



SLOVENSKI STANDARD
SIST-TP CEN/TR 17603-50:2022
01-september-2022

Vesoljska tehnika - Smernice za komuniciranje

Space engineering - Communication guidelines

Raumfahrttechnik - Richtlinien zur Kommunikation

Ingénierie spatiale - Recommandations pour les systèmes de communications

Ta slovenski standard je istoveten z: CEN/TR 17603-50:2022

<https://standards.iteh.ai/catalog/standards/sist/447d69a7-38c1-4b6e-b562-fa9d42c01d69/sist-tp-cen-tr-17603-50-2022>

ICS:

49.140 Vesoljski sistemi in operacije Space systems and operations

SIST-TP CEN/TR 17603-50:2022 en,fr,de

TECHNICAL REPORT

CEN/TR 17603-50

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

June 2022

ICS 49.140

English version

Space engineering - Communication guidelines

Ingénierie spatiale - Recommandations pour les
systèmes de communications

Raumfahrttechnik - Richtlinien zur Kommunikation

This Technical Report was approved by CEN on 20 April 2022. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[SIST-TP CEN/TR 17603-50:2022](https://standards.iteh.ai/catalog/standards/sist/447d69a7-38c1-4b6e-b562-fa9d42c01d69/sist-tp-cen-tr-17603-50-2022)

<https://standards.iteh.ai/catalog/standards/sist/447d69a7-38c1-4b6e-b562-fa9d42c01d69/sist-tp-cen-tr-17603-50-2022>



**CEN-CENELEC Management Centre:
Rue de la Science 23, B-1040 Brussels**

Table of contents

European Foreword	15
1 Introduction	16
1.1 Purpose.....	16
1.2 Scope.....	16
1.3 Document structure.....	16
2 Terms, definitions and abbreviations	18
2.1 Terms and definitions from other documents.....	18
2.2 Terms specific to the present document.....	18
2.3 Conventions.....	18
2.3.1 Bit numbering and most significant bit.....	18
2.4 Abbreviated terms.....	19
3 The E-50 series of standards	23
3.1 Background.....	23
3.1.1 Scope of the ECSS E-50 series.....	23
3.1.2 CCSDS standards.....	23
3.1.3 Relationship to PSS standards.....	24
3.1.4 Relationship of ECSS standards to CCSDS standards.....	25
3.2 Standards covered in this handbook.....	25
3.3 ECSS E-50 Protocols.....	28
3.3.1 Physical Layer.....	30
3.3.2 Data Link Layer.....	30
3.3.3 Network Layer.....	31
3.3.4 Transport Layer.....	31
3.3.5 Application Layer.....	32
3.4 End to End Aspects.....	32
4 Standards overview	35
4.1 Introduction.....	35
4.2 E-ST-50: Communications.....	35
4.2.1 Purpose and usage.....	35

4.2.2	Description	35
4.2.3	Options	36
4.2.4	Recommended practice	36
4.3	E-ST-50-02: Ranging and Doppler tracking	37
4.3.1	Purpose and usage	37
4.3.2	Description	37
4.3.3	Options	38
4.3.4	Recommended practice	39
4.4	E-ST-50-05: Radio frequency and modulation	40
4.4.1	Purpose and usage	40
4.4.2	Description	40
4.4.3	Differences from CCSDS 401.0-B	41
4.4.4	Options	42
4.4.5	Recommended practice	42
4.5	E-ST-50-01: Telemetry synchronization and channel coding	45
4.5.1	Purpose and usage	45
4.5.2	Description	45
4.5.3	Differences from CCSDS 131.0-B-1	49
4.5.4	Options	50
4.5.5	Recommended practice	51
4.6	E-ST-50-03: Telemetry transfer frame protocol	52
4.6.1	Purpose and usage	52
4.6.2	Description	53
4.6.3	Differences from CCSDS 132.0-B-1	56
4.6.4	Options	58
4.6.5	Recommended practice	58
4.7	E-ST-50-04: Telecommand protocols, synchronization and channel coding	60
4.7.1	Introduction	60
4.7.2	Purpose and usage	60
4.7.3	Description	61
4.7.4	Differences from CCSDS recommendations	67
4.7.5	Options	73
4.7.6	Recommended practice	73
4.7.7	Telecommand decoder specification	74
4.8	CCSDS 732.0-B: AOS Space Data Link Protocol	75
4.8.1	Purpose and usage	75
4.8.2	Options	78

CEN/TR 17603-50:2022 (E)

4.8.3	Recommended practice	78
4.9	CCSDS Proximity-1 Space Link Protocol	80
4.9.1	Purpose and usage	80
4.9.2	Description	80
4.9.3	Options	82
4.9.4	Recommended practice	82
4.10	CCSDS Packet Protocols	84
4.10.1	Introduction	84
4.10.2	CCSDS 133.0-B: Space Packet Protocol	84
4.10.3	CCSDS 133.1-B: Encapsulation Service	87
4.11	Internet Protocols	88
4.11.1	Introduction	88
4.11.2	RFC 791: Internet Protocol Version 4	88
4.11.3	RFC 1883: Internet Protocol Version 6	89
4.12	E-ST-70-41: Telemetry and telecommand packet utilization	91
4.12.1	Purpose and usage	91
4.12.2	Description	91
4.12.3	Options	92
4.12.4	Recommended practice	92
4.13	CCSDS 727.0-B: CCSDS File Delivery Protocol (CFDP)	93
4.13.1	Purpose and usage	93
4.13.2	Description	94
4.13.3	Options	97
4.13.4	Recommended practice	97
4.14	CCSDS 135.0-B: Space Link Identifiers	99
4.14.1	Purpose and usage	99
4.14.2	Description	99
4.14.3	Options	102
4.14.4	Recommended practice	102
4.15	CCSDS 320.0-B: CCSDS Global Spacecraft Identification Field	103
4.15.1	Purpose and usage	103
4.15.2	Description	103
4.15.3	Options	103
4.15.4	Recommended practice	104
4.16	Data Compression	105
4.16.1	Purpose and usage	105
4.16.2	CCSDS 121.0-B: Lossless Data Compression	106

4.16.3	CCSDS 122.0-B: Image Data Compression	107
4.17	CCSDS 301.0-B: Time Code Formats	112
4.17.1	Purpose and usage	112
4.17.2	Description	112
4.17.3	Options	112
4.17.4	Recommended practice	112
4.18	E-ST-50-12: SpaceWire. Links, nodes, routers and networks	113
4.18.1	Purpose and usage	113
4.18.2	Description	113
4.18.3	Options	114
4.18.4	Recommended practice	114
4.19	E-ST-50-13: MIL 1553 Standard extension	115
4.19.1	Purpose and usage	115
4.19.2	Description	115
4.19.3	Recommended practice	115
4.20	E-ST-50-14: Spacecraft discrete interfaces.....	116
4.20.1	Purpose and usage	116
4.20.2	Description	116
4.20.3	Options	117
4.20.4	Recommended practice	118
5	Specific topics	119
5.1	Introduction.....	119
5.2	Synchronization and channel coding	119
5.2.1	Functions of synchronization and channel coding	119
5.2.2	Coding options	120
5.3	Playback of recorded data	123
5.3.1	Legacy systems with stored TM Transfer Frames	123
5.3.2	Systems with stored AOS Transfer Frames.....	123
5.3.3	Current systems	124
5.4	Idle data.....	124
5.4.1	Synchronous channel: TM and AOS	124
5.4.2	Asynchronous channel: TC and Proximity-1	127
5.5	Compression	127
5.6	Security	128
5.7	Interoperability	129
5.8	Conformance and PICS	130
6	Rationale and architectures.....	132

CEN/TR 17603-50:2022 (E)

6.1	Evolution of space communications standards	132
6.1.1	The beginning of CCSDS	132
6.1.2	Standards for TC and TM.....	133
6.1.3	Later standards: AOS, Proximity-1 and CFDP.....	133
6.1.4	New developments: DTN and SOIS	133
6.1.5	CCSDS and ECSS standards	135
6.2	Guidelines	135
7	Supporting components	137
7.1	Introduction.....	137
7.2	Flight components	137
7.3	Ground components	137
7.4	Industry.....	137
Annex A	(informative) Draft PICS for ECSS-E-ST-50-01: Sending end.....	138
A.1	Introduction to the PICS.....	138
A.1.1	Purpose	138
A.1.2	Format of the PICS	138
A.2	Identification	141
A.3	Channel coding.....	142
A.4	Convolutional code	143
A.5	Reed-Solomon code	144
A.6	Concatenation of Reed-Solomon code and convolutional code	145
A.7	Reed-Solomon code and 4D-8PSK-TCM.....	147
A.8	Turbo code	148
A.9	Uncoded	149
A.10	External items.....	150
Annex B	(informative) Draft PICS for ECSS-E-ST-50-01: Receiving end	151
B.1	Introduction to the PICS.....	151
B.1.1	Purpose	151
B.1.2	Format of the PICS	151
B.2	Identification	154
B.3	Channel coding.....	155
B.4	Convolutional code	156
B.5	Reed-Solomon code	158
B.6	Concatenation of Reed-Solomon code and convolutional code	159
B.7	Reed-Solomon code and 4D-8PSK-TCM.....	161
B.8	Turbo code	162

B.9	Uncoded	163
B.10	External items	164
Annex C (informative) Draft PICS for ECSS-E-ST-50-03: Sending end		165
C.1	Introduction to the PICS	165
C.1.1	Purpose	165
C.1.2	Format of the PICS	165
C.2	Identification	168
C.3	TM Transfer Frame format	169
C.3.1	General	169
C.3.2	Transfer Frame Primary Header	169
C.3.3	Transfer Frame Secondary Header	172
C.3.4	Transfer Frame Data Field	174
C.3.5	Operational Control Field	176
C.3.6	Frame Error Control Field	178
C.4	TM Transfer Frame length	179
C.5	Packet processing function	179
C.6	External items	181
Annex D (informative) Draft PICS for ECSS-E-ST-50-03: Receiving end		183
D.1	Introduction to the PICS	183
D.1.1	Purpose	183
D.1.2	Format of the PICS	183
D.2	Identification	186
D.3	TM Transfer Frame format	187
D.3.1	General	187
D.3.2	Transfer Frame Primary Header	187
D.3.3	Transfer Frame Secondary Header	189
D.3.4	Transfer Frame Data Field	191
D.3.5	Operational Control Field	193
D.3.6	Frame Error Control Field	194
D.4	TM Transfer Frame length	194
D.5	Packet extraction function	195
Annex E (informative) Draft PICS for ECSS-E-ST-50-04: Sending end		196
E.1	Introduction to the PICS	196
E.1.1	Purpose	196
E.1.2	Format of the PICS	196
E.2	Identification	199

CEN/TR 17603-50:2022 (E)

E.3	Supported layers and sublayers.....	200
E.4	Segmentation sublayer	201
E.4.1	Introduction	201
E.4.2	Elements of the segmentation sublayer.....	202
E.4.3	TC Segments	203
E.4.4	Segmentation.....	204
E.4.5	Blocking function on a virtual channel that carries TC Segments	205
E.4.6	Blocking function on a virtual channel that does not carry TC Segments.....	207
E.4.7	MAP multiplexing	208
E.4.8	Transfer notification.....	208
E.5	Transfer sublayer.....	209
E.5.1	Introduction	209
E.5.2	Elements of the transfer sublayer	209
E.5.3	TC Transfer Frame data structure	210
E.5.4	CLCW data structure.....	211
E.5.5	Sending end of COP-1 protocol, FOP-1	212
E.5.6	Procedures below FOP-1	213
E.5.7	Virtual channel multiplexing.....	214
E.6	Synchronization and channel coding sublayer	215
E.6.1	Introduction	215
E.6.2	Elements of the synchronization and channel coding sublayer.....	215
E.6.3	CLTU and BCH codeblock	216
E.6.4	Pseudo-randomization procedure	218
E.6.5	BCH encoding procedure	218
E.6.6	Handling of Abort request from FOP-1	219
E.7	Physical layer	220
E.7.1	Introduction	220
E.7.2	Elements of the physical layer.....	221
E.7.3	Data structures.....	222
E.7.4	Carrier Modulation Modes.....	223
E.7.5	PLOP-2.....	224
E.7.6	PLOP-1	224
E.7.7	Handling of Abort request from FOP-1	225
Annex F (informative) Draft PICS for ECSS-E-ST-50-04: Receiving end		226
F.1	Introduction to the PICS.....	226
F.1.1	Purpose	226

F.1.2	Format of the PICS	226
F.2	Identification	229
F.3	Supported layers and sublayers.....	230
F.4	Segmentation sublayer	231
F.4.1	Introduction	231
F.4.2	Elements of the segmentation sublayer.....	232
F.4.3	TC Segments	233
F.4.4	MAP demultiplexing	234
F.4.5	Reassembly function.....	235
F.4.6	Deblocking function on a virtual channel that carries TC Segments	237
F.4.7	Deblocking function on a virtual channel that does not carry TC Segments.....	238
F.5	Transfer sublayer.....	239
F.5.1	Introduction	239
F.5.2	Elements of the transfer sublayer	239
F.5.3	TC Transfer Frame data structure	240
F.5.4	CLCW data structure.....	241
F.5.5	Procedures to process a candidate frame	241
F.5.6	Virtual channel demultiplexing	242
F.5.7	FARM-1 (receiving end of COP-1 protocol).....	243
F.6	Synchronization and channel coding sublayer	244
F.6.1	Introduction	244
F.6.2	Elements of synchronization and channel coding sublayer.....	244
F.6.3	CLTU and BCH codeblock	245
F.6.4	Receiving-end channel logic	246
F.6.5	BCH decoding procedure	246
F.6.6	Pseudo-derandomization procedure	247
F.7	Physical layer	248
Annex G (informative) False decoding probabilities for concatenated R-S E=8 with 4D-8PSK-TCM.....		249
G.1	Introduction.....	249
G.2	False decoding probabilities	249
References		253
Figures		
Figure 2-1: Bit numbering convention		19
Figure 3-1: ECSS E-50 standards and associated layers		29

CEN/TR 17603-50:2022 (E)

Figure 3-2: Some options for combining the protocols	30
Figure 3-3: Simplified end-to-end communication system.....	33
Figure 3-4: End-to-end system with example protocol stacks	33
Figure 3-5: Store and forward system with example protocol stacks.....	34
Figure 4-1: Ranging and Doppler tracking - Functional block diagram.....	38
Figure 4-2: Cryosat-2 S-band TT&C subsystem	44
Figure 4-3: Format of channel access data unit (CADU).....	46
Figure 4-4: Coding, randomization and synchronization configurations (1).....	47
Figure 4-5: Coding, randomization and synchronization configurations (2).....	48
Figure 4-6: TM Transfer Frame	53
Figure 4-7: TM Transfer Frame Primary Header.....	56
Figure 4-8: Layers and sublayers in ECSS-E-ST-50-04.....	61
Figure 4-9: Telecommand layers, sublayers and data units.....	61
Figure 4-10: TC Transfer Frame.....	65
Figure 4-11: AOS Transfer Frame	76
Figure 4-12: AOS Transfer Frame Primary Header	76
Figure 4-13: Relationships between channels of the Space Data Link Protocols	100
Figure 4-14: Functional parts of the compressor.....	108
Figure 4-15: Architectural context of interfaces defined in ECSS-E-ST-50-14	117
Figure 6-1: SOIS overall architecture.....	134
https://standards.iteh.ai/catalog/standards/sist/447d69a7-38c1-4b6e-b562-17603-50-2022	
Figure G-1 : WER (byte) Performance Comparison.....	251
Figure G-2 : For 4D-8PSK-TCM 2 b/s/Hz + RS(254,238), I=8	251
Figure G-3 : For 4D-8PSK-TCM 2.5 b/s/Hz + RS(254,238), I=8	252

Tables

Table 3-1: ECSS E-ST-50 standards covered in this handbook.....	26
Table 3-2: Other standards covered in this handbook	27
Table 3-3: Standards for the TM, TC and AOS Space Data Link Protocols	27
Table 4-1: Options for Ranging and Doppler tracking	39
Table 4-2: Interpretation of Bypass Flag and Control Command Flag.....	65
Table 4-3: Name correspondence between CCSDS and ECSS-E-ST-50-04.....	71
Table 4-4: Some differences between AOS and TM transfer frames	77
Table 4-5: CFDP best practice for options and parameters	83
Table 4-6: Some of the identifiers covered by CCSDS 135.0-B.....	99
Table 4-7: Space link addressing	101
Table 4-8: Space network addressing	102

Table 5-1 Functions of synchronization and channel coding standards	120
Table 5-2: Coding gains and bandwidth expansions.....	121
Table 5-3: Idle data in a TM Transfer Frame	125
Table 5-4 Idle data in an AOS Transfer Frame	125
Table 5-5: Draft PICS proforma included in the annexes	131
Table 6-1: Applicability of standards for space link	135
Table 6-2: Applicability of standards for Network / Transport / Application layers	136
Table 6-3: Applicability of standards for management	136
Table 6-4: Applicability of standards for onboard	136
Table A-1 : Symbols for item status	139
Table A-2 : Labelled boxes for support	139
Table A-3 : PICS identification.....	141
Table A-4 : Supported channel codes.....	142
Table A-5 : Items for convolutional code.....	143
Table A-6 : Items for Reed-Solomon code.....	144
Table A-7 : Items for concatenated R-S and convolutional code.....	146
Table A-8 : Items for Reed-Solomon code and 4D-8PSK-TCM	147
Table A-9 : Items for turbo code	148
Table A-10 : Items when no channel coding is used	149
Table A-11 : External items	150
Table B-1 : Symbols for item status	152
Table B-2 : Labelled boxes for support	152
Table B-3 : PICS identification.....	154
Table B-4 : Supported channel codes.....	155
Table B-5 : Items for convolutional code.....	157
Table B-6 : Items for Reed-Solomon code.....	158
Table B-7 : Items for concatenated R-S and convolutional code.....	159
Table B-8 : Items for Reed-Solomon code and 4D-8PSK-TCM	161
Table B-9 : Items for turbo code	162
Table B-10 : Items when no channel coding is used	163
Table B-11 : External items	164
Table C-1 : Symbols for item status.....	166
Table C-2 : Labelled boxes for support.....	166
Table C-3 : PICS identification.....	168
Table C-4 : Major fields in TM Transfer Frame	169
Table C-5 : Items for Transfer Frame Primary Header.....	169

CEN/TR 17603-50:2022 (E)

Table C-6 : Items for Transfer Frame Primary Header when Synchronization Flag = '0'	171
Table C-7 : Items for frames with Transfer Frame Secondary Header	173
Table C-8 : Items for frames with extended virtual channel frame count	174
Table C-9 : Items for Transfer Frame Data Field	174
Table C-10 : Items for frames with asynchronously inserted data as specified in clause 5.4.4	175
Table C-11 : Items for frames with Operational Control Field	177
Table C-12 : Items for frames with Frame Error Control Field	178
Table C-13 : Items for the length of the TM Transfer Frame	179
Table C-14 : Items for packet processing function	180
Table C-15 : External items	181
Table D-1 : Symbols for item status	184
Table D-2 : Labelled boxes for support	184
Table D-3 : PICS identification	186
Table D-4 : Major fields in TM Transfer Frame	187
Table D-5 : Items for Transfer Frame Primary Header	188
Table D-6 : Items for Transfer Frame Primary Header when Synchronization Flag = '0'	189
Table D-7 : Items for frames with Transfer Frame Secondary Header	190
Table D-8 : Items for frames with extended virtual channel frame count	190
Table D-9 : Items for Transfer Frame Data Field	191
Table D-10 : Items for frames with asynchronously inserted data as specified in clause 5.4.4	192
Table D-11 : Items for frames with Operational Control Field	193
Table D-12 : Items for frames with Frame Error Control Field	194
Table D-13 : Items for the length of the TM Transfer Frame	194
Table D-14 : Items for packet extraction function	195
Table E-1 : Symbols for item status	197
Table E-2 : Labelled boxes for support	197
Table E-3 : PICS identification	199
Table E-4 : Layers and sublayers supported	200
Table E-5 : Main items for segmentation sublayer	202
Table E-6 : Items for TC Segment data structure	203
Table E-7 : Items for segmenting function	204
Table E-8 : Items for packet assembly controller (PAC)	205
Table E-9 : Items for blocking function on a MAP	206
Table E-10 : Items for blocking function on a virtual channel	207
Table E-11 : Items for MAP multiplexing	208
Table E-12 : Items for transfer notification	208

Table E-13 : Main items for transfer sublayer	209
Table E-14 : Items for TC Transfer Frame	210
Table E-15 : Items for CLCW	211
Table E-16 : Items for FOP-1	212
Table E-17 : Items for management of FOP-1	213
Table E-18 : Items for procedures below FOP-1	214
Table E-19 : Items for virtual channel multiplexing	214
Table E-20 : Main items for synchronization and channel coding sublayer functions	215
Table E-21 : Items for Command Link Transmission Unit (CLTU)	216
Table E-22 : Items for BCH codeblocks of a CLTU	217
Table E-23 : Items for pseudo-randomization procedure	218
Table E-24 : Items for BCH encoding procedure	219
Table E-25 : Items for Abort request	219
Table E-26 : Main items for physical layer	221
Table E-27 : Items for acquisition sequence and idle sequence	222
Table E-28 : Items for Command Link Transmission Unit (CLTU)	222
Table E-29 : Items for Carrier Modulation Modes (CMMs)	223
Table E-30 : Items for PLOP-2	224
Table E-31 : Items for PLOP-1	224
Table E-32 : Items for Abort request	225
Table F-1 : Symbols for item status	227
Table F-2 : Labelled boxes for support	227
Table F-3 : PICS identification	229
Table F-4 : Layers and sublayers supported	230
Table F-5 : Main items for segmentation sublayer	232
Table F-6 : Items for TC Segment data structure	233
Table F-7 : Items for MAP demultiplexing	234
Table F-8 : Items for reassembly function	235
Table F-9 : Items for packet assembly controller (PAC)	236
Table F-10 : Items for deblocking function on a MAP	237
Table F-11 : Items for deblocking function on a virtual channel	238
Table F-12 : Main items for transfer sublayer	239
Table F-13 : Items for TC Transfer Frame	240
Table F-14 : Items for CLCW	241
Table F-15 : Items for procedures to process a candidate frame	242
Table F-16 : Items for virtual channel demultiplexing	242
Table F-17 : Items for FARM-1	243