ISO/IEC 18000-6:2010-12 (E)

Information technology - Radio frequency identification for item management - Par t 6: Parameters for air interface communications at 860 MHz to 960 MHz

Contents

Page

Foreword xiii

Introduction xiv

1 Scope 1

2 Conformance 2
2.1 Claiming conformance 2
2.2 Interrogator conformance and obligations 2
2.3 Tag conformance and obligations 2

3 Normative references 3

4 Terms, definitions, symbols and abbreviated terms 3
4.1 Terms and definitions 3
4.2 Symbols 6
4.3 Abbreviated terms 7
4.4 Notation 10

5 Overview 10
5.1 General 10
5.2 Parameter tables 12

6 Common elements of the physical layer for Types A, B, and D 21
6.1 General 21
6.2 Interrogator power-up waveform 21
6.3 Interrogator power-down 22
6.4 Frequency hopping carrier rise and fall times 23
6.5 FM0 return link 24
6.5.1 FM0 return link general 24
6.5.2 Modulation 24
6.5.3 Data rate 24
6.5.4 Data coding 24
6.5.5 Message format 25
6.5.6 Return preamble 25
6.5.7 Cyclic redundancy check (CRC) 26

7 Type A 28
7.1 Physical layer and data coding 28
7.1.1 PIE (Pulse interval encoding) forward link 28
7.2 Data elements 32
7.2.1 Unique identifier (Tag ID) 32
7.2.2 Sub-UID 33
7.2.3 Application family identifier 33
7.2.4 Data storage format identifier (DSFID) 34
7.3 Protocol elements 34
7.3.1 Tag memory organisation 34
7.3.2 Support of battery-assisted tags 34
7.3.3 Block lock status 35
7.3.4 Tag signature 35
7.4 Protocol description 36

7.4.1 Protocol concept ... 36
7.4.2 Command format ... 37
7.4.3 Command flags ... 37
7.4.4 Round size ... 38
7.4.5 Command code definition and structure ... 39
7.4.6 Command classes ... 39
7.4.7 Command codes and CRC ... 40
7.4.8 Response format ... 43
7.4.9 Tag states ... 45
7.4.10 Collision arbitration ... 47
7.4.11 General explanation of the collision arbitration mechanism ... 47
7.5 Timing specifications ... 50
7.5.1 Timing specifications general ... 50
7.5.2 Tag state storage ... 50
7.5.3 Forward link to return link handover ... 50
7.5.4 Return link to forward link handover ... 51
7.5.5 Acknowledgement time window ... 51
7.6 Command format examples ... 53
7.7 Mandatory commands ... 53
7.7.1 Mandatory commands general ... 53
7.7.2 Next_slot ... 53
7.7.3 Standby_round ... 54
7.7.4 Reset_to_ready ... 56
7.7.5 Init_round_all ... 56
7.8 Optional commands ... 59
7.8.1 Optional commands general ... 59
7.8.2 Init_round ... 59
7.8.3 Close_slot ... 60
7.8.4 New_round ... 61
7.8.5 Select (by SUID) ... 63
7.8.6 Read_blocks ... 64
7.8.7 Get_system_information ... 68
7.8.8 Begin_round ... 71
7.8.9 Write_single_block ... 73
7.8.10 Write_multiple_blocks ... 75
7.8.11 Lock_blocks ... 77
7.8.12 Write_AFI ... 79
7.8.13 Lock_AFI ... 81
7.8.14 Write_DSFID command ... 83
7.8.15 Lock_DSFID ... 85
7.8.16 Get_blocks_lock_status ... 87
7.8.17 Init_Fast_Slots ... 89
7.9 Custom commands ... 92
7.10 Proprietary commands ... 93

8 Type B ... 93
8.1 Physical layer and data coding ... 93
8.1.1 Forward link ... 93
8.1.2 Return link ... 96
8.1.3 Protocol concept ... 96
8.1.4 Command format ... 97
8.1.5 Response format ... 99
8.1.6 WAIT ... 99
8.1.7 Examples of a command packet ... 99
8.1.8 Communication sequences at packet level ... 100
8.2 Btree protocol and collision arbitration ... 101
8.2.1 Definition of data elements, bit and byte ordering ... 101
8.2.2 Tag memory organisation ... 102
8.2.3 Block security status ... 103
8.2.4 Overall protocol description, Btree protocol ... 103
8.2.5 Collision arbitration ... 108
8.2.6 Commands ... 110

8.2.7 Command types 110
8.2.8 Transmission errors 137

9 Type C 138
9.1 Protocol overview 138
9.1.1 Physical layer 138
9.1.2 Tag-identification layer 138
9.2 Command types and command structure 138
9.2.1 General 138
9.2.2 Mandatory 138
9.2.3 Optional 138
9.2.4 Custom 139
9.2.5 Proprietary 139
9.3 Description of operating procedure 139
9.3.1 Signalling 139
9.3.2 Tag selection, inventory, and access 154

10 Type D 202
10.1 Applicability 202
10.2 Protocol overview 203
10.2.1 General 203
10.2.2 Protocol parameter values 204
10.2.3 Tag arbitration 204
10.2.4 Operating procedure 205
10.2.5 TagMsg 207
10.2.6 CW control 208
10.2.7 Message encoding 208
10.2.8 Symbol modulation 208
10.2.9 Page modulation 208
10.2.10 Interrogator modulation detection 211
10.3 Type D Data 211
10.3.1 General 211
10.3.2 TID 212
10.3.3 Structured data encoding 214
10.3.4 Tag configuration 218
10.4 Encoding and decoding TID-S Tags 218
10.4.1 Encoding rules 218
10.4.2 Decoding rules 219

11 Battery Assisted Passive (BAP) Interrogator Talks First Type C systems (optional) 220
11.1 Applicability 220
11.2 General overview, definitions, and requirements of BAP 220
11.3 Battery Assisted Passive inventoried flag and state machine behaviour modifications 222
11.3.1 Modification to ready state and power-down support for BAP Tags 222
11.3.2 Signal loss tolerance via timer (mandatory) 222
11.3.3 Modified persistence of BAP PIE inventory flags (optional) 225
11.4 Battery Assisted Passive PIE (optional) 227
11.4.1 Flex_Query command (optional) 227
11.4.2 BAP PIE detailed operation including optional Battery Saver Mode 228
11.5 Manchester mode Battery Assisted operation protocol extensions 235
11.5.1 Introduction 235
11.5.2 Physical layer 236
11.5.3 Manchester Activation 241
11.5.4 Commands summary 257
11.6 Extended Protocol Control and Battery Tag Capabilities Reporting and Setting 271
11.6.1 General 271
11.6.2 Extended Protocol Control definition 272
11.6.3 Battery Assisted Passive Tag Capability Reporting, Setting, and duty cycle/mode control (optional) 274

12 Sensor support 303
12.1 Applicability 303

12.2 Overview ... 303
12.3 Real Time Clock (RTC) ... 304
12.3.1 General ... 304
12.3.2 Setting the RTC ... 304
12.3.3 BroadcastSync command (optional, for Type C) ... 305
12.3.4 Time synchronisation ... 306
12.4 HandleSensor command (optional, for Type C) ... 307
12.5 Simple Sensor ... 308
12.5.1 Type C and Simple Sensor ... 308
12.5.2 Type D and Simple Sensor ... 310
12.6 Sensor Directory System and Full Function Sensors ... 310
12.6.1 Sensor Access - General Approach ... 310

Annex A (informative) Calculation of 5-bit and 16-bit cyclic redundancy checks for A.1 Example CRC-5 encoder/decoder ... 317

A.2 Example CRC-16 encoder/decoder ... 317
A.3 Example CRC-16 calculations ... 318

B.1 Unique identifier (normative) ... 322
B.1.1 Unique identifier general ... 322
B.1.2 Unique identifier format ... 322
B.1.3 Unique identifier according to ANSI 256 ... 322
B.1.4 Remaining system memory ... 323

C.1 Tag memory map ... 327

E.1 Contents ... 329
E.2 State transition tables for passive ... 329
E.2.1 Present state: Ready ... 329
E.2.2 Present state: Arbitrate ... 330
E.2.3 Present state: Reply ... 331
E.2.4 Present state: Acknowledged ... 332
E.2.5 Present state: Open ... 333
E.2.6 Present state: Secured ... 334
E.2.7 Present state: Killed ... 335
E.3 State transition tables for BAP PIE ... 336
E.3.1 Present state: sleep ... 336
E.3.2 Present state: low power listen ... 336
E.3.3 Present state: listen or stateful listen ... 336
E.3.4 Present state: stateful sleep or stateful low power listen ... 336
E.3.5 Present state: battery ready ... 337
E.3.6 Present state: Arbitrate ... 337
E.3.7 Present state: Reply ... 338
E.3.8 Present state: Acknowledged ... 339
E.3.9 Present state: Open ... 340
E.3.10 Present state: Secured ... 342
E.3.11 Present state: Killed ... 344
E.4 State transition tables for BAP Manchester ... 344
E.4.1 Present state: Hibernate ... 344
E.4.2 Present state: Activation code check ... 345
E.4.3 Present state: Stateful Hibernate ... 345
E.4.4 Present state: Battery Ready ... 346
E.4.5 Present state: Arbitrate ... 348
E.4.6 Present state: Reply ... 350
E.4.7 Present state: Acknowledged ... 352
E.4.8 Present state: Open ... 354
E.4.9 Present state: Secured ... 356
E.4.10 Present state: Killed ... 359

F.1 Contents ... 360
F.2 Command response tables for passive ... 360

F.2.1 Command response: Power-up 360
F.2.2 Command response: Query 360
F.2.3 Command response: QueryRep 361
F.2.4 Command response: QueryAdjust 361
F.2.5 Command response: ACK 362
F.2.6 Command response: NAK 362
F.2.7 Command response: Req_RN 362
F.2.8 Command response: Select 363
F.2.9 Command response: Read 363
F.2.10 Command response: Write 363
F.2.11 Command response: Kill 364
F.2.12 Command response: Lock 364
F.2.13 Command response: Access 365
F.2.14 Command response: BlockWrite 365
F.2.15 Command response: BlockErase 366
F.2.16 Command response: BlockPermalock 366
F.2.17 Command response: T2 timeout 367
F.2.18 Command response: Invalid command 367
F.3 Command response tables for BAP PIE 368
F.3.1 Command response: Flex_Query (optional for BAP PIE) 368
F.3.2 Command response: INACT_T or Selective Global Timeout 368
F.3.3 Command response: Global Timeout 369
F.3.4 Command response: HandleSensor 369
F.3.5 Command response: BroadcastSync 369
F.4 Command Response Tables for Manchester 370
F.4.1 Command response: Power-up 370
F.4.2 Command response: QueryRep 370
F.4.3 Command response: QueryAdjust 370
F.4.4 Command response: ACK 371
F.4.5 Command response: NAK 372
F.4.6 Command response: Req_RN 372
F.4.7 Command response: Select 372
F.4.8 Command response: Read 372
F.4.9 Command response: Write 372
F.4.10 Command response: Kill 372
F.4.11 Command response: Lock 372
F.4.12 Command response: Access 373
F.4.13 Command response: BlockWrite 373
F.4.14 Command response: BlockErase 373
F.4.15 Command response: BlockPermalock 373
F.4.16 Command response: T2 timeout 373
F.4.17 Command response: Long Activation 373
F.4.18 Command response: Short Activation 374
F.4.19 Command response: Query_BAT 375
F.4.20 Command response: Next 376
F.4.21 Command response: Deactivate_BAT 376
F.4.22 Command response: Broadcast ID 377
F.4.23 Command response: Multirate_Reset 378
F.4.24 Command response: HandleSensor 378
F.4.25 Command response: BroadcastSync 378
F.4.26 Command response: Session Flag timer timeout 379
F.4.27 Command response: INACT_T or Selective Global Timeout 379
F.4.28 Command response: Global Timeout 379
F.4.29 Command response: TA 380
F.4.30 Command response: OpRegister Read/Write 380
F.4.31 Command response: Invalid command 381

G.1 Example algorithm an Interrogator might use to choose Q 382

H.1 Example inventory and access of a single Tag 383

Type C 387

I.1 General 387
I.2 Overview of Dense-Interrogator channelised signalling (informative) 387

J.1 Baseband waveforms, modulated RF, and detected waveforms 390

K.1 Tag error codes and their usage 392

L.1 Slot-counter operation 394

M.1 Overview of the data-flow exchange 395
M.2 Tag memory contents and lock-field values 395
M.3 Data-flow exchange and command sequence 396

N.1 General 397
N.2 Optional Tag passwords 397
N.2.1 Kill password 397
N.2.2 Access password 397
N.3 Optional Tag memory banks and memory-bank sizes 397
N.3.1 Reserved memory 397
N.3.2 UII memory 397
N.3.3 TID memory 397
N.3.4 User memory 397
N.4 Optional Tag commands 398
N.5 Optional Tag error-code reporting format 398
N.6 Optional Tag backscatter modulation format 398
N.7 Optional Tag functionality 398

O.1 Type D TID CRC-16 399

Annex P (informative) Battery Assisted Tag to Interrogator synchronization for P.1 Introduction .. 400

P.2 General concept 400
P.3 Tag to Interrogator synchronization 401

Q.1 Simple sensor types 403
Q.2 General bit-based rules 404
Q.3 Temperature sensor with 14° C span 404
Q.3.1 Monitored measurement span 404
Q.3.2 Accuracy 404
Q.3.3 Sampling regime 405
Q.3.4 High in-range limit level 405
Q.3.5 Low in-range limit level 406
Q.3.6 Monitor delay 406
Q.3.7 High out-of-range alarm delay 407
Q.3.8 Low out-of-range alarm delay 407
Q.3.9 Alarms 408
Q.4 Temperature sensor with 28° C span 409
Q.4.1 Monitored measurement span 409
Q.4.2 Accuracy 409
Q.4.3 Sampling regime 409
Q.4.4 High in-range limit 409
Q.4.5 Low in-range limit 409
Q.4.6 Monitor delay 410
Q.4.7 High out-of-range alarm delay 410
Q.4.8 Low out-of-range alarm delay 410
Q.4.9 Alarms 410
Q.5 Relative humidity 410
Q.5.1 Monitored measurement span 410
Q.5.2 Accuracy 410
Q.5.3 Sampling regime 411
Q.5.4 High in-range limit level 411

Q.5.5 Low in-range limit level 411
Q.5.6 Monitor delay 411
Q.5.7 High out-of-range alarm delay 411
Q.5.8 Low out-of-range alarm delay 411
Q.5.9 Alarms 411
Q.6 Impact 412
Q.6.1 Monitored measurement span 412
Q.6.2 Accuracy 412
Q.6.3 Sampling regime 412
Q.6.4 High in-range limit 412
Q.6.5 Low in-range limit 412
Q.6.6 Monitor delay 412
Q.6.7 High out-of-range alarm delay 412
Q.6.8 Low out-of-range alarm delay 413
Q.6.9 Alarms 413
Q.7 Tilt 413
Q.7.1 Monitored measurement span 413
Q.7.2 Accuracy 413
Q.7.3 Sampling regime 413
Q.7.4 High in-range limit 413
Q.7.5 Low in-range limit 413
Q.7.6 Monitor delay 413
Q.7.7 High out-of-range alarm delay 414
Q.7.8 Low out-of-range alarm delay 414
Q.7.9 Alarms 414

Annex R (normative) Record structures and commands for Ported Simple Sensors for R.1 Record structure types 415

R.1.1 Simple sensor data block 416
R.1.2 Sensor characteristics record block 416
R.1.3 Manufacturer record block 416
R.1.4 Authorisation password record block 417
R.1.5 Calibration record block 417
R.1.6 Sample and configuration record block 419
R.1.7 Event record block 420
R.1.8 Time synchronisation record block 421
R.2 Ported Simple Sensor commands 421
R.2.1 Read-Simple-Sensor-Data-Block 422
R.2.2 Read-Manufacturer-Record 422
R.2.3 Write-Password 423
R.2.4 Read-Calibration-Record 423
R.2.5 Write-Sample-And-Configuration-Record 424
R.2.6 Initialise-Sensor-Monitoring 425
R.2.7 Read-Sample-And-Configuration-Record 425
R.2.8 Read-Event-Record 426
R.2.9 Write-UTC-Timestamp 427
R.2.10 Read-Time-Synchronisation-Record 428
R.2.11 Erase-Monitored-Data 428
R.2.12 Activate-Simple-Sensor 429
R.2.13 Deactivate-Simple-Sensor 429

S.1 Executive summary of Battery Assisted Passive RFID in this standard 430
S.2 Battery Assisted Passive fundamentals 432
S.2.1 Propagation physics and resulting relationship between Interrogator and Tag sensitivity 432
S.2.2 Tag receiver issues 434
S.3 BAP PIE 435
S.4 Manchester 435
S.5 Guidance on using Next vs. Deactivate_BAT (PIE and Manchester) 436
S.6 Reliable inventory status tracking 436
S.7 Environmental validation 437
S.7.1 INACT_T and (Selective) Global Timeout timer refresh 437

S.8 Fade delay tolerance via INACT_T and Global Timeout 438
S.9 Clocks and commanded data rates and BLFs 438
S.10 Tag Capabilities Reporting and Setting (TCRS) 439
S.11 BAP PIE persistence compliance 439

T.1 General 440
T.2 Power levelling description 440
T.3 Power leveling algorithm 442

Bibliography 445