

ISO 16484-5:2014-05 (E)

Building automation and control systems (BACS) - Part 5: Data communication protocol

Contents

Page

FOREWORD	vii
1 PURPOSE.....	1
2 SCOPE.....	1
3 DEFINITIONS	1
3.1 Terms Adopted from International Standards	1
3.2 Terms Defined for this Standard	2
3.3 Abbreviations and Acronyms Used in this Standard.....	7
4 BACnet PROTOCOL ARCHITECTURE	10
4.1 The BACnet Collapsed Architecture.....	11
4.2 BACnet Network Topology	13
4.3 Security	15
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	42
5.6 Application Layer Service Conventions.....	51
6 THE NETWORK LAYER	53
6.1 Network Layer Service Specification.....	53
6.2 Network Layer PDU Structure	55
6.3 Messages for Multiple Recipients	60
6.4 Network Layer Protocol Messages.....	61
6.5 Network Layer Procedures.....	64
6.6 BACnet Routers	66
6.7 Point-To-Point Half-Routers	71
7 DATA LINK/PHYSICAL LAYERS: ISO 8802-3 ("Ethernet") 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 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.....	92
9.4 Overview of the MS/TP Network	93
9.5 MS/TP Medium Access Control	94
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.....	112
10 DATA LINK/PHYSICAL LAYERS: POINT-TO-POINT (PTP).....	114
10.1 Overview	114
10.2 Service Specification.....	114
10.3 Point-to-Point Frame Format.....	119
10.4 PTP Medium Access Control Protocol.....	121
11 DATA LINK/PHYSICAL LAYERS: EIA/CEA-709.1 ("LonTalk") LAN	142
11.1 The Use of ISO 8802-2 Logical Link Control (LLC)	142
11.2 Parameters Required by the LLC Primitives.....	142

11.3	Mapping the LLC Services to the LonTalk Application Layer	142
11.4	Parameters Required by the Application Layer Primitives	142
11.5	Physical Media	143
12	MODELING CONTROL DEVICES AS A COLLECTION OF OBJECTS	144
12.1	Accumulator Object Type	148
12.2	Analog Input Object Type	157
12.3	Analog Output Object Type	162
12.4	Analog Value Object Type	167
12.5	Averaging Object Type	172
12.6	Binary Input Object Type	175
12.7	Binary Output Object Type	181
12.8	Binary Value Object Type	187
12.9	Calendar Object Type	193
12.10	Command Object Type	195
12.11	Device Object Type	199
12.12	Event Enrollment Object Type	208
12.13	File Object Type	215
12.14	Group Object Type	218
12.15	Life Safety Point Object Type	220
12.16	Life Safety Zone Object Type	227
12.17	Loop Object Type	234
12.18	Multi-state Input Object Type	242
12.19	Multi-state Output Object Type	247
12.20	Multi-state Value Object Type	252
12.21	Notification Class Object Type	257
12.22	Program Object Type	260
12.23	Pulse Converter Object Type	266
12.24	Schedule Object Type	274
12.25	Trend Log Object Type	280
12.26	Access Door Object Type	289
12.27	Event Log Object Type	297
12.28	Load Control Object Type	304
12.29	Structured View Object Type	314
12.30	Trend Log Multiple Object Type	317
12.31	Access Point Object Type	326
12.32	Access Zone Object Type	342
12.33	Access User Object Type	350
12.34	Access Rights Object Type	353
12.35	Access Credential Object Type	359
12.36	Credential Data Input Object Type	368
12.37	CharacterString Value Object Type	373
12.38	DateTime Value Object Type	378
12.39	Large Analog Value Object Type	381
12.40	BitString Value Object Type	386
12.41	OctetString Value Object Type	391
12.42	Time Value Object Type	394
12.43	Integer Value Object Type	397
12.44	Positive Integer Value Object Type	402
12.45	Date Value Object Type	407
12.46	DateTime Pattern Value Object Type	410
12.47	Time Pattern Value Object Type	413
12.48	Date Pattern Value Object Type	416
12.49	Network Security Object Type	419
12.50	Global Group Object Type	422
12.51	Notification Forwarder Object Type	429
12.52	Alert Enrollment Object Type	435
12.53	Channel Object Type	438

12.54	Lighting Output Object Type	447
13	ALARM AND EVENT SERVICES.....	460
13.1	Change of Value Reporting	461
13.2	Event Reporting	464
13.3	Event Algorithms	475
13.4	Fault Algorithms	504
13.5	AcknowledgeAlarm Service.....	509
13.6	ConfirmedCOVNotification Service	511
13.7	UnconfirmedCOVNotification Service	512
13.8	ConfirmedEventNotification Service	514
13.9	UnconfirmedEventNotification Service	517
13.10	GetAlarmSummary Service	519
13.11	GetEnrollmentSummary Service.....	521
13.12	GetEventInformation Service	524
13.13	LifeSafetyOperation Service	526
13.14	SubscribeCOV Service.....	528
13.15	SubscribeCOVProperty Service	531
14	FILE ACCESS SERVICES	534
14.1	AtomicReadFile Service	535
14.2	AtomicWriteFile Service.....	538
15	OBJECT ACCESS SERVICES	541
15.1	AddListElement Service	541
15.2	RemoveListElement Service	543
15.3	CreateObject Service.....	545
15.4	DeleteObject Service.....	547
15.5	ReadProperty Service	548
15.6	Deleted Clause	550
15.7	ReadPropertyMultiple Service	551
15.8	ReadRange Service	554
15.9	WriteProperty Service	559
15.10	WritePropertyMultiple Service	561
15.11	WriteGroup Service.....	564
16	REMOTE DEVICE MANAGEMENT SERVICES	566
16.1	DeviceCommunicationControl Service.....	566
16.2	ConfirmedPrivateTransfer Service	568
16.3	UnconfirmedPrivateTransfer Service	570
16.4	ReinitializeDevice Service	571
16.5	ConfirmedTextMessage Service	573
16.6	UnconfirmedTextMessage Service	575
16.7	TimeSynchronization Service	576
16.8	UTCTimeSynchronization Service	577
16.9	Who-Has and I-Have Services	578
16.10	Who-Is and I-Am Services	580
17	VIRTUAL TERMINAL SERVICES.....	582
17.1	Virtual Terminal Model	582
17.2	VT-Open Service.....	586
17.3	VT-Close Service	588
17.4	VT-Data Service.....	589
17.5	Default-terminal Characteristics.....	591
18	ERROR, REJECT, and ABORT CODES.....	595
18.1	Error Class - DEVICE.....	595
18.2	Error Class - OBJECT	595
18.3	Error Class - PROPERTY	596
18.4	Error Class - RESOURCES	597
18.5	Error Class - SECURITY	597
18.6	Error Class - SERVICES.....	599
18.7	Error Class - COMMUNICATION.....	600

18.8	Error Class - VT	602
18.9	Reject Reason.....	603
18.10	Abort Reason.....	603
18.11	Confirmed Service Common Errors.....	604
19	BACnet PROCEDURES	605
19.1	Backup and Restore.....	605
19.2	Command Prioritization	609
19.3	Device Restart Procedure	613
20	ENCODING BACnet PROTOCOL DATA UNITS	614
20.1	Encoding the Fixed Part of BACnet APDUs.....	614
20.2	Encoding the Variable Part of BACnet APDUs	625
21	FORMAL DESCRIPTION OF APPLICATION PROTOCOL DATA UNITS	639
22	CONFORMANCE AND INTEROPERABILITY	714
22.1	Conformance to BACnet	714
22.2	BACnet Interoperability	715
23	EXTENDING BACnet TO ACCOMMODATE VENDOR PROPRIETARY INFORMATION	717
23.1	Extending Enumeration Values	717
23.2	Using the PrivateTransfer Services to Invoke Non-Standardized Services.....	718
23.3	Adding Proprietary Properties to a Standardized Object.....	718
23.4	Adding Proprietary Object Types to BACnet.....	719
23.5	Restrictions on Extending BACnet	719
24	NETWORK SECURITY	720
24.1	Overview	720
24.2	Security Wrapper.....	724
24.3	Security Messages	728
24.4	Securing an APDU	744
24.5	Securing an NPDU	745
24.6	Securing a BVLL	745
24.7	Securing Messages	747
24.8	Network Security Network Trust Levels.....	749
24.9	Network Security Policies	750
24.10	Network Security.....	751
24.11	End-to-End Security	752
24.12	Wrapping and Unwrapping Secure Messages	752
24.13	Authenticating Messages.....	754
24.14	User Authentication.....	757
24.15	Time Synchronization Requirements	758
24.16	Integrating the Security Layer into the BACnet Stack	759
24.17	BACnet Security In A NAT Environment	766
24.18	BACnet Security Proxy.....	766
24.19	Deploying Secure Device on Non-Security Aware Networks.....	766
24.20	Deploying Secure Single Network Installations.....	766
24.21	Security Keys	767
24.22	Key Server.....	768
25	REFERENCES	772
	ANNEX A - PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT (NORMATIVE)	775
	ANNEX B - GUIDE TO SPECIFYING BACnet DEVICES (INFORMATIVE)	778
	ANNEX C - Removed	779
	ANNEX D - Removed.....	780
	ANNEX E - EXAMPLES OF BACnet APPLICATION SERVICES (INFORMATIVE).....	781
	E.1 Alarm and Event Services	781
	E.2 File Access Services.....	785
	E.3 Object Access Services.....	787
	E.4 Remote Device Management Services	793
	E.5 Virtual Terminal Services.....	796
	ANNEX F - EXAMPLES OF APDU ENCODING (INFORMATIVE)	798
	F.1 Example Encodings for Alarm and Event Services	798

F.2 Example Encodings for File Access Services.....	807
F.3 Example Encodings for Object Access Services	809
F.4 Example Encodings for Remote Device Management Services.....	819
F.5 Example Encodings for Virtual Terminal Services	824
ANNEX G - CALCULATION OF CRC (INFORMATIVE).....	827
G.1 Calculation of the Header CRC	827
G.2 Calculation of the Data CRC	833
ANNEX H - COMBINING BACnet NETWORKS WITH NON-BACnet NETWORKS (NORMATIVE)	838
H.1 Mapping Non-BACnet Networks onto BACnet Routers	838
H.2 Multiple "Virtual" BACnet Devices in a Single Physical Device	838
H.3 Using BACnet with the DARPA Internet Protocols	838
H.4 Using BACnet with the IPX Protocol	839
H.5 Using BACnet with EIB/KNX.....	841
H.6 Using BACnet with the BACnet/WS Web Services Interface (Annex N).....	854
H.7 Virtual MAC Addressing	856
ANNEX I - COMMANDABLE PROPERTIES WITH MINIMUM ON AND OFF TIMES (INFORMATIVE).....	857
ANNEX J - BACnet/IP (NORMATIVE).....	859
J.1 General.....	859
J.2 BACnet Virtual Link Layer.....	859
J.3 BACnet/IP Directed Messages	863
J.4 BACnet/IP Broadcast Messages	863
J.5 Addition of Foreign B/IP Devices to an Existing B/IP Network	865
J.6 Routing Between B/IP and non-B/IP BACnet Networks	867
J.7 Routing Between Two B/IP BACnet Networks.....	868
J.8 Use of IP Multicast within BACnet/IP	873
J.9 Sources for Internet Information.....	874
ANNEX K - BACnet INTEROPERABILITY BUILDING BLOCKS (BIBBs) (NORMATIVE).....	875
K.1 Data Sharing BIBBs.....	875
K.2 Alarm and Event Management BIBBs.....	882
K.3 Scheduling BIBBs.....	890
K.4 Trending BIBBs	893
K.5 Device and Network Management BIBBs	897
ANNEX L - DESCRIPTIONS AND PROFILES OF STANDARDIZED BACnet DEVICES (NORMATIVE).....	905
L.1 Operator Interfaces	905
L.2 BACnet Building Controller (B-BC).....	907
L.3 BACnet Advanced Application Controller (B-AAC).....	907
L.4 BACnet Application Specific Controller (B-ASC)	908
L.5 BACnet Smart Actuator (B-SA).....	908
L.6 BACnet Smart Sensor (B-SS)	909
L.7 Profiles of the Standard BACnet Devices	910
ANNEX M - GUIDE TO EVENT NOTIFICATION PRIORITY ASSIGNMENTS (INFORMATIVE).....	911
ANNEX N - BACnet/WS WEB SERVICES INTERFACE (NORMATIVE)	915
N.1 Data Model	915
N.2 Paths.....	916
N.3 Normalized Points.....	916
N.4 Reference Nodes	917
N.5 Localization	917
N.6 Security	917
N.7 Sessions.....	918
N.8 Attributes	918
N.9 Standard Nodes	924
N.10 Encodings.....	925
N.11 Service Options.....	926
N.12 Services.....	929
N.13 Errors	947
N.14 Extending BACnet/WS	948
ANNEX O - BACnet OVER ZigBee AS A DATA LINK LAYER (NORMATIVE)	949

O.1 General.....	949
O.2 ZigBee Overview	949
O.3 Definitions	950
O.4 Unicast Addressing	950
O.5 Broadcast Addressing	950
O.6 BACnet/ZigBee Data Link Layer (BZLL).....	951
O.7 Maximum Payload Size	954
O.8 Vendor Specific Commands	954
ANNEX P - BACnet ENCODING OF STANDARD AUTHENTICATION FACTOR FORMATS (NORMATIVE)	955
ANNEX Q - XML DATA FORMATS (NORMATIVE)	962
Q.1 Introduction.....	962
Q.2 Document Structure	965
Q.3 Expressing BACnet Datatypes in XML	966
Q.4 Expressing BACnet Objects and Properties in XML	1000
Q.5 Definitions, Types, Instances, and Inheritance	1000
Q.7 Extensibility	1007
ANNEX R - MAPPING NETWORK LAYER ERRORS (NORMATIVE)	1010
ANNEX S - EXAMPLES OF SECURE BACnet MESSAGES (INFORMATIVE).....	1012
HISTORY OF REVISIONS	1027