
**Information technology —
Telecommunications and information
exchange between systems — Local and
metropolitan area networks — Specific
requirements —**

**Part 15-4:
Wireless medium access control (MAC)
and physical layer (PHY) specifications
for low-rate wireless personal area
networks (WPANs)**

*Technologies de l'information — Télécommunications et échange
d'information entre systèmes — Réseaux locaux et métropolitains —
Exigences spécifiques —*

*Partie 15-4: Spécifications du contrôle d'accès du milieu sans fil (MAC)
et de la couche physique (PHY) pour les réseaux personnels sans fil de
faible débit (WPAN)*

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- *Part 15-4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs).*



**IEEE Standard for
Information technology—
Telecommunications and information
exchange between systems—
Local and metropolitan area networks—
Specific requirements**

Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)

IEEE Computer Society

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Sponsor

**LAN/MAN Standards Committee
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Approved 7 June 2006

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Abstract: IEEE Std 802.15.4-2003 defined the protocol and compatible interconnection for data communication devices using low-data-rate, low-power, and low-complexity short-range radio frequency (RF) transmissions in a wireless personal area network (WPAN). This revision extends the market applicability of IEEE Std 802.15.4, removes ambiguities in the standard, and makes improvements revealed by implementations of IEEE Std 802.15.4-2003.

Keywords: ad hoc network, low data rate, low power, LR-WPAN, mobility, PAN, personal area network, radio frequency, RF, short range, wireless, wireless personal area network, WPAN

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Introduction

This introduction is not part of IEEE Std 802.15.4-2006, IEEE Standard for Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs).

This standard defines the protocol and interconnection of devices via radio communication in a personal area network (PAN). The standard uses carrier sense multiple access with collision avoidance (CSMA-CA) medium access mechanism and supports star as well as peer-to-peer topologies. The media access is contention based; however, using the optional superframe structure, time slots can be allocated by the PAN coordinator to devices with time critical data. Connectivity to higher performance networks is provided through a PAN coordinator.

This revision was initiated to incorporate additional features and enhancements as well as some simplifications to the 2003 edition of this standard. The standard now includes two optional physical layers (PHYs) yielding higher data rates in the lower frequency bands and, therefore, specifies the following four PHYs:

- An 868/915 MHz direct sequence spread spectrum (DSSS) PHY employing binary phase-shift keying (BPSK) modulation
- An 868/915 MHz DSSS PHY employing offset quadrature phase-shift keying (O-QPSK) modulation
- An 868/915 MHz parallel sequence spread spectrum (PSSS) PHY employing BPSK and amplitude shift keying (ASK) modulation
- A 2450 MHz DSSS PHY employing O-QPSK modulation

The 868/915 MHz PHYs support over-the-air data rates of 20 kb/s, 40 kb/s, and optionally 100kb/s and 250kb/s. The 2450 MHz PHY supports an over-the-air data rate of 250 kb/s. The PHY chosen depends on local regulations and user preference.

This revision also incorporates the following additions and enhancements to the 2003 edition:

- Adds support for a shared time base through the addition of a data time stamping mechanism
- Adds extensions of the 2.4GHz derivative modulation yielding higher data rates at the lower frequency bands
- Incorporates a mechanism for communicating the revision level on a frame-by-frame basis
- Adds support for beacon scheduling
- Allows synchronization of broadcast messages in beacon-enabled PANs
- Improves usage of security suite

Also, this revision incorporates the following changes and simplifications:

- Makes GTS support optional
- Removes restrictions for manually enabling the receiver
- Simplifies passive and active scan procedures
- Allows for more flexibility in the CSMA-CA algorithm
- Reduces association time in nonbeacon networks

This revision is backward-compatible to the 2003 edition; in other words, devices conforming to this standard are capable of joining and functioning in a PAN composed of devices conforming to IEEE Std 802.15.4-2003.

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Contents

1.	Overview	1
1.1	General	1
1.2	Scope	1
1.3	Purpose	2
2.	Normative references	3
3.	Definitions	5
4.	Acronyms and abbreviations	9
5.	General description	13
5.1	Introduction	13
5.2	Components of the IEEE 802.15.4 WPAN	13
5.3	Network topologies	14
5.3.1	Star network formation	14
5.3.2	Peer-to-peer network formation	15
5.4	Architecture	15
5.4.1	Physical layer (PHY)	17
5.4.2	MAC sublayer	17
5.5	Functional overview	17
5.5.1	Superframe structure	17
5.5.2	Data transfer model	18
5.5.2.1	Data transfer to a coordinator	19
5.5.2.2	Data transfer from a coordinator	20
5.5.2.3	Peer-to-peer data transfers	21
5.5.3	Frame structure	21
5.5.3.1	Beacon frame	21
5.5.3.2	Data frame	22
5.5.3.3	Acknowledgment frame	22
5.5.3.4	MAC command frame	23
5.5.4	Improving probability of successful delivery	23
5.5.4.1	CSMA-CA mechanism	23
5.5.4.2	Frame acknowledgment	24
5.5.4.3	Data verification	24
5.5.5	Power consumption considerations	24
5.5.6	Security	24
5.6	Concept of primitives	25
6.	PHY specification	27
6.1	General requirements and definitions	27
6.1.1	Operating frequency range	27
6.1.2	Channel assignments	28
6.1.2.1	Channel numbering	29
6.1.2.2	Channel pages	29
6.1.3	Minimum long interframe spacing (LIFS) and short interframe spacing (SIFS) periods	30

6.1.4	RF power measurement	31
6.1.5	Transmit power	31
6.1.6	Out-of-band spurious emission	31
6.1.7	Receiver sensitivity definitions	31
6.2	PHY service specifications	31
6.2.1	PHY data service	32
6.2.1.1	PD-DATA.request	32
6.2.1.2	PD-DATA.confirm	33
6.2.1.3	PD-DATA.indication	34
6.2.2	PHY management service	34
6.2.2.1	PLME-CCA.request	35
6.2.2.2	PLME-CCA.confirm	35
6.2.2.3	PLME-ED.request	36
6.2.2.4	PLME-ED.confirm	36
6.2.2.5	PLME-GET.request	37
6.2.2.6	PLME-GET.confirm	38
6.2.2.7	PLME-SET-TRX-STATE.request	39
6.2.2.8	PLME-SET-TRX-STATE.confirm	40
6.2.2.9	PLME-SET.request	40
6.2.2.10	PLME-SET.confirm	41
6.2.3	PHY enumerations description	42
6.3	PPDU format	43
6.3.1	Preamble field	43
6.3.2	SFD field	44
6.3.3	Frame Length field	45
6.3.4	PSDU field	45
6.4	PHY constants and PIB attributes	45
6.4.1	PHY constants	45
6.4.2	PHY PIB attributes	45
6.5	2450 MHz PHY specifications	47
6.5.1	Data rate	47
6.5.2	Modulation and spreading	47
6.5.2.1	Reference modulator diagram	47
6.5.2.2	Bit-to-symbol mapping	47
6.5.2.3	Symbol-to-chip mapping	47
6.5.2.4	O-QPSK modulation	48
6.5.2.5	Pulse shape	49
6.5.2.6	Chip transmission order	49
6.5.3	2450 MHz band radio specification	49
6.5.3.1	Transmit power spectral density (PSD) mask	49
6.5.3.2	Symbol rate	49
6.5.3.3	Receiver sensitivity	49
6.5.3.4	Receiver jamming resistance	50
6.6	868/915 MHz band binary phase-shift keying (BPSK) PHY specifications	50
6.6.1	868/915 MHz band data rates	50
6.6.2	Modulation and spreading	50
6.6.2.1	Reference modulator diagram	50
6.6.2.2	Differential encoding	51
6.6.2.3	Bit-to-chip mapping	51
6.6.2.4	BPSK modulation	51
6.6.3	868/915 MHz band radio specification	52
6.6.3.1	Operating frequency range	52
6.6.3.2	915 MHz band transmit PSD mask	52
6.6.3.3	Symbol rate	52

6.6.3.4	Receiver sensitivity.....	52
6.6.3.5	Receiver jamming resistance	52
6.7	868/915 MHz band (optional) amplitude shift keying (ASK) PHY specifications.....	53
6.7.1	868/915 MHz band data rates	53
6.7.2	Modulation and spreading	53
6.7.2.1	Reference modulator diagram.....	53
6.7.2.2	Bit-to-symbol mapping	54
6.7.2.3	Symbol-to-chip mapping	54
6.7.2.4	ASK modulation	55
6.7.3	868/915 MHz band radio specification for the ASK PHY	57
6.7.3.1	Operating frequency range.....	57
6.7.3.2	915 MHz band transmit PSD mask.....	57
6.7.3.3	Symbol rate	57
6.7.3.4	Receiver sensitivity.....	57
6.7.3.5	Receiver jamming resistance	57
6.7.4	SHR for ASK PHY	58
6.7.4.1	Preamble for ASK PHY.....	58
6.7.4.2	SFD for ASK PHY	58
6.7.4.3	Example of PSSS encoding	58
6.8	868/915 MHz band (optional) O-QPSK PHY specifications.....	60
6.8.1	868/915 MHz band data rates	60
6.8.2	Modulation and spreading	60
6.8.2.1	Reference modulator diagram.....	60
6.8.2.2	Bit-to-symbol mapping	60
6.8.2.3	Symbol-to-chip mapping	60
6.8.2.4	O-QPSK modulation.....	61
6.8.2.5	Pulse shape.....	62
6.8.2.6	Chip transmission order	62
6.8.3	868/915 MHz band radio specification.....	62
6.8.3.1	Operating frequency range.....	62
6.8.3.2	Transmit PSD mask	62
6.8.3.3	Symbol rate	63
6.8.3.4	Receiver sensitivity.....	63
6.8.3.5	Receiver jamming resistance	63
6.9	General radio specifications.....	63
6.9.1	TX-to-RX turnaround time	63
6.9.2	RX-to-TX turnaround time	64
6.9.3	Error vector magnitude (EVM) definition.....	64
6.9.4	Transmit center frequency tolerance.....	65
6.9.5	Transmit power	65
6.9.6	Receiver maximum input level of desired signal.....	65
6.9.7	Receiver ED	65
6.9.8	Link quality indicator (LQI)	65
6.9.9	Clear channel assessment (CCA).....	66
7.	MAC sublayer specification	67
7.1	MAC sublayer service specification	67
7.1.1	MAC data service	68
7.1.1.1	MCPS-DATA.request.....	68
7.1.1.2	MCPS-DATA.confirm.....	71
7.1.1.3	MCPS-DATA.indication	72
7.1.1.4	MCPS-PURGE.request.....	75
7.1.1.5	MCPS-PURGE.confirm.....	75

7.1.1.6	Data service message sequence chart	76
7.1.2	MAC management service.....	76
7.1.3	Association primitives	77
7.1.3.1	MLME-ASSOCIATE.request.....	78
7.1.3.2	MLME-ASSOCIATE.indication	80
7.1.3.3	MLME-ASSOCIATE.response	81
7.1.3.4	MLME-ASSOCIATE.confirm	83
7.1.3.5	Association message sequence charts.....	85
7.1.4	Disassociation primitives.....	86
7.1.4.1	MLME-DISASSOCIATE.request	86
7.1.4.2	MLME-DISASSOCIATE.indication.....	89
7.1.4.3	MLME-DISASSOCIATE.confirm.....	90
7.1.4.4	Disassociation message sequence charts	91
7.1.5	Beacon notification primitive	92
7.1.5.1	MLME-BEACON-NOTIFY.indication.....	92
7.1.6	Primitives for reading PIB attributes	94
7.1.6.1	MLME-GET.request.....	95
7.1.6.2	MLME-GET.confirm.....	96
7.1.7	GTS management primitives	97
7.1.7.1	MLME-GTS.request	97
7.1.7.2	MLME-GTS.confirm.....	99
7.1.7.3	MLME-GTS.indication.....	100
7.1.7.4	GTS management message sequence charts.....	102
7.1.8	Primitives for orphan notification.....	103
7.1.8.1	MLME-ORPHAN.indication.....	103
7.1.8.2	MLME-ORPHAN.response.....	104
7.1.8.3	Orphan notification message sequence chart.....	106
7.1.9	Primitives for resetting the MAC sublayer	106
7.1.9.1	MLME-RESET.request	106
7.1.9.2	MLME-RESET.confirm	107
7.1.10	Primitives for specifying the receiver enable time	108
7.1.10.1	MLME-RX-ENABLE.request.....	108
7.1.10.2	MLME-RX-ENABLE.confirm.....	110
7.1.10.3	Message sequence chart for changing the state of the receiver	110
7.1.11	Primitives for channel scanning.....	111
7.1.11.1	MLME-SCAN.request.....	111
7.1.11.2	MLME-SCAN.confirm.....	114
7.1.11.3	Channel scan message sequence charts	116
7.1.12	Communication status primitive	116
7.1.12.1	MLME-COMM-STATUS.indication	116
7.1.13	Primitives for writing PIB attributes.....	119
7.1.13.1	MLME-SET.request	119
7.1.13.2	MLME-SET.confirm	121
7.1.14	Primitives for updating the superframe configuration.....	122
7.1.14.1	MLME-START.request.....	122
7.1.14.2	MLME-START.confirm.....	126
7.1.14.3	Message sequence chart for updating the superframe configuration.....	126
7.1.15	Primitives for synchronizing with a coordinator	127
7.1.15.1	MLME-SYNC.request.....	127
7.1.15.2	MLME-SYNC-LOSS.indication	128
7.1.15.3	Message sequence chart for synchronizing with a coordinator	131
7.1.16	Primitives for requesting data from a coordinator	131
7.1.16.1	MLME-POLL.request.....	132
7.1.16.2	MLME-POLL.confirm	133

7.1.16.3	Message sequence chart for requesting data from a coordinator.....	134
7.1.17	MAC enumeration description.....	135
7.2	MAC frame formats.....	137
7.2.1	General MAC frame format.....	138
7.2.1.1	Frame Control field.....	138
7.2.1.2	Sequence Number field.....	140
7.2.1.3	Destination PAN Identifier field.....	140
7.2.1.4	Destination Address field.....	140
7.2.1.5	Source PAN Identifier field.....	141
7.2.1.6	Source Address field.....	141
7.2.1.7	Auxiliary Security Header field.....	141
7.2.1.8	Frame Payload field.....	141
7.2.1.9	FCS field.....	141
7.2.2	Format of individual frame types.....	142
7.2.2.1	Beacon frame format.....	142
7.2.2.2	Data frame format.....	146
7.2.2.3	Acknowledgment frame format.....	147
7.2.2.4	MAC command frame format.....	147
7.2.3	Frame compatibility.....	148
7.3	MAC command frames.....	149
7.3.1	Association request command.....	150
7.3.1.1	MHR fields.....	150
7.3.1.2	Capability Information field.....	150
7.3.2	Association response command.....	151
7.3.2.1	MHR fields.....	151
7.3.2.2	Short Address field.....	152
7.3.2.3	Association Status field.....	152
7.3.3	Disassociation notification command.....	152
7.3.3.1	MHR fields.....	153
7.3.3.2	Disassociation Reason field.....	153
7.3.4	Data request command.....	153
7.3.5	PAN ID conflict notification command.....	154
7.3.6	Orphan notification command.....	155
7.3.7	Beacon request command.....	156
7.3.8	Coordinator realignment command.....	156
7.3.8.1	MHR fields.....	157
7.3.8.2	PAN Identifier field.....	157
7.3.8.3	Coordinator Short Address field.....	157
7.3.8.4	Logical Channel field.....	157
7.3.8.5	Short Address field.....	157
7.3.8.6	Channel Page field.....	157
7.3.9	GTS request command.....	158
7.3.9.1	MHR fields.....	158
7.3.9.2	GTS Characteristics field.....	158
7.4	MAC constants and PIB attributes.....	159
7.4.1	MAC constants.....	159
7.4.2	MAC PIB attributes.....	160
7.5	MAC functional description.....	166
7.5.1	Channel access.....	167
7.5.1.1	Superframe structure.....	167
7.5.1.2	Incoming and outgoing superframe timing.....	169
7.5.1.3	Interframe spacing (IFS).....	169
7.5.1.4	CSMA-CA algorithm.....	170
7.5.2	Starting and maintaining PANs.....	172

7.5.2.1	Scanning through channels	172
7.5.2.2	PAN identifier conflict resolution	176
7.5.2.3	Starting and realigning a PAN	177
7.5.2.4	Beacon generation	178
7.5.2.5	Device discovery	179
7.5.3	Association and disassociation	179
7.5.3.1	Association	179
7.5.3.2	Disassociation	181
7.5.4	Synchronization	182
7.5.4.1	Synchronization with beacons	182
7.5.4.2	Synchronization without beacons	183
7.5.4.3	Orphaned device realignment	183
7.5.5	Transaction handling	183
7.5.6	Transmission, reception, and acknowledgment	185
7.5.6.1	Transmission	185
7.5.6.2	Reception and rejection	186
7.5.6.3	Extracting pending data from a coordinator	187
7.5.6.4	Use of acknowledgments and retransmissions	189
7.5.6.5	Promiscuous mode	190
7.5.6.6	Transmission scenarios	191
7.5.7	GTS allocation and management	192
7.5.7.1	CAP maintenance	193
7.5.7.2	GTS allocation	193
7.5.7.3	GTS usage	194
7.5.7.4	GTS deallocation	195
7.5.7.5	GTS reallocation	196
7.5.7.6	GTS expiration	197
7.5.8	Frame security	197
7.5.8.1	Security-related MAC PIB attributes	197
7.5.8.2	Functional description	199
7.6	Security suite specifications	206
7.6.1	PIB security material	206
7.6.2	Auxiliary security header	210
7.6.2.1	Integer and octet representation	210
7.6.2.2	Security Control field	210
7.6.2.3	Frame Counter field	212
7.6.2.4	Key Identifier field	212
7.6.3	Security operations	213
7.6.3.1	Integer and octet representation	213
7.6.3.2	CCM* Nonce	213
7.6.3.3	CCM* prerequisites	213
7.6.3.4	CCM* transformation data representation	214
7.6.3.5	CCM* inverse transformation data representation	215
7.7	Message sequence charts illustrating MAC-PHY interaction	216
Annex A (normative)	Service-specific convergence sublayer (SSCS)	227
A.1	IEEE 802.2 convergence sublayer	227
A.1.1	MA-UNITDATA.request	227
A.1.1.1	Semantics of the service primitive	227
A.1.1.2	Appropriate usage	228
A.1.1.3	Effect on receipt	228
A.1.2	MA-UNITDATA.indication	228
A.1.2.1	Semantics of the service primitive	228

A.1.2.2	When generated	228
A.1.2.3	Appropriate usage	228
A.1.3	MA-UNITDATA-STATUS.indication.....	229
A.1.3.1	Semantics of the service primitive.....	229
A.1.3.2	When generated	229
A.1.3.3	Appropriate usage	229
Annex B (normative)	CCM* mode of operation	231
B.1	Introduction.....	231
B.2	Notation and representation	231
B.2.1	Strings and string operations.....	231
B.2.2	Integers, octets, and their representation	231
B.3	Symmetric-key cryptographic building blocks.....	231
B.3.1	Block cipher	231
B.3.2	Mode of operation.....	232
B.4	Specification of generic CCM* mode of operation.....	232
B.4.1	CCM* mode encryption and authentication transformation.....	232
B.4.1.1	Input transformation	233
B.4.1.2	Authentication transformation.....	233
B.4.1.3	Encryption transformation	234
B.4.2	CCM* mode decryption and authentication checking transformation	234
B.4.2.1	Decryption transformation.....	235
B.4.2.2	Authentication checking transformation.....	235
B.4.3	Restrictions	235
Annex C (informative)	Test vectors for cryptographic building blocks.....	237
C.1	AES block cipher.....	237
C.2	Mode of operation	237
C.2.1	MAC beacon frame.....	237
C.2.1.1	Description.....	237
C.2.1.2	CCM* mode encryption and authentication transformation.....	238
C.2.1.3	CCM* mode decryption and authentication checking transformation	240
C.2.2	MAC data frame	241
C.2.2.1	Description.....	241
C.2.2.2	CCM* mode encryption and authentication transformation.....	241
C.2.2.3	CCM* mode decryption and authentication checking transformation	243
C.2.3	MAC command frame	245
C.2.3.1	Description.....	245
C.2.3.2	CCM* mode encryption and authentication transformation.....	245
C.2.3.3	CCM* mode decryption and authentication checking transformation	247
Annex D (normative)	Protocol implementation conformance statement (PICS) proforma	251
D.1	Introduction.....	251
D.1.1	Scope.....	251
D.1.2	Purpose.....	251
D.2	Abbreviations and special symbols.....	251
D.3	Instructions for completing the PICS proforma.....	252
D.4	Identification of the implementation.....	252
D.5	Identification of the protocol	253
D.6	Global statement of conformance	253
D.7	PICS proforma tables.....	254

D.7.1	Major roles for devices compliant with IEEE Std 802.15.4-2006.....	254
D.7.2	Major capabilities for the PHY	255
D.7.2.1	PHY functions.....	255
D.7.2.2	PHY packet.....	255
D.7.2.3	Radio frequency (RF)	256
D.7.3	Major capabilities for the MAC sublayer	256
D.7.3.1	MAC sublayer functions.....	256
D.7.3.2	MAC frames	258
Annex E (informative) Coexistence with other IEEE standards and proposed standards.....		261
E.1	Introduction.....	261
E.2	Standards and proposed standards characterized for coexistence.....	261
E.3	General coexistence issues.....	261
E.3.1	Clear channel assessment (CCA).....	262
E.3.2	Modulation.....	262
E.3.2.1	2400 MHz band PHY	262
E.3.2.2	800/900 MHz band PHYs.....	262
E.3.3	ED and LQI.....	263
E.3.4	Low duty cycle.....	263
E.3.5	Low transmit power.....	263
E.3.5.1	2400 MHz band PHY.....	263
E.3.5.2	800 MHz band PHYs.....	263
E.3.5.3	900 MHz band PHYs.....	264
E.3.6	Channel alignment	264
E.3.7	Dynamic channel selection	264
E.3.8	Neighbor piconet capability.....	264
E.4	2400 MHz band coexistence performance.....	265
E.4.1	Assumptions for coexistence quantification	265
E.4.1.1	Channel model.....	265
E.4.1.2	Receiver sensitivity.....	266
E.4.1.3	Transmit power	266
E.4.1.4	Receiver bandwidth	266
E.4.1.5	Transmit spectral masks.....	266
E.4.1.6	IEEE 802.11b transmit PSD	267
E.4.1.7	Interference characteristics	267
E.4.1.8	Bit error rate (BER) calculations	267
E.4.1.9	Packet error rate (PER).....	268
E.4.2	BER model.....	268
E.4.3	Coexistence simulation results.....	268
E.5	800/900 MHz bands coexistence performance.....	273
E.5.1	Victims and assailants.....	273
E.5.2	Bandwidth.....	273
E.5.3	Path loss model	273
E.5.4	Temporal model.....	274
E.5.5	Coexistence assurance results.....	275
E.5.5.1	868 MHz BPSK PHY	275
E.5.5.2	868 MHz O-QPSK PHY	276
E.5.5.3	868 MHz PSSS PHY	278
E.5.5.4	915 MHz BPSK PHY	279
E.5.5.5	915 MHz O-QPSK PHY	280
E.5.5.6	915 MHz PSSS PHY	281
E.6	Notes on the calculations	282

Annex F (informative) IEEE 802.15.4 regulatory requirements	283
F.1 Introduction.....	283
F.2 Applicable U.S. (FCC) rules.....	285
F.2.1 Section 15.35 of FCC CFR47	285
F.2.2 Section 15.209 of FCC CFR47	287
F.2.3 Section 15.205 of FCC CFR47	287
F.2.4 Section 15.247 of FCC CFR47	288
F.2.5 Section 15.249 of FCC CFR47	289
F.3 Applicable European rules.....	290
F.3.1 European 2400 MHz band rules	291
F.3.2 European 868–870 MHz band rules	292
F.4 Applicable Japanese rules.....	294
F.5 Emissions specification analysis with respect to known worldwide regulations	295
F.5.1 General analysis and impact of detector bandwidth and averaging rules.....	295
F.5.2 Frequency spreading and averaging effects specific to IEEE Std 802.15.4	297
F.6 Summary of out-of-band spurious emissions limits	299
F.7 Phase noise requirements inferred from regulatory limits.....	300
F.8 Summary of transmission power levels	301
Annex G (informative) Bibliography	303
G.1 General.....	303
G.2 Regulatory documents	304
Annex H (informative) IEEE list of participants	306

**IEEE Standard for
Information technology—
Telecommunications and information
exchange between systems—
Local and metropolitan area networks—
Specific requirements—**

**Part 15.4: Wireless Medium Access Control
(MAC) and Physical Layer (PHY)
Specifications for Low-Rate Wireless
Personal Area Networks (WPANs)**

1. Overview

1.1 General

Wireless personal area networks (WPANs) are used to convey information over relatively short distances. Unlike wireless local area networks (WLANs), connections effected via WPANs involve little or no infrastructure. This feature allows small, power-efficient, inexpensive solutions to be implemented for a wide range of devices.

This document defines a standard for a low-rate WPAN (LR-WPAN).

1.2 Scope

The scope of this revision is to produce specific enhancements and corrections to IEEE Std 802.15.4, all of which will be backwards compatible with IEEE Std 802.15.4-2003. These enhancements and corrections include resolving ambiguities, reducing unnecessary complexity, increasing flexibility in security key usage, considerations for newly available frequency allocations, and others.

IEEE Std 802.15.4 defines the physical layer (PHY) and medium access control (MAC) sublayer specifications for low-data-rate wireless connectivity with fixed, portable, and moving devices with no battery or very limited battery consumption requirements typically operating in the personal operating space (POS) of 10 m. It is foreseen that, depending on the application, a longer range at a lower data rate may be an acceptable tradeoff.

It is the intent of this revision to work toward a level of coexistence with other wireless devices in conjunction with Coexistence Task Groups, such as IEEE 802.15.2 and IEEE 802.11/ETSI-BRAN/MMAC 5GSG.

1.3 Purpose

The purpose of this revision is to extend the market applicability of IEEE Std 802.15.4 and to remove ambiguities in the standard. Implementations of the 2003 edition of this standard have revealed potential areas of improvements. Additional frequency bands are being made available in various countries that are attractive for this application space.

Withdrawn

2. Normative references

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

FIPS Pub 197, Advanced Encryption Standard (AES).¹

IEEE Std 802[®], IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture.²

ISO/IEC 8802-2 (IEEE Std 802.2[™]), Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 2: Logical link control.³

ISO/IEC 9646-7 (ITU-T Rec. X.296), Information technology — Open systems interconnection — Conformance testing methodology and framework — Part 7: Implementation conformance statements.

¹FIPS publications are available from the National Technical Information Service (NTIS), U. S. Dept. of Commerce, 5285 Port Royal Rd., Springfield, VA 22161 (<http://www.ntis.org/>).

²IEEE Publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org>).

³ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO/IEC publications are also available in the United States from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>). Electronic copies are available in the United States from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).