

ETSI TS 146 060 V14.0.0 (2017-04)



**Digital cellular telecommunications system (Phase 2+) (GSM);
Enhanced Full Rate (EFR) speech transcoding
(3GPP TS 46.060 version 14.0.0 Release 14)**



Reference

RTS/TSGS-0446060ve00

Keywords

GSM

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 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
<http://www.etsi.org/standards-search>

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 only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
<https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx>

If you find errors in the present document, please send your comment to one of the following services:
<https://portal.etsi.org/People/CommiteeSupportStaff.aspx>

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.

© European Telecommunications Standards Institute 2017.
All rights reserved.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are Trade Marks of ETSI registered for the benefit of its Members.
3GPP™ and **LTE™** are Trade Marks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners.
GSM® and the GSM logo are Trade Marks registered and owned by the GSM Association.

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is 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 Web server (<https://ipr.etsi.org>).

Pursuant to the ETSI IPR Policy, no investigation, 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.

Foreword

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, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under <http://webapp.etsi.org/key/queryform.asp>.

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
Foreword.....	2
Modal verbs terminology.....	2
Foreword.....	5
1 Scope	6
2 References	6
3 Definitions, symbols and abbreviations	7
3.1 Definitions	7
3.2 Symbols.....	8
3.3 Abbreviations	12
4 Outline description	12
4.1 Functional description of audio parts	12
4.2 Preparation of speech samples.....	13
4.2.1 PCM format conversion	13
4.3 Principles of the GSM enhanced full rate speech encoder	13
4.4 Principles of the GSM enhanced full rate speech decoder	15
4.5 Sequence and subjective importance of encoded parameters	15
5 Functional description of the encoder	15
5.1 Pre-processing	15
5.2 Linear prediction analysis and quantization	16
5.2.1 Windowing and auto-correlation computation.....	16
5.2.2 Levinson-Durbin algorithm	17
5.2.3 LP to LSP conversion	18
5.2.4 LSP to LP conversion	19
5.2.5 Quantization of the LSP coefficients	20
5.2.6 Interpolation of the LSPs	21
5.3 Open-loop pitch analysis	21
5.4 Impulse response computation	22
5.5 Target signal computation	22
5.6 Adaptive codebook search.....	23
5.7 Algebraic codebook structure and search.....	24
5.8 Quantization of the fixed codebook gain.....	27
5.9 Memory update	28
6 Functional description of the decoder	28
6.1 Decoding and speech synthesis	28
6.2 Post-processing.....	30
6.2.1 Adaptive post-filtering.....	30
6.2.2 Up-scaling.....	31
7 Variables, constants and tables in the C-code of the GSM EFR codec.....	31
7.1 Description of the constants and variables used in the C code	31
8 Homing sequences.....	34
8.1 Functional description	34
8.2 Definitions	34
8.3 Encoder homing	36
8.4 Decoder homing	36
8.5 Encoder home state	37
8.6 Decoder home state	38
9 Bibliography.....	43
Annex A (informative): Change history	44

History45

Foreword

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

The present document describes the detailed mapping between input blocks of 160 speech samples in 13-bit uniform PCM format to encoded blocks of 244 bits and from encoded blocks of 244 bits to output blocks of 160 reconstructed speech samples within the digital cellular telecommunications system.

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 describes the detailed mapping between input blocks of 160 speech samples in 13-bit uniform PCM format to encoded blocks of 244 bits and from encoded blocks of 244 bits to output blocks of 160 reconstructed speech samples. The sampling rate is 8 000 sample/s leading to a bit rate for the encoded bit stream of 12,2 kbit/s. The coding scheme is the so-called Algebraic Code Excited Linear Prediction Coder, hereafter referred to as ACELP.

The present document also specifies the conversion between A-law or μ -law (PCS 1900) PCM and 13-bit uniform PCM. Performance requirements for the audio input and output parts are included only to the extent that they affect the transcoder performance. This part also describes the codec down to the bit level, thus enabling the verification of compliance to the part to a high degree of confidence by use of a set of digital test sequences. These test sequences are described in GSM 06.54 [7] and are available on disks.

In case of discrepancy between the requirements described in the present document and the fixed point computational description (ANSI-C code) of these requirements contained in GSM 06.53 [6], the description in GSM 06.53 [6] will prevail.

The transcoding procedure specified in the present document is applicable for the enhanced full rate speech traffic channel (TCH) in the GSM system.

In GSM 06.51 [5], a reference configuration for the speech transmission chain of the GSM enhanced full rate (EFR) system is shown. According to this reference configuration, the speech encoder takes its input as a 13-bit uniform PCM signal either from the audio part of the Mobile Station or on the network side, from the PSTN via an 8-bit/A-law or μ -law (PCS 1900) to 13-bit uniform PCM conversion. The encoded speech at the output of the speech encoder is delivered to a channel encoder unit which is specified in GSM 05.03 [3]. In the receive direction, the inverse operations take place.

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] GSM 01.04: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".
- [2] GSM 03.50: "Digital cellular telecommunications system (Phase 2+); Transmission planning aspects of the speech service in the GSM Public Land Mobile Network (PLMN) system".
- [3] GSM 05.03: "Digital cellular telecommunications system (Phase 2+); Channel coding".
- [4] GSM 06.32: "Digital cellular telecommunications system (Phase 2+); Voice Activity Detection (VAD)".
- [5] GSM 06.51: "Digital cellular telecommunications system (Phase 2+); Enhanced Full Rate (EFR) speech processing functions General description".
- [6] GSM 06.53: "Digital cellular telecommunications system (Phase 2+); ANSI-C code for the GSM Enhanced Full Rate (EFR) speech codec".
- [7] GSM 06.54: "Digital cellular telecommunications system (Phase 2+); Test vectors for the GSM Enhanced Full Rate (EFR) speech codec".