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*European Standard (Telecommunications series)*

**Digital cellular telecommunications system (Phase 2+);  
Half rate speech;  
ANSI-C code for the GSM half rate speech codec  
(GSM 06.06 version 7.0.1 Release 1998)**

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**GSM**®  
GLOBAL SYSTEM FOR  
MOBILE COMMUNICATIONS

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Reference

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Keywords

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**ETSI**

Postal address

---

F-06921 Sophia Antipolis Cedex - FRANCE

Office address

---

650 Route des Lucioles - Sophia Antipolis  
Valbonne - 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

Internet

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secretariat@etsi.fr  
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## Foreword

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

An electronic attachment accompanies the present document, this contains clause 5, the bit-exact ANSI-C code for the GSM half rate codec.

The present document specifies the half rate speech traffic channels for the digital cellular telecommunications system. The present document is part of a series covering the half rate speech traffic channels as described below:

GSM 06.02	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech processing functions".
<b>GSM 06.06</b>	<b>"Digital cellular telecommunications system (Phase 2+); Half rate speech; ANSI-C code for the GSM half rate speech codec".</b>
GSM 06.07	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Test sequences for the GSM half rate speech codec".
GSM 06.20	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech transcoding".
GSM 06.21	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Substitution and muting of lost frames for half rate speech traffic channels".
GSM 06.22	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Comfort noise aspects for half rate speech traffic channels".
GSM 06.41	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Discontinuous Transmission (DTX) for half rate speech traffic channels".
GSM 06.42	"Digital cellular telecommunications system (Phase 2+); Half rate speech; Voice Activity Detector (VAD) for half rate speech traffic channels".

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

Version 7.x.y

where:

- 7 indicates Release 1998 of GSM Phase 2+.
- x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the third digit is incremented when editorial only changes have been incorporated in the specification.

<b>National transposition dates</b>	
Date of adoption of this EN:	31 December 1999
Date of latest announcement of this EN (doa):	31 March 2000
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 September 2000
Date of withdrawal of any conflicting National Standard (dow):	30 September 2000

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# 1 Scope

The present document contains an electronic copy of the ANSI-C code for the GSM half rate codec. The ANSI-C code is necessary for a bit exact implementation of the half rate speech transcoder (GSM 06.20 [2]), Voice Activity Detector (GSM 06.42 [6]), comfort noise (GSM 06.22 [4]), Discontinuous Transmission (GSM 06.41 [5]) and example solutions for substituting and muting of lost frames (GSM 06.21 [3]).

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# 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.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release 1998 document, references to GSM documents are for Release 1998 versions (version 7.x.y).

- [1] GSM 01.04: "Digital cellular telecommunication system (Phase 2+); Abbreviations and acronyms".
- [2] GSM 06.20: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Half rate speech transcoding".
- [3] GSM 06.21: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Substitution and muting of lost frame for half rate speech traffic channels".
- [4] GSM 06.22: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Comfort noise aspects for half rate speech traffic channels".
- [5] GSM 06.41: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Discontinuous Transmission (DTX) for half rate speech traffic channels".
- [6] GSM 06.42: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Voice Activity Detector (VAD) for half rate speech traffic channels".
- [7] GSM 06.07: "Digital cellular telecommunications system (Phase 2+); Half rate speech; Test sequences for the GSM half rate speech codec".
- [8] American National Standards Institute ANSI 9899 (1990): "Programming Language - C (ISO)".

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# 3 Definitions and abbreviations

## 3.1 Definitions

Definition of terms used in the present document can be found in GSM 06.20 [2], GSM 06.21 [3], GSM 06.22 [4], GSM 06.41 [5] and GSM 06.42 [6].

## 3.2 Abbreviations

For the purposes of the present document, 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 [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 electronic attachment accompanying the present document.

The C code has been verified on the following systems:

- Sun Microsystem's <sup>1)</sup> workstations and Sun Microsystems acc;
- IBM <sup>2)</sup> PC/AT compatible computers and Borlands Turbo-C <sup>3)</sup> compiler;
- VAX <sup>4)</sup> and Digital Equipment Corporations CC.

ANSI-C 9899 [8] was selected as the programming language because portability was desirable.

The code representation is contained in a MS-DOS <sup>5)</sup> file (called Disk and contained in archive 8vo03i0o.ZIP which accompanies the present document.

### 4.1 Directory structure

A listing of the directories is given in table 1.

**Table 1: Directory structure listing**

Directory name	Contents	Size (bytes)
\c	C files and headers	1 215 563
\d	example binary data input and output files	72 400
\exec	executables and makefiles	5 509
\utils	utility programs and the "reid" program	49 531
readme.txt	usage description of files	9 116

The C code file (called Disk and contained in archive 8vo03i0o.ZIP) which accompanies the present document has one main directory and four subdirectories. The top directory has in it the file readme.txt which explains the installation procedure, along with some miscellaneous descriptive information regarding the code.

Below this directory, are the four subdirectories. The "c" subdirectory contains all the source code and header files. This directory alone is essential, the others aid in the building, or testing of the code. All ROM data is in this source directory. After installation, this directory can be made read only.

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 2) Registered trade mark of International Business Machines  
 3) Registered trade mark of Borland  
 4) Registered trade mark of Digital Equipment Corporation  
 5) Registered trade mark of Microsoft

The "d" subdirectory contains all the speech coder installation verification data files. All of the data files are written/read as 16 bit words, so these may require byte swapping on the target platform. All data and text files are formatted such that they are correct for an IBM PC/AT compatible.

Final verification is to be performed using the GSM half rate test sequences described in GSM 06.07 [7].

The "utils" subdirectory contains miscellaneous utilities which may be useful in the installation of the software. Two programs are provided to transform text files: topcwild and tosnwild. The program topcwild takes UNIX text files and converts them to pc text files. tosnwild does the opposite. The program swapbin is also in this directory. This performs byte swapping on a binary data file. A fourth program, reid, is also contained in this sub directory. This is the residual error insertion program which also provides the format conversion between the encoder output file format and the decoder input file format.

The "exec" subdirectory contains the makefiles for the various platforms. Once the software is installed, this directory will have a compiled version of gsm\_hr (the bit-exact C executable), programs from the "utils" directory, and all the object files.

The program gsm\_hr is the name of the GSM half rate codec executable file.

## 4.2 Program execution

The GSM half rate speech codec is implemented as two separate programs:

- (gsm\_hr) speech codec;
- (reid) encoder/decoder interface.

The gsm\_hr program operates in one of two modes:

- (0) encoding only;
- (1) decoding only.

For encoding, the input is a binary speech file (\*.inp) and the output is a binary encoded parameter file (\*.cod). For decoding, the input is a binary parameter files (\*.dec) and the output is a binary synthesized speech file (\*.out). Note that 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 reid program will translate an \*.cod file into an \*.dec file (select error-free mode, EP0).

See the file readme.txt for more information on how to run the gsm\_hr and reid programs.

## 4.3 Code hierarchy

Figures 1 to 7 are call graphs that show the functions used in the speech codec.

The encode call graph is broken down into six separate call graphs. Those sections, which are large, are separated from the primary encode call tree and given their own call tree. Each vertical column represents a call level. For example, main() is at level 0, encode() at level 1, speechEncoder() at level 2, openLoopLagSearch() at level 3, getCCThreshold() at level 4, etc. The basic operations are not counted as extending the depth, therefore the deepest level is this software is level 6.

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\_mpy\_ls()) appear in the graphs.



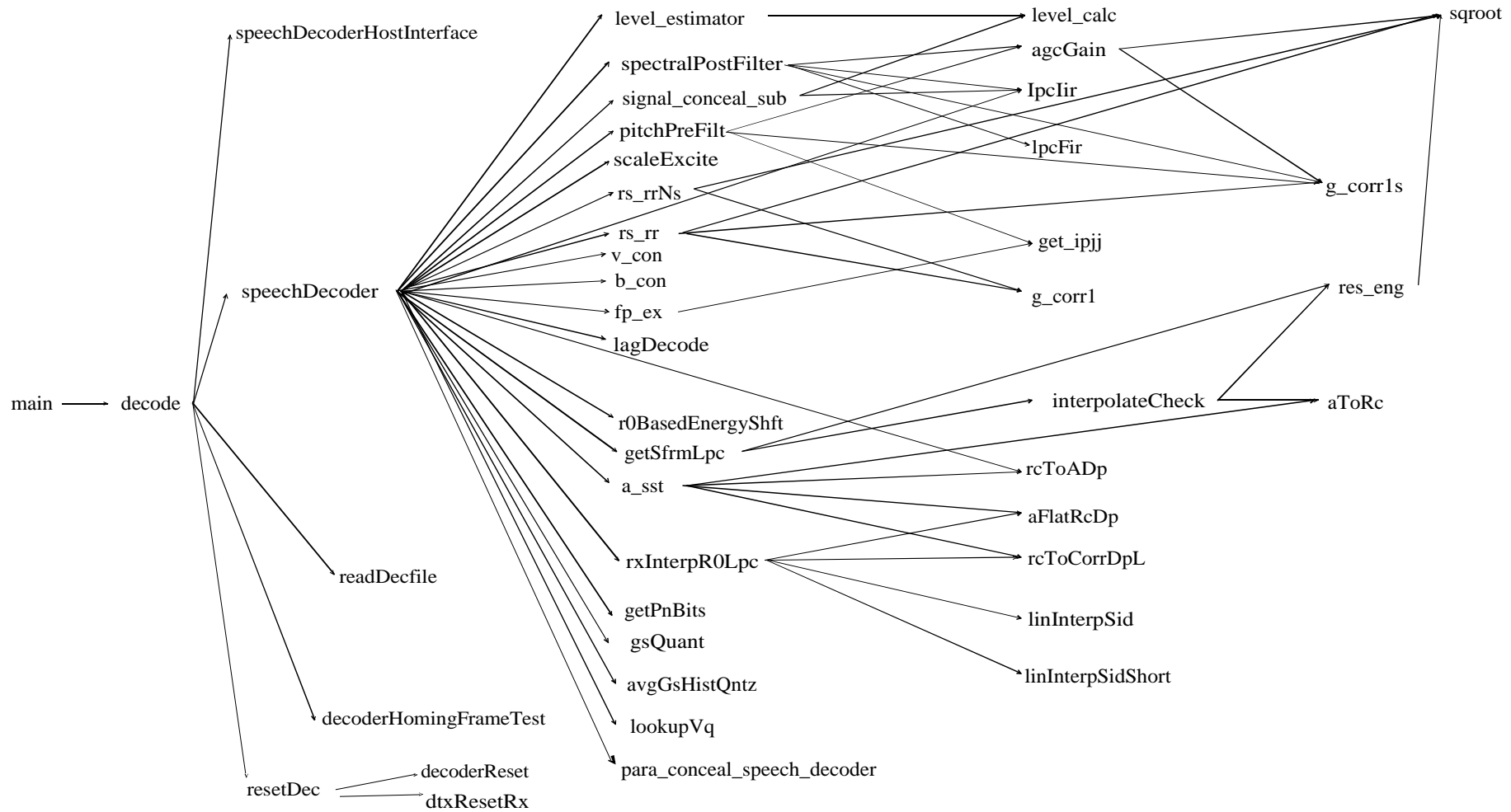


Figure 1: Speech decoder call graph

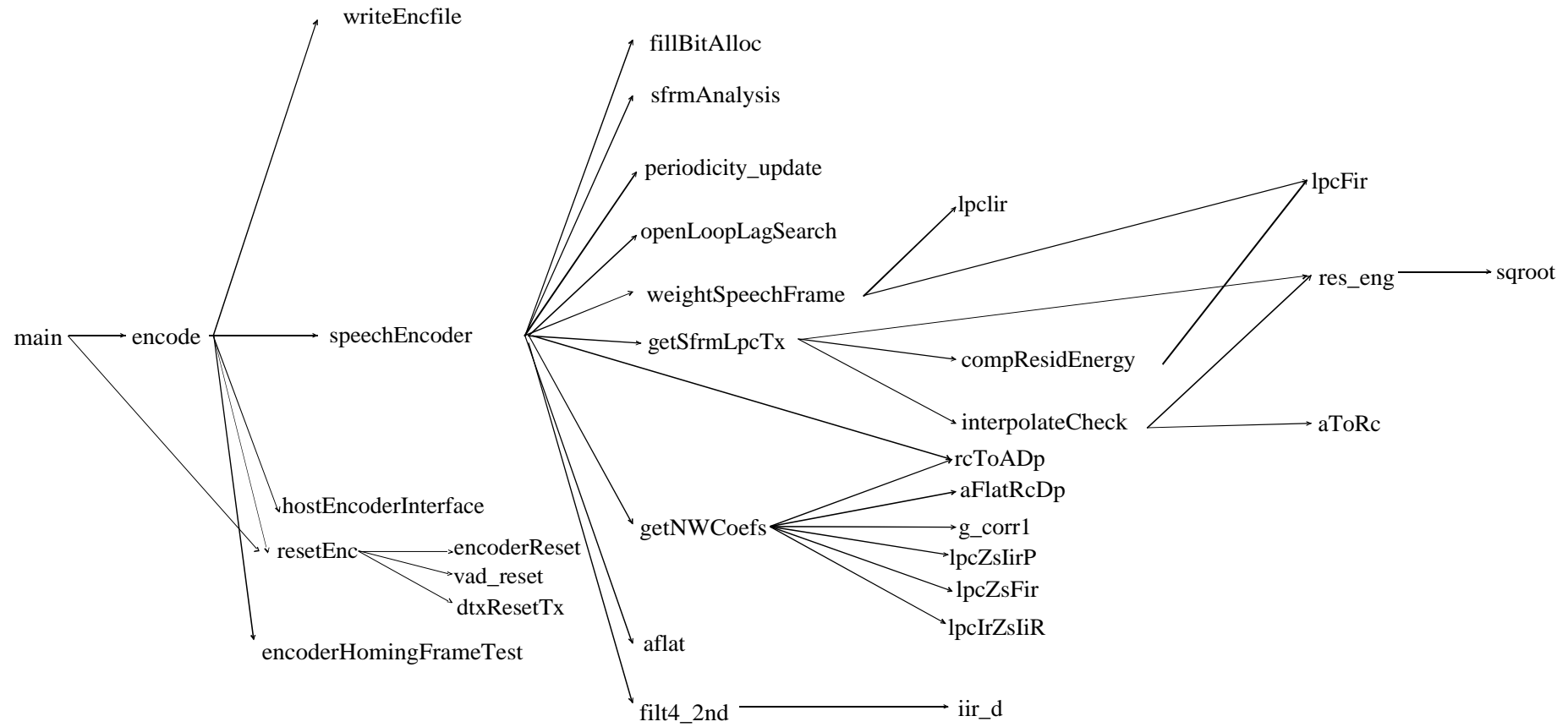


Figure 2: Speech encoder call graph



Figure 3: Speech encoder LPC quantization call graph

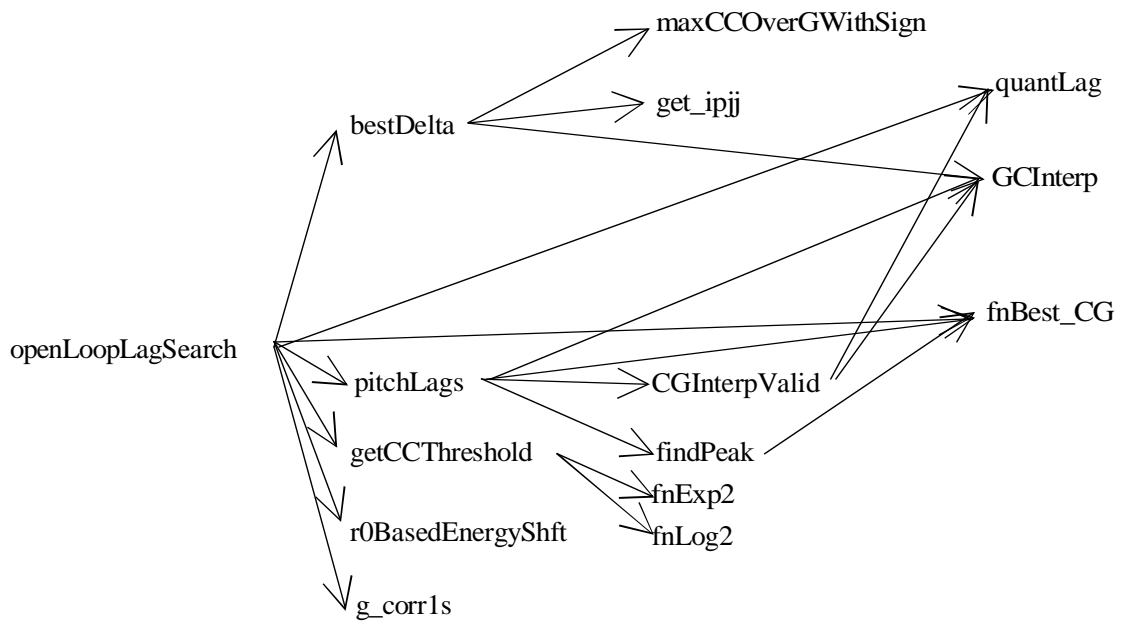


Figure 4: Speech encoder open-loop lag search call graph

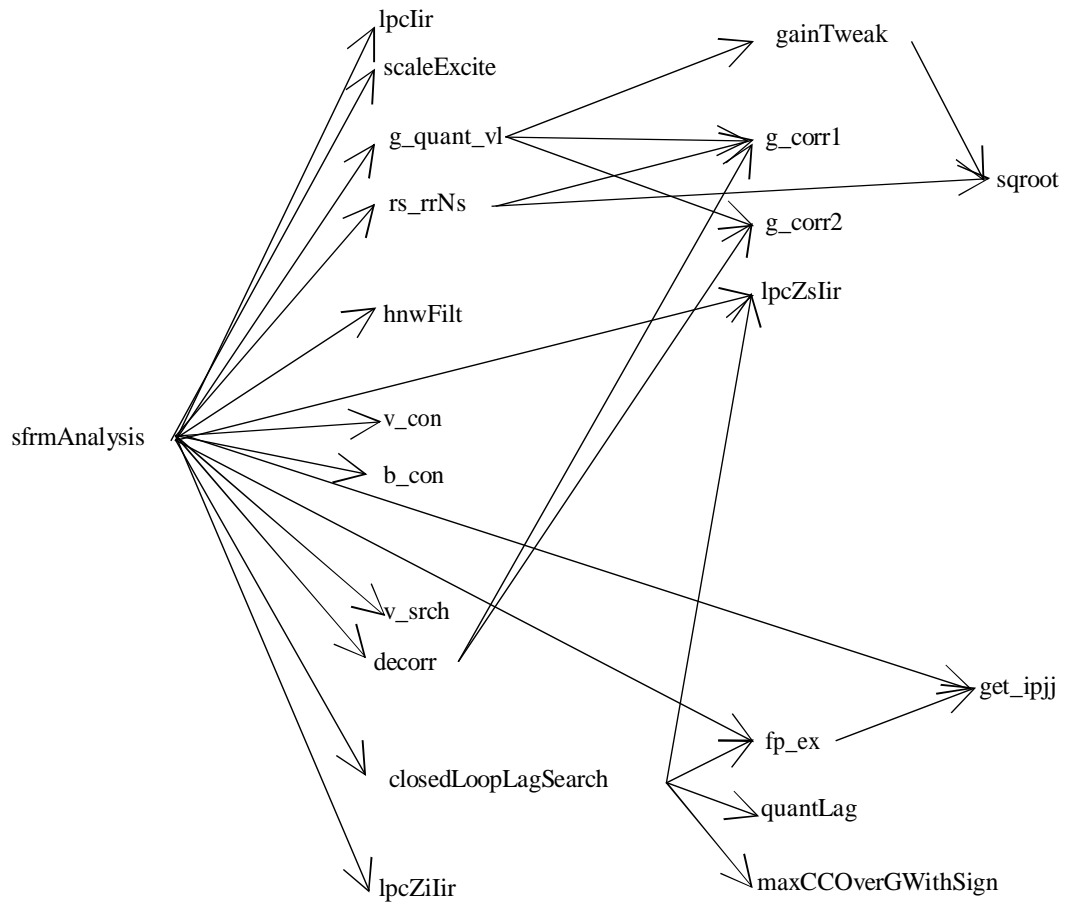


Figure 5: Speech encoder subframe processing call graph

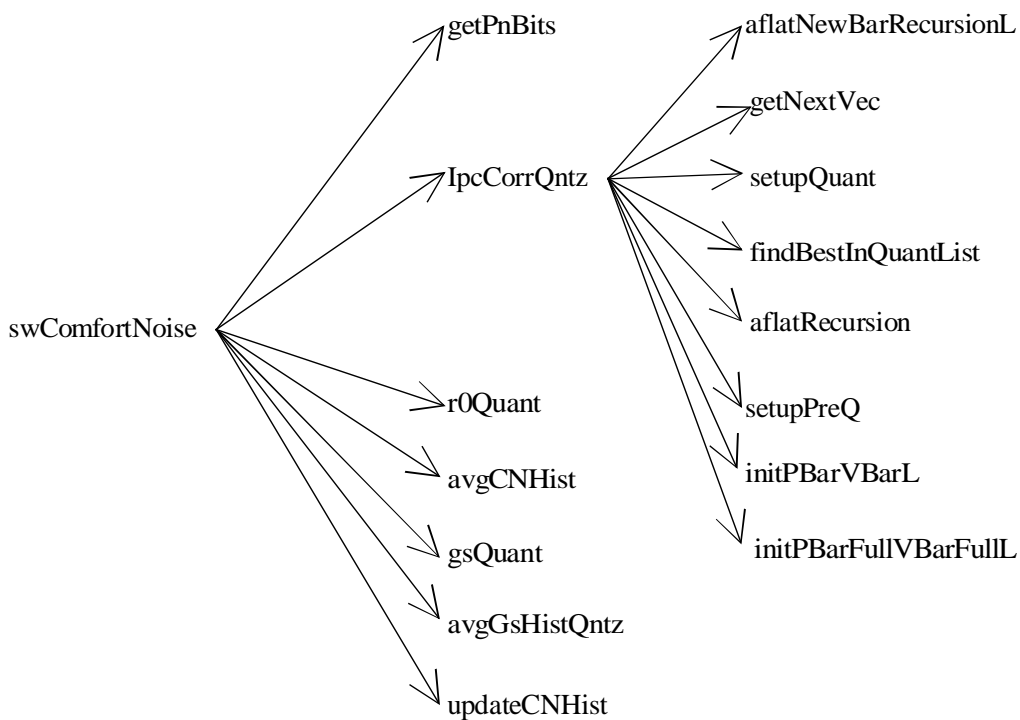


Figure 6: Comfort noise call graph

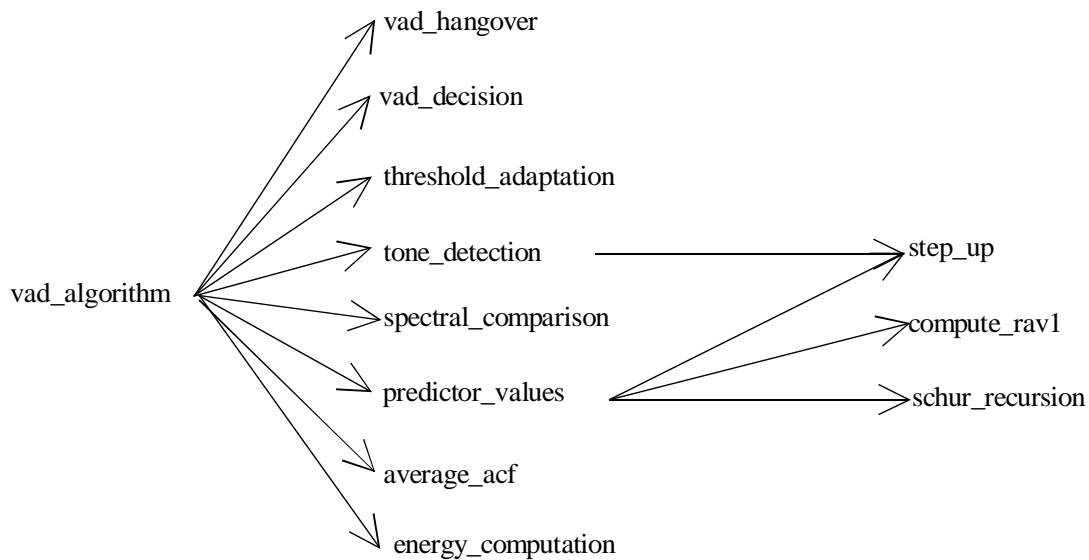


Figure 7: Voice Activity Detector (VAD) call graph

## 5 ANSI-C code for the GSM half rate speech codec

NOTE: This clause is contained in archive 8vo03i0o.ZIP which accompanies the present document.

## Annex A (informative): Change Request History

<b>Change history</b>					
<b>SMG No.</b>	<b>TDoc. No.</b>	<b>CR. No.</b>	<b>Section affected</b>	<b>New version</b>	<b>Subject/Comments</b>
SMG#16				4.0.3	ETSI Publication
SMG#17	332/95 119/96	A001 A002		4.1.0	HR C-code GSM half rate Codec Homing Procedure
SMG#23	97-737	A002		4.1.1	UAP60 and Supplementary notes on 06.06 Call Graph Changes
SMG#20				5.0.0	Release 1996 version
SMG#20				5.0.1	ETSI version change
SMG#22	430/97	A002		5.1.0	UAP 60
SMG#23	97-737	A003		5.1.1	UAP60 and Supplementary notes on 06.06 Call Graph Changes
SMG#27				6.0.0	Release 1997 version
SMG#28				6.0.1	ETSI Publication
SMG#29				7.0.0	Release 1998 version
				7.0.1	Version update to 7.0.1 for Publication



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# History

<b>Document history</b>		
V7.0.0	August 1999	One-step Approval Procedure OAP 9956: 1999-08-25 to 1999-12-24
V7.0.1	January 2000	Publication