# EUROPEAN TELECOMMUNICATION STANDARD

**ETS 300 724**

**March 1997**

Source: ETSI TC-SMG

Reference: DE/SMG-020653

ICS: 33.020

**Key words:** EFR, CODEC, digital cellular telecommunications system, Global System for Mobile communications (GSM), speech, ANSI-C code

GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

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

**ETSI**

European Telecommunications Standards Institute

**ETSI Secretariat**

**Postal address:** F-06921 Sophia Antipolis CEDEX - FRANCE
**Office address:** 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
**X.400:** c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

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

# Contents

Blank page

## Foreword

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

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

This ETS corresponds to GSM technical specification, GSM 06.53, version 5.1.2.

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

| **Transposition dates** | |
|---|---|
| Date of adoption: | 28 February 1997 |
| Date of latest announcement of this ETS (doa): | 30 June 1997 |
| Date of latest publication of new National Standard or endorsement of this ETS (dop/e): | 31 December 1997 |
| Date of withdrawal of any conflicting National Standard (dow): | 31 December 1997 |

Blank page

# 1 Scope

This European Telecommunication Standard (ETS) 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 (ETS 300 726) [3]), Voice Activity Detection (GSM 06.82 (ETS 300 730) [7]), comfort noise (GSM 06.62 (ETS 300 728) [5]), Discontinuous Transmission (GSM 06.81 (ETS 300 729) [6]) and example solutions for substituting and muting of lost frames (GSM 06.61 (ETS 300 727) [4]).

# 2 Normative references

This ETS 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 ETS 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 (ETS 300 725): "Digital cellular telecommunications system (Phase 2); Test sequences for the GSM Enhanced Full Rate (EFR) speech codec".

[3] GSM 06.60 (ETS 300 726): "Digital cellular telecommunications system; Enhanced Full Rate (EFR) speech transcoding".

[4] GSM 06.61 (ETS 300 727): "Digital cellular telecommunications system; Substitution and muting of lost frame for Enhanced Full Rate (EFR) speech traffic channels".

[5] GSM 06.62 (ETS 300 728): "Digital cellular telecommunications system; Comfort noise aspects for Enhanced Full Rate (EFR) speech traffic channels".

[6] GSM 06.81 (ETS 300 729): "Digital cellular telecommunications system; Discontinuous transmission (DTX) for Enhanced Full Rate (EFR) speech traffic channels".

[7] GSM 06.82 (ETS 300 730): "Digital cellular telecommunications system; 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 ETS can be found in GSM 06.60 (ETS 300 726) [3], GSM 06.61 (ETS 300 727) [4], GSM 06.62 (ETS 300 728) [5], GSM 06.81 (ETS 300 729) [6] and GSM 06.82 (ETS 300 730) [7].

## 3.2 Abbreviations

For the purposes of this ETS, 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 (ETS 300 725) [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.

---

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

### 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.

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.

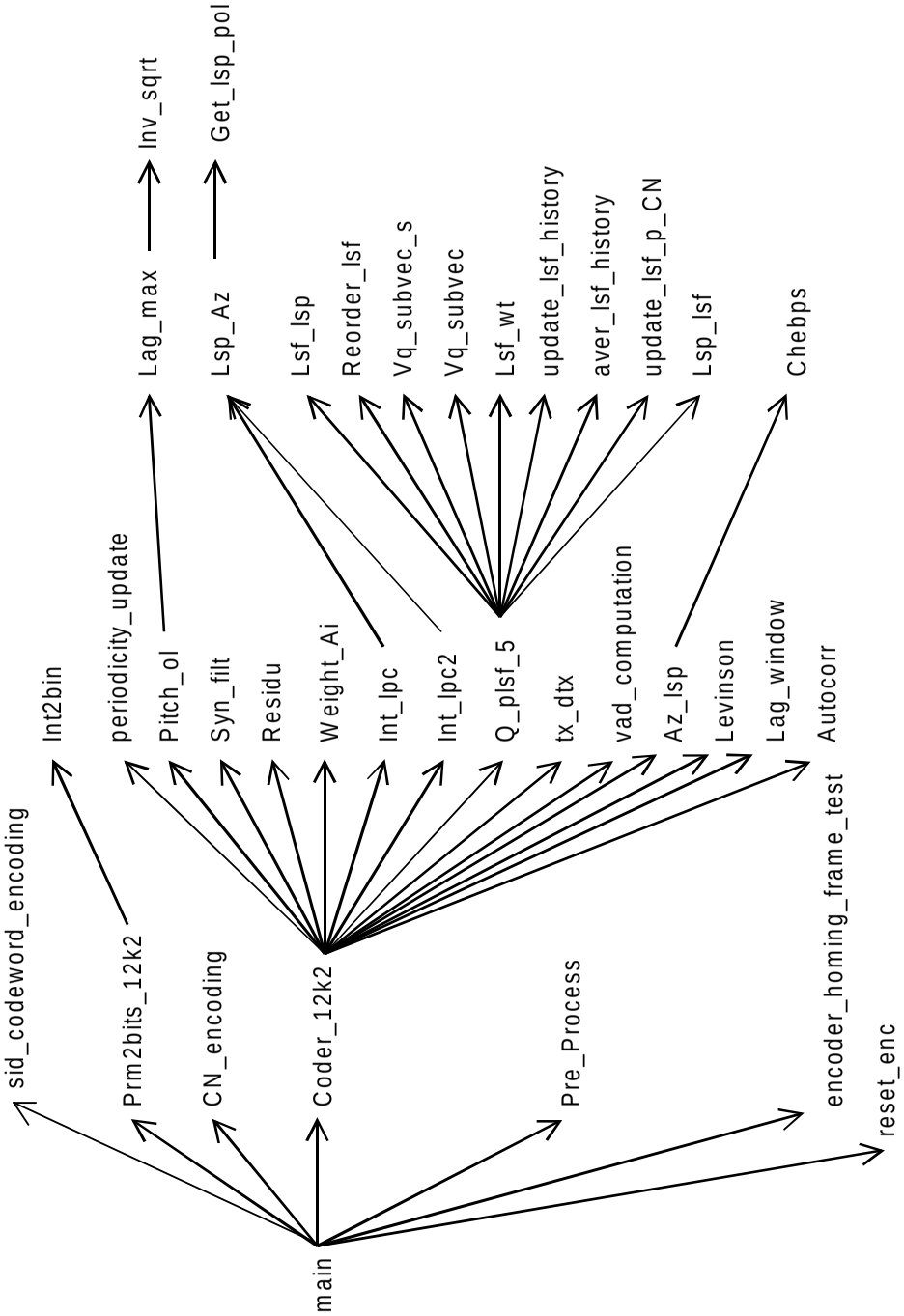


**Figure 1: Speech encoder call graph (see figures 2 and 3)**

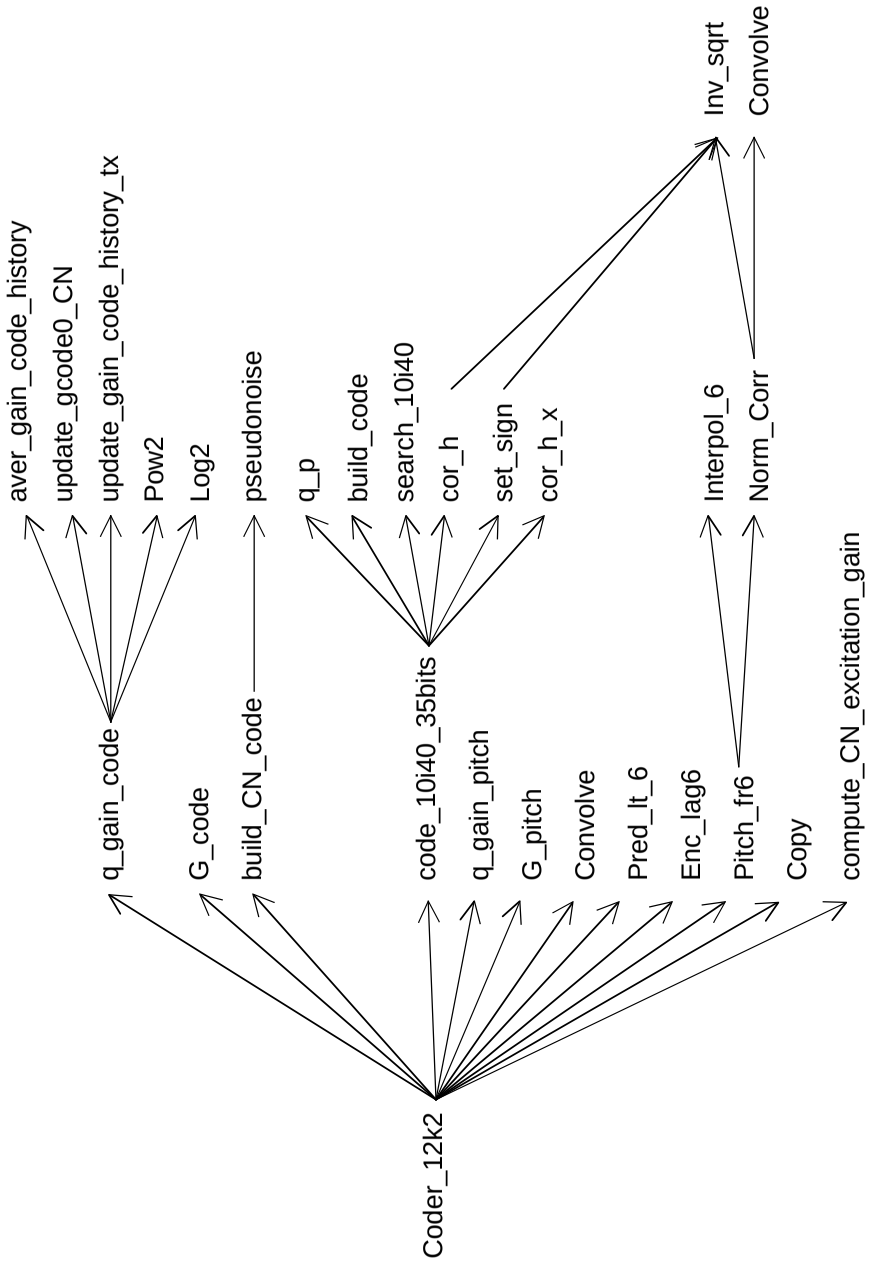


**Figure 2: Speech encoder subframe processing call graph**

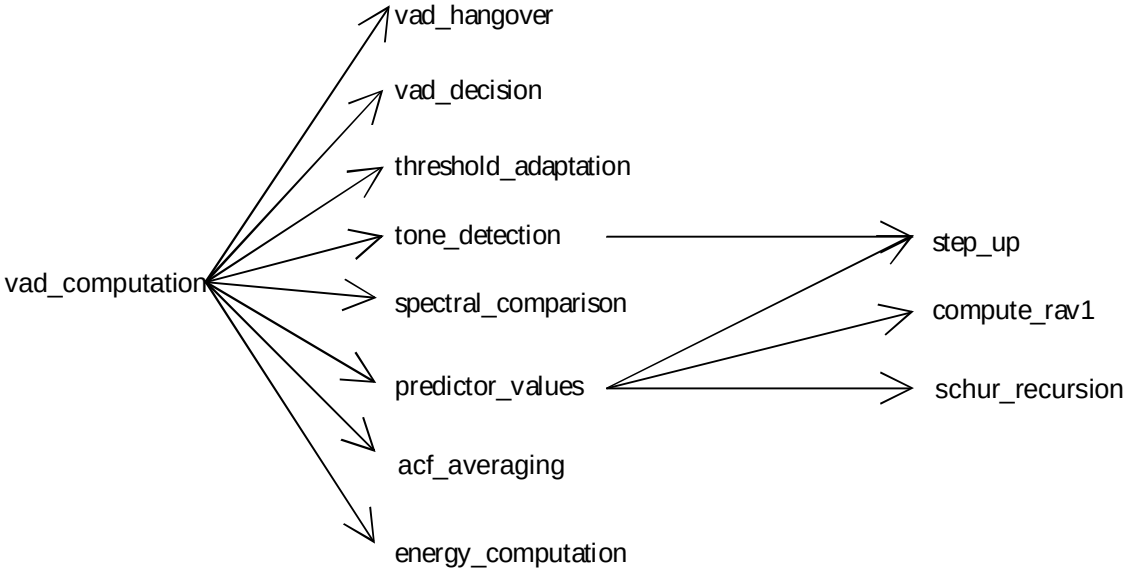


**Figure 3: Voice Activity Detector (VAD) call graph**

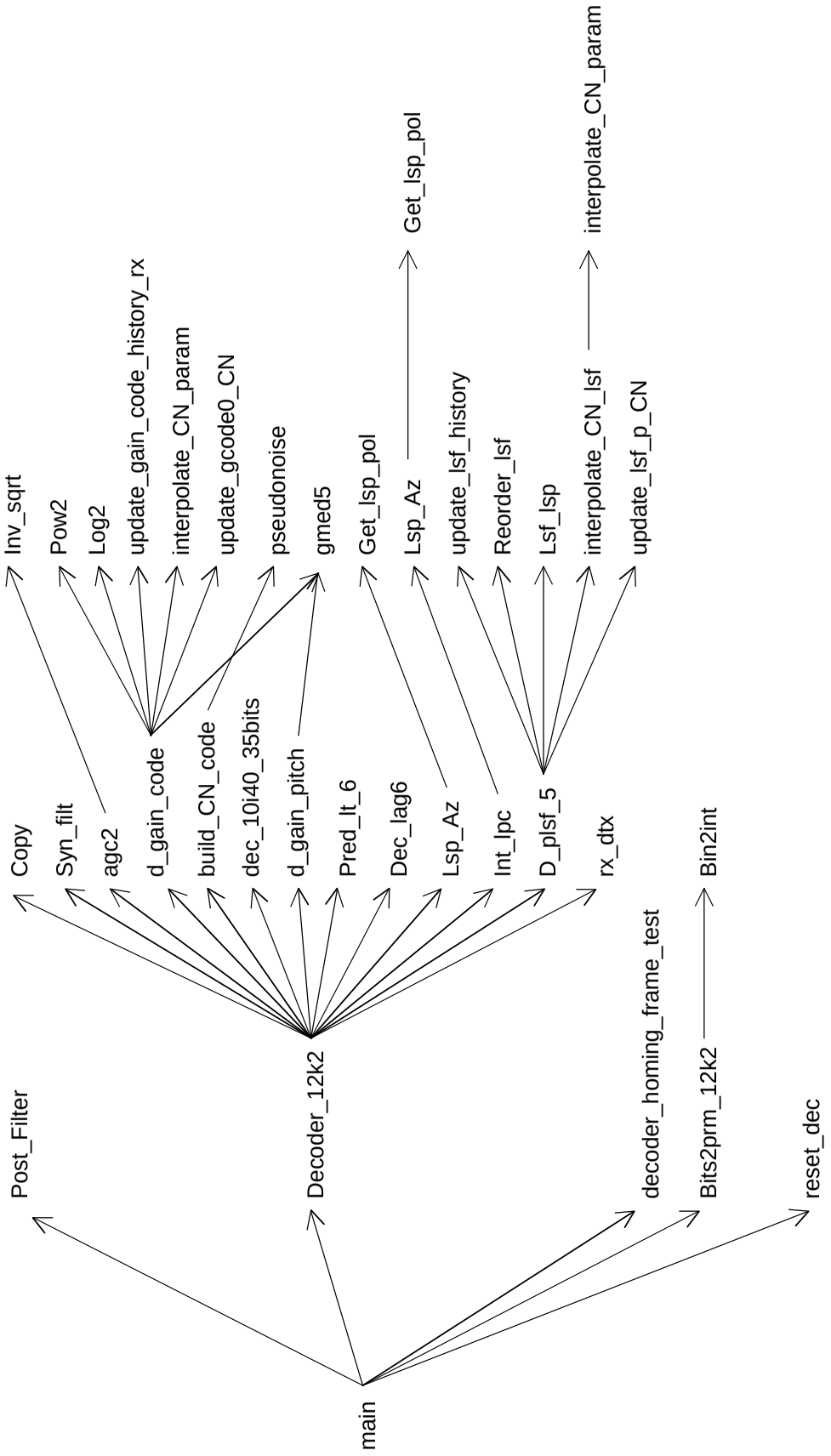


**Figure 4: Speech decoder call graph (see figure 5)**

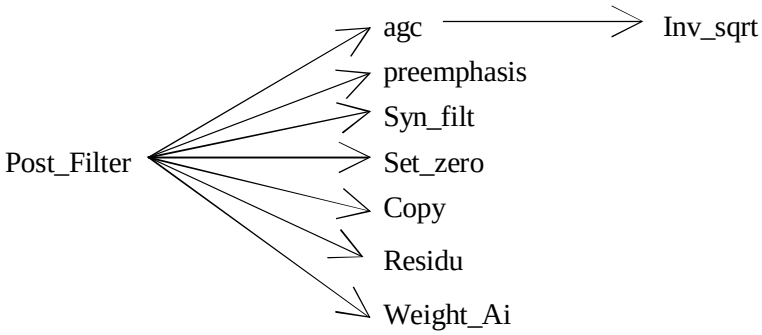


**Figure 5: Speech decoder postfilter call graph**

## History

| Document history | | | |
|---|---|---|---|
| February 1996 | Public Enquiry | PE 103: | 1996-03-04 to 1996-06-28 |
| November 1996 | Vote | V 115: | 1996-11-25 to 1997-02-21 |
| March 1997 | First Edition | | |
| | | | |
| | | | |

ISBN 2-7437-1343-7
Dépôt légal : Mars 1997