DIN EN 16603-50-01:2014-12 (E)

Space engineering - Space data links - Telemetry synchronization and channel coding; English version EN 16603-50-01:2014

Contents

Page

Foreword **6**

1 Scope **7**

2 Normative references **8**

3 Terms, definitions and abbreviated terms **9**

3.1 Terms from other standards 9

3.2 Terms specific to the present standard 9

3.3 Abbreviations 9

3.4 Conventions 10

4 Overview **11**

4.1 Introduction 11

4.2 Coding 11

4.2.1 Channel codes 11

4.2.2 Connection vectors 12

4.3 Convolutional codes 12

4.4 Reed-Solomon codes 12

4.5 Concatenated codes 13

4.6 Turbo codes 13

4.7 Synchronization and pseudo-randomization 13

5 Convolutional coding **16**

5.1 Properties 16

5.2 General 16

5.3 Basic convolutional code 17

5.4 Punctured convolutional code 18

6 Reed-Solomon coding **20**

6.1 Properties 20

6.2 General 20

6.3 Specification 21

6.3.1 Parameters and general characteristics 21

6.3.2 Generator polynomials 21

6.3.3 Symbol interleaving depth 22
6.3.4 Symbol interleaving mechanism 22
6.3.5 Reed-Solomon codeblock partitioning 23
6.3.6 Shortened codeblock length 24
6.3.7 Dual basis symbol representation and ordering 25
6.3.8 Synchronization 26
6.3.9 Ambiguity resolution 26
6.4 Reed-Solomon with *E*=8 26
6.4.1 Introduction 26
6.4.2 General 27

7 Turbo coding 28
7.1 Properties 28
7.2 General 28
7.3 Specification 29
7.3.1 General 29
7.3.2 Parameters and general characteristics 29
7.3.3 Turbo code permutation 30
7.3.4 Backward and forward connection vectors 32
7.3.5 Turbo encoder block 33
7.3.6 Turbo codeblock specification 33
7.3.7 Turbo codeblock synchronization 34

8 Frame synchronization 35
8.1 Introduction 35
8.2 The attached sync marker (ASM) 35
8.2.1 Overview 35
8.2.2 Encoder side 36
8.2.3 Decoder side 36
8.3 ASM bit patterns 36
8.4 Location of ASM 37
8.5 Relationship of ASM to Reed-Solomon and turbo codeblocks 37
8.6 ASM for embedded data stream 38
8.6.1 Overview 38
8.6.2 Embedded ASM 38

9 Pseudo-randomizer 39
9.1 General 39
9.1.1 Overview 39

9.1.2 Application 39
9.2 Pseudo-randomizer description 39
9.3 Synchronization and application of pseudo-randomizer 40
9.3.1 Overview 40
9.3.2 Application 40
9.4 Sequence specification 41

Annex A (informative) Transformation between Berlekamp and conventional representations 43

Annex B (informative) Expansion of Reed-Solomon coefficients 50

Annex C (informative) Compatible frame lengths 52

Annex D (informative) Application profiles 54

Annex E (informative) Changes from ESA-PSS-04-103 60

Annex F (informative) Differences from CCSDS recommendations 61

Annex G (informative) Mission configuration parameters 62

Annex H (informative) Turbo code patent rights 66

Bibliography 67

Figures

Figure 3-1: Bit numbering convention 10
Figure 4-1: Coding, randomization and synchronization (1) 14
Figure 4-2: Coding, randomization and synchronization (2) 15
Figure 5-1: Convolutional encoder block diagram 18
Figure 5-2: Punctured encoder block diagram 19
Figure 6-1: Functional representation of R-S interleaving 23
Figure 6-2: Reed-Solomon codeblock partitioning 24
Figure 7-1: Interpretation of permutation 31
Figure 7-2: Turbo encoder block diagram 32
Figure 7-3: Turbo codeblocks for code rates 1/2 and 1/4 34
Figure 7-4: Turbo codeblock with attached sync marker 34
Figure 8-1: Format of channel access data unit (CADU) 35
Figure 8-2 ASM bit pattern for non-turbo-coded data 36
Figure 8-3: ASM bit pattern for rate 1/2 turbo-coded data 36
Figure 8-4: ASM bit pattern for rate 1/4 turbo-coded data 37
Figure 8-5: Embedded ASM bit pattern 38

Figure 9-1: Pseudo-randomizer configuration 40
Figure 9-2: Pseudo-randomizer logic diagram 42
Figure A-1 : Transformational equivalence 44

Tables

Table 5-1: Basic convolutional code characteristics 17
Table 5-2: Punctured convolutional code characteristics 19
Table 5-3: Puncture code patterns for convolutional codes 19
Table 7-1: Specified information block lengths 30
Table 7-2: Codeblock lengths (measured in bits) 30
Table 7-3: Parameters k_1 and k_2 for specified information block lengths 31
Table 7-4: Forward connection vectors 32
Table 8-1: ASM bit patterns in hexadecimal notation 37
Table A-1 : Equivalence of representations (Part 1 of 4) 46
Table B-1 : Expansion for *E*=16 50
Table B-2 : Expansion for *E*=8 51
Table C-1 : Maximum frame lengths for *E*=16 53
Table C-2 : Maximum frame lengths for *E*=8 53
Table D-1 : Preferred coding schemes 56
Table D-2 : Coding gains and bandwidth expansions 58
Table D-3 : Coding gains for R-S(255, 239) and 4D-8PSK-TCM 59