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European Standard (Telecommunications series)

Digital cellular telecommunications system (Phase 2); ANSI-C code for the GSM Enhanced Full Rate (EFR) speech codec (GSM 06.53 version 4.0.1)

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

European Telecommunications Standards Institute

Reference

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Contents

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Foreword

This European Standard (Telecommunications series) has been produced by the Special Mobile Group (SMG) of the European Telecommunications Standards Institute (ETSI).

This EN provides the bit exact definition of the Enhanced Full Rate (EFR) speech traffic codec for the digital cellular telecommunications system.

A 3.5 inch diskette is attached to the back cover of this EN, this diskette contains clause 5, the bit-exact ANSI-C code for the Enhanced Full Rate speech transcoder.

National transposition dates	
Date of adoption of this EN:	19 December 1997
Date of latest announcement of this EN (doa):	30 April 1998
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 October 1998
Date of withdrawal of any conflicting National Standard (dow):	31 October 1998

1 Scope

This EN contains an electronic copy of the ANSI-C code for the GSM Enhanced Full Rate codec. The ANSI-C code is necessary for a bit exact implementation of the Enhanced Full Rate speech transcoder (GSM 06.60 (EN 301 245) [3]), Voice Activity Detection (GSM 06.82 (EN 301 249) [7]), comfort noise (GSM 06.62 (EN 301 247) [5]), Discontinuous Transmission (GSM 06.81 (EN 301 248) [6]) and example solutions for substituting and muting of lost frames (GSM 06.61 (EN 301 246) [4]).

2 Normative references

This EN incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this EN only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 350): "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms".

[2] GSM 06.54 (EN 301 250): "Digital cellular telecommunications system (Phase 2); Test sequences for the GSM Enhanced Full Rate (EFR) speech codec".

[3] GSM 06.60 (EN 301 245): "Digital cellular telecommunications system (Phase 2); Enhanced Full Rate (EFR) speech transcoding".

[4] GSM 06.61 (EN 301 246): "Digital cellular telecommunications system (Phase 2); Substitution and muting of lost frame for Enhanced Full Rate (EFR) speech traffic channels".

[5] GSM 06.62 (EN 301 247): "Digital cellular telecommunications system (Phase 2); Comfort noise aspects for Enhanced Full Rate (EFR) speech traffic channels".

[6] GSM 06.81 (EN 301 248): "Digital cellular telecommunications system (Phase 2); Discontinuous transmission (DTX) for Enhanced Full Rate (EFR) speech traffic channels".

[7] GSM 06.82 (EN 301 249): "Digital cellular telecommunications system (Phase 2); Voice Activity Detector (VAD) for Enhanced Full Rate (EFR) speech traffic channels".

3 Definitions and abbreviations

3.1 Definitions

Definition of terms used in this EN can be found in GSM 06.60 (EN 301 245) [3], GSM 06.61 (EN 301 246) [4], GSM 06.62 (EN 301 247) [5], GSM 06.81 (EN 301 248) [6] and GSM 06.82 (EN 301 249) [7].

3.2 Abbreviations

For the purposes of this EN, the following abbreviations apply:

ANSI American National Standards Institute
DS-HD Double Sided High Density
ETS European Telecommunication Standard
GSM Global System for Mobile communications
I/O Input/Output
ROM Read Only Memory

For abbreviations not given in this subclause see GSM 01.04 (ETR 350) [1].

4 C code structure

This clause gives an overview of the structure of the bit-exact C code and provides an overview of the contents and organization of the 3.5 inch diskette attached to this document.

The C code has been verified on the following systems:

- Sun Microsystems [1)] workstations and Sun Microsystems cc compiler and gcc compiler;
- IBM [2)] PC/AT compatible computers and Borland Turbo-C++ [3)] compiler;
- Hewlett Packard's [4)] workstations and HP cc compiler;

ANSI-C 9899 was selected as the programming language because portability was desirable. The data medium for the code dissemination is MS-DOS [5)] formatted 3.5 inch DS-HD floppy disk.

4.1 Contents of the C source code diskette

The C code diskette has all of the files in the root level.

In this diskette, the files with suffix "c" contain the source code and the files with suffix "h" are the header files. The ROM data is contained mostly in files with suffix "tab". All text files are formatted such that they are correct for an IBM PC/AT compatible.

The diskette contains one speech coder installation verification data file, "spch_dos.inp". The reference encoder output file is named "spch_dos.cod", the reference decoder input file is named "spch_dos.dec" and the reference decoder output file is named "spch_dos.out". These four files are formatted such that they are correct for an IBM PC/AT compatible. The same files with reversed byte order of the 16 bit words are named "spch_unx.inp", "spch_unx.cod", "spch_unx."dec" and "spch_unx.out", respectively.

In an IBM PC/AT compatible platform, the installation verification can be performed by running the batch file "ts_dos.bat". In most UNIX platforms, the installation verification can be performed by running the batch file "ts_unx.bat". Final verification is to be performed using the GSM Enhanced Full Rate test sequences described in GSM 06.54 (EN 301 250) [2].

Makefiles are provided for the three platforms in which the C code has been verified (listed above). Once the software is installed, this directory will have compiled versions of *coder* and *decoder* (the bit-exact C executables of the speech codec), *ed_iface* (interface program between coder and decoder) and all the object files.

The programs *coder* and *decoder* are the GSM Enhanced Full Rate encoder and decoder executable files, respectively. A third program, *ed_iface*, is also contained in this directory. This is the program which provides the format conversion between the encoder output file format and the decoder input file format.

4.2 Program execution

The GSM enhanced full rate speech codec is implemented as three separate programs:

- (*coder*) speech encoder;
- *(ed_iface)* encoder/decoder interface;
- (*decoder*) speech decoder.

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1) Registered trade mark of Sun Microsystems
2) Registered trade mark of International Business Machines
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4) Registered trade mark of Hewlett Packard
5) Registered trade mark of Microsoft

For encoding using the *coder* program, the input is a binary speech file (*.inp) and the output is a binary encoded parameter file (*.cod). For decoding using the *decoder* program, the input is a binary parameter file (*.dec) and the output is a binary synthesized speech file (*.out).

NOTE: The format for the parameter input file required for decoding (*.dec) is not the same as the format of the parameter output file generated by encoding (*.cod). The *ed_iface* program will translate an *.cod file into a *.dec file.

See the file readme.txt for more information on how to run the coder, *ed_iface* and *decoder* programs.

4.3 Code hierarchy

Figures 1 to 5 are call graphs that show the functions used in the speech codec, including the functions of VAD, DTX, and comfort noise generation.

The encode call graph is broken down into three separate call graphs, and the decode call graph is broken down into two separate call graphs. Those sections which are large are separated from the primary call tree and given their own call tree. Each vertical column represents a call level. For example, main() is at level 0, Coder_12k2() at level 1, Int_lpc2() at level 2, Lsp_Az() at level 3, Get_lsp_pol() at level 4, etc. The basic operations are not counted as extending the depth, therefore the deepest level in this software is level 4.

Some items have been omitted from this call graph. All standard C functions: printf(), fwrite(), etc. have been omitted. Also, no basic operations (add(), L_add(), mac(), etc.) or double precision extended operations (e.g. L_Extract()) appear in the graphs. The reset functions of the encoder and decoder are only visible as the functions reset_enc and reset_dec, respectively. There are several subroutine calls from inside these functions.

The time order in the call graphs is from the bottom upwards as the processing of a frame advances.

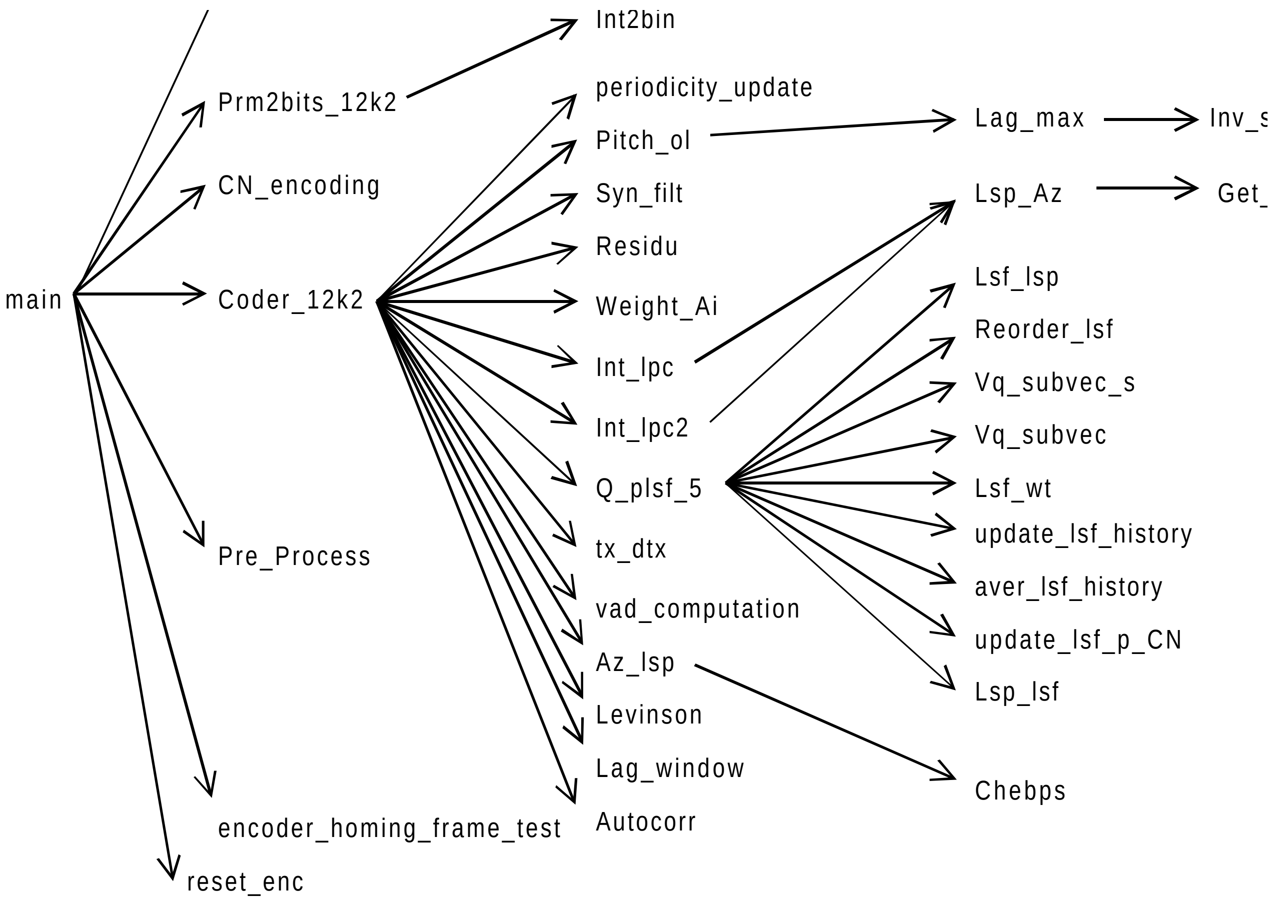

Figure 1: Speech encoder call graph (see figures 2 and 3)

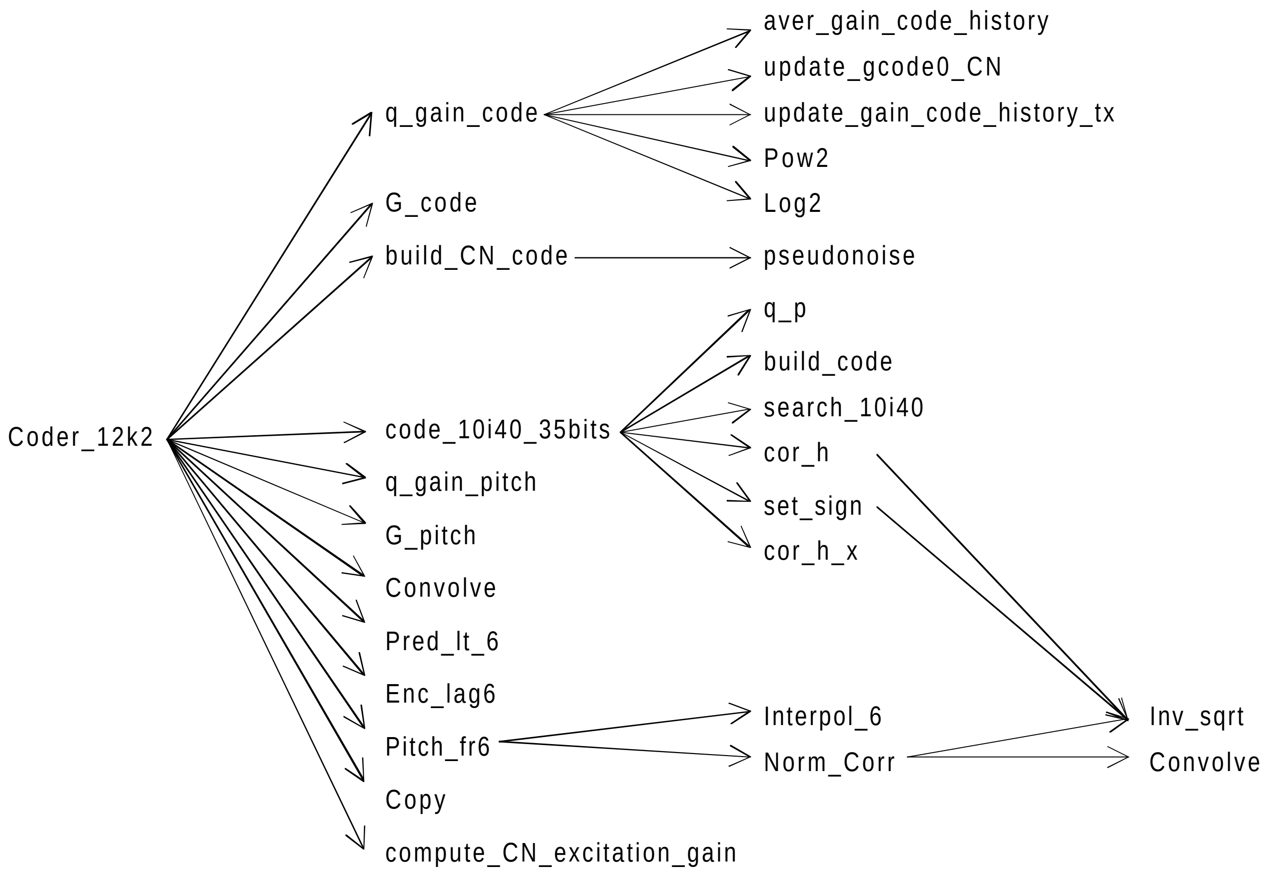

Figure 2: Speech encoder subframe processing call graph

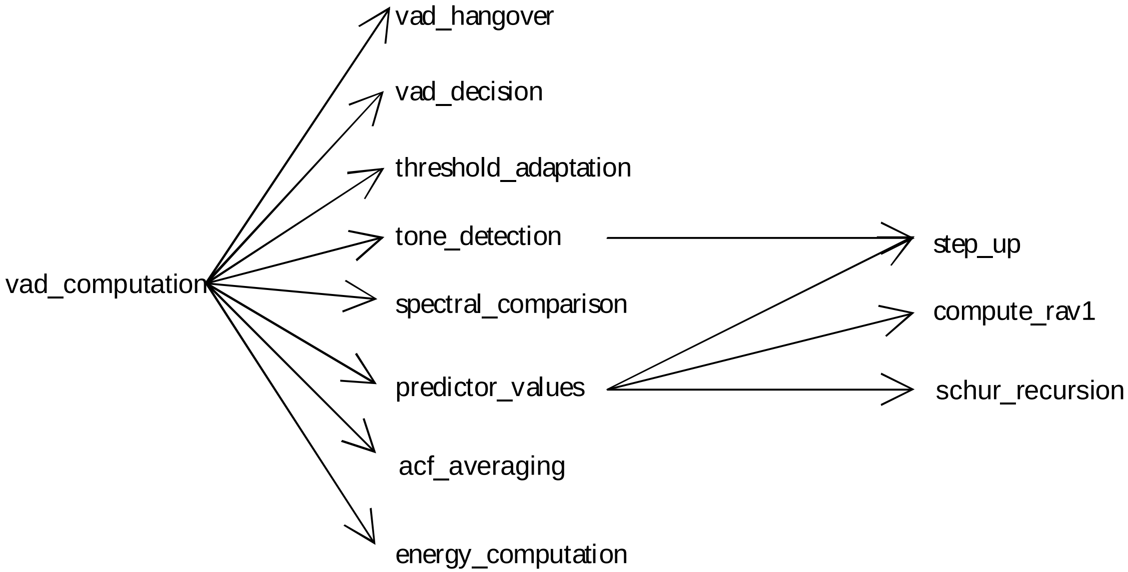

Figure 3: Voice Activity Detector (VAD) call graph

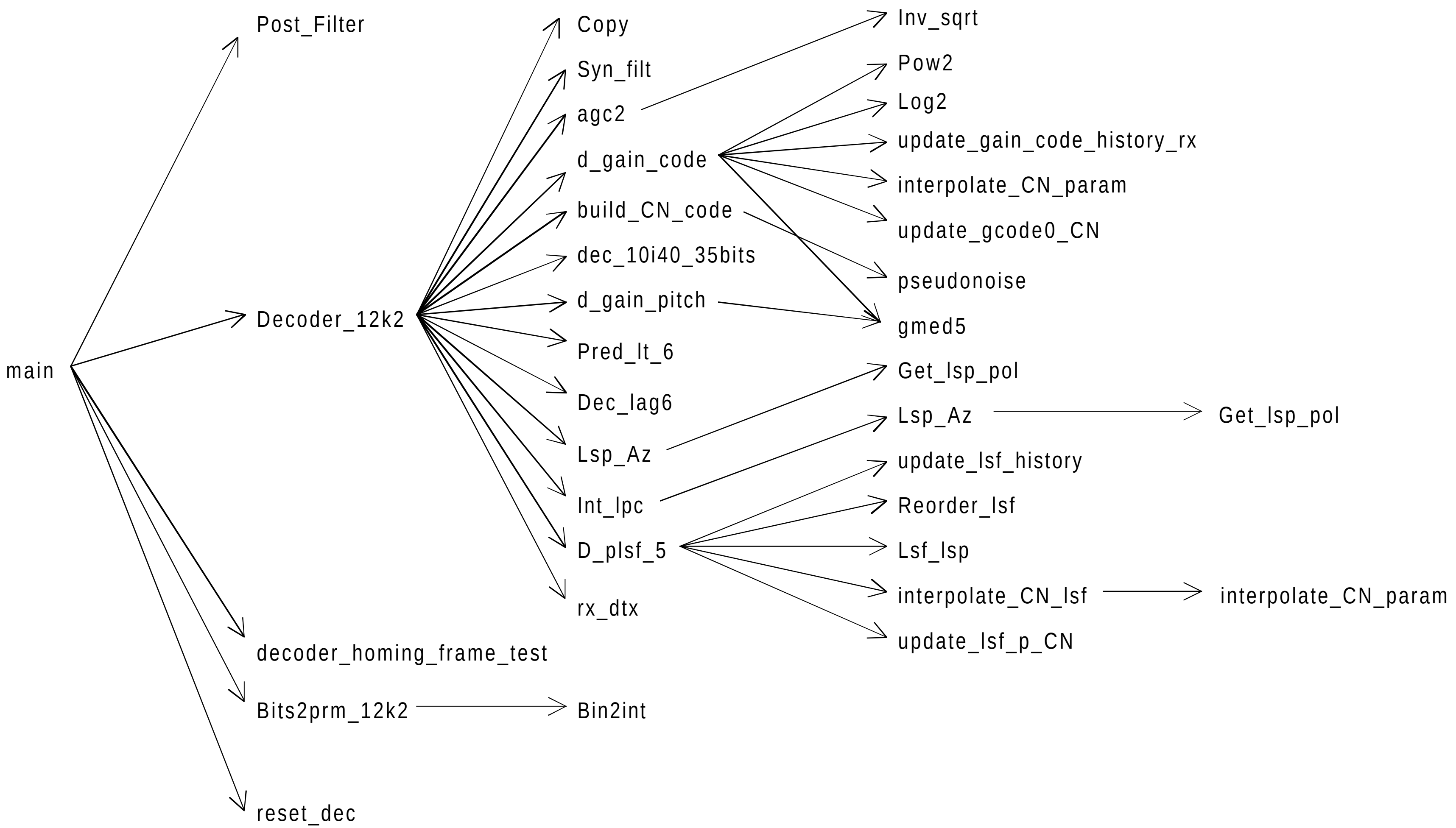

Figure 4: Speech decoder call graph (see figure 5)

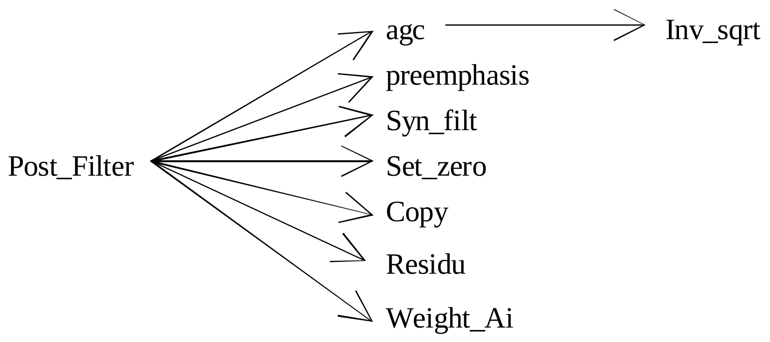

Figure 5: Speech decoder postfilter call graph

History

Document history		
V4.0.0	August 1997	One-step Approval Procedure OAP 9750: 1997-08-15 to 1997-12-12
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