no active event checking, so the Event Block Size for the Device-to-Controller Connection shall also be zero. This effectively closes the Event Channel.

- Service Block Size: This value represents the size to the Service Data Block in 32-bit word units including the header. A Service Block Size value of 0 indicates there is no service request to process. If the Service Block Size for the Controller-to-Device Connection is zero, then the Service Block Size for the Device-to-Controller Connection shall also be zero. This effectively closes the Service Channel.

6.4.3.3.3 Cyclic data block

The Cyclic Data Header at the top of the Cyclic Data Block is always included regardless of the connection format. This header contains key elements related to the content of the Cyclic Data Block of both the Controller-to-Device Connection and Device-to-Controller Connection, and the context of the data as determined by the Control Mode and Feedback Mode (see Figure 20). The header also provides a mechanism to control the state of the targeted drive axis.

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