



**Universal Mobile Telecommunications System (UMTS);
LTE;
Codec for Enhanced Voice Services (EVS);
Detailed algorithmic description
(3GPP TS 26.445 version 12.17.0 Release 12)**



Reference

RTS/TSGS-0426445vch0

Keywords

5G,LTE,UMTS

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Important notice

The present document can be downloaded from the
[ETSI Search & Browse Standards](#) application.

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the prevailing version of an ETSI deliverable is the one made publicly available in PDF format on [ETSI deliver](#) repository.

Users should be aware that the present document may be revised or have its status changed, this information is available in the [Milestones listing](#).

If you find errors in the present document, please send your comments to the relevant service listed under [Committee Support Staff](#).

If you find a security vulnerability in the present document, please report it through our [Coordinated Vulnerability Disclosure \(CVD\)](#) program.

Notice of disclaimer & limitation of liability

The information provided in the present deliverable is directed solely to professionals who have the appropriate degree of experience to understand and interpret its content in accordance with generally accepted engineering or other professional standard and applicable regulations.

No recommendation as to products and services or vendors is made or should be implied.

No representation or warranty is made that this deliverable is technically accurate or sufficient or conforms to any law and/or governmental rule and/or regulation and further, no representation or warranty is made of merchantability or fitness for any particular purpose or against infringement of intellectual property rights.

In no event shall ETSI be held liable for loss of profits or any other incidental or consequential damages.

Any software contained in this deliverable is provided "AS IS" with no warranties, express or implied, including but not limited to, the warranties of merchantability, fitness for a particular purpose and non-infringement of intellectual property rights and ETSI shall not be held liable in any event for any damages whatsoever (including, without limitation, damages for loss of profits, business interruption, loss of information, or any other pecuniary loss) arising out of or related to the use of or inability to use the software.

Copyright Notification

No part may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm except as authorized by written permission of ETSI.

The content of the PDF version shall not be modified without the written authorization of ETSI.

The copyright and the foregoing restriction extend to reproduction in all media.

© ETSI 2026.
All rights reserved.

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: "*Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards*", which is available from the ETSI Secretariat. Latest updates are available on the [ETSI IPR online database](#).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™**, **LTE™** and **5G™** logo are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM®** and the GSM logo are trademarks registered and owned by the GSM Association.

Legal Notice

This Technical Specification (TS) has been produced by ETSI 3rd Generation Partnership Project (3GPP).

The present document may refer to technical specifications or reports using their 3GPP identities. These shall be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between 3GPP and ETSI identities can be found at [3GPP to ETSI numbering cross-referencing](#).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Contents

Intellectual Property Rights	2
Legal Notice	2
Modal verbs terminology.....	2
Foreword.....	14
1 Scope	14
2 References	14
3 Definitions, abbreviations and mathematical expressions.....	16
3.1 Definitions	16
3.2 Abbreviations	17
3.3 Mathematical Expressions.....	18
4 General description of the coder	19
4.1 Introduction	19
4.2 Input/output sampling rate.....	19
4.3 Codec delay	20
4.4 Coder overview	20
4.4.1 Encoder overview	20
4.4.1.1 Linear Prediction Based Operation	21
4.4.1.2 Frequency Domain Operation	22
4.4.1.3 Inactive Signal coding.....	22
4.4.1.4 Source Controlled VBR Coding.....	23
4.4.2 Decoder overview	23
4.4.2.1 Parametric Signal Representation Decoding (Bandwidth Extension)	23
4.4.2.2 Frame loss concealment	23
4.4.3 DTX/CNG operation.....	23
4.4.3.1 Inactive Signal coding.....	24
4.4.4 AMR-WB-interoperable option	24
4.4.5 Channel-Aware Mode.....	24
4.5 Organization of the rest of the Technical Standard	24
5 Functional description of the encoder	25
5.1 Common processing	25
5.1.1 High-pass Filtering	25
5.1.2 Complex low-delay filter bank analysis.....	25
5.1.2.1 Sub-band analysis	25
5.1.2.2 Sub-band energy estimation	26
5.1.3 Sample rate conversion to 12.8 kHz	27
5.1.3.1 Conversion of 16, 32 and 48 kHz signals to 12.8 kHz	27
5.1.3.2 Conversion of 8 kHz signals to 12.8 kHz.....	27
5.1.3.3 Conversion of input signals to 16, 25.6 and 32 kHz	29
5.1.4 Pre-emphasis.....	29
5.1.5 Spectral analysis	30
5.1.5.1 Windowing and DFT.....	30
5.1.5.2 Energy calculations	31
5.1.6 Bandwidth detection	32
5.1.6.1 Mean and maximum energy values per band.....	32
5.1.7 Bandwidth decision.....	34
5.1.8 Time-domain transient detection	37
5.1.9 Linear prediction analysis.....	38
5.1.9.1 LP analysis window	38
5.1.9.2 Autocorrelation computation.....	38
5.1.9.3 Adaptive lag windowing	38
5.1.9.4 Levinson-Durbin algorithm.....	39
5.1.9.5 Conversion of LP coefficients to LSP parameters	40
5.1.9.6 LSP interpolation	41

5.1.9.7	Conversion of LSP parameters to LP coefficients	41
5.1.9.8	LP analysis at 16kHz.....	42
5.1.10	Open-loop pitch analysis	43
5.1.10.1	Perceptual weighting	43
5.1.10.2	Correlation function computation	44
5.1.10.3	Correlation reinforcement with past pitch values.....	44
5.1.10.4	Normalized correlation computation.....	45
5.1.10.5	Correlation reinforcement with pitch lag multiples.....	46
5.1.10.6	Initial pitch lag determination and reinforcement based on pitch coherence with other half-frames.....	47
5.1.10.7	Pitch lag determination and parameter update	47
5.1.10.8	Correction of very short and stable open-loop pitch estimates	48
5.1.10.9	Fractional open-loop pitch estimate for each subframe.....	50
5.1.11	Background noise energy estimation	51
5.1.11.1	First stage of noise energy update	51
5.1.11.2	Second stage of noise energy update.....	53
5.1.11.2.1	Basic parameters for noise energy update	54
5.1.11.2.2	Spectral diversity	54
5.1.11.2.3	Complementary non-stationarity	55
5.1.11.2.4	HF energy content	55
5.1.11.2.5	Tonal stability.....	56
5.1.11.2.6	High frequency dynamic range.....	59
5.1.11.2.7	Combined decision for background noise energy update	59
5.1.11.3	Energy-based parameters for noise energy update	61
5.1.11.3.1	Closeness to current background estimate.....	61
5.1.11.3.2	Features related to last correlation or harmonic event	61
5.1.11.3.3	Energy-based pause detection	62
5.1.11.3.4	Long-term linear prediction efficiency	62
5.1.11.3.5	Additional long-term parameters used for noise estimation	63
5.1.11.4	Decision logic for noise energy update	64
5.1.12	Signal activity detection.....	67
5.1.12.1	SAD1 module.....	68
5.1.12.1.1	SNR outlier filtering	70
5.1.12.2	SAD2 module.....	71
5.1.12.3	Combined decision of SAD1 and SAD2 modules for WB and SWB signals	74
5.1.12.4	Final decision of the SAD1 module for NB signals	74
5.1.12.5	Post-decision parameter update.....	75
5.1.12.6	SAD3 module.....	76
5.1.12.6.1	Sub-band FFT.....	76
5.1.12.6.2	Computation of signal features.....	77
5.1.12.6.3	Computation of SNR parameters.....	80
5.1.12.6.4	Decision of background music	82
5.1.12.6.5	Decision of background update flag.....	82
5.1.12.6.6	SAD3 Pre-decision	83
5.1.12.6.7	SAD3 Hangover	85
5.1.12.7	Final SAD decision	85
5.1.12.8	DTX hangover addition.....	87
5.1.13	Coding mode determination.....	89
5.1.13.1	Unvoiced signal classification.....	90
5.1.13.1.1	Voicing measure	91
5.1.13.1.2	Spectral tilt	91
5.1.13.1.3	Sudden energy increase from a low energy level	92
5.1.13.1.4	Total frame energy difference	93
5.1.13.1.5	Energy decrease after spike	93
5.1.13.1.6	Decision about UC mode.....	94
5.1.13.2	Stable voiced signal classification.....	95
5.1.13.3	Signal classification for FEC.....	95
5.1.13.3.1	Signal classes for FEC.....	96
5.1.13.3.2	Signal classification parameters	96
5.1.13.3.3	Classification procedure	97
5.1.13.4	Transient signal classification	98
5.1.13.5	Modification of coding mode in special cases	99

5.1.13.6	Speech/music classification.....	100
5.1.13.6.1	First stage of the speech/music classifier.....	100
5.1.13.6.2	Scaling of features in the first stage of the speech/music classifier.....	102
5.1.13.6.3	Log-probability and decision smoothing.....	103
5.1.13.6.4	State machine and final speech/music decision.....	104
5.1.13.6.5	Improvement of the classification for mixed and music content.....	107
5.1.13.6.6	Second stage of the speech/music classifier.....	111
5.1.13.6.7	Context-based improvement of the classification for stable tonal signals.....	113
5.1.13.6.8	Detection of sparse spectral content.....	117
5.1.13.6.9	Decision about AC mode.....	119
5.1.13.6.10	Decision about IC mode.....	119
5.1.14	Coder technology selection.....	119
5.1.14.1	ACELP/MDCT-based technology selection at 9.6kbps, 16.4 and 24.4 kbps.....	120
5.1.14.1.1	Segmental SNR estimation of the MDCT-based technology.....	120
5.1.14.1.2	Segmental SNR estimation of the ACELP technology.....	126
5.1.14.1.3	Hysteresis and final decision.....	127
5.1.14.2	TCX/HQ MDCT technology selection at 13.2 and 16.4 kbps.....	128
5.1.14.3	TCX/HQ MDCT technology selection at 24.4 and 32 kbps.....	130
5.1.14.4	TD/Multi-mode FD BWE technology selection at 13.2 kbps and 32 kbps.....	133
5.2	LP-based Coding.....	134
5.2.1	Perceptual weighting.....	134
5.2.2	LP filter coding and interpolation.....	135
5.2.2.1	LSF quantization.....	135
5.2.2.1.1	LSF weighting function.....	135
5.2.2.1.2	Bit allocation.....	138
5.2.2.1.3	Predictor allocation.....	139
5.2.2.1.4	LSF quantizer structure.....	139
5.2.2.1.5	LSFQ for voiced coding mode at 16 kHz internal sampling frequency : BC-TCVQ.....	144
5.2.2.1.6	Mid-frame LSF quantizer.....	150
5.2.3	Excitation coding.....	151
5.2.3.1	Excitation coding in the GC, VC and high rate IC/UC modes.....	151
5.2.3.1.1	Computation of the LP residual signal.....	152
5.2.3.1.2	Target signal computation.....	153
5.2.3.1.3	Impulse response computation.....	153
5.2.3.1.4	Adaptive codebook.....	153
5.2.3.1.5	Algebraic codebook.....	156
5.2.3.1.6	Combined algebraic codebook.....	165
5.2.3.1.7	Gain quantization.....	179
5.2.3.2	Excitation coding in TC mode.....	184
5.2.3.2.1	Glottal pulse codebook search.....	184
5.2.3.2.2	TC frame configurations.....	188
5.2.3.2.3	Pitch period and gain coding in the TC mode.....	190
5.2.3.2.4	Update of filter memories.....	193
5.2.3.3	Excitation coding in UC mode at low rates.....	193
5.2.3.3.1	Structure of the Gaussian codebook.....	193
5.2.3.3.2	Correction of the Gaussian codebook spectral tilt.....	194
5.2.3.3.3	Search of the Gaussian codebook.....	195
5.2.3.3.4	Quantization of the Gaussian codevector gain.....	196
5.2.3.3.5	Other parameters in UC mode.....	197
5.2.3.4	Excitation coding in IC and UC modes at 9.6 kbps.....	197
5.2.3.4.1	Algebraic codebook.....	198
5.2.3.4.2	Gaussian noise generation.....	199
5.2.3.4.3	Gain coding.....	199
5.2.3.4.4	Memory update.....	201
5.2.3.5	Excitation coding in GSC mode.....	201
5.2.3.5.1	Determining the subframe length.....	202
5.2.3.5.2	Computing time-domain excitation contribution.....	202
5.2.3.5.3	Frequency transform of residual and time-domain excitation contribution.....	203
5.2.3.5.4	Computing energy dynamics of transformed residual and quantization of noise level.....	204
5.2.3.5.5	Find and encode the cut-off frequency.....	204
5.2.3.5.6	Band energy computation and quantization.....	206
5.2.3.5.7	PVQ Bit allocation.....	206

5.2.3.5.8	Quantization of difference signal.....	207
5.2.3.5.9	Spectral dynamic and noise filling	207
5.2.3.5.10	Quantized gain addition, temporal and frequency contributions combination	207
5.2.3.5.11	Specifics for wideband 8kbps.....	207
5.2.3.5.12	Inverse DCT	209
5.2.3.5.13	Remove pre-echo in case of onset detection.....	209
5.2.4	Bass post-filter gain quantization.....	210
5.2.5	Source Controlled VBR Coding	210
5.2.5.1	Principles of VBR Coding	210
5.2.5.2	EVS VBR Encoder Coding Modes and Bit-Rates	211
5.2.5.3	Prototype-Pitch-Period (PPP) Encoding	211
5.2.5.3.1	PPP Algorithm.....	211
5.2.5.3.2	Amplitude Quantization	212
5.2.5.3.3	Phase Quantization	213
5.2.5.4	Noise-Excited-Linear-Prediction (NELP) Encoding.....	213
5.2.5.5	Average Data Rate (ADR) Control for the EVS VBR mode	213
5.2.6	Coding of upper band for LP-based Coding Modes	216
5.2.6.1	Bandwidth extension in time domain	216
5.2.6.1.1	High band target signal generation	217
5.2.6.1.2	TBE LP analysis	218
5.2.6.1.3	Quantization of linear prediction parameters.....	220
5.2.6.1.4	Interpolation of LSF coefficients.....	223
5.2.6.1.5	Target and residual energy calculation and quantization.....	225
5.2.6.1.6	Generation of the upsampled version of the lowband excitation.....	226
5.2.6.1.7	Non-Linear Excitation Generation	226
5.2.6.1.8	Spectral flip of non-linear excitation in time domain	227
5.2.6.1.9	Down-sample using all-pass filters.....	227
5.2.6.1.10	Adaptive spectral whitening	228
5.2.6.1.11	Envelope modulated noise mixing.....	228
5.2.6.1.12	Spectral shaping of the noise added excitation	230
5.2.6.1.13	Post processing of the shaped excitation	231
5.2.6.1.14	Estimation of temporal gain shape parameters	233
5.2.6.1.15	Estimation of frame gain parameters.....	235
5.2.6.1.16	Estimation of TEC/TFA envelope parameters.....	237
5.2.6.1.17	Estimation of full-band frame energy parameters	240
5.2.6.2	Multi-mode FD Bandwidth Extension Coding	241
5.2.6.2.1	SWB/FB Multi-mode FD Bandwidth Extension	242
5.2.6.2.2	WB Multi-mode FD Bandwidth Extension	252
5.2.6.3	Coding of upper band at 64 kb/s	256
5.2.6.3.1	Coding in normal mode	257
5.2.6.3.2	Coding in transient mode.....	260
5.3	MDCT Coding Mode	263
5.3.1	General description	263
5.3.2	Time-to-frequency transformations	263
5.3.2.1	Transform sizes and MDCT configurations	263
5.3.2.2	Long block transformation (ALDO window).....	263
5.3.2.2.1	Folding and on-the-fly window decimation.....	265
5.3.2.2.2	eDCT	267
5.3.2.3	Transient location dependent overlap and transform length	269
5.3.2.4	Short block transformation.....	270
5.3.2.4.2	Short window transform for MDCT based TCX.....	274
5.3.2.5	Special window transitions	275
5.3.2.5.1	ALDO to short transition	275
5.3.2.5.2	Short to ALDO transition	275
5.3.2.6	Modified Discrete Sine Transform.....	275
5.3.3	MDCT based TCX.....	276
5.3.3.1	General description	276
5.3.3.1.1	High level overview	276
5.3.3.1.2	Rate dependent configuration	276
5.3.3.2	General encoding procedure.....	277
5.3.3.2.1	LPC parameter calculation	277
5.3.3.2.2	Temporal Noise Shaping	281

5.3.3.2.3	LPC shaping in MDCT domain.....	282
5.3.3.2.4	Adaptive low frequency emphasis.....	286
5.3.3.2.5	Spectrum noise measure in power spectrum.....	287
5.3.3.2.6	Low pass factor detector.....	287
5.3.3.2.7	Uniform quantizer with adaptive dead-zone.....	288
5.3.3.2.8	Arithmetic coder.....	288
5.3.3.2.9	Global gain coding.....	300
5.3.3.2.10	Noise Filling.....	301
5.3.3.2.11	Intelligent Gap Filling.....	303
5.3.3.2.12	Memory updates.....	318
5.3.3.2.13	Global Gain Adjuster.....	318
5.3.4	High Quality MDCT coder (HQ).....	319
5.3.4.1	Low-rate HQ coder.....	319
5.3.4.1.1	Tonality Estimation.....	320
5.3.4.1.2	Grouping of spectral coefficients.....	320
5.3.4.1.3	Energy Envelope coding.....	324
5.3.4.1.4	MDCT coefficients quantization.....	330
5.3.4.2	High-rate HQ coder.....	367
5.3.4.2.1	Normal Mode.....	369
5.3.4.2.2	Transient Mode.....	378
5.3.4.2.3	Generic, Harmonic and HVQ mode detector.....	379
5.3.4.2.4	Harmonic Mode.....	381
5.3.4.2.5	HVQ.....	381
5.3.4.2.6	Generic Mode.....	384
5.3.4.2.7	Pyramid Vector Quantization (PVQ) and indexing.....	391
5.4	Switching of Coding Modes.....	402
5.4.1	General description.....	402
5.4.2	MDCT coding mode to CELP coding mode.....	402
5.4.2.1	MDCT to CELP transition 1 (MC1).....	403
5.4.2.2	MDCT to CELP transition 2 (MC2).....	403
5.4.2.3	MDCT to CELP transition 3 (MC3).....	403
5.4.3	CELP coding mode to MDCT coding mode.....	403
5.4.3.1	CELP coding mode to MDCT based TCX coding mode.....	403
5.4.3.2	CELP coding mode to HQ MDCT coding mode.....	404
5.4.3.2.1	Constrained CELP coding and simplified BWE coding.....	404
5.4.3.2.2	HQ MDCT coding with a modified analysis window.....	405
5.4.4	Internal sampling rate switching.....	406
5.4.4.1	Reset of LPC memory.....	406
5.4.4.2	Conversion of LP filter between 12.8 and 16 kHz internal sampling rates.....	406
5.5.4.1.1	Modification of the Power Spectrum.....	406
5.5.4.1.2	Computation of the Power Spectrum.....	407
5.5.4.1.3	Computation of the Autocorrelation.....	408
5.4.4.3	Extrapolation of LP filter.....	409
5.4.4.4	Buffer resampling with linear interpolation.....	409
5.4.4.5	Update of CELP input signal memories.....	409
5.4.4.6	Update of MDCT-based TCX input signal memories.....	410
5.4.4.7	Update of CELP synthesis memories.....	410
5.4.5	EVS primary and AMR-WB IO.....	410
5.4.5.1	Switching from primary modes to AMR-WB IO.....	410
5.4.5.2	Switching from AMR-WB IO mode to primary modes.....	411
5.4.6	Rate switching.....	411
5.4.6.1	Rate switching along with internal sampling rate switching.....	411
5.4.6.2	Rate switching along with coding mode switching.....	411
5.5	Frame erasure concealment side information.....	412
5.5.1	Signal classification parameter.....	412
5.5.2	Energy information.....	412
5.5.3	Phase control information.....	413
5.5.4	Pitch lag information.....	413
5.5.5	Spectral envelope diffuser.....	414
5.5.6	Tonality flag information.....	415
5.6	DTX/CNG operation.....	416
5.6.1	Overview.....	416

5.6.1.1	SID update.....	416
5.6.1.2	Spectral tilt based SID transmission.....	418
5.6.1.3	CNG selector.....	419
5.6.2	Encoding for LP-CNG.....	419
5.6.2.1	LP-CNG CN parameters estimation.....	420
5.6.2.1.1	LP-CNG Hangover analysis period determination.....	420
5.6.2.1.2	LP-CNG filter parameters evaluation for low-band signal.....	420
5.6.2.1.3	LP-CNG CNG-LSF quantization for low-band signal.....	421
5.6.2.1.4	LP-CNG synthesis filter computation for local CNG synthesis.....	422
5.6.2.1.5	LP-CNG energy calculation and quantization.....	423
5.6.2.1.6	LP-CNG energy smoothing for local CNG synthesis.....	424
5.6.2.1.7	LP-CNG LF-BOOST determination and quantization.....	424
5.6.2.1.8	LP-CNG high band analysis and quantization.....	425
5.6.2.2	LP-CNG local CNG synthesis.....	427
5.6.2.3	LP-CNG CNG Memory update.....	427
5.6.3	Encoding for FD-CNG.....	427
5.6.3.1	Spectral partition energies.....	428
5.6.3.1.1	Computation of the FFT partition energies.....	428
5.6.3.1.2	Computation of the CLDFB partition energies.....	428
5.6.3.1.3	FD-CNG configurations.....	428
5.6.3.2	FD-CNG noise estimation.....	429
5.6.3.2.1	Dynamic range compression for the input energies.....	429
5.6.3.2.2	Noise tracking.....	429
5.6.3.2.3	Dynamic range expansion for the estimated noise energies.....	434
5.6.3.3	Adjusting the first SID frame in FD-CNG.....	434
5.6.3.4	FD-CNG resetting mechanism.....	434
5.6.3.5	Encoding SID frames in FD-CNG.....	434
5.6.3.6	FD-CNG local CNG synthesis.....	436
5.6.3.6.1	SID parameters interpolation.....	437
5.6.3.6.2	LPC estimation from the interpolated SID parameters.....	437
5.6.3.6.3	FD-CNG encoder comfort noise generation.....	437
5.6.3.6.4	FD-CNG encoder memory update.....	437
5.7	AMR-WB-interoperable modes.....	438
5.7.1	Pre-processing.....	438
5.7.2	Linear prediction analysis and quantization.....	438
5.7.2.1	Windowing and auto-correlation computation.....	438
5.7.2.2	Levinson-Durbin algorithm.....	438
5.7.2.3	LP to ISP conversion.....	438
5.7.2.4	ISP to LP conversion.....	439
5.7.2.5	Quantization of the ISP coefficients.....	439
5.7.2.6	Interpolation of the ISPs.....	439
5.7.3	Perceptual weighting.....	439
5.7.4	Open-loop pitch analysis.....	439
5.7.5	Impulse response computation.....	439
5.7.6	Target signal computation.....	439
5.7.7	Adaptive codebook search.....	440
5.7.8	Algebraic codebook search.....	440
5.7.9	Quantization of the adaptive and fixed codebook gains.....	440
5.7.10	Memory update.....	440
5.7.11	High-band gain generation.....	440
5.7.12	CNG coding.....	440
5.8	Channel Aware Coding.....	440
5.8.1	Introduction.....	440
5.8.2	Principles of Channel Aware Coding.....	441
5.8.3	Bit-Rate Allocation for Primary and Partial Redundant Frame Coding.....	442
5.8.3.1	Primary frame bit-rate reduction.....	442
5.8.3.2	Partial Redundant Frame Coding.....	442
5.8.3.2.1	Construction of partial redundant frame for Generic and Voiced Coding modes.....	442
5.8.3.2.2	Construction of partial redundant frame for Unvoiced Coding mode.....	442
5.8.3.2.3	Construction of partial redundant frame for TCX frame.....	443
5.8.3.2.4	RF_NO_DATA partial redundant frame type.....	443
5.8.3.3	Decoding.....	443

5.8.4	Channel aware mode encoder configurable parameters.....	443
6	Functional description of the Decoder	445
6.1	LP-based Decoding	445
6.1.1	General LP-based decoding	445
6.1.1.1	LSF decoding	445
6.1.1.1.1	General LSF decoding	445
6.1.1.1.2	LSF decoding for voiced coding mode at 16 kHz internal sampling frequency.....	448
6.1.1.2	Reconstruction of the excitation.....	450
6.1.1.2.1	Reconstruction of the excitation in GC and VC modes and high rate IC/UC modes	450
6.1.1.2.2	Reconstruction of the excitation in TC mode	457
6.1.1.2.3	Reconstruction of the excitation in UC mode at low rates	457
6.1.1.2.4	Reconstruction of the excitation in IC/UC mode at 9.6 kbps	459
6.1.1.2.5	Reconstruction of the excitation in GSC	460
6.1.1.3	Excitation post-processing	461
6.1.1.3.1	Anti-sparseness processing.....	461
6.1.1.3.2	Gain smoothing for noise enhancement	461
6.1.1.3.3	Pitch enhancer	462
6.1.1.3.4	Music post processing	463
6.1.2	Source Controlled VBR decoding	470
6.1.3	Synthesis.....	470
6.1.4	Post-processing.....	471
6.1.4.1.1	Long-term post-filter	471
6.1.4.1.2	Short-term post-filter	472
6.1.4.1.3	Post-filter NB parameters	472
6.1.4.1.4	Post-filter WB and SWB parameters.....	473
6.1.4.1.5	Tilt compensation	473
6.1.4.1.6	Adaptive gain control	474
6.1.4.2	Bass post-filter	474
6.1.5	Decoding of upper band for LP-based Coding Modes.....	477
6.1.5.1	Decoding Time-domain Bandwidth Extension	477
6.1.5.1.1	Generation of the upsampled version of the lowband excitation.....	477
6.1.5.1.2	Non-Linear Excitation Generation	478
6.1.5.1.3	De-quantization of high band parameters.....	479
6.1.5.1.4	LSP interpolation.....	479
6.1.5.1.5	Spectral flip in time domain	479
6.1.5.1.6	Down-sample using all-pass filters.....	479
6.1.5.1.7	Adaptive spectral whitening	480
6.1.5.1.8	Envelope modulated noise mixing.....	480
6.1.5.1.9	Spectral shaping of the noise added excitation.....	482
6.1.5.1.10	Post processing of the shaped excitation	482
6.1.5.1.11	Gain shape update.....	482
6.1.5.1.12	SHB synthesis.....	483
6.1.5.1.13	Core-switching and high-band memory updates	484
6.1.5.1.14	TEC/TFA post processing	485
6.1.5.1.15	Full-band synthesis.....	487
6.1.5.2	Multi-mode FD Bandwidth Extension decoding.....	487
6.1.5.2.1	SWB multi-mode FD BWE decoding	487
6.1.5.2.2	WB multi-mode FD BWE decoding.....	495
6.1.5.3	Decoding of upper band at 64 kb/s.....	503
6.1.5.3.1	Decoding in normal mode	503
6.1.5.3.2	Decoding in transient mode.....	508
6.1.5.3.3	Windowing and frequency-to-time transformation	510
6.1.5.3.4	Post-processing in temporal domain.....	510
6.2	MDCT Coding mode decoding	513
6.2.1	General MDCT decoding.....	513
6.2.2	MDCT based TCX.....	513
6.2.2.1	Rate dependent configurations	513
6.2.2.2	Init module parameters.....	513
6.2.2.2.1	TCX block configuration.....	513
6.2.2.2.2	LPC parameter.....	513
6.2.2.2.3	PLC Waveform adjustment	514

6.2.2.2.4	Global Gain	514
6.2.2.2.5	Noise fill parameter	515
6.2.2.2.6	LTP	515
6.2.2.2.7	TNS parameter.....	515
6.2.2.2.8	Harmonic model	515
6.2.2.2.9	IGF bit stream reader.....	515
6.2.2.2.10	Spectral data	518
6.2.2.2.11	Residual bits	518
6.2.2.3	Decoding process	519
6.2.2.3.1	Arithmetic decoder	519
6.2.2.3.2	Adaptive low frequency de-emphasis.....	520
6.2.2.3.3	Global gain decoding.....	521
6.2.2.3.4	Residual bits decoding.....	521
6.2.2.3.5	TCX formant enhancement	522
6.2.2.3.6	Noise Filling	523
6.2.2.3.7	Apply global gain and LPC shaping in MDCT domain	524
6.2.2.3.8	IGF apply.....	525
6.2.2.3.9	Inverse window grouping (TCX5 separation)	530
6.2.2.3.10	Temporal Noise Shaping	531
6.2.2.3.11	IGF temporal flattening	531
6.2.3	High Quality MDCT decoder (HQ).....	532
6.2.3.1	Low-rate HQ decoder.....	532
6.2.3.1.1	Mode decoding	532
6.2.3.1.2	Energy Envelope decoding.....	532
6.2.3.1.3	Spectral coefficients decoding.....	534
6.2.3.2	High-rate HQ decoder	544
6.2.3.2.1	Normal Mode	544
6.2.3.2.2	Transient Mode.....	553
6.2.3.2.3	Harmonic Mode.....	553
6.2.3.2.4	HVQ	556
6.2.3.2.5	Generic Mode.....	557
6.2.3.2.6	PVQ decoding and de-indexing.....	562
6.2.4	Frequency-to-time transformation	564
6.2.4.1	Long block transformation (ALDO window).....	564
6.2.4.1.1	eDCT	564
6.2.4.1.2	Unfolding and windowing	564
6.2.4.1.3	Overlap-add	565
6.2.4.1.4	Pre-echo attenuation	566
6.2.4.2	Transient location dependent overlap and transform length	572
6.2.4.3	Short block transformation.....	572
6.2.4.3.1	Short window transform in TDA domain	572
6.2.4.3.2	Short window transform for MDCT based TCX.....	573
6.2.4.4	Special window transitions	573
6.2.4.4.1	ALDO to short transition	573
6.2.4.4.2	Short to ALDO transition	574
6.2.4.5	Low Rate MDCT Synthesis	574
6.3	Switching coding modes in decoding	574
6.3.1	General description	574
6.3.2	MDCT coding mode to CELP coding mode.....	575
6.3.2.1	MDCT to CELP transition 1 (MC1)	575
6.3.2.2	MDCT to CELP transition 2 (MC2)	576
6.3.2.3	MDCT to CELP transition 3 (MC3)	576
6.3.3	CELP coding mode to MDCT coding mode.....	576
6.3.3.1	CELP coding mode to MDCT based TCX coding mode.....	577
6.3.3.2	CELP coding mode to HQ MDCT coding mode	578
6.3.3.2.1	Constrained CELP decoding and simplified BWE decoding	579
6.3.3.2.1.1	Optimized cubic interpolation.....	579
6.3.3.2.2	HQ MDCT decoding with a modified synthesis window.....	580
6.3.3.2.3	Cross-fading	580
6.3.4	Internal sampling rate switching	580
6.3.4.1	Reset of LPC memory.....	580
6.3.4.2	Conversion of LP filter between 12.8 and 16 kHz internal sampling rates	581

6.3.4.3	Extrapolation of LP filter	581
6.3.4.4	Update of CELP synthesis memories	581
6.3.4.5	Update of CELP decoded past signal	581
6.3.4.6	Post-processing	581
6.3.4.6.1	Adaptive post-filtering	581
6.3.4.6.2	Bass post filter.....	581
6.3.4.7	CLDFB	581
6.3.5	EVS primary modes and AMR-WB IO	582
6.3.5.1	Switching from primary modes to AMR-WB IO	582
6.3.5.2	Switching from AMR-WB IO mode to primary modes	582
6.3.6	Rate switching	582
6.3.6.1	Rate switching along with internal sampling rate switching	582
6.3.6.2	Rate switching along with coding mode switching	582
6.3.6.3	Adaptive post-filter reset and smoothing	582
6.3.7	Bandwidth switching	582
6.3.7.1	Bandwidth switching detector.....	582
6.3.7.2	Super wideband switching to wideband.....	583
6.3.7.2.1	TBE mode.....	583
6.3.7.2.2	Multi-mode FD BWE mode	585
6.3.7.2.3	MDCT core.....	586
6.3.7.3	Wideband switching to super wideband.....	586
6.4	De-emphasis	586
6.5	Resampling to the output sampling frequency	586
6.6	Decoding of frame erasure concealment side information	586
6.7	Decoding in DTX/CNG operation.....	587
6.7.1	Overview	587
6.7.2	Decoding for LP-CNG.....	587
6.7.2.1	LP-CNG decoding Overview	587
6.7.2.1.1	CNG parameter updates in active periods	587
6.7.2.1.2	DTX-hangover based parameter analysis in LP-CNG mode.....	588
6.7.2.1.3	LP-CNG low-band energy decoding	590
6.7.2.1.4	LP-CNG low-band filter parameters decoding	590
6.7.2.1.5	LP-CNG low-band excitation generation	590
6.7.2.1.6	LP-CNG low-band synthesis	592
6.7.2.1.7	LP-CNG high-band decoding and synthesis.....	592
6.7.2.2	Memory update	594
6.7.3	Decoding for FD-CNG	594
6.7.3.1	Decoding SID frames in FD-CNG	594
6.7.3.1.1	SID parameters decoding.....	595
6.7.3.1.2	SID parameters interpolation.....	595
6.7.3.1.3	LPC estimation from the interpolated SID parameters.....	596
6.7.3.2	Noise tracking during active frames in FD-CNG.....	596
6.7.3.2.1	Spectral partition energies	596
6.7.3.2.2	FD-CNG noise estimation	597
6.7.3.2.3	Noise shaping in FD-CNG	597
6.7.3.3	Noise generation for SID or zero frames in FD-CNG.....	599
6.7.3.3.1	Update of the noise levels for FD-CNG	599
6.7.3.3.2	Comfort noise generation in the frequency domain.....	599
6.7.3.3.3	Comfort noise generation in the time domain	599
6.7.3.3.4	FD-CNG decoder memory update.....	601
6.8	AMR-WB-interoperable modes	602
6.8.1	Decoding and speech synthesis.....	602
6.8.1.1	Excitation decoding.....	602
6.8.1.2	Excitation post-processing	603
6.8.1.2.1	Anti-sparseness processing.....	603
6.8.1.2.2	Gain smoothing for noise enhancement	603
6.8.1.2.3	Pitch enhancer	603
6.8.1.3	Synthesis filtering	603
6.8.1.4	Music and Unvoiced/inactive Post-processing.....	603
6.8.1.4.1	Music post processing	603
6.8.1.4.2	Unvoiced and inactive post processing.....	604
6.8.1.5	Synthesis filtering and overwriting the current CELP synthesis	607

6.8.1.6	Formant post-filter	607
6.8.1.7	Comfort noise addition.....	607
6.8.1.8	Bass post-filter	607
6.8.2	Resampling	608
6.8.3	High frequency band.....	608
6.8.3.1	Preliminary estimation steps	608
6.8.3.1.1	Estimation of tilt, figure of merit and voice factors.....	609
6.8.3.1.2	Estimation of sub-frame gains based on LP spectral envelopes	610
6.8.3.2	Generation of high-band excitation.....	613
6.8.3.2.1	DCT	613
6.8.3.2.2	High band generation	613
6.8.3.2.3	Extraction of tonal and ambiance components	615
6.8.3.2.4	Recombination.....	616
6.8.3.2.5	Filtering in DCT domain	617
6.8.3.2.6	Inverse DCT	618
6.8.3.2.7	Gain computation and scaling of excitation	618
6.8.3.3	LP filter for the high frequency band	620
6.8.3.4	High band synthesis	620
6.8.4	CNG decoding	621
6.9	Common post-processing.....	621
6.9.1	Comfort noise addition	621
6.9.1.1	Noisy speech detection.....	621
6.9.1.2	Noise estimation for CNA.....	622
6.9.1.2.1	CNA noise estimation in DTX-on mode when FD-CNG is triggered.....	622
6.9.1.2.2	CNA noise estimation in DTX-on mode when LP-CNG is triggered	622
6.9.1.2.3	CNA noise estimation in DTX-off mode.....	622
6.9.1.3	Noise generation in the FFT domain and addition in the time domain	622
6.9.1.4	Noise generation and addition in the MDCT domain	623
6.9.2	Long term prediction processing	623
6.9.2.1	Decoding LTP parameters.....	623
6.9.2.2	LTP post filtering	624
6.9.3	Complex low delay filter bank synthesis	626
6.9.4	High pass filtering.....	627
7	Description of the transmitted parameter indices.....	627
7.1	Bit allocation for the default option.....	627
7.1.1	Bit allocation at VBR 5.9, 7.2 – 9.6 kbps	627
7.1.2	Bit allocation at 13.2 kbps	627
7.1.3	Bit allocation at 16.4 and 24.4 kbps.....	628
7.1.4	Bit allocation at 32 kbps	629
7.1.5	Bit allocation at 48, 64, 96 and 128 kbps.....	630
7.2	Bit allocation for SID frames in the DTX operation	630
7.3	Bit allocation for the AMR-WB-interoperable option.....	631
7.4	Bit Allocation for the Channel-Aware Mode	631
Annex A (normative):	RTP Payload Format and SDP Parameters	633
A.0	General	633
A.1	RTP Header Usage	633
A.2	EVS RTP Payload Format.....	633
A.2.1	EVS codec Compact Format	633
A.2.1.1	Compact format for EVS Primary mode.....	634
A.2.1.2	Compact format for EVS AMR-WB IO mode (except SID).....	634
A.2.1.2.1	Representation of Codec Mode Request (CMR) in Compact format for EVS AMR-WB IO mode ...	634
A.2.1.2.2	Payload structure of Compact EVS AMR-WB IO mode frame.....	635
A.2.1.3	Special case for 56 bit payload size (EVS Primary or EVS AMR-WB IO SID)	636
A.2.2	EVS codec Header-Full format	636
A.2.2.1	EVS RTP payload structure	636
A.2.2.1.1	CMR byte.....	637
A.2.2.1.2	ToC byte.....	639
A.2.2.1.3	Speech Data.....	641

A.2.2.1.4	Zero padding	641
A.2.2.1.4.1	Zero padding for octet alignment of speech data (EVS AMR-WB IO).....	641
A.2.2.1.4.2	Zero padding for size collision avoidance	641
A.2.2.1.4.3	Additional zero padding	641
A.2.3	Header-Full/Compact format handling.....	641
A.2.3.1	Default format handling	642
A.2.3.2	Header-Full-only format handling	642
A.2.4	AMR-WB backward compatible EVS AMR-WB IO mode format	642
A.2.5	Sessions with multiple mono channels.....	642
A.2.5.1	Encoding of multiple mono channels.....	642
A.2.5.2	RTP header usage	642
A.2.5.3	Construction of the RTP payload.....	642
A.2.6	Storage Format	643
A.2.6.1	Header.....	643
A.2.6.2	Speech Frames	644
A.3	Payload Format Parameters.....	644
A.3.1	EVS Media Type Registration.....	644
A.3.2	Mapping Media Type Parameters into SDP	647
A.3.3	Detailed Description of Usage of SDP Parameters	647
A.3.3.1	Offer-Answer Model Considerations.....	647
A.3.3.2	Examples	649
A.3.3.3	Interactions of the dtx and dtx-recv parameters.....	650
Annex B (informative):	Change history	651
History		652

Sample Document

get full document from standards.iteh.ai

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
 - 1 presented to TSG for information;
 - 2 presented to TSG for approval;
 - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document is a detailed description of the signal processing algorithms of the Enhanced Voice Services coder.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

- [1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".
- [2] 3GPP TS 26.441: "Codec for Enhanced Voice Services (EVS); General Overview".
- [3] 3GPP TS 26.442: "Codec for Enhanced Voice Services (EVS); ANSI C code (fixed-point)".
- [4] 3GPP TS 26.444: "Codec for Enhanced Voice Services (EVS); Test Sequences".
- [5] 3GPP TS 26.446: "Codec for Enhanced Voice Services (EVS); AMR-WB Backward Compatible Functions".
- [6] 3GPP TS 26.447: "Codec for Enhanced Voice Services (EVS); Error Concealment of Lost Packets".
- [7] 3GPP TS 26.448: "Codec for Enhanced Voice Services (EVS); Jitter Buffer Management".