

E DIN EN ISO 16484-5 rev:2022-10 (E)

Erscheinungsdatum: 2022-09-23

Building automation and control systems (BACS) - Part 5: Data communication protocol (ISO/FDIS 16484-5:2022); English version prEN ISO 16484-5:2022, only on CD-ROM

Contents

| | Page |
|--------------------------------------------------------------------------|------|
| FOREWORD | xii |
| 1 PURPOSE..... | 1 |
| 2 SCOPE..... | 1 |
| 3 DEFINITIONS | 1 |
| 3.1 Terms Adopted from International Standards | 1 |
| 3.2 Terms Defined for this Standard..... | 3 |
| 3.3 Abbreviations and Acronyms Used in this Standard..... | 7 |
| 4 BACnet PROTOCOL ARCHITECTURE | 11 |
| 4.1 The BACnet Collapsed Architecture..... | 12 |
| 4.2 BACnet Network Topology | 14 |
| 4.3 Security | 14 |
| 5 THE APPLICATION LAYER..... | 16 |
| 5.1 The Application Layer Model..... | 16 |
| 5.2 Segmentation of BACnet Messages | 20 |
| 5.3 Transmission of BACnet APDUs | 21 |
| 5.4 Application Protocol State Machines..... | 25 |
| 5.5 Application Protocol Time Sequence Diagrams | 41 |
| 5.6 Application Layer Service Conventions | 50 |
| 6 THE NETWORK LAYER | 52 |
| 6.1 Network Layer Service Specification..... | 52 |
| 6.2 Network Layer PDU Structure..... | 54 |
| 6.3 Messages for Multiple Recipients | 59 |
| 6.4 Network Layer Protocol Messages..... | 60 |
| 6.5 Network Layer Procedures | 64 |
| 6.6 BACnet Routers | 66 |
| 6.7 Point-To-Point Half-Routers | 71 |
| 7 DATA LINK/PHYSICAL LAYERS: Ethernet (ISO 8802-3) LAN | 76 |
| 7.1 The Use of ISO 8802-2 Logical Link Control (LLC)..... | 76 |
| 7.2 Parameters Required by the LLC Primitives..... | 76 |
| 7.3 Parameters Required by the MAC Primitives..... | 76 |
| 7.4 Physical Media..... | 76 |
| 8 DATA LINK/PHYSICAL LAYERS: ARCNET (ATA 878.1) LAN | 77 |
| 8.1 The Use of ISO 8802-2 Logical Link Control (LLC)..... | 77 |
| 8.2 Parameters Required by the LLC Primitives..... | 77 |
| 8.3 Mapping the LLC Services to the ARCNET MAC Layer | 77 |
| 8.4 Parameters Required by the MAC Primitives..... | 77 |
| 8.5 Physical Media..... | 77 |
| 9 DATA LINK/PHYSICAL LAYERS: MASTER-SLAVE/TOKEN-PASSING (MS/TP) LAN..... | 79 |
| 9.1 Service Specification | 79 |
| 9.2 Physical Layer | 81 |
| 9.3 MS/TP Frame Format..... | 90 |
| 9.4 Overview of the MS/TP Network | 92 |
| 9.5 MS/TP Medium Access Control | 92 |
| 9.6 Cyclic Redundancy Check (CRC)..... | 111 |
| 9.7 Interfacing MS/TP LANs with Other BACnet LANs | 112 |
| 9.8 Responding BACnet User Processing of Messages from MS/TP | 112 |
| 9.9 Repeaters | 113 |
| 9.10 COBS (Consistent Overhead Byte Stuffing) Encoding | 114 |
| 9.11 Documenting MS/TP Device Design Choices | 118 |
| 10 DATA LINK/PHYSICAL LAYERS: POINT-TO-POINT (PTP)..... | 119 |
| 10.1 Overview | 119 |
| 10.2 Service Specification | 119 |
| 10.3 Point-to-Point Frame Format | 124 |
| 10.4 PTP Medium Access Control Protocol..... | 126 |
| 11 DATA LINK/PHYSICAL LAYERS: LonTalk (ISO/IEC 14908.1) LAN | 147 |
| 11.1 The Use of ISO 8802-2 Logical Link Control (LLC)..... | 147 |
| 11.2 Parameters Required by the LLC Primitives..... | 147 |

| | | |
|-----------|------------------------------------------------------------------|------------|
| 11.3 | Mapping the LLC Services to the LonTalk Application Layer | 147 |
| 11.4 | Parameters Required by the Application Layer Primitives..... | 147 |
| 11.5 | Physical Media | 148 |
| 12 | MODELING CONTROL DEVICES AS A COLLECTION OF OBJECTS | 149 |
| 12.1 | Object Characteristics and Requirements..... | 149 |
| 12.2 | Analog Input Object Type | 155 |
| 12.3 | Analog Output Object Type | 162 |
| 12.4 | Analog Value Object Type..... | 169 |
| 12.5 | Averaging Object Type | 177 |
| 12.6 | Binary Input Object Type..... | 181 |
| 12.7 | Binary Output Object Type..... | 188 |
| 12.8 | Binary Value Object Type | 197 |
| 12.9 | Calendar Object Type | 205 |
| 12.10 | Command Object Type..... | 208 |
| 12.11 | Device Object Type | 214 |
| 12.12 | Event Enrollment Object Type | 226 |
| 12.13 | File Object Type..... | 234 |
| 12.14 | Group Object Type | 238 |
| 12.15 | Life Safety Point Object Type | 241 |
| 12.16 | Life Safety Zone Object Type | 248 |
| 12.17 | Loop Object Type..... | 255 |
| 12.18 | Multi-state Input Object Type | 265 |
| 12.19 | Multi-state Output Object Type..... | 271 |
| 12.20 | Multi-state Value Object Type | 278 |
| 12.21 | Notification Class Object Type..... | 285 |
| 12.22 | Program Object Type..... | 291 |
| 12.23 | Pulse Converter Object Type | 298 |
| 12.24 | Schedule Object Type | 306 |
| 12.25 | Trend Log Object Type..... | 313 |
| 12.26 | Access Door Object Type..... | 323 |
| 12.27 | Event Log Object Type | 332 |
| 12.28 | Load Control Object Type | 340 |
| 12.29 | Structured View Object Type | 350 |
| 12.30 | Trend Log Multiple Object Type | 355 |
| 12.31 | Access Point Object Type | 365 |
| 12.32 | Access Zone Object Type | 382 |
| 12.33 | Access User Object Type | 390 |
| 12.34 | Access Rights Object Type | 394 |
| 12.35 | Access Credential Object Type | 400 |
| 12.36 | Credential Data Input Object Type | 410 |
| 12.37 | CharacterString Value Object Type | 416 |
| 12.38 | DateTime Value Object Type | 423 |
| 12.39 | Large Analog Value Object Type | 429 |
| 12.40 | BitString Value Object Type | 437 |
| 12.41 | OctetString Value Object Type | 444 |
| 12.42 | Time Value Object Type | 448 |
| 12.43 | Integer Value Object Type | 454 |
| 12.44 | Positive Integer Value Object Type | 462 |
| 12.45 | Date Value Object Type | 470 |
| 12.46 | DateTime Pattern Value Object Type | 476 |
| 12.47 | Time Pattern Value Object Type | 482 |
| 12.48 | Date Pattern Value Object Type | 488 |
| 12.49 | Deleted Clause | 494 |
| 12.50 | Global Group Object Type | 495 |
| 12.51 | Notification Forwarder Object Type | 502 |
| 12.52 | Alert Enrollment Object Type | 510 |
| 12.53 | Channel Object Type | 514 |
| 12.54 | Lighting Output Object Type | 524 |
| 12.55 | Binary Lighting Output Object Type | 539 |
| 12.56 | Network Port Object Type..... | 549 |

| | | |
|-----------|--------------------------------------------------|------------|
| 12.57 | Timer Object Type | 573 |
| 12.58 | Elevator Group Object Type | 585 |
| 12.59 | Lift Object Type | 589 |
| 12.60 | Escalator Object Type | 601 |
| 12.61 | Accumulator Object Type | 608 |
| 12.62 | Staging Object Type | 618 |
| 12.63 | Audit Reporter Object Type | 628 |
| 12.64 | Audit Log Object Type | 633 |
| 13 | ALARM AND EVENT SERVICES..... | 640 |
| 13.1 | Change of Value Reporting..... | 640 |
| 13.2 | Event Reporting | 645 |
| 13.3 | Event Algorithms..... | 656 |
| 13.4 | Fault Algorithms | 685 |
| 13.5 | AcknowledgeAlarm Service..... | 692 |
| 13.6 | ConfirmedCOVNotification Service | 694 |
| 13.7 | UnconfirmedCOVNotification Service | 696 |
| 13.8 | ConfirmedEventNotification Service | 697 |
| 13.9 | UnconfirmedEventNotification Service | 700 |
| 13.10 | GetAlarmSummary Service | 703 |
| 13.11 | GetEnrollmentSummary Service | 705 |
| 13.12 | GetEventInformation Service | 708 |
| 13.13 | LifeSafetyOperation Service | 710 |
| 13.14 | SubscribeCOV Service | 712 |
| 13.15 | SubscribeCOVProperty Service | 715 |
| 13.16 | SubscribeCOVPropertyMultiple Service | 718 |
| 13.17 | ConfirmedCOVNotificationMultiple Service | 723 |
| 13.18 | UnconfirmedCOVNotificationMultiple Service | 726 |
| 13.19 | AuditLogQuery | 728 |
| 13.20 | ConfirmedAuditNotification | 732 |
| 13.21 | UnconfirmedAuditNotification | 733 |
| 14 | FILE ACCESS SERVICES | 734 |
| 14.1 | AtomicReadFile Service | 734 |
| 14.2 | AtomicWriteFile Service | 737 |
| 15 | OBJECT ACCESS SERVICES | 740 |
| 15.1 | AddListElement Service | 740 |
| 15.2 | RemoveListElement Service | 742 |
| 15.3 | CreateObject Service | 744 |
| 15.4 | DeleteObject Service | 747 |
| 15.5 | ReadProperty Service | 748 |
| 15.6 | Deleted Clause | 750 |
| 15.7 | ReadPropertyMultiple Service | 751 |
| 15.8 | ReadRange Service | 754 |
| 15.9 | WriteProperty Service | 762 |
| 15.10 | WritePropertyMultiple Service | 764 |
| 15.11 | WriteGroup Service | 767 |
| 16 | REMOTE DEVICE MANAGEMENT SERVICES..... | 769 |
| 16.1 | DeviceCommunicationControl Service | 769 |
| 16.2 | ConfirmedPrivateTransfer Service | 771 |
| 16.3 | UnconfirmedPrivateTransfer Service | 773 |
| 16.4 | ReinitializeDevice Service | 774 |
| 16.5 | ConfirmedTextMessage Service | 776 |
| 16.6 | UnconfirmedTextMessage Service | 778 |
| 16.7 | TimeSynchronization Service | 779 |
| 16.8 | UTCTimeSynchronization Service | 780 |
| 16.9 | Who-Has and I-Have Services | 781 |
| 16.10 | Who-Is and I-Am Services | 783 |
| 16.11 | Who-Am-I and You-Are Services | 785 |
| 17 | VIRTUAL TERMINAL SERVICES..... | 787 |
| 17.1 | Virtual Terminal Model | 787 |
| 17.2 | VT-Open Service | 791 |

| | | |
|-------|-----------------------------------------------------------------------------|------|
| 17.3 | VT-Close Service | 793 |
| 17.4 | VT-Data Service..... | 794 |
| 17.5 | Default Terminal Characteristics | 796 |
| 18 | ERROR, REJECT, and ABORT CODES | 800 |
| 18.1 | Error Class - DEVICE | 800 |
| 18.2 | Error Class - OBJECT | 800 |
| 18.3 | Error Class - PROPERTY | 801 |
| 18.4 | Error Class - RESOURCES | 802 |
| 18.5 | Error Class - SECURITY | 803 |
| 18.6 | Error Class - SERVICES | 804 |
| 18.7 | Error Class - COMMUNICATION | 805 |
| 18.8 | Error Class - VT | 809 |
| 18.9 | Reject Reason..... | 810 |
| 18.10 | Abort Reason..... | 810 |
| 18.11 | Confirmed Service Common Errors | 811 |
| 19 | BACnet PROCEDURES | 812 |
| 19.1 | Backup and Restore..... | 812 |
| 19.2 | Command Prioritization..... | 817 |
| 19.3 | Device Restart Procedure | 822 |
| 19.4 | Determining Maximum Conveyable APDU | 823 |
| 19.5 | Value Source Mechanism | 825 |
| 19.6 | Audit Logging | 827 |
| 19.7 | Unconfigured Device Discovery and Address Assignment..... | 838 |
| 20 | ENCODING BACnet PROTOCOL DATA UNITS | 839 |
| 20.1 | Encoding the Fixed Part of BACnet APDUs | 840 |
| 20.2 | Encoding the Variable Part of BACnet APDUs | 851 |
| 21 | FORMAL DESCRIPTION OF APPLICATION PROTOCOL DATA UNITS | 866 |
| 21.1 | APDU Definitions | 866 |
| 21.2 | Confirmed Service Productions | 868 |
| 21.3 | Unconfirmed Service Productions | 878 |
| 21.4 | Error Productions | 881 |
| 21.5 | Application Types | 891 |
| 21.6 | Base Types | 892 |
| 22 | CONFORMANCE AND INTEROPERABILITY | 960 |
| 22.1 | Conformance to BACnet | 960 |
| 22.2 | BACnet Interoperability | 961 |
| 23 | EXTENDING BACnet TO ACCOMMODATE VENDOR PROPRIETARY INFORMATION | 963 |
| 23.1 | Extending Enumeration Values..... | 963 |
| 23.2 | Using the PrivateTransfer Services to Invoke Non-Standardized Services..... | 964 |
| 23.3 | Adding Proprietary Properties to a Standardized Object | 964 |
| 23.4 | Adding Proprietary Object Types to BACnet..... | 965 |
| 23.5 | Restrictions on Extending BACnet..... | 965 |
| 24 | DELETED CLAUSE..... | 966 |
| 25 | REFERENCES..... | 967 |
| | ANNEX A - PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT (NORMATIVE)..... | 971 |
| | ANNEX B - GUIDE TO SPECIFYING BACnet DEVICES (INFORMATIVE)..... | 974 |
| | ANNEX C - Removed | 975 |
| | ANNEX D - Removed..... | 976 |
| | ANNEX E - EXAMPLES OF BACnet APPLICATION SERVICES (INFORMATIVE) | 977 |
| E.1 | Alarm and Event Services | 977 |
| E.2 | File Access Services | 981 |
| E.3 | Object Access Services | 983 |
| E.4 | Remote Device Management Services | 989 |
| E.5 | Virtual Terminal Services | 993 |
| | ANNEX F - EXAMPLES OF APDU ENCODING (INFORMATIVE) | 995 |
| F.1 | Example Encodings for Alarm and Event Services | 995 |
| F.2 | Example Encodings for File Access Services | 1006 |
| F.3 | Example Encodings for Object Access Services..... | 1008 |
| F.4 | Example Encodings for Remote Device Management Services..... | 1018 |
| F.5 | Example Encodings for Virtual Terminal Services | 1024 |

| | |
|-------------------------------------------------------------------------------------------|------|
| ANNEX G - CALCULATION OF CRC (INFORMATIVE) | 1026 |
| G.1 Calculation of the Header CRC..... | 1026 |
| G.2 Calculation of the Data CRC | 1032 |
| G.3 Calculation of the Encoded CRC-32K..... | 1036 |
| ANNEX H - COMBINING BACnet NETWORKS WITH NON-BACnet NETWORKS (NORMATIVE)..... | 1040 |
| H.1 BACnet Gateways..... | 1040 |
| H.2 Requirements and Best Practices for BACnet Gateway Implementations..... | 1040 |
| H.3 Using BACnet with the DARPA Internet Protocols | 1042 |
| H.4 Using BACnet with the IPX Protocol..... | 1044 |
| H.5 Using BACnet with EIB/KNX..... | 1045 |
| H.6 Using BACnet with the Former BACnet/WS Web Services Interface Defined by Annex N..... | 1055 |
| H.7 Virtual MAC Addressing..... | 1057 |
| ANNEX I - COMMANDABLE PROPERTIES WITH MINIMUM ON AND OFF TIMES (INFORMATIVE) | 1059 |
| ANNEX J - BACnet/IP (NORMATIVE)..... | 1061 |
| J.1 General | 1061 |
| J.2 BACnet Virtual Link Layer | 1062 |
| J.3 BACnet/IP Directed Messages | 1065 |
| J.4 BACnet/IP Broadcast Messages | 1065 |
| J.5 Addition of Foreign B/IP Devices to an Existing B/IP Network | 1068 |
| J.6 Routing Between B/IP and non-B/IP BACnet Networks | 1069 |
| J.7 Routing Between Two B/IP BACnet Networks | 1070 |
| J.8 Use of IP Multicast within BACnet/IP | 1075 |
| ANNEX K - BACnet INTEROPERABILITY BUILDING BLOCKS (BIBBs) (NORMATIVE)..... | 1077 |
| K.1 Data Sharing BIBBs | 1077 |
| K.2 Alarm and Event Management BIBBs | 1098 |
| K.3 Scheduling BIBBs | 1111 |
| K.4 Trending BIBBs..... | 1115 |
| K.5 Device Management BIBBs..... | 1118 |
| K.6 Network Management BIBBs..... | 1125 |
| K.7 Gateway BIBBs | 1128 |
| K.8 Audit Reporting BIBBs..... | 1129 |
| ANNEX L - DESCRIPTIONS AND PROFILES OF STANDARDIZED BACnet DEVICES (NORMATIVE) | 1131 |
| L.1 Operator Interface Profiles | 1131 |
| L.2 Life Safety Operator Interface Profiles | 1134 |
| L.3 Access Control Operator Interface Profiles | 1136 |
| L.4 Controller Profiles..... | 1139 |
| L.5 Life Safety Controller Profiles | 1142 |
| L.6 Access Control Controller Profiles..... | 1143 |
| L.7 Miscellaneous Profiles..... | 1145 |
| L.8 BACnet General (B-GENERAL) Profile | 1148 |
| L.9 Lighting Operator Interface Profiles | 1149 |
| L.10 Lighting Control Station Profiles..... | 1151 |
| L.11 Lighting Controller Profiles..... | 1152 |
| L.12 Elevator Operator Interface Profiles | 1154 |
| L.13 Elevator Controller Profiles | 1156 |
| ANNEX M - GUIDE TO EVENT NOTIFICATION PRIORITY ASSIGNMENTS (INFORMATIVE) | 1159 |
| M.1 Life Safety Message Group (0 - 31)..... | 1159 |
| M.2 Property Safety Message Group (32 - 63) | 1160 |
| M.3 Supervisory Message Group (64 - 95) | 1160 |
| M.4 Trouble Message Group (96 - 127) | 1161 |
| M.5 Miscellaneous Higher Priority Message Group (128 - 191)..... | 1162 |
| M.6 Miscellaneous Lower Priority Message Group (192 - 255)..... | 1162 |
| ANNEX N - FORMER BACnet/WS WEB SERVICES INTERFACE (INFORMATIVE) | 1163 |
| N.1 Data Model..... | 1163 |
| N.2 Paths | 1164 |
| N.3 Normalized Points..... | 1164 |
| N.4 Reference Nodes | 1165 |
| N.5 Localization | 1165 |
| N.6 Security..... | 1165 |
| N.7 Sessions..... | 1166 |

| | |
|----------------------------------------------------------------------------------------------|-------------|
| N.8 Attributes..... | 1166 |
| N.9 Standard Nodes..... | 1172 |
| N.10 Encodings | 1172 |
| N.11 Service Options | 1173 |
| N.12 Services..... | 1176 |
| N.13 Errors..... | 1193 |
| N.14 Extending BACnet/WS..... | 1194 |
| ANNEX O - BACnet OVER ZigBee AS A DATA LINK LAYER (NORMATIVE) | 1195 |
| 0.1 General..... | 1195 |
| 0.2 ZigBee Overview..... | 1195 |
| 0.3 Definitions..... | 1196 |
| 0.4 Unicast Addressing..... | 1196 |
| 0.5 Broadcast Addressing | 1196 |
| 0.6 BACnet/ZigBee Data Link Layer (BZLL)..... | 1197 |
| 0.7 Maximum Payload Size..... | 1200 |
| 0.8 Vendor Specific Commands..... | 1200 |
| ANNEX P - BACnet ENCODING OF STANDARD AUTHENTICATION FACTOR FORMATS (NORMATIVE) | 1201 |
| ANNEX Q - XML DATA FORMATS (NORMATIVE)..... | 1208 |
| Q.1 Introduction | 1208 |
| Q.2 XML Document Structure..... | 1211 |
| Q.3 Expressing Data | 1215 |
| Q.5 Expressing Values..... | 1216 |
| Q.6 Binary Encoding and Access Rules..... | 1218 |
| Q.7 Extensibility..... | 1218 |
| Q.8 BACnet URI Scheme | 1219 |
| ANNEX R - MAPPING NETWORK LAYER ERRORS (NORMATIVE) | 1220 |
| ANNEX S - Removed..... | 1221 |
| ANNEX T - COBS (CONSISTENT OVERHEAD BYTE STUFFING) FUNCTIONS (INFORMATIVE) | 1222 |
| T.1 Preparing a COBS-Encoded MS/TP Frame for Transmission..... | 1222 |
| T.2 Decoding an Extended MS/TP Frame upon Reception | 1224 |
| T.3 Example COBS-Encoded Frame - Who-Has Service | 1226 |
| ANNEX U - BACnet/IPv6 (NORMATIVE) | 1228 |
| U.1 General..... | 1228 |
| U.2 BACnet/IPv6 BACnet Virtual Link Layer..... | 1229 |
| U.3 BACnet/IPv6 Directed Messages | 1233 |
| U.4 BACnet/IPv6 Broadcast Messages | 1233 |
| U.5 BACnet /IPv6 VMAC Table Management | 1238 |
| ANNEX V - MIGRATION FROM SOAP SERVICES (INFORMATIVE) | 1239 |
| V.1 Services..... | 1239 |
| V.2 Service Options..... | 1241 |
| ANNEX W - BACnet/WS RESTful WEB SERVICES INTERFACE (NORMATIVE) | 1242 |
| W.1 Data Model..... | 1242 |
| W.2 Paths..... | 1242 |
| W.3 Security | 1243 |
| W.4 Sessions..... | 1252 |
| W.5 Standard Data Items | 1252 |
| W.6 Metadata | 1257 |
| W.7 Functions | 1257 |
| W.8 Query Parameters..... | 1259 |
| W.9 Representation of Data..... | 1261 |
| W.10 Representation of Metadata | 1261 |
| W.11 Representation of Logs..... | 1262 |
| W.12 Filtering Items | 1266 |
| W.13 Limiting Number of Items | 1268 |
| W.14 Selecting Children | 1268 |
| W.15 Controlling Content of Data Representations | 1269 |
| W.16 Specifying Ranges | 1272 |
| W.17 Localized Values | 1274 |
| W.18 Accessing Individual Tags and Bits | 1275 |
| W.19 Semantics..... | 1275 |

| | |
|---------------------------------------------------------------------------------------|-------------|
| W.20 Links and Relationships | 1275 |
| W.21 Foreign XML and Other Media Types | 1275 |
| W.22 Logical Modeling | 1276 |
| W.23 Mapped Modeling | 1277 |
| W.24 Commandability | 1277 |
| W.25 Writability and Visibility | 1277 |
| W.26 Working with Optional Data | 1279 |
| W.27 Working with Optional Metadata | 1279 |
| W.28 Creating Data | 1280 |
| W.29 Setting Data | 1280 |
| W.30 Deleting Data | 1282 |
| W.31 Parentally Inherited Values | 1283 |
| W.32 Concurrency Control | 1283 |
| W.33 Server Support for Data Definitions | 1283 |
| W.34 Server Support for Metadata | 1284 |
| W.35 Client Implementation Guidelines | 1285 |
| W.36 Subscriptions | 1285 |
| W.37 Reading Multiple Resources | 1287 |
| W.38 Writing Multiple Resources | 1288 |
| W.39 Mapping of BACnet Systems | 1288 |
| W.40 Errors | 1292 |
| W.41 Examples | 1294 |
| ANNEX X - EXTENDED DISCOVERY OF DEVICES, PROFILES, AND VIEWS (NORMATIVE) | 1321 |
| X.1 Profiles | 1321 |
| X.2 xdd Files | 1322 |
| X.3 Example of Definition of Objects, Properties, and Datatypes | 1323 |
| X.4 Views | 1324 |
| X.5 PICS Declarations | 1330 |
| ANNEX Y - ABSTRACT DATA MODEL (NORMATIVE) | 1331 |
| Y.1 Model Components | 1331 |
| Y.2 Trees | 1333 |
| Y.3 Base Types | 1335 |
| Y.4 Common Metadata | 1335 |
| Y.5 Named Values | 1349 |
| Y.6 Named Bits | 1352 |
| Y.7 Primitive Values | 1353 |
| Y.8 Range Restrictions | 1355 |
| Y.9 Engineering Units | 1356 |
| Y.10 Length Restrictions | 1357 |
| Y.11 Collections | 1359 |
| Y.12 Primitive Data | 1360 |
| Y.13 Constructed Data | 1364 |
| Y.14 Data of Undefined Type | 1368 |
| Y.15 Logical Modeling | 1368 |
| Y.16 Links | 1368 |
| Y.17 Change Indications | 1370 |
| Y.18 Definitions, Types, Instances, and Inheritance | 1370 |
| Y.19 Data Revisions | 1376 |
| Y.20 BACnet-Specific Base Types | 1379 |
| Y.21 BACnet-Specific Metadata | 1380 |
| ANNEX Z - JSON DATA FORMATS (NORMATIVE) | 1384 |
| Z.1 Introduction | 1384 |
| Z.2 JSON Document Structure | 1387 |
| Z.3 Expressing Data | 1390 |
| Z.4 Expressing Metadata | 1390 |
| Z.5 Expressing Values | 1392 |
| Z.6 Extensibility | 1393 |
| ANNEX AA – TIME SERIES DATA EXCHANGE FILE FORMAT (NORMATIVE) | 1395 |
| AA.1 File Format | 1395 |
| AA.2 Representation of Data | 1395 |

| | |
|----------------------------------------------------|------|
| AA.3 File Generation | 1396 |
| AA.4 Example Files | 1397 |
| ANNEX AB – BACnet Secure Connect (NORMATIVE) | 1398 |
| AB.1 BACnet Secure Connect Data link | 1398 |
| AB.2 BACnet/SC Virtual Link Layer Messages | 1404 |
| AB.3 BACnet/SC Node Operation | 1414 |
| AB.4 Node Switch and Direct Connections | 1416 |
| AB.5 Hub Function and Hub Connector | 1419 |
| AB.6 BACnet/SC Connections | 1422 |
| AB.7 Application of WebSockets in BACnet/SC | 1426 |
| HISTORY OF REVISIONS | 1432 |