

DIN EN ISO 16484-6

ICS 35.240.99; 91.140.01

Ersatz für
DIN EN ISO 16484-6:2009-11

**Systeme der Gebäudeautomation –
Teil 6: Datenübertragungsprotokoll –
Konformitätsprüfung (ISO 16484-6:2014);
Englische Fassung EN ISO 16484-6:2014, nur auf CD-ROM**

Building automation and control systems (BACS) –
Part 6: Data communication conformance testing (ISO 16484-6:2014);
English version EN ISO 16484-6:2014, only on CD-ROM

Systèmes d'automatisation et de gestion technique du bâtiment –
Partie 6: Essais de conformité de la communication de données (ISO 16484-6:2014);
Version anglaise EN ISO 16484-6:2014, seulement en CD-ROM

Gesamtumfang 588 Seiten

DIN-Normenausschuss Heiz- und Raumlufttechnik (NHRS)
DIN/VDE-DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik

Nationales Vorwort

Dieses Dokument (EN ISO 16484-6:2014) wurde vom Technischen Komitee ISO/TC 205 „Building environment design“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 247 „Gebäudeautomation und Gebäudemanagement“ (Sekretariat: SNV, Schweiz) unter Beteiligung deutscher Experten erarbeitet.

Das zuständige deutsche Gremium ist der Arbeitsausschuss NA 041-03-68 AA „Gebäudeautomation und -kommunikation (SpA CEN/TC 247/WG 4)“ im DIN-Normenausschuss Heiz- und Raumlufttechnik (NHRS).

Dieses Dokument (EN ISO 16484-6:2014) übernimmt den englischen Originaltext des ANSI/ASHRAE Standard 135.1 „BACnet — A Data Communication Protocol for Building Automation and Control Networks“, Ausgabe 2011. In derselben Weise sollen zwischenzeitlich veröffentlichte bzw. noch zu veröffentlichende Änderungen und Erweiterungen von ANSI/ASHRAE Standard 135.1 bei der Fortschreibung von EN ISO 16484-6 übernommen werden. Der Inhalt dieses Dokumentes befindet sich auf der beiliegenden CD-ROM.

Der NHRS war für das DIN Deutsches Institut für Normung e. V. an der Erstellung dieser Norm beteiligt. Da davon auszugehen ist, dass die Fachleute der Kommunikationstechnik sich bereits mit der englischen Fassung befasst haben, wurde von einer Übersetzung ins Deutsche abgesehen. Nach dem DIN-Präsidialbeschluss 13/1983 ist insbesondere auf dem Gebiet der Informatik die Veröffentlichung in Englisch zulässig, insbesondere wenn dadurch Fehler bei der Übertragung vermieden werden können.

Dieses Dokument (EN ISO 16484-6:2014) stellt ein genormtes Testverfahren zur Verfügung, um eine Implementierung (de: Umsetzung) des BACnet-Protokolls auf ihre Konformität zur Protokoll-Norm DIN EN ISO 16484-5 zu überprüfen. Dies geschieht für alle Funktionen, die vom Hersteller im „Protocol Implementation Conformance Statement“, dem so genannten PICS, für diese Implementierung angegeben worden sind.

Änderungen

Gegenüber DIN EN ISO 16484-6:2009-11 wurden folgende Änderungen vorgenommen:

- a) Inhalt technisch überarbeitet.

Frühere Ausgaben

DIN EN ISO 16484-6: 2006-04, 2009-11

Nationaler Anhang NA (informativ)

Begriffe und Definitionen

Im Folgenden wird ISO 16484-6:2014, Abschnitt 3 ins Deutsche übersetzt. Die Benennung der folgenden Begriffe und Abkürzungen ist identisch mit der Benennung in der englischen Fassung.

3 Begriffe und Abkürzungen

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.1

Lokales Netzwerk

(en: local network)

Netzwerk, mit dem ein BACnet Gerät direkt verbunden ist

3.2

Remote Netzwerk

(en: remote network)

Netzwerk, das von einem BACnet Gerät nur über einen oder mehrere Router zugänglich ist

3.3

Testdatenbank

(en: test database)

Datenbank von BACnet-Funktionalitäten und Objekten erstellt durch das Auslesen des Inhaltes eines EPICS

Abkürzungen

Abkürzung (englisch)	Bedeutung (englisch)	Bedeutung (deutsch)
BNF	Backus-Naur Form syntax	Backus-Naur Form Syntax
EPICS	electronic protocol implementation conformance statement	elektronische Protokoll-Implementierung Konformitätserklärung
IUT	implementation under test	Umsetzung im Test
TCSL	testing and conformance scripting language	Prüfungs- und Konformitätsskriptsprache
TD	testing device	Testgerät
TPI	text protocol information	Text Protokoll Information

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN ISO 16484-6

May 2014

ICS 91.040.01

Supersedes EN ISO 16484-6:2009

English Version

Building automation and control systems (BACS) - Part 6: Data
communication conformance testing (ISO 16484-6:2014)

Systèmes d'automatisation et de gestion technique du
bâtiment - Partie 6: Essais de conformité de la
communication de données (ISO 16484-6:2014)

Systeme der Gebäudeautomation - Teil 6:
Datenübertragungsprotokoll - Konformitätsprüfung (ISO
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Foreword

This document (EN ISO 16484-6:2014) has been prepared by Technical Committee ISO/TC 205 “Building environment design” in collaboration with Technical Committee CEN/TC 247 “Building Automation, Controls and Building Management” the secretariat of which is held by SNV.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2014, and conflicting national standards shall be withdrawn at the latest by November 2014.

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Endorsement notice

The text of ISO 16484-6:2014 has been approved by CEN as EN ISO 16484-6:2014 without any modification.

**Building automation and control systems
(BACS) —**

Part 6:
Data communication conformance testing

*Systèmes d'automatisation et de gestion technique du bâtiment —
Partie 6: Essais de conformité de la communication de données*



Reference number
ISO 16484-6:2014(E)

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Published in Switzerland

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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The committee responsible for this document is ISO/TC 205, *Building environment design*.

This third edition cancels and replaces the second edition (ISO 16484-6:2009), of which it forms the subject of a minor revision.

ISO 16484 consists of the following parts, under the general title *Building automation and control systems (BACS) — Data communication conformance testing*:

- *Part 1: Project specification and implementation*
- *Part 2: Hardware*
- *Part 3: Functions*
- *Part 5: Data communication protocol*
- *Part 6: Data communication conformance testing*

Applications and project implementation are to form the subjects of future Parts 4 and 7.

Building automation and control systems (BACS) — Part 6: Data communication conformance testing

1 Scope

This part of ISO 16484 defines a standard method for verifying that an implementation of the BACnet protocol provides each capability claimed in its Protocol Implementation Conformance Statement (PICS) in conformance with the BACnet standard. This part of ISO 16484 provides a comprehensive set of procedures for verifying the correct implementation of each capability claimed on a BACnet PICS, including

- a) support of each claimed BACnet service, either as an initiator, executor, or both,
- b) support of each claimed BACnet object-type, including both required properties and each claimed optional property,
- c) support of the BACnet network layer protocol,
- d) support of each claimed data link option, and
- e) support of all claimed special functionality.

2 Relationship between this part of ISO 16484 and ANSI/ASHRAE 135.1-2011

This part of ISO 16484 comprises the US standard ANSI/ASHRAE 135.1-2011, *Method of Test for Conformance to BACnet*, published by the American National Standards Institute and the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

STANDARD

**ANSI/ASHRAE Standard 135.1-2011**

(Supersedes ANSI/ASHRAE Standard 135.1-2009)

Includes ANSI/ASHRAE Addenda listed in the History of Revisions

Method of Test for Conformance to BACnet®

See the History of Revisions at the back of this standard for approval dates of addenda.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE Web site (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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ISSN 1041-2336

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1. PURPOSE

To define a standard method for verifying that an implementation of the BACnet protocol provides each capability claimed in its Protocol Implementation Conformance Statement (PICS) in conformance with the BACnet standard.

2. SCOPE

This standard provides a comprehensive set of procedures for verifying the correct implementation of each capability claimed on a BACnet PICS including:

- (a) support of each claimed BACnet service, either as an initiator, executor, or both,
- (b) support of each claimed BACnet object-type, including both required properties and each claimed optional property,
- (c) support of the BACnet network layer protocol,
- (d) support of each claimed data link option, and
- (e) support of all claimed special functionality.

3. DEFINITIONS

All definitions from ANSI/ASHRAE Standard 135-2008 also apply to this addendum.

3.1 local network: the network to which a BACnet device is directly connected.

3.2 remote network: a network that is accessible from a BACnet device only by passing through one or more routers.

3.3 test database: a database of BACnet functionality and objects created by reading the contents of an EPICS.

3.4 Abbreviations and Acronyms Used in the Standard

BNF	Backus-Naur Form syntax
EPICS	electronic protocol implementation conformance statement
IUT	implementation under test
TCSL	testing and conformance scripting language
TD	testing device
TPI	text protocol information

4. ELECTRONIC PICS FILE FORMAT

An electronic protocol implementation conformance statement (EPICS) file contains a BACnet protocol implementation conformance statement expressed in a standardized text form. EPICS files are machine and human readable representations of the implementation of BACnet objects and services within a given device. EPICS files shall use the extension ".TPI" (text protocol information) and contain normal editable text lines consisting of text character codes ending in carriage return/linefeed pairs (X'0D', X'0A').

EPICS files are used by software testing tools to conduct and interpret the results of tests defined in this standard. An EPICS file shall accompany any device tested according to the procedures of this standard.

4.1 Character Encoding

BACnet provides for a variety of possible character encodings. The character encodings in BACnet fall into three groups: octet streams, double octet streams and quad octet streams. Octet streams represent characters as single octet values. In some cases, such as Microsoft DBCS and JIS C 6226, certain octet values signal that the second octet which follows should be viewed along with the leading octet as a single value, thus extending the range to greater than 256 possible characters. In contrast, double octet streams view pairs of octets as representing single characters. The ISO 10646 UCS-2 encoding is an example. The first or leading octet of the pair is the most significant part of the value. Quad octet streams, such as ISO 10646 UCS-4, treat tuples of four octets at a time as single characters with the first or leading octet being the most significant.

4. ELECTRONIC PICS FILE FORMAT

To accommodate the various encodings that may be used with BACnet device descriptions, EPICS files begin with a header that serves both to identify the file as an EPICS file, and to identify the particular encoding used. The header begins with the string "PICS #" where # is replaced by a numeral representing the character set as shown in Table 4-1.

Table 4-1. Character Set Codes

code	character set
0	ANSI X3.4
1	Microsoft DBCS
2	JIS C 6226
3	ISO 10646 (UCS-4)
4	ISO 10646 (UCS-2)
5	ISO 8859-1

An octet stream format can be recognized by examining the first eight octets of the EPICS file. Using ANSI X3.4 encoding as an example these eight octets will contain: X'50' X'49' X'43' X'53' X'20' X'30' X'0D' X'0A'. This represents the text "PICS 0" followed by carriage return and linefeed.

A double octet stream format can be recognized by examining the first 16 octets of the EPICS file. Using ISO 10646 UCS-2 encoding as an example these 16 octets will contain:

X'00' X'50' X'00' X'49' X'00' X'43' X'00' X'53'
X'00' X'20' X'00' X'34' X'00' X'0D' X'00' X'0A'

This represents the text "PICS 4" followed by carriage return and linefeed.

A quad octet stream format can be recognized by examining the first 32 octets of the EPICS file. Using ISO 10646 UCS-4 as an example these 32 octets will contain:

X'00' X'00' X'00' X'50' X'00' X'00' X'00' X'49'
X'00' X'00' X'00' X'43' X'00' X'00' X'00' X'53'
X'00' X'00' X'00' X'20' X'00' X'00' X'00' X'33'
X'00' X'00' X'00' X'0D' X'00' X'00' X'00' X'0A'

This represents the text "PICS 3" followed by carriage return and linefeed.

4.2 Structure of EPICS Files

EPICS files consist of text lines ending in carriage return/linefeed pairs (X'0D', X'0A') encoded as octet, double octet or quad octet streams as defined in 4.1. In the rest of this standard, the term "character" will be used to mean one symbol encoded as one, two, or four octets based on the character encoding used in the EPICS file header. For example, the character space may be encoded as X'20' or X'0020' or X'00000020'. In this standard all characters will be shown in their single octet form.

The special symbol ¶ is used in this Clause to signify the presence of a carriage return/linefeed pair (X'0D0A'). Except within character strings, the character codes tab (X'09'), space (X'20'), carriage return (X'0D') and linefeed (X'0A') shall be considered to be white space. Any sequence of 1 or more white space characters shall be equivalent to a single white space character. Except within a character string, a sequence of two dashes (X'2D') shall signify the beginning of a comment which shall end with the next carriage return/linefeed pair, i.e., the end of the line upon which the -- appears. Comments shall be considered to be white space, and may thus be inserted freely.

EPICS files shall have, as their first line following the header, the literal text:

BACnet Protocol Implementation Conformance Statement ¶

This text serves as a signature identifying the EPICS file format.

Lines that define the sections of the EPICS (see 4.5) and the particular implementation data for a given device follow the signature line.

The EPICS file ends with a line containing the following literal text:

End of BACnet Protocol Implementation Conformance Statement ↵

4.3 Character Strings

The occurrence of a double quote (X'22'), single quote (X'27') or accent grave (X'60') shall signify character strings. For double quotes, the end of the string shall be signified by the next occurrence of a double quote, or the end of the line. For single quote or accent grave, the end of the string shall be signified by the next occurrence of a single quote (X'27'), or the end of the line. Thus strings which need to include a single quote or accent grave as a literal character in the string shall use the double quote quoting method, while strings which need to include double quote shall use the single quote or accent grave quoting method.

4.4 Notational Rules for Parameter Values

Within each section, parameters may need to be expressed in one of several forms. The following rules govern the format for parameters:

- (a) key words are case insensitive so that X'41' through X'5A' are equivalent to X'61' through X'7A';
- (b) null values are shown by the string "NULL";
- (c) Boolean values are shown by the strings "T" or "TRUE" if the value is true, or "F" or "FALSE" if the value is false;
- (d) integer values are shown as strings of digits, possibly with a leading minus (-): 12345 or -111;
- (e) real values are shown with a decimal point, which may not be the first or last character: 1.23, 0.02, 1.0 but not .02;
- (f) octet strings are shown as pairs of hex digits enclosed in either single quotes (X'2D') or accent graves (X'60'), and preceded by the letter "X": X'001122';
- (g) character strings are represented as one or more characters enclosed in double, single or accent grave quotes as defined in 4.3: 'text' or 'text' or "text";
- (h) bitstrings are shown as a list, enclosed by curly brackets ({ } or X'7B' and X'7D'), of true and false values: {T,T,F} or {TRUE, TRUE, FALSE}. When the actual value of a bit does not matter, a question mark is used: {T,T,?};
- (i) enumerated values are represented as named, rather than numeric, values. Enumeration names are case insensitive so that X'41' through X'5A' are equivalent to X'61' through X'7A'. The underscore (X'5F') and dash (X'2D') are considered equivalent in enumeration names. Proprietary values are shown as a named text with no whitespace and ending in a non-negative decimal numeric. Each must start with the word "proprietary": Object_Type, proprietary-object-type-653;
- (j) dates are represented enclosed in parenthesis: (Monday, 24-January-1998). Any "wild card" or unspecified field is shown by an asterisk (X'2A'): (Monday, *-January-1998). The omission of day of week implies that the day is unspecified: (24-January-1998);
- (k) times are represented as hours, minutes, seconds, hundredths in the format hh:mm:ss.xx: 2:05:44.00, 16:54:59.99. Any "wild card" field is shown by an asterisk (X'2A'): 16:54:*. *;
- (l) object identifiers are shown enclosed by parentheses, with commas separating the object type and the instance number: (analog-input, 56). Proprietary object types replace the object type enumeration with the word "proprietary" followed by the numeric value of the object type: (proprietary 700,1);
- (m) constructed data items are represented enclosed by curly brackets ({ } or X'7B' and X'7D'), with elements separated by commas. If an element is itself a constructed value, then that element shall be enclosed in curly brackets.

4.4.1 Complex Parameter Values

Some parameter values, notably property values for constructed or CHOICE types of encoded values, need to use a more complex notation to represent their values. This notation is tied to the ASN.1 encoding for those property values and may appear obscure out of context. These additional rules govern the presentation of those types of parameter values:

- (a) values which are a CHOICE of application-tagged values are represented by the value of the chosen item encoded as described in 4.4;
- (b) values which are a CHOICE of context-tagged values are represented by the context tag number enclosed in square brackets, followed by the representation of the value of the chosen item;

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- (c) list values (ASN.1 "SEQUENCE OF") are represented enclosed in parenthesis, with the elements of the list separated by commas. If an element is itself a constructed value, then that element shall be enclosed in curly brackets;
- (d) array values are represented enclosed in curly brackets, with the elements of the array separated by commas. If an element is itself a constructed value, then that element shall be enclosed in curly brackets.

4.4.2 Specifying Limits on Parameter Values

Some properties may have restrictions on the range or resolution of their values. In order to correctly interpret the results of tests in which the value of a property is changed using WriteProperty, WritePropertyMultiple, or AddListElement then read back using ReadProperty or ReadPropertyMultiple, it is necessary to know what these restrictions are. The test database may contain restriction statements that define these constraints. The permissible restrictions and the datatypes they apply to are:

- (a) **minimum** - the minimum value for Unsigned, Integer, Real, or Double datatypes. The earliest date for the Date datatype;
- (b) **maximum** - the maximum value for Unsigned, Integer, Real, or Double datatypes. The latest date for the Date datatype;
- (c) **resolution** - the minimum guaranteed resolution for Real and Double datatypes. The minimum time resolution in seconds for the Time datatype;
- (d) **maximum length string** - the maximum length of a CharacterString or OctetString;
- (e) **maximum length list** - the maximum number of elements guaranteed to fit in a list;
- (f) **maximum length array** - the maximum number of elements in an array;
- (g) **allowed values** - a comma-delimited list of supported enumerations for an Enumerated datatype. A comma-delimited list of object types for properties that reference an external object identifier.

Restriction statements shall be listed within pointed brackets (< and >) following the default value. If there are multiple restrictions within a single set of angle brackets, then the restrictions shall be separated by a semicolon (;). A restriction statement consists of the restriction name followed by a colon (:) followed by the restriction value or, where appropriate, a comma-delimited list of possible values.

Here are some examples of property values with restriction statements as they could appear in the test database.

```
present-value: 13.4 <minimum: 0.0; maximum: 20.0; resolution: 0.1>
description: "this is a description" <maximum length string: 30>
units: milliamperes <allowed values: milliamperes, amperes>
object-property-reference: (analog input, 12) <allowed values: analog input, analog value>
```

The Units property is a special case, because changing the units can change the value of the Present_Value property as well as any restrictions on its value. Therefore, minimum, maximum, and resolution restrictions are only valid for the default value of the Units property.

It is possible to specify default restrictions for most datatypes as described in 4.5.8. Restriction statements in the test database override the default restrictions for the individual property that contains the restriction statement.

4.5 Sections of the EPICS File

Each section of the EPICS file begins with a section name followed by a colon (: or X'3A'). After the colon is a set of one or more parameters delimited by a set of curly braces ({ } or X'7B' X'7D').

The following symbols are used as placeholders to indicate the presence of parameter information:

- (a) the open box symbol inside quotation marks, "□", is used to indicate that a character string parameter shall be present;
- (b) the open box symbol with no quotation marks, □, is used to indicate that a parameter with a datatype other than a character string shall be present;
- (c) a question mark, ?, is used in the test database to indicate that the property is present but the value is unknown because it depends on hardware input or is being changed by an internal algorithm.

An example EPICS file may be found in Annex A.

4.5.1 General Information Sections

These sections provide general information about the BACnet device. The syntax for these sections is shown below.

```
Vendor Name: " "↵
Product Name: " "↵
Product Model Number: " "↵
Product Description: " "↵
```

4.5.2 Conformance Sections

These sections provide information about the BACnet functionality that the device claims to support.

4.5.2.1 BIBBs Supported

This section indicates which BIBBs are supported. The syntax is shown below. Each BIBB shall be listed, one per line between the curly braces. An empty list indicates that no BIBBs are supported.

```
BIBBs Supported: ↵
{↵
  ↵↵
}↵
```

The BIBBs may be any of those BIBBs described in Annex K. The format in the EPICS shall be to use the short acronym described in the title for each BIBB. For example: A device which supports 'Data Sharing - ReadProperty - B' should include 'DS-RP-B' in this section.

For example:

```
BIBBS Supported: ↵
{↵
  DS-RP-B↵
  DS-WP-B↵
  DS-RPM-B↵
  DM-DOB-B↵
  DM-DDB-B↵
  DM-DDB-A↵
}↵
```

4.5.3 Application Services Supported

This section indicates which standard application services are supported. The syntax is shown below. Each supported service shall be listed between curly braces one service per line, followed by the words "Initiate" or "Execute" to indicate whether the service can be initiated, executed, or both.

```
BACnet Standard Application Services Supported: ↵
{↵
  Initiate↵
  Execute↵
  Initiate Execute↵
}
```

The standard services may be any of the services listed in the Clause 21 production BACnetServicesSupported.

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The format should match the title of each corresponding services section in the standard minus the text 'Service'. For example, if the device supports the AcknowledgeAlarm service, the text 'AcknowledgeAlarm' should be included in this section of the EPICS.

For example:

```
BACnet Standard Application Services Supported: ↵
{↵
  Who-Is                Initiate Execute↵
  I-Am                  Initiate Execute↵
  Who-Has                Execute↵
  I-Have                Initiate ↵
  ReadProperty           Execute↵
  ReadPropertyMultiple   Execute↵
  WriteProperty          Execute↵
}
```

4.5.4 Object Types Supported

This section indicates which standard object types are supported. The syntax is shown below. Each supported object type shall be listed between curly braces one object type per line, optionally followed by the words "Createable", "Deleteable", or both to indicate that dynamic creation or deletion is supported.

```
Standard Object Types Supported: ↵
{↵
  □↵
  □ Createable↵
  □ Deleteable↵
  □ Createable Deleteable↵
}↵
```

The standard objects may be any of the objects listed in the Clause 21 production, BACnetObjectTypesSupported.

The format should be the title of each corresponding object section in the standard minus the text Object Type. For example, if the device supports the object access door, the text 'Access Door' should be included in this section.

For example:

```
BACnet Standard Application Services Supported: ↵
{↵
  Analog Value Createable Deleteable↵
  Analog Input↵
  Device↵
}
```

4.5.5 Data Link Layer Options

This section indicates which standard data link layer options are supported. The syntax is shown below. Each supported data link layer type shall be listed between the curly braces one per line. MS/TP and Point-To-Point data links shall also specify supported baud rate(s).

```
Data Link Layer Option: ↵
{↵
  ISO 8802-3, 10BASE5↵
  ISO 8802-3, 10BASE2↵
  ISO 8802-3, 10BASET↵
}
```

```

ISO 8802-3, fiber↵
ARCNET, coax star↵
ARCNET, coax bus↵
ARCNET, twisted pair star↵
ARCNET, twisted pair bus↵
ARCNET, fiber star↵
ARCNET, twisted pair, EIA-485, Baud rate(s): □↵
MS/TP master. Baud rate(s): 9600, □↵
MS/TP slave. Baud rate(s): 9600, □↵
Point-To-Point. EIA 232, Baud rate(s): □↵
Point-To-Point. Modem, Baud rate(s): □↵
Point-To-Point. Modem, Autobaud range: □to □↵
BACnet/IP, 'DIX' Ethernet↵
BACnet/IP, Other↵
Other↵
}↵

```

4.5.6 Character Sets

This section indicates which BACnet character sets are supported. The syntax is shown below. Each supported character set shall be listed one per line between the curly braces.

```

Character Sets Supported: ↵
{↵
ANSI X3.4↵
IBM/Microsoft DBCS↵
JIS C 6226↵
ISO 8859-1 ↵
ISO 10646 (UCS-4) ↵
ISO 10646 (UCS2) ↵
}↵

```

4.5.7 Special Functionality

This section indicates which BACnet special functionalities are supported. The syntax is shown below. Each special functionality supported shall be listed one per line between the curly braces. The maximum APDU size and window sizes shall be specified as integers.

```

Special Functionality: ↵
{↵
Maximum APDU size in octets: □↵
Segmented Requests Supported, window size: □↵
Segmented Responses Supported, window size: □↵
Router↵
BACnet/IP BBMD↵
}↵

```

4.5.8 Property Value Restrictions

This section defines default restrictions on the values of writable properties. Restrictions listed for a particular datatype apply to every writable property or component of a writable property of that datatype. The restriction may be overridden for a particular property by adding a new restriction specifically for that property in the test database section of the EPICS. See 4.4.2. Only those datatypes for which default restrictions are being defined should be listed, one datatype per line. An empty list indicates that no default restrictions apply.

```

Default Property Value Restrictions: ↵

```

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```
{
  unsigned-integer: <minimum: □; maximum: □>
  signed-integer: <minimum: □; maximum: □>
  real: <minimum: □; maximum: □; resolution: □>
  double: <minimum: □; maximum: □; resolution: □>
  date: <minimum: □; maximum: □>
  octet-string: <maximum length string: □>
  character-string: <maximum length string: □>
  list: <maximum length list: □>
  variable-length-array: <maximum length array: □>
}
```

4.5.9 Timers

This section defines timer values that are used to determine when a test has failed because an appropriate response has not been observed by the TD. A Real value in seconds must be provided for each timer. See 6.3.

```
Fail Times:
{
  Notification Fail Time: □
  Internal Processing Fail Time: □
  Minimum ON/OFF Time: □
  Schedule Evaluation Fail Time: □
  External Command Fail Time: □
  Program Object State Change Fail Time: □
  Acknowledgement Fail Time: □
  Slave Proxy Confirm Interval: □
  Unconfirmed Response Fail Time: □
}
```

4.5.10 Test Database

The last section of the EPICS file defines the contents of the device's test database of objects and their properties. The syntax for this section is described below.

```
List of Objects in Test Device:
{
  object1
  object2
  ...
  objectN
}
```

Each of the objects is defined by a collection of object property values contained within curly braces. The first property to appear within the curly braces shall always be the Object_Identifier which specifies the tuple of (object type, instance). The second property shall always be Object_Name and the third property shall always be Object_Type with a value matching the object type portion of the object-identifier tuple:

```
{
  object-identifier: (object-type, instance)
  object-name: "□"
  object-type: object-type
  other properties...
}
```

Definitions of nonstandard objects shall contain only the three properties required by the BACnet standard, as shown below:

```
{
```

```

object-identifier: (proprietary □, instance)
object-name: "□"
object-type: proprietary □
}

```

Properties in the test database that are writable shall have a "W" following the property value, as shown in the example below:

```

{
  object-identifier: (analog-value, 6)
  object-name: "□"
  object-type: analog-value
  present-value: 23.4 W
  other properties...
}

```

Properties in the test database that are conditionally writable shall have a "C" following the property value, as shown in the example below. It is recommended that the governing mechanism be identified in a comment:

```

{
  object-identifier: (analog-input, 6)
  object-name: "□"
  object-type: analog-input
  present-value: 12.3 C          -- Writable when Out_Of_Service is TRUE
  other properties...
}

```

The following sections show templates for each of the standard object types. To improve readability, the carriage return/linefeed pairs are not explicitly shown in the examples.

4.5.10.1 Accumulator

```

{
  object-identifier: (accumulator, □)
  object-name: "□"
  object-type: accumulator
  present-value: □
  description: "□"
  device-type: "□"
  status-flags: □
  event-state: □
  reliability: □
  out-of-service: □
  scale: □
  units: □
  prescale: □
  max-pres-value: □
  value-change-time: □
  value-before-change: □
  value-set: □
  logging-record: □
  logging-object: □
  pulse-rate: □
  high-limit: □
  low-limit: □
  limit-monitoring-interval: □
  notification-class: □
  time-delay: □
  limit-enable: □
}

```

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```

event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.2 Analog Input

```

{
  object-identifier: (analog-input, □)
  object-name: "□"
  object-type: analog-input
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  update-interval: □
  units: □
  min-pres-value: □
  max-pres-value: □
  resolution: □
  cov-increment: □
  time-delay: □
  notification-class: □
  high-limit: □
  low-limit: □
  deadband: □
  limit-enable: {□,□}
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.3 Analog Output

```

{
  object-identifier: (analog-output, □)
  object-name: "□"
  object-type: analog-output
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  units: □
  min-pres-value: □
  max-pres-value: □
  resolution: □
  priority-array: {□,□,?,?,□,?,?,□,?,?,?,?,?,?}
  relinquish-default: □
}

```

```

cov-increment: □
time-delay: □
notification-class: □
high-limit: □
low-limit: □
deadband: □
limit-enable: {□,□}
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.4 Analog Value

```

{
  object-identifier: (analog-value, □)
  object-name: "□"
  object-type: analog-value
  present-value: ?
  description: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  units: □
  priority-array: {□,□,?,?,□,?,?,□,?,?,?,?,?,?}
  relinquish-default: □
  cov-increment: □
  time-delay: □
  notification-class: □
  high-limit: □
  low-limit: □
  deadband: □
  limit-enable: {□,□}
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.5 Averaging

```

{
  object-identifier: (averaging, □)
  object-name: "□"
  object-type: averaging
  minimum-value: □
  minimum-value-timestamp: {□,□}
  average-value: □
  variance-value: □
  maximum-value: □
  maximum-value-timestamp: {□,□}
  description: "□"
  attempted-samples: □
  valid-samples: □
}

```

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```

object-property-reference: □
window-interval: □
window-samples: □
profile-name: "□"
}

```

4.5.10.6 Binary Input

```

{
  object-identifier: (binary-input, □)
  object-name: "□"
  object-type: binary-input
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  polarity: □
  inactive-text: "□"
  active-text: "□"
  change-of-state-time: {□,□}
  change-of-state-count: □
  time-of-state-count-reset: {□,□}
  elapsed-active-time: □
  time-of-active-time-reset: {□,□}
  time-delay: □
  notification-class: □
  alarm-value: □
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.7 Binary Output

```

{
  object-identifier: (binary-output, □)
  object-name: "□"
  object-type: binary-output
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  polarity: □
  inactive-text: "□"
  active-text: "□"
  change-of-state-time: {□,□}
  change-of-state-count: □
  time-of-state-count-reset: {□,□}
  elapsed-active-time: □
  time-of-active-time-reset: {□,□}
}

```

```

minimum-off-time: □
minimum-on-time: □
priority-array: {□,□,?,?,□,?,?,□,?,?,?,?,?,?}
relinquish-default: □
time-delay: □
notification-class: □
feedback-value: ?
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.8 Binary Value

```

{
  object-identifier: (binary-value, □)
  object-name: "□"
  object-type: binary-value
  present-value: ?
  description: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  inactive-text: "□"
  active-text: "□"
  change-of-state-time: {□,□}
  change-of-state-count: □
  time-of-state-count-reset: {□,□}
  elapsed-active-time: □
  time-of-active-time-reset: {□,□}
  minimum-off-time: □
  minimum-on-time: □
  priority-array: {□,□,?,?,□,?,?,□,?,?,?,?,?,?}
  relinquish-default: □
  time-delay: □
  notification-class: □
  alarm-value: □
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.9 Calendar

```

{
  object-identifier: (calendar, □)
  object-name: "□"
  object-type: calendar
  description: "□"
  present-value: □
  date-list: (□,□...)
  profile-name: "□"
}

```

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4.5.10.10 Command

```
{
  object-identifier: (command, □)
  object-name: "□"
  object-type: command
  description: "□"
  present-value: □
  in-process: □
  all-writes-successful: □
  action: {□, □...}
  action-text: {"□", "□"...}
  profile-name: "□"
}
```

4.5.10.11 Device

```
{
  object-identifier: (device, □)
  object-name: "□"
  object-type: device
  system-status: □
  vendor-name: "□"
  vendor-identifier: □
  model-name: "□"
  firmware-revision: "□"
  application-software-version: "□"
  location: "□"
  description: "□"
  protocol-version: □
  protocol-revision: □
  protocol-services-supported: {□, □...}
  protocol-object-types-supported: {□, □...}
  object-list: {□, □...}
  max-APDU-length-accepted: □
  segmentation-supported: □
  vt-classes-supported: (□, □...)
  active-vt-sessions: (□, □...)
  local-time: □
  local-date: □
  utc-offset: □
  daylight-savings-status: □
  apdu-segment-timeout: □
  apdu-timeout: □
  number-of-APDU-retries: □
  list-of-session-keys: (□, □...)
  time-synchronization-recipients: (□, □...)
  max-master: □
  max-info-frames: □
  device-address-binding: (□, □...)
  database-revision: □
  configuration-files: □
  last-restore-time: □
  backup-failure-timeout: □
  active-cov-subscriptions: □
  profile-name: "□"
}
```

4.5.10.12 Event Enrollment

```

{
  object-identifier: (event-enrollment, □)
  object-name: "□"
  object-type: event-enrollment
  description: "□"
  event-type: □
  notify-type: □
  event-parameters: {□,□...}
  object-property-reference: (□)
  event-state: □
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notification-class: □
  -- The following four properties were removed from Event Enrollment objects in protocol revision 4:
  -- recipient: □
  -- process-identifier: □
  -- priority: □
  -- issue-confirmed-notifications: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.13 File

```

{
  object-identifier: (file, □)
  object-name: "□"
  object-type: file
  description: "□"
  file-type: "□"
  file-size: □
  modification-date: {□,□}
  archive: □
  read-only: □
  file-access-method: □
  profile-name: "□"
}

```

4.5.10.14 Group

```

{
  object-identifier: (group, □)
  object-name: "□"
  object-type: group
  description: "□"
  list-of-group-members: (□, □...)
  present-value: (□, □...)
  profile-name: "□"
}

```

4.5.10.15 Life Safety Point

```

{
  object-identifier: (life-safety-point, □)
  object-name: "□"
  object-type: life-safety-point
  present-value: ?
}

```

4. ELECTRONIC PICS FILE FORMAT

```

tracking-value: □
description: "□"
device-type: "□"
status-flags: {□,□,□,□}
event-state: □
reliability: □
out-of-service: □
mode: □
time-delay: □
notification-class: □
life-safety-alarm-values: (□,□...)
alarm-values: (□,□...)
fault-values: (□,□...)
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
silenced: □
operation-expected: □
maintenance-required: □
setting: □
direct-reading□
units: □
member-of: (□,□...)
profile-name: "□"
}

```

4.5.10.16 Life Safety Zone

```

{
  object-identifier: (life-safety-zone, □)
  object-name: "□"
  object-type: life-safety-zone
  present-value: ?
  tracking-value: □
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  mode: □
  time-delay: □
  notification-class: □
  life-safety-alarm-values: (□,□...)
  alarm-values: (□,□...)
  fault-values: (□,□...)
  event-enable: (□,□,□)
  acked-transitions: (□,□,□)
  notify-type: □
  event-time-stamps: {□,□,□}
  silenced: □
  operation-expected: □
  maintenance-required: □
  zone-members: (□,□...)
  member-of: (□,□...)
  profile-name: "□"
}

```

}

4.5.10.17 Loop

```

{
  object-identifier: (loop, □)
  object-name: "□"
  object-type: loop
  present-value: ?
  description: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  update-interval: □
  output-units: □
  manipulated-variable-reference: {□}
  controlled-variable-reference: {□}
  controlled-variable-value □
  controlled-variable-units □
  setpoint-reference: {□}
  setpoint: □
  action: □
  proportional-constant: □
  proportional-constant-units: □
  integral-constant: □
  integral-constant-units: □
  derivative-constant: □
  derivative-constant-units: □
  bias: □
  maximum-output: □
  minimum-output: □
  priority-for-writing: □
  cov-increment: □
  time-delay: □
  notification-class: □
  error-limit: □
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.18 Multi-state Input

```

{
  object-identifier: (multi-state-input, □)
  object-name: "□"
  object-type: multi-state-input
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  number-of-states: □
}

```

4. ELECTRONIC PICS FILE FORMAT

```

state-text: {"□", "□" ...}
time-delay: □
notification-class: □
alarm-values: (□,□...)
fault-values: (□,□...)
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.19 Multi-state Output

```

{
  object-identifier: (multi-state-output, □)
  object-name: "□"
  object-type: multi-state-output
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  number-of-states: □
  state-text: {"□", "□" ...}
  priority-array: {□,□,?,?,□,?,?,□,?,?,?,?,?,?}
  relinquish-default: □
  time-delay: □
  notification-class: □
  feedback-value: □
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.20 Multi-state Value

```

{
  object-identifier: (multi-state-value, □)
  object-name: "□"
  object-type: multi-state-value
  present-value: ?
  description: "□"
  device-type: "□"
  status-flags: {□,□,□,□}
  event-state: □
  reliability: □
  out-of-service: □
  number-of-states: □
  state-text: {"□", "□" ...}
  priority-array: {□,□,?,?,□,?,?,□,?,?,?,?,?,?}
  relinquish-default: □
  time-delay: □
  notification-class: □
}

```

```

alarm-values: (□,□...)
fault-values: (□,□...)
feedback-value: □
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.21 Notification Class

```

{
  object-identifier: (notification-class, □)
  object-name: "□"
  object-type: notification-class
  description: "□"
  notification-class: □
  priority: {□, □, □}
  ack-required: {□,□,□}
  recipient-list: (□,□...)
  profile-name: "□"
}

```

4.5.10.22 Program

```

{
  object-identifier: (program, □)
  object-name: "□"
  object-type: program
  program-state: □
  program-change: □
  reason-for-halt: □
  description-of-halt: "□"
  program-location: "□"
  description: "□"
  instance-of: "□"
  status-flags: {□,□,□,□}
  reliability: □
  out-of-service: □
  profile-name: "□"
}

```

4.5.10.23 Pulse Converter

```

{
  object-identifier: (pulse-converter, □)
  object-name: "□"
  object-type: pulse-converter
  description: "□"
  present-value: □
  input-reference: □
  status-flags: □
  event-state: □
  reliability: □
  out-of-service: □
  units: □
  scale-factor: □
}

```

4. ELECTRONIC PICS FILE FORMAT

```

adjust-value: □
count: □
update-time: □
count-change-time: □
count-before-change: □
cov-increment: □
cov-period: □
notification-class: □
time-delay: □
high-limit: □
low-limit: □
deadband: □
limit-enable: □
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.24 Schedule

```

{
  object-identifier: (schedule, □)
  object-name: "□"
  object-type: schedule
  present-value: □
  description: "□"
  effective-period: {□,□}
  weekly-schedule: {□,□...}
  exception-schedule: {□,□...}
  list-of-object-property-references: (□,□...)
  priority-for-writing □
  profile-name: "□"
}

```

4.5.10.25 Trend Log

```

{
  object-identifier: (trend-log, □)
  object-name: "□"
  object-type: trend-log
  description: "□"
  log-enable: □
  start-time: □
  stop-time: □
  log-device-object-property: {□}
  log-interval: □
  cov-resubscription-interval : □
  client-cov-increment: □
  stop-when-full: □
  buffer-size: □
  log-buffer: □
  record-count: □
  total-record-count: □
  notification-threshold: □
  records-since-notification: □
  previous-notify-time: □
}

```

```

current-notify-time: □
event-state: □
notification-class: □
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.26 Access Door

```

{
  object-identifier: (access-door, □)
  object-name: "□"
  object-type: access-door
  present-value : □
  description: "□"
  status-flags: □
  event-state: □
  reliability: □
  out-of-service: □
  priority-array: □
  relinquish-default: □
  door-status: □
  lock-status: □
  secured-status: □
  door-members: {□, □...}
  door-pulse-time: □
  door-extended-pulse-time: □
  door-unlock-delay-time: □
  door-open-too-long-time: □
  door-alarm-state: □
  masked-alarm-values: {□, □ ...}
  maintenance-required: □
  time-delay: □
  notification-class: □
  alarm-values: {□, □...}
  fault-values: {□, □...}
  event-enable: {□,□,□}
  acked-transitions: {□,□,□}
  notify-type: □
  event-time-stamps: {□,□,□}
  profile-name: "□"
}

```

4.5.10.27 Load Control

```

{
  object-identifier: (load-control, □)
  object-name: "□"
  object-type: load-control
  description: "□"
  present-value: □
  state-description: "□"
  status-flags: □
  event-state: □
}

```

4. ELECTRONIC PICS FILE FORMAT

```

reliability: □
requested-shed-level: □
start-time: □
shed-duration: □
duty-window: □
enabled: □
full-duty-baseline: □
expected-shed-level: □
actual-shed-level: □
shed-levels: {□, □...}
shed-level-descriptions: {"□", "□"...}
notification-class: □
time-delay: □
event-enable: {□,□,□}
acked-transitions: {□,□,□}
notify-type: □
event-time-stamps: {□,□,□}
profile-name: "□"
}

```

4.5.10.28 Structured View

```

{
  object-identifier: (structured-view, □)
  object-name: "□"
  object-type: structured-view
  description: "□"
  node-type: □
  node-subtype: "□"
  subordinate-list: {□, □...}
  subordinate-annotations: {"□", "□"...}
  profile-name: "□"
}

```

5. EPICS CONSISTENCY TESTS

Each implementation shall be tested to ensure consistency among interrelated data elements. These tests shall include:

- (a) All object types required by the specified BIBBs shall be indicated as supported in the Standard Object Types Supported section of the EPICS.
- (b) A minimum of one instance of each object type required by the specified BIBBs shall be included in the test database.
- (c) The Object_Types_Supported property of the Device object in the test database shall indicate support for each object type required by the supported BIBBs.
- (d) All application services required by the supported BIBBs shall be indicated as supported in the BACnet Standard Application Services Supported section of the EPICS with Initiate and Execute indicated as required by the supported BIBBs.
- (e) The Application_Services_Supported property of the Device object in the test database shall indicate support for each application service for which the supported BIBBs requires support for execution of the service.
- (f) The object types listed in the Standard Object Types Supported section of the EPICS shall have a one-to-one correspondence with object types listed in the Object_Types_Supported property of the Device object contained in the test database.
- (g) For each object type listed in the Standard Object Types Supported section of the EPICS there shall be at least one object of that type in the test database.
- (h) There shall be a one-to-one correspondence between the objects listed in the Object_List property of the Device object and the objects included in the test database. The Object_List property and the test database shall both include all proprietary objects. Properties of proprietary objects that are not required by BACnet Clause 23.4.3 need not be included in the test database.
- (i) For each object included in the test database, all required properties for that object as defined in Clause 12 of BACnet shall be present. In addition, if any of the properties supported for an object require the conditional presence of other properties, their presence shall be verified.
- (j) For each property that is required to be writable, that property shall be marked as writable in the EPICS.
- (k) The length of the Protocol_Services_Supported bitstring shall have the number of bits defined for BACnetProtocolServicesSupported for the IUT's declared protocol revision.
- (l) The length of the Protocol_Object_Types_Supported bitstring shall have the number of bits defined for BACnetObjectTypesSupported for the IUT's declared protocol revision.

6. CONVENTIONS FOR SPECIFYING BACnet CONFORMANCE TESTS

6. CONVENTIONS FOR SPECIFYING BACnet CONFORMANCE TESTS

In order to shorten and clarify test descriptions a simple Testing and Conformance Scripting Language (TCSL) is used. Following the Backus-Naur Form (BNF) syntax for programming language grammars, the following symbols will be used:

<part>	language component names are enclosed in pointed brackets
::=	is defined as
<a> <c>	implicit concatenation
	pattern selection
()	required component
[]	optional component
()...	one required, may be repeated
[]...	optional, may be repeated
<d>...	component appears once, may be repeated
'?'	symbols are in single quotes
WOW	reserved words are upper case
--	indicates that the remaining characters in this line are a comment

Because TCSL is pseudo language that is not intended to be an implementation language for a TD, the rigorous forms of BNF are relaxed in some places and an English statement or phrase is used in their place.

In the tests defined using TCSL an exchange of messages exactly as prescribed constitutes a passing result unless some additional constraint is explicitly noted.

6.1 TCSL Components

6.1.1 Common Symbols and Characters

The following definitions are used to represent common symbols and characters.

<binary digit> ::=	'0' '1'
<decimal digit> ::=	'0' '1' '2' '3' '4' '5' '6' '7' '8' '9'
<hex digit> ::=	<decimal digit> 'A' 'B' 'C' 'D' 'E' 'F'
<single quote> ::=	(the single quote character)
<double quote> ::=	(the double quote character)
<conditional> ::=	'=' '<' '>' '<=' '>=' '~=' '<>'

The conditional '~=' is approximately equal to. The definition of approximate is dependant on the context of its use.

6.1.2 Integers

The following definitions are used to represent integers. These definitions match the syntax used in the BACnet standard.

<integer> ::=	<binary int> <decimal int> <hex int>
<binary int> ::=	B <single quote> <binary digit>... <single quote>
<decimal int> ::=	['-'] <unsigned> D <single quote> <decimal digit>... <single quote>
<hex int> ::=	X <single quote> <hex digit>... <single quote>
<unsigned> ::=	<decimal digit>...

6.1.3 Text Strings

Text strings representing the value of a property or service parameter may be upper, lower or mixed case and are enclosed in double quotes (").

Examples: Object_Name = "CW_STEMP", Description = "AC1 Supply Temperature".

6.1.4 Enumerations

The value of a property or parameter that is an enumerated type is represented in all UPPER CASE letters without quotation.

Examples: TRUE, FALSE, RELIABLE, UNRELIABLE.

6.1.5 Property Identifiers

Property identifiers are represented by mixed case letters with each component word capitalized and joined with other component words, if present, by an underscore (_).

Examples: Present_Value, Reliability, Object_Identifier, Object_Type, and Vendor_Name.

6.1.6 Service Parameters

The names of service parameters are enclosed in single quotes.

Examples: 'Return Read Access Specifications with Result', 'List of Read Access Results'.

6.1.7 Object Identifiers

The representation of object identifiers is defined as follows:

$$\langle \text{object identifier} \rangle ::= '(' \langle \text{object type} \rangle ',' \langle \text{instance number} \rangle ')'$$

Where:

<object type> ::= (one of the object types defined in BACnet Clause 12)

$$\langle \text{instance number} \rangle ::= \langle \text{unsigned} \rangle$$

Examples: (Analog Input, 1), (Device, 150)

6.2 TCSL Statements

Statements in TCSL fall into two categories, those that control the flow and order of tests and those that tell the TD to send data, receive data, or both.

$$\langle \text{statement} \rangle ::= \langle \text{simple statement} \rangle \mid \langle \text{compound statement} \rangle$$
$$\langle \text{compound statement} \rangle ::= \{ \langle \text{statement} \rangle \dots \}$$

A <compound statement> can be used anywhere a <simple statement> can be used.

```

<simple statement> ::= <if statement> | <repeat statement> | <error statement>
                    | <check statement> | <make statement>
                    | <transmit statement> | <receive statement>
                    | <write statement> | <verify statement> | <before statement>
                    | <read statement>

```

6.2.1 IF Statement

The IF statement is used to test for a condition and take an alternate flow of control based on the result of the test.

$$\langle \text{if statement} \rangle ::= \text{IF '}' \langle \text{condition} \rangle \text{'}' THEN } \langle \text{statement} \rangle \text{ [ELSE } \langle \text{statement} \rangle \text{]}$$

The <condition> is a simple English phrase describing a decision the TD must make. If the <condition> is true, the statement after the THEN keyword will execute. If the <condition> is false and the ELSE clause has been specified, the statement following the ELSE will execute. For example:

```
IF (it is raining outside) THEN
    VERIFY Present_Value = 1
ELSE
    VERIFY Present_Value = 2
```

6. CONVENTIONS FOR SPECIFYING BACnet CONFORMANCE TESTS

6.2.2 REPEAT Statement

The REPEAT statement is used to iterate through a list of similar objects or values.

<repeat statement> ::= REPEAT <var> '=' '(' <list description> ')' DO <statement>

The <var> is some unique identifier that will take on each of the values in the <list description>. By convention it is usually the letter 'X', 'Y', or 'Z' and is specified as an uppercase character. The <list description> is a simple English phrase that describes the elements to iterate through. For example:

```
REPEAT X = (values specified by 6.3 appropriate to the object type) DO {
    WRITE Present_Value = X
    VERIFY Present_Value = X
}
```

6.2.3 ERROR Statement

Some TCSL steps may result in an error condition that is made visible by the ERROR statement.

<error statement> ::= ERROR [<explanation string>]

The optional <explanation string> is a text string provided to the operator of the TD for diagnostic purposes. For example:

```
ERROR "Retry count exceeded"
```

6.2.4 CHECK Statement

The CHECK statement is used when the operator must verify that some action by the TD has resulted in a change to the IUT that is not network visible.

<check statement> ::= CHECK '(' <condition> ')'

The operator is given an opportunity to notify the TD that an operation was or was not successful, the <condition> is a simple English phrase that describes what to check. If the operation was not successful, the test will fail. For example:

```
CHECK (Did the IUT reboot?)
```

6.2.5 MAKE Statement

The MAKE statement is used when the operator must perform some action to create a change in the IUT.

<make statement> ::= MAKE '(' <action> ')'

Where <action> is a text string describing the action that is to take place. For example:

```
MAKE (Out_Of_Service TRUE)
```

6.2.6 TRANSMIT Statement

The TRANSMIT statement is used to transmit a packet.

<transmit statement> ::= TRANSMIT <packet desc>

Where:

<packet desc> ::= [<port> ','] [<addressing> ','] (<service specification> | <pdu specification> | <string>)

<port> ::= PORT <port identifier>

<port identifier> ::= 'A' | 'B' ... 'Z'

6. CONVENTIONS FOR SPECIFYING BACnet CONFORMANCE TESTS

```

<addressing> ::= ( <dst> | <src> | <dst> ',' <src> )
<src> ::= SOURCE '=' <src parm value>
<src parm value> ::= TD | IUT
<dst> ::= DESTINATION '=' <dst parm value>
<dst parm value> ::= LOCAL BROADCAST | GLOBAL BROADCAST
                    | REMOTE BROADCAST <net>
                    | IUT | TD
<net> ::= (a valid BACnet network number)

<service specification> ::= <BACnet service> [ ',' <pdu parm list> ] [ ',' <service parm list> ]
<BACnet service> ::= (any BACnet service choice)
<service parm list> ::= <service parameter> '=' <parameter value> [ ',' <service parm list> ]
<service parameter> ::= (parameter name specific to the BACnet service)

<pdu specification> ::= <pdu type> [ ',' <pdu parm list> ]
<pdu type> ::= (any BACnet application, network, link, or MAC layer PDU type)
<pdu parm list> ::= <pdu parameter> '=' <parameter value> [ ',' <pdu parm list> ]
<pdu parameter> ::= (any BACnet application, network, data link, or MAC layer PDU
                    parameter)

<parameter value> ::= ( <atomic value> | <parameter value list> | <parameter cond value> )
<parameter value list> ::= '(' <parameter value> [ '|' <parameter value> ]... ')'
<parameter cond value> ::= '(' IF <condition> THEN <parameter value> ELSE <parameter value> ')'

<string> ::= "<ASCII Char>"
<ASCII Char> ::= (ANSI X3.4 character)

```

The SOURCE and DESTINATION parameters are used to briefly specify common combinations of NPDU, LPDU and MPDU parameter values. If DESTINATION and SOURCE are not specified, the source address shall be TD and the destination address shall be IUT.

A list of <pdu parameter> = <parameter value> pairs indicate that the specified parameters shall convey the indicated values. The parameter values may be specified in any order.

A list of <service parameter> = <parameter value> pairs indicate that the specified parameters shall convey the indicated values. The parameter values may be specified in any order.

Example 1:

TRANSMIT DESTINATION = GLOBAL BROADCAST, Who-Is

In this simple case, the Who-Is service does not have any mandatory parameters and the <pdu type> is known to be a BACnet-Unconfirmed-Request-PDU by definition. The DESTINATION implies parameter values in the NPDU, LPDU and MPDU layers. The following statement is identical, but more completely specified:

```

TRANSMIT
  DA = LOCAL BROADCAST,
  SA = TD,
  DNET = GLOBAL BROADCAST,
  BACnet-Unconfirmed-Request-PDU,
  'Service Choice' = Who-Is

```

Example 2:

```

TRANSMIT ReadProperty-Request,
  'Object Identifier' = (Analog Input,1),

```

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'Property Identifier' = Present_Value

In this case a ReadProperty service request will be sent from the TD to the IUT with the specified service parameter values.

6.2.7 RECEIVE Statement

The RECEIVE procedure is used to define a message from the IUT.

<receive statement> ::= RECEIVE (<packet desc> | '(' <packet desc> ')' ['(' <packet desc> ')'] ...)

The <pdu specification> parameter is the same as used in the TRANSMIT statement. If unspecified the SOURCE defaults to IUT and DESTINATION defaults to TD.

Example: TRANSMIT SubscribeCOV-Request,

'Subscriber Process Identifier' = any value selected by the TD,
 'Monitored Object Identifier' = any object supporting COV notification,
 'Issue Confirmed Notifications' = TRUE,
 'Lifetime' = 0

RECEIVE ConfirmedCOVNotification-Request,

'Subscriber Process Identifier' = the value from the previous subscription,
 'Monitored Object' = the value from the previous subscription,
 'Initiating Device Identifier' = IUT,
 'Lifetime' = 0,
 'List of Values' = values appropriate to the object type of the monitored object

6.2.8 WAIT Statement

The WAIT statement is used to pause the execution of the TD for some specified amount of time.

<wait statement> ::= WAIT <timer value>

Test Steps: The TD shall pause the amount of time specified by the <timer value> before proceeding to the next test step. The <timer value> shall be one of the timers specified in 6.3 of this standard, in ANSI/ASHRAE 135-2008, or as otherwise specified.

Example: WAIT **Internal Processing Fail Time**

6.2.9 WRITE Statement

The WRITE statement is used to modify the value of a specific property of an object.

<write statement> ::= WRITE [<object identifier> ';'] <property identifier> '=' <property value>
 [';' ARRAY INDEX '=' <index value>]
 [';' PRIORITY '=' <write priority>]

This is a shortcut of the following statements:

1. TRANSMIT WriteProperty-Request,
 'Object Identifier' = <object identifier>,
 'Property Identifier' = <property identifier>,
 'Property Value' = <property value>,
 'Array Index' = <array index>,
 'Priority' = <write priority>
2. RECEIVE BACnet-SimpleACK-PDU

Note: In some tests <object identifier> is omitted from the description because it is clear from the context what object type should be written to and any instance of that object type would be acceptable. In cases where there may be some ambiguity this parameter will be explicitly specified.

If <index value> or <write priority> are omitted then the corresponding service parameter shall be omitted in the WriteProperty service request.

Example: WRITE (Analog Output, 1), Present_Value = 6.5, PRIORITY = 8

6.2.10 VERIFY Statement

<verify statement> ::= VERIFY [<object identifier> ','] <property identifier> <conditional> <property value>
[',' ARRAY INDEX '=' <array index>]

The verify procedure consists of the following steps:

1. WAIT **Internal Processing Fail Time**
2. TRANSMIT ReadProperty-Request,
 'Object Identifier' = <object identifier>,
 'Property Identifier' = <property identifier>,
 'Property Array Index' = <array index>
3. RECEIVE BACnet-ComplexACK-PDU,
 'Object Identifier' = <object identifier>,
 'Property Identifier' = <property identifier>,
 'Property Array Index' = <array index>,
 'Property Value' = (any valid value x, where x <conditional> <property value> is TRUE subject to the resolution constraints of 4.4.2)

Example: WRITE (Analog Output, 1), Present_Value = 6.5, PRIORITY = 8
 VERIFY (Analog Output, 1), Present_Value = 6.5

6.2.11 BEFORE Statement

The BEFORE statement is used to test for the occurrence of an expected action before a timer expires.

<before statement> ::= BEFORE <timer> <statement>

The <timer value> shall be one of the timers specified in 6.3 of this standard, in ANSI/ASHRAE 135-2008, or as otherwise specified. If the action indicated by <statement> has not yet occurred when the timer expires the test fails. Otherwise this test step passes and the test continues. For example:

BEFORE **Acknowledgment Fail Time** RECEIVE BACnet-Simple-ACK

6.2.12 WHILE Statement

The WHILE statement is used to repeatedly perform a step or series of steps until some condition becomes FALSE.

<while statement> ::= WHILE '(' <condition> ')' DO <statement>

Example:

```
WHILE (IUT not initialized) DO {
  TRANSMIT Poll For Master
}
```

6.2.13 READ Statement

<read statement> ::= READ <variable> '=' [<object identifier> ','] <property identifier>
[',' ARRAY INDEX '=' <array index>]

The read procedure consists of the following steps:

1. WAIT **Internal Processing Fail Time**
2. TRANSMIT ReadProperty-Request,

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- 'Object Identifier' = <object identifier>,
 'Property Identifier' = <property identifier>,
 'Property Array Index' = <array index>
3. RECEIVE BACnet-ComplexACK-PDU,
 'Object Identifier' = <object identifier>,
 'Property Identifier' = <property identifier>,
 'Property Array Index' = <array index>,
 'Property Value' = (any valid value, <variable>)

Example: READ X = Priority_Array, ARRAY_INDEX=10

6.3 Time Dependencies

The BACnet standard does not define how long it should take for actions that result from service requests to become network visible. These time delays can reasonably be expected to vary from implementation to implementation. In a testing environment it is necessary to place a bound on these times in order to decide if a test has passed or failed. The timers defined in this clause are used for this purpose. The vendor shall provide the actual value of the timers for a particular implementation in the EPICS. See 4.5.9. The data type for these timers shall be Real.

6.3.1 Notification Fail Time

The **Notification Fail Time** is the elapsed time, in seconds, between when the conditions that constitute an event or change of value become externally observable and when a test is considered to have failed because the expected notification message has not been transmitted.

6.3.2 Internal Processing Fail Time

The **Internal Processing Fail Time** is the elapsed time, in seconds, between the receipt of a write to a BACnet property or some other event that changes the value of the property and when a test is considered to have failed because the property value has not been updated.

6.3.3 Minimum ON/OFF Fail Time

The **Minimum ON/OFF Fail Time** is the maximum elapsed time, in seconds, between the expiration of a minimum on or minimum off timer and when the test is considered to have failed because the value at command priority level 6 is not as expected.

6.3.4 Schedule Evaluation Fail Time

The **Schedule Evaluation Fail Time** is the elapsed time, in seconds, between a change to a property defining a Calendar or a Schedule, or a change in the device's Local_Time, and when a test is considered to have failed because the Present_Value of the Calendar or Schedule does not reflect the correct state.

6.3.5 External Command Fail Time

The **External Command Fail Time** is the elapsed time, in seconds, between a change to the Present_Value of a Command object and when a test is considered to have failed because the first message associated with the newly commanded state has not been transmitted.

6.3.6 Program Object State Change Fail Time

The **Program Object State Change Fail Time** is the time, in seconds, between a write to the Program_Change property and when a test is considered to have failed because the expected program result was not observed.

6.3.7 Acknowledgment Fail Time

The **Acknowledgment Fail Time** is the elapsed time, in seconds, between when a BACnet confirmed service request is transmitted and the corresponding acknowledgment shall have been received.

6.3.8 Default Time Delay in Test Descriptions

For the test cases defined in this standard it is acceptable to have a time delay of up to **Internal Processing Fail Time** before a message specified by a RECEIVE statement is actually received unless a different timing constraint is explicitly stated.