

<b>STN</b>	<b>Kozmická technika. Dátové linky v kozmickom programe. Protokoly, synchronizácia a kódovanie kanálov na diaľkové ovládanie.</b>	<b>STN EN 16603-50-04</b>  31 0543
------------	---	--

Space engineering - Space data links - Telecommand protocols, synchronization and channel coding

Táto norma obsahuje anglickú verziu európskej normy.  
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 01/15

Obsahuje: EN 16603-50-04:2014

**120153**

---

Úrad pre normalizáciu, metrológiu a skúšobníctvo SR, odbor SÚTN, 2015  
Podľa zákona č. 264/1999 Z. z. v znení neskorších predpisov sa môžu slovenské technické normy rozmnožovať a rozširovať iba so súhlasom Úradu pre normalizáciu, metrológiu a skúšobníctvo SR.

---

ICS 33.040.40; 49.090; 49.140

English version

## Space engineering - Space data links - Telecommand protocols, synchronization and channel coding

Ingénierie spatiale - Liaisons de données spatiales -  
Protocoles, synchronisation et codage canal des liaisons  
télécommande

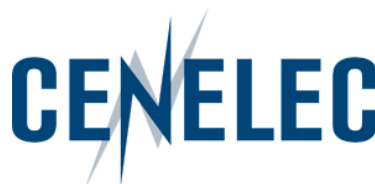
Raumfahrttechnik - Telekommando-Protokolle, -  
synchronisation und -kanalkodierung

This European Standard was approved by CEN on 25 April 2014.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN and CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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



**CEN-CENELEC Management Centre:  
Avenue Marnix 17, B-1000 Brussels**

# Table of contents

---

<b>Foreword .....</b>	<b>10</b>
<b>1 Scope.....</b>	<b>11</b>
<b>2 Normative references .....</b>	<b>12</b>
<b>3 Terms, definitions and abbreviated terms.....</b>	<b>13</b>
3.1 Terms from other standards.....	13
3.2 Terms specific to the present standard .....	13
3.3 Abbreviated terms.....	14
3.4 Conventions.....	15
3.4.1 Bit 0, bit 1, bit N-1.....	15
3.4.2 Most significant bit.....	15
3.4.3 Use of capitals for the names of data structures and fields.....	15
<b>4 Overview.....</b>	<b>16</b>
4.1 Presentation .....	16
4.2 Protocol profiles.....	16
4.3 Segmentation sublayer .....	17
4.4 Transfer sublayer.....	18
4.5 Synchronization and channel coding sublayer .....	18
4.6 Physical layer .....	18
4.7 Virtual channels .....	19
<b>5 Segmentation sublayer .....</b>	<b>20</b>
5.1 Overview .....	20
5.2 TC Segment .....	21
5.2.1 General.....	21
5.2.2 Segment Header.....	22
5.2.3 Segment Data Field .....	23
5.3 Transfer notification .....	23
5.3.1 Overview.....	23
5.3.2 Requirements.....	24
5.4 Blocking of packets.....	25

5.4.1	Overview .....	25
5.4.2	Virtual channels where TC Segments are used.....	25
5.4.3	Virtual channels where TC Segments are not used.....	26
5.4.4	Packet properties .....	26
5.4.5	Blocking function .....	27
5.4.6	Deblocking function.....	27
5.5	Segmentation .....	27
5.5.1	Overview.....	27
5.5.2	Segmenting function .....	28
5.5.3	Reassembly function.....	28
5.5.4	Packet assembly controller .....	29
5.6	MAP multiplexing .....	32
<b>6</b>	<b>Transfer sublayer .....</b>	<b>33</b>
6.1	Overview .....	33
6.1.1	Data structures in the transfer sublayer.....	33
6.1.2	Procedures in the transfer sublayer.....	33
6.2	TC Transfer Frame definition .....	35
6.2.1	General.....	35
6.2.2	Transfer Frame Primary Header.....	36
6.2.3	Transfer Frame Data Field .....	40
6.2.4	Frame Error Control Field.....	41
6.3	CLCW definition.....	43
6.3.1	General.....	43
6.3.2	Control Word Type .....	45
6.3.3	CLCW Version Number.....	45
6.3.4	Status Field .....	45
6.3.5	COP in Effect .....	45
6.3.6	Virtual Channel Identification.....	45
6.3.7	Reserved Spare .....	46
6.3.8	No RF Available Flag .....	46
6.3.9	No Bit Lock Flag.....	47
6.3.10	Lockout Flag .....	47
6.3.11	Wait Flag.....	48
6.3.12	Retransmit Flag.....	48
6.3.13	FARM-B Counter .....	48
6.3.14	Reserved Spare .....	48
6.3.15	Report Value .....	49

**EN 16603-50-04:2014 (E)**

6.4	Frame header procedure .....	49
6.5	Frame error control procedure at the sending end .....	49
6.6	Frame delimiting and fill removal procedure.....	49
6.6.1	Overview.....	49
6.6.2	Actions .....	50
6.7	Frame error control procedure at the receiving end .....	50
6.8	Frame header validation procedure .....	50
6.8.1	Overview.....	50
6.8.2	Actions .....	51
6.9	Virtual channel multiplexing .....	51
6.9.1	Overview.....	51
6.9.2	Multiplexing mechanism.....	52
6.9.3	Demultiplexing .....	52
<b>7</b>	<b>COP-1.....</b>	<b>53</b>
7.1	Overview .....	53
7.1.1	Scope.....	53
7.1.2	Interfaces .....	53
7.1.3	Retransmission protocol.....	53
7.1.4	Frames.....	54
7.1.5	Services .....	54
7.1.6	Protocol machine .....	56
7.2	Internal variables .....	56
7.2.1	Overview.....	56
7.2.2	FOP-1 Variables .....	57
7.2.3	FARM-1 variables .....	64
7.3	Features of COP-1 interfaces .....	69
7.3.1	Overview.....	69
7.3.2	Parameters .....	70
7.4	Upper interface of COP-1 at the sending end .....	70
7.4.1	Overview.....	70
7.4.2	Sequence-controlled service management interface .....	71
7.4.3	Sequence-controlled service data transfer interface.....	77
7.4.4	Expedited service data transfer interface .....	80
7.5	Upper interface of COP-1 at the receiving end.....	82
7.5.1	Overview.....	82
7.5.2	Buffer management mechanism.....	82
7.5.3	The wait system .....	82

7.5.4	Single back-end buffer .....	83
7.5.5	FDU Arrived Indication .....	84
7.6	Lower interface of COP-1 at the sending end .....	84
7.6.1	Overview .....	84
7.6.2	Transmit Request for Frame signal .....	85
7.6.3	Abort request signal .....	85
7.6.4	Response signal .....	86
7.7	Lower interface of COP-1 at the receiving end.....	86
7.7.1	Overview .....	86
7.7.2	Valid Frame Arrived Indication .....	87
7.8	Format of COP-1 control commands .....	87
7.8.1	Overview .....	87
7.8.2	General .....	87
7.8.3	Unlock.....	87
7.8.4	Set V(R).....	88
7.9	Actions.....	88
7.9.1	Format of the state tables.....	88
7.9.2	FOP-1 .....	89
7.9.3	FARM-1 .....	96
<b>8</b>	<b>Synchronization and channel coding sublayer .....</b>	<b>111</b>
8.1	Overview .....	111
8.2	BCH codeblock.....	111
8.2.1	General.....	111
8.2.2	Information.....	112
8.2.3	Error Control .....	112
8.3	Communications link transmission unit (CLTU).....	113
8.3.1	General.....	113
8.3.2	Start Sequence .....	113
8.3.3	Encoded Data .....	114
8.3.4	Tail Sequence .....	114
8.4	Randomization procedure.....	115
8.4.1	Overview.....	115
8.4.2	General.....	115
8.4.3	Random sequence.....	115
8.4.4	Application of the randomizer .....	116
8.5	BCH codeblock encoding procedure.....	116
8.6	Fill bits .....	117

**EN 16603-50-04:2014 (E)**

8.6.1	Overview.....	117
8.6.2	General.....	117
8.7	Channel logic at the receiving end.....	118
8.8	BCH codeblock decoding procedures.....	119
8.8.1	Overview.....	119
8.8.2	General.....	120
<b>9</b>	<b>Physical layer.....</b>	<b>121</b>
9.1	Overview.....	121
9.2	Physical layer data structures.....	121
9.2.1	Acquisition sequence.....	121
9.2.2	CLTU.....	122
9.2.3	Idle sequence.....	122
9.3	Physical layer procedures.....	122
9.3.1	Overview.....	122
9.3.2	Carrier modulation modes.....	122
9.3.3	Telecommand session.....	124
9.3.4	Physical layer operation procedure (PLOP).....	124
<b>Annex A</b>	<b>(informative) Frame error control.....</b>	<b>127</b>
A.1	Overview.....	127
A.2	Encoding.....	127
A.3	Decoding.....	128
<b>Annex B</b>	<b>(informative) Changes from ESA-PSS-04-107.....</b>	<b>129</b>
B.1	Overview.....	129
B.2	Technical changes.....	129
<b>Annex C</b>	<b>(informative) Differences from CCSDS recommendations.....</b>	<b>132</b>
C.1	Overview.....	132
C.2	Differences.....	132
<b>Annex D</b>	<b>(informative) Performance issues.....</b>	<b>135</b>
D.1	Introduction.....	135
D.2	Performance components.....	136
D.3	Factors affecting frame rejection rate.....	136
D.3.1	Bit synchronization factor.....	136
D.3.2	CLTU Start Sequence factors.....	137
D.3.3	BCH Codeblock Factor.....	138
D.3.4	Tail Sequence factor.....	140

D.3.5	Frames and CLTUs.....	141
D.4	Factors affecting frame undetected error rate .....	143
<b>Annex E (informative) Mission configuration parameters .....</b>		<b>147</b>
E.1	Introduction.....	147
E.2	Parameters of a physical channel .....	147
E.2.1	Overview.....	147
E.2.2	Fixed parameters .....	147
E.2.3	Length of the acquisition sequence .....	147
E.2.4	Physical layer operation procedure .....	148
E.2.5	Transfer Frame Version Number.....	148
E.2.6	Maximum length of a TC Transfer Frame.....	148
E.2.7	Virtual channels .....	148
E.2.8	Use of the expedited service .....	148
E.2.9	Multiplexing parameters .....	148
E.3	Parameters of a virtual channel .....	149
E.3.1	Overview.....	149
E.3.2	Spacecraft Identifier and Virtual Channel Identifier.....	149
E.3.3	Maximum length of a TC Transfer Frame.....	149
E.3.4	FOP-1 parameters .....	149
E.3.5	CLCW reporting rate .....	149
E.3.6	Status Field of CLCW.....	149
E.3.7	Fixed parameters .....	149
E.3.8	FARM-1 sliding window parameters.....	150
E.3.9	Use of TC Segments.....	150
E.3.10	Parameters of a virtual channel with TC Segments .....	150
E.3.11	Parameters of a virtual channel without TC Segments .....	150
E.4	Parameters of a MAP .....	151
E.4.1	Overview.....	151
E.4.2	MAP Identifier .....	151
E.4.3	Use of the blocking function .....	151
E.4.4	Segmentation function .....	151
E.5	Parameters for packet types .....	152
E.5.1	Overview.....	152
E.5.2	Valid packet version numbers .....	152
<b>Bibliography.....</b>		<b>153</b>



**Figures**

Figure 3-1: numbering convention .....	15
Figure 4-1: Layers and sublayers specified in this Standard .....	17
Figure 5-1: TC Segment .....	21
Figure 5-2: Example of blocking of packets .....	25
Figure 5-3: Example of segmentation of a user data unit .....	28
Figure 6-1: TC Transfer Frame format .....	36
Figure 6-2: Format of a CLCW .....	44
Figure 7-1: COP-1 sequence variables .....	55
Figure 7-2: FARM sliding window concept .....	67
Figure 7-3: State table format .....	89
Figure 7-4: Actions for look for directive .....	94
Figure 7-5: Actions for look for FDU .....	95
Figure 7-6: FOP-1 state transitions for main protocol .....	105
Figure 7-7: FOP-1 state transitions for initialisation protocol .....	106
Figure 7-8: FOP-1 state transitions .....	107
Figure 7-9: FARM-1 state transitions .....	110
Figure 8-1: BCH codeblock format .....	112
Figure 8-2: Format of a CLTU .....	113
Figure 8-3: Bit pattern of the Start Sequence .....	113
Figure 8-4: Bit transition generator logic diagram .....	116
Figure 8-5: (63,56) Modified BCH code generator .....	117
Figure 8-6: State diagram for the channel (receiving end) .....	119
Figure 9-1: Sequence of CMMs comprising PLOP-2 .....	125
Figure 9-2: Sequence of CMMs comprising PLOP-1 .....	126
Figure A-1 : Encoder .....	127
Figure A-2 : Decoder .....	128
Figure D-1 : Frame rejection probability, $P_{FY}$ , in SEC mode using PLOP-2 .....	143
Figure D-2 : Probability of undetected error in a frame in SEC mode .....	146

**Tables**

Table 6-1: Sending-end procedures in the transfer sublayer .....	34
Table 6-2: Receiving-end procedures in the transfer sublayer .....	35
Table 6-3: Combined Bypass Flag and Control Command Flag .....	38
Table 6-4: Fields in a CLCW .....	43
Table 7-1: COP-1 interfaces .....	70

Table 7-2: Signals for management interface .....	71
Table 7-3: FOP-1 directive types and qualifiers .....	73
Table 7-4: Reasons for an Alert notification .....	75
Table 7-5: Signals for sequence-controlled service data transfer interface .....	78
Table 7-6: Signals for expedited service data transfer interface.....	80
Table 7-7: Signals for the interface of FOP-1 to the lower procedures.....	84
Table 7-8: FOP-1 state table .....	98
Table 7-9: FARM-1 state table.....	108
Table 8-1: Channel states (receiving end) .....	118
Table 8-2: Channel events (receiving end) .....	119
Table 9-1: Carrier modulation modes .....	123
Table B-1 : Field name differences from ESA-PSS-04-107 .....	131
Table B-2 : Names with “Communications” or “Command” .....	131
Table C-1 : Name differences from CCSDS recommendations .....	134
Table D-1 : Probability of not recognizing the Start Sequence .....	138
Table D-2 : Meaning of decoding values .....	138
Table D-3 : Decoding cases in SEC mode.....	138
Table D-4 : Probability of codeblock rejection for a CLTU during decoding in SEC mode...	140
Table D-5 : Parity and Syndrome when Tail Sequence has errors.....	141
Table D-6 : Probability of missing the Tail Sequence.....	141
Table D-7 : Frame rejection probability, $P_{FY}$ (PLOP-2).....	142
Table D-8 : Sources of undetected errors (SEC mode).....	143
Table D-9 : Probability of $n$ errors occurring in a codeblock.....	144
Table D-10 : Error detection performance when decoding a codeblock in SEC mode .....	144
Table D-11 : Probability of undetected error in a frame, SEC mode, with CRC .....	145

## Foreword

---

This document (EN 16603-50-04:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-50-04:2014) originates from ECSS-E-ST-50-04C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2015, and conflicting national standards shall be withdrawn at the latest by March 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# 1 Scope

---

This Standard specifies the data structures and protocols for a telecommand space data link and the procedure for physical layer operation.

Usually, the source of data on a telecommand space data link is located on the ground and the receiver is located in space. However, the Standard may also be used for space-to-space telecommand data links.

Further provisions and guidance on the application of this standard can be found, respectively, in the following documents:

- The higher level standard ECSS-E-ST-50 “Communications”, which defines the principle characteristics of communication protocols and related services for all communication layers relevant for space communication (physical- to application-layer), and their basic relationship to each other.
- The handbook ECSS-E-HB-50 “Communications guidelines”, which provides information about specific implementation characteristics of these protocols in order to support the choice of a certain communications profile for the specific requirements of a space mission.

Users of this present standard are invited to consult these documents before taking decisions on the implementation of the present one.

This standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

**2****Normative references**

---

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications, do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

<b>EN reference</b>	<b>Reference in text</b>	<b>Title</b>
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system - Glossary of terms
	CCSDS 135.0-B-3 Issue 3, October 2006	Space Link Identifiers – Blue Book

**koniec náhľadu – text ďalej pokračuje v platenej verzii STN**