

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