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ANSI-C code for the Adaptive Multi Rate (AMR) speech codec

(Release 16)

** 

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# Foreword

This Technical Specification (TS) 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:

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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 contains an electronic copy of the ANSI‑C code for the Adaptive Multi-Rate codec. The ANSI‑C code is necessary for a bit exact implementation of the Adaptive Multi Rate speech transcoder (TS 26.090 [2]), Voice Activity Detection (TS 26.094 [6]), comfort noise (TS 26.092 [4]), source controlled rate operation (TS 26.093 [5]) and example solutions for substituting and muting of lost frames (TS 26.091 [3]).

# 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.

[1] 3GPP TS 26.074: "AMR Speech Codec; Test sequences".

[2] 3GPP TS 26.090: "AMR Speech Codec; Speech transcoding".

[3] 3GPP TS 26.091: "AMR Speech Codec; Substitution and muting of lost frames".

[4] 3GPP TS 26.092: "AMR Speech Codec; Comfort noise aspects".

[5] 3GPP TS 26.093: "AMR Speech Codec; Source controlled rate operation".

[6] 3GPP TS 26.094: "AMR Speech Codec; Voice Activity Detection".

[7] RFC 3267: "A Real-Time Transport Protocol (RTP) Payload Format and File Storage Format for Adaptive Multi-Rate (AMR) and Adaptive Multi-Rate Wideband (AMR-WB) Audio Codecs", June 2002.

# 3 Definitions and abbreviations

## 3.1 Definitions

Definition of terms used in the present document, can be found in TS 06.090  [2], TS 06.091  [3], TS 06.092  [4], TS 06.093  [5] and TS 06.094  [6].

## 3.2 Abbreviations

For the purpose of the present document, the following abbreviations apply:

ANSI American National Standards Institute

ETS European Telecommunication Standard

GSM Global System for Mobile communications

I/O Input/Output

RAM Random Access Memory

ROM Read Only Memory

# 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 C code attached to this document.

The C code has been verified on the following systems:

- Sun Microsystems workstations and GNU gcc compiler;

- DEC Alpha workstations and GNU gcc compiler;

- IBM PC/AT compatible computers with Linux operating system and GNU gcc compiler.

ANSI‑C 9899 was selected as the programming language because portability was desirable.

## 4.1 Contents of the C source code

The C code distribution has all files in the root level.

The distributed 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".

The C code distribution also 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 computer. 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.

Final verification is to be performed using the GSM Adaptive Multi-Rate test sequences described in GSM 06.74  [2].

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

## 4.2 Program execution

The GSM Adaptive Multi-Rate codec is implemented in two programs:

*-* (*encoder*) speech encoder;

*-* (*decoder*) speech decoder.

The programs should be called like:

- encoder [encoder options] <speech input file> <parameter file>;

- decoder [decoder options] <parameter file> <speech output file>.

The speech files contain 16-bit linear encoded PCM speech samples and the parameter files contain encoded speech data and some additional flags.

The encoder and decoder options will be explained by running the applications with option –h. See the file readme.txt for more information on how to run the *encoder* and *decoder*  programs.

## 4.3 Coding style

The C code is written according to the following structuring conventions. Each function func() that needs static variables is considered a module. A module consists of:

- a 'state structure' (struct) combining the static variables of the module;

- three auxiliary functions func\_init(), func\_reset(), and func\_exit();

- the processing function func() itself.

The initialization function func\_init() allocates (from the heap) a new state structure, calls the func\_reset() function, stores the pointer to the newly allocated structure in its first function parameter, and returns with a value of 0 if completed successful or a value of 1 otherwise.

The reset function func\_reset() takes a pointer to the state structure and resets all members of the structure to a predefined value ('homing').

The exit function func\_exit() performs any necessary cleanup and frees the state structure memory.

The processing function func() also takes a pointer to the state structure as well as all other necessary parameters and performs its task using (and possibly modifying) the values in the state structure.

If a module calls other modules, the higher level state structure contains a pointer to the lower level state structures, and the init, reset, and exit functions recursively call the corresponding lower level functions.

By this convention, the code becomes "instantiable" (more than one copy of a module can be used in the same program) and the static data hierarchy is clearly visible in the code.

## 4.4 Code hierarchy

Figures 1 to 4 are call graphs that show the functions used in the speech codec, including the functions of VAD, DTX, and comfort noise generation.

Each column represents a call level and each cell a function. The functions contain calls to the functions in rightwards neighbouring cells. The time order in the call graphs is from the top downwards as the processing of a frame advances. 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 initialization of the static RAM (i.e. calling the \_init functions) is also omitted.

The basic operations are not counted as extending the depth, therefore the deepest level in this software is level 7.

The encoder call graph is broken down into three separate call graphs, Table 1 to 3.

Table 1: Speech encoder call structure

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Speech\_Encode\_Frame | Pre\_Process |  |  |  |  |
|  | cod\_amr | Copy |  |  |  |
|  |  | Vad1[[1]](#footnote-2)1 | filter\_bank | first\_filter\_stage |  |
|  |  |  |  | filter5 |  |
|  |  |  |  | filter3 |  |
|  |  |  |  | level\_calculation |  |
|  |  |  | vad\_decision | complex\_estimate\_adapt |  |
|  |  |  |  | complex\_vad |  |
|  |  |  |  | noise\_estimate\_update | update\_cntrl |
|  |  |  |  | hangover\_addition |  |
|  |  | Vad2**1** | block\_norm |  |  |
|  |  |  | r\_fft | c\_fft |  |
|  |  |  | fn10Log10 | Log2 | Log2\_norm |
|  |  |  | Pow2 |  |  |
|  |  | tx\_dtx\_handler |  |  |  |
|  |  | lpc | Autocorr |  |  |
|  |  |  | Lag\_window |  |  |
|  |  |  | Levinson |  |  |
|  |  | lsp | Az\_lsp | Chebps |  |
|  |  |  | Q\_plsf\_5 | Lsp\_lsf |  |
|  |  |  |  | Lsf\_wt |  |
|  |  |  |  | Vq\_subvec |  |
|  |  |  |  | Vq\_subvec\_s |  |
|  |  |  |  | Reorder\_lsf |  |
|  |  |  |  | Lsf\_lsp |  |
|  |  |  | Int\_lpc\_1and3\_2 | Lsp\_az | Get\_lsp\_pol |
|  |  |  | Int\_lpc\_1and3 | Lsp\_az | Get\_lsp\_pol |
|  |  |  | Q\_plsf\_3 | Lsp\_lsf |  |
|  |  |  |  | Lsf\_wt |  |
|  |  |  |  | Copy |  |
|  |  |  |  | Vq\_subvec3 |  |
|  |  |  |  | Vq\_subvec4 |  |
|  |  |  |  | Reorder\_lsf |  |
|  |  |  |  | Lsf\_lsp |  |
|  |  |  | Int\_lpc\_1to3\_2 | Lsp\_az | Get\_lsp\_pol |
|  |  |  | Int\_lpc\_1to3 | Lsp\_az | Get\_lsp\_pol |
|  |  |  | Copy |  |  |
|  |  | dtx\_buffer | Copy |  |  |
|  |  |  | Log2 | Log2\_norm |  |
|  |  | dtx\_enc | Lsp\_lsf |  |  |
|  |  |  | Reorder\_lsf |  |  |
|  |  |  | Lsf\_lsp |  |  |
|  |  | Set\_zero |  |  |  |
|  |  | lsp\_reset | Copy |  |  |
|  |  |  | Q\_plsf\_reset |  |  |
|  |  | cl\_ltp\_reset | Pitch\_fr\_reset |  |  |
|  |  | check\_lsp |  |  |  |
|  |  | pre\_big | Weight\_Ai |  |  |
|  |  |  | Residu |  |  |
|  |  |  | Syn\_filt |  |  |
|  |  | ol\_ltp | Pitch\_ol | vad\_tone\_detection\_update[[2]](#footnote-3)2 |  |
|  |  |  |  | Lag\_max | vad\_tone\_detection**2** |
|  |  |  |  |  | Inv\_sqrt |
|  |  |  |  | comp\_corr**2** |  |
|  |  |  |  | hp\_max**2** |  |
|  |  |  |  | vad\_complex\_detection\_update**2** |  |
|  |  |  | Pitch\_ol\_wgh | comp\_corr**2** |  |
|  |  |  |  | Lag\_max**2** | vad\_tone\_detection\_update**2** |
|  |  |  |  |  | vad\_tone\_detection**2** |
|  |  |  |  | gmed\_n |  |
|  |  |  |  | hp\_max**2** |  |
|  |  |  |  | vad\_complex\_detection\_update**2** |  |
|  |  | vad\_pitch\_detection | LTP\_flag\_update[[3]](#footnote-4)3 |  |  |
|  |  | subframePreProc | Weight\_Ai |  |  |
|  |  |  | Syn\_filt |  |  |
|  |  |  | Residu |  |  |
|  |  |  | Copy |  |  |
|  |  | cl\_ltp | Pitch\_fr | getRange |  |
|  |  |  |  | Norm\_Corr | Convolve |
|  |  |  |  |  | Inv\_sqrt |
|  |  |  |  | searchFrac | Interpol\_3or6 |
|  |  |  |  | Enc\_lag3 |  |
|  |  |  |  | Enc\_lag6 |  |
|  | | | | | |
| (continued) | | | | | |

Table 1 (concluded): Speech encoder call structure

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | Pred\_lt\_3or6 |  |  |
|  |  |  | Convolve |  |  |
|  |  |  | G\_pitch |  |  |
|  |  |  | check\_gp\_clipping |  |  |
|  |  |  | q\_gain\_pitch |  |  |
|  |  | cbsearch | see Table 2 |  |  |
|  |  | gainQuant | see Table 3 |  |  |
|  |  | update\_gp\_clipping | Copy |  |  |
|  |  | subframePostProc | Syn\_filt |  |  |
|  |  | Pred\_lt\_3or6 |  |  |  |
|  |  | Convolve |  |  |  |
|  | Prm2bits | Int2bin |  |  |  |

Table 2: cbsearch call structure

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| cbsearch | code\_2i40\_9bits | cor\_h\_x |  |  |  |
|  |  | set\_sign |  |  |  |
|  |  | cor\_h | Inv\_sqrt |  |  |
|  |  | search\_2i40 |  |  |  |
|  |  | build\_code |  |  |  |
|  | code\_2i40\_11bits | cor\_h\_x |  |  |  |
|  |  | set\_sign |  |  |  |
|  |  | cor\_h | Inv\_sqrt |  |  |
|  |  | search\_2i40 |  |  |  |
|  |  | build\_code |  |  |  |
|  | code\_3i40\_14bits | cor\_h\_x |  |  |  |
|  |  | set\_sign |  |  |  |
|  |  | cor\_h | Inv\_sqrt |  |  |
|  |  | search\_3i40 |  |  |  |
|  |  | build\_code |  |  |  |
|  | code\_4i40\_17bits | cor\_h\_x |  |  |  |
|  |  | set\_sign |  |  |  |
|  |  | cor\_h | Inv\_sqrt |  |  |
|  |  | search\_4i40 |  |  |  |
|  |  | build\_code |  |  |  |
|  | code\_8i40\_31bits | cor\_h\_x |  |  |  |
|  |  | set\_sign12k2 | Inv\_sqrt |  |  |
|  |  | cor\_h | Inv\_sqrt |  |  |
|  |  | search\_10and8i40 |  |  |  |
|  |  | build\_code |  |  |  |
|  |  | compress\_code | compress10 |  |  |
|  | code\_10i40\_35bits | cor\_h\_x |  |  |  |
|  |  | set\_sign12k2 | Inv\_sqrt |  |  |
|  |  | cor\_h | Inv\_sqrt |  |  |
|  |  | search\_10and8i40 |  |  |  |
|  |  | build\_code |  |  |  |
|  |  | q\_p |  |  |  |

Table 3: gainQuant call structure

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| gainQuant | gc\_pred\_copy | Copy |  |  |
|  | gc\_pred | Log2 | Log2\_norm |  |
|  |  | Log2\_norm |  |  |
|  | calc\_filt\_energies |  |  |  |
|  | calc\_target\_energy |  |  |  |
|  | MR475\_update\_unq\_pred | gc\_pred\_update |  |  |
|  | MR475\_gain\_quant | MR475\_quant\_store\_results | Log2 | Log2\_norm |
|  |  |  | gc\_pred\_update |  |
|  |  | gc\_pred | Log2 | Log2\_norm |
|  |  |  | Log2\_norm |  |
|  | G\_code |  |  |  |
|  | q\_gain\_code | Pow2 |  |  |
|  | MR795\_gain\_quant | q\_gain\_pitch |  |  |
|  |  | MR795\_gain\_code\_quant3 |  |  |
|  |  | calc\_unfilt\_energies | Log2 | Log2\_norm |
|  |  | gain\_adapt | gmed\_n |  |
|  |  | MR795\_gain\_code\_quant\_mod | sqrt\_l\_exp |  |
|  | Qua\_gain | Pow2 |  |  |
|  | gc\_pred\_update |  |  |  |

Table 4: Speech decoder call structure

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Speech\_Decode\_Frame | Bits2prm | Bin2int |  |  |  |
|  | Decoder\_amr | rx\_dtx\_handler |  |  |  |
|  |  | Decoder\_amr\_reset | lsp\_avg\_reset |  |  |
|  |  |  | D\_plsf\_reset |  |  |
|  |  |  | ec\_gain\_pitch\_reset |  |  |
|  |  |  | ec\_gain\_code\_reset |  |  |
|  |  |  | gc\_pred\_reset |  |  |
|  |  |  | Bgn\_scd\_reset | Set\_zero |  |
|  |  |  | ph\_disp\_reset |  |  |
|  |  |  | dtx\_dec\_reset | Copy |  |
|  |  |  |  | Set\_zero |  |
|  |  | dtx\_dec | Copy |  |  |
|  |  |  | Lsf\_lsp |  |  |
|  |  |  | Init\_D\_plsf\_3 | Copy |  |
|  |  |  | D\_plsf\_3 | Reorder\_lsf |  |
|  |  |  |  | Copy |  |
|  |  |  |  | Lsf\_lsp |  |
|  |  |  | pseudonoise |  |  |
|  |  |  | Lsp\_lsf |  |  |
|  |  |  | Reorder\_lsf |  |  |
|  |  |  | Lsp\_Az | Get\_lsp\_pol |  |
|  |  |  | A\_Refl |  |  |
|  |  |  | Log2 | Log2\_norm |  |
|  |  |  | Build\_CN\_code | pseudonoise |  |
|  |  |  | Syn\_filt |  |  |
|  |  | Lsf\_lsp |  |  |  |
|  |  | lsp\_avg |  |  |  |
|  |  | Copy |  |  |  |
|  |  | D\_plsf\_3 | Reorder\_lsf |  |  |
|  |  |  | Copy |  |  |
|  |  |  | Lsf\_lsp |  |  |
|  |  | Int\_lpc\_1to3 | Lsp\_Az | Get\_lsp\_pol |  |
|  |  | D\_plsf\_5 | Reorder\_lsf |  |  |
|  |  |  | Copy |  |  |
|  |  |  | Lsf\_lsp |  |  |
|  |  | Int\_lpc\_1and3 | Lsp\_Az | Get\_lsp\_pol |  |
|  |  | Dec\_lag3 |  |  |  |
|  |  | Pred\_lt\_3or6 |  |  |  |
|  |  | Dec\_lag6 |  |  |  |
|  |  | decode\_2i40\_9bits |  |  |  |
|  |  | decode\_2i40\_11bits |  |  |  |
|  |  | decode\_3i40\_14bits |  |  |  |
|  |  | decode\_4i40\_17bits |  |  |  |
|  |  | decode\_8i40\_31bits | decompress\_code | decompress10 |  |
|  |  | ec\_gain\_pitch | gmed\_n |  |  |
|  |  | d\_gain\_pitch |  |  |  |
|  |  | ec\_gain\_pitch\_update |  |  |  |
|  |  | decode\_10i40\_35bits |  |  |  |
|  |  | Dec\_gain | Log2 | Log2\_norm |  |
|  |  |  | gc\_pred | Log2 | Log2\_norm |
|  |  |  |  | Log2\_norm |  |
|  |  |  | Pow2 |  |  |
|  |  |  | gc\_pred\_update |  |  |
|  |  | ec\_gain\_code | gmed\_n |  |  |
|  |  |  | gc\_pred\_average\_limeted |  |  |
|  |  |  | gc\_pred\_update |  |  |
|  |  | ec\_gain\_code\_update |  |  |  |
|  |  | d\_gain\_code | gc\_pred | Log2 | Log2\_norm |
|  |  |  |  | Log2\_norm |  |
|  |  |  | Pow2 |  |  |
|  |  |  | gc\_pred\_update |  |  |
|  |  | Int\_lsf |  |  |  |
|  |  | Cb\_gain\_average |  |  |  |
|  |  | ph\_disp\_release |  |  |  |
|  |  | ph\_disp\_lock |  |  |  |
|  |  | ph\_disp |  |  |  |
|  |  | sqrt\_l\_exp |  |  |  |
|  |  | Ex\_ctrl | gmed\_n |  |  |
|  |  | agc2 | Inv\_sqrt |  |  |
|  |  | Syn\_filt |  |  |  |
|  |  | Bgn\_scd | gmed\_n |  |  |
|  |  | dtx\_dec\_activity\_update | Copy |  |  |
|  |  |  | Log2 | Log2\_norm |  |
|  |  | lsp\_avg |  |  |  |
|  | Post\_Filter | Copy |  |  |  |
|  |  | Weight\_Ai |  |  |  |
|  |  | Residu |  |  |  |
|  |  | Set\_zero |  |  |  |
|  |  | Syn\_filt |  |  |  |
|  |  | Preemphasis |  |  |  |
|  |  | agc | energy\_old |  |  |
|  |  |  | energy\_new | energy\_old |  |
|  |  |  | Inv\_sqrt |  |  |
|  | Post\_Process |  |  |  |  |

## 4.5 Variables, constants and tables

The data types of variables and tables used in the fixed point implementation are signed integers in 2's complement representation, defined by:

- **Word16** 16 bit variable;

- **Word32** 32 bit variable.

Furthermore some **enum** types are used, all possible to represent with one byte, and a Boolean **Flag**.

### 4.5.1 Description of constants used in the C-code

This subclause contains a listing of all global constants defined in cnst.h.

Table 5: Global constants

|  |  |  |
| --- | --- | --- |
| **Constant** | **Value** | **Description** |
| L\_TOTAL | 320 | total size of speech buffer. |
| L\_WINDOW | 240 | window size in LP analysis |
| L\_FRAME | 160 | frame size |
| L\_FRAME\_BY2 | 80 | frame size divided by 2 |
| L\_SUBFR | 40 | subframe size |
| L\_CODE | 40 | codevector length |
| NB\_TRACK | 5 | number of tracks |
| STEP | 5 | codebook step size |
| NB\_TRACK\_MR102 | 4 | number of tracks mode mr102 |
| STEP\_MR102 | 4 | codebook step size mode mr102 |
| M | 10 | order of LP filter |
| MP1 | (M+1) | order of LP filter + 1 |
| LSF\_GAP | 205 | minimum distance between LSF after quantization; 50 Hz = 205 |
| LSP\_PRED\_FAC\_MR122 | 21299 | MR122 LSP prediction factor (0.65 Q15) |
| AZ\_SIZE | 44 | size of array of LP filters in 4 subframes (4\*M+4) |
| PIT\_MIN\_MR122 | 18 | minimum pitch lag (MR122 mode) |
| PIT\_MIN | 20 | minimum pitch lag (all other modes) |
| PIT\_MAX | 143 | maximum pitch lag |
| L\_INTERPOL | (10+1) | length of filter for interpolation |
| L\_INTER\_SRCH | 4 | length of filter for CL LTP search interpolation |
| MU | 26214 | factor for tilt compensation filter 0,8 |
| AGC\_FAC | 29491 | factor for automatic gain control 0,9 |
| L\_NEXT | 40 | overhead in LP analysis |
| SHARPMAX | 13017 | maximum value of pitch sharpening |
| SHARPMIN | 0 | minimum value of pitch sharpening |
| MAX\_PRM\_SIZE | 57 | max. num. of params |
| MAX\_SERIAL\_SIZE | 244 | max. num. of serial bits |
| GP\_CLIP | 15565 | pitch gain clipping = 0.95 |
| N\_FRAME | 7 | old pitch gains in average calculation |
| EHF\_MASK | 8 | 16 bit representation of all samples in the encoder homing frame (left justification) |

### 4.5.2 Description of fixed tables used in the C-code

This section contains a listing of all fixed tables sorted by source file name and table name. All table data is declared as **Word16**.

Table 6: Fixed tables

|  |  |  |  |
| --- | --- | --- | --- |
| File | Table name | Length | Description |
| c2\_9pf.c | trackTable | 4\*5 | track table for algebraic code book search (MR475, MR515) |
| cod\_amr.c | gamma1 | 10 | spectral expansion factors |
| cod\_amr.c | gamma1\_12k2 | 10 | spectral expansion factors |
| cod\_amr.c | gamma2 | 10 | spectral expansion factors |
| dtx\_dec.c | lsf\_hist\_mean\_scale | 10 | initialization values for DTX lsf parameters |
| dtx\_dec.c | dtx\_log\_en\_adjust | 9 | level adjustments for ech mode |
| ec\_gains.c | cdown | 7 | attenuation factors for codebook gain |
| ec\_gains.c | pdown | 7 | attenuation factors for adaptive codebook gain |
| gc\_pred.c | pred | 4 | algebraic code book gain MA predictor coefficients |
| gc\_pred.c | pred\_MR122 | 4 | algebraic code book gain MA predictor coefficients (MR122) |
| pitch\_fr.c | mode\_dep\_parm | 72 | parameters defining the adaptive codebook search per mode |
| post\_pro.c | a | 3 | HP filter coefficients (denominator) in Post\_Process |
| post\_pro.c | b | 3 | HP filter coefficients (numerator) in Post\_Process |
| pre\_proc.c | a | 3 | HP filter coefficients (denominator) in Pre\_Process |
| pre\_proc.c | b | 3 | HP filter coefficients (numerator) in Pre\_Process |
| pred\_lt.c | inter\_6 | 61 | interpolation filter coefficients |
| pstfilt.c | gamma3\_MR122 | 10 | spectral expansion factors |
| pstfilt.c | gamma3 | 10 | spectral expansion factors |
| pstfilt.c | gamma4\_MR122 | 10 | spectral expansion factors |
| pstfilt.c | gamma4 | 10 | spectral expansion factors |
| bitno.tab | prmno | 9 | number of bits for each mode |
| bitno.tab | prmnofsf | 8 | number of parameters for LPC and first subframe for each mode (used for decoder homing procedure) |
| bitno.tab | bitno | 9 | pointers to the bitno\_MR... tables |
| bitno.tab | bitno\_MR475 | 17 | number of bits per parameter to transmit (MR475) |
| bitno.tab | bitno\_MR515 | 19 | number of bits per parameter to transmit (MR515) |
| bitno.tab | bitno\_MR59 | 19 | number of bits per parameter to transmit (MR59) |
| bitno.tab | bitno\_MR67 | 19 | number of bits per parameter to transmit (MR67) |
| bitno.tab | bitno\_MR74 | 19 | number of bits per parameter to transmit (MR74) |
| bitno.tab | bitno\_MR795 | 23 | number of bits per parameter to transmit (MR795) |
| bitno.tab | bitno\_MR102 | 39 | number of bits per parameter to transmit (MR102) |
| bitno.tab | bitno\_MR122 | 57 | number of bits per parameter to transmit (MR122) |
| bitno.tab | bitno\_MRDTX | 5 | number of bits per parameter to transmit (MRDTX) |
| c2\_11pf.tab | startPos1 | 2 | track start search position for first pulse |
| c2\_11pf.tab | startPos2 | 4 | track start search position for second pulse |
| c2\_9pf.tab | startPos | 16 | track start search position |
| corrwght.tab | corrweight | 251 | weighting of the correlation function in open loop LTP search (MR102) |
| d\_homing.tab | dhf | 8 | pointers to the dhf\_MR… tables |
| d\_homing.tab | dhf\_MR475 | 17 | parameter values for the decoder homing frame (MR475) |
| d\_homing.tab | dhf\_MR515 | 19 | parameter values for the decoder homing frame (MR515) |
| d\_homing.tab | dhf\_MR59 | 19 | parameter values for the decoder homing frame (MR59) |
| d\_homing.tab | dhf\_MR67 | 19 | parameter values for the decoder homing frame (MR67) |
| d\_homing.tab | dhf\_MR74 | 19 | parameter values for the decoder homing frame (MR74) |
| d\_homing.tab | dhf\_MR795 | 23 | parameter values for the decoder homing frame (MR795) |
| d\_homing.tab | dhf\_MR102 | 39 | parameter values for the decoder homing frame (MR102) |
| d\_homing.tab | dhf\_MR122 | 57 | parameter values for the decoder homing frame (MR122) |
| gains.tab | qua\_gain\_pitch | 16 | adaptive codebook gain quantization table (MR122, MR795) |
| gains.tab | qua\_gain\_code | 96 | fixed codebook gain quantization table (MR122, MR795) |
| gray.tab | gray | 8 | gray coding table |
| gray.tab | dgray | 8 | gray decoding table |
| grid.tab | grid | 61 | grid points at wich Chebyshev polynomials are evaluated |
| inter\_36.tab | inter\_6 | 25 | interpolation filter coefficients |
| inv\_sqrt.tab | table | 49 | table used in inverse square root computation |
| lag\_wind.tab | lag\_h | 10 | high part of the lag window table |
| lag\_wind.tab | lag\_l | 10 | low part of the lag window table |
| (continued) | | | |

Table 6 (concluded): Fixed tables

|  |  |  |  |
| --- | --- | --- | --- |
| File | Table name | Length | Description |
| log2.tab | table | 33 | table used inbase 2 logharithm computation |
| lsp.tab | lsp\_init\_data | 10 | initialization table for lsp history in DTX |
| lsp\_lsf.tab | table | 65 | table to compute cos(x) in Lsf\_lsp() |
| lsp\_lsf.tab | slope | 64 | table to compute acos(x) in Lsp\_lsf() |
| ph\_disp.tab | ph\_imp\_low\_MR795 | 40 | phase dispersion impulse response (MR795) |
| ph\_disp.tab | ph\_imp\_mid\_MR795 | 40 | phase dispersion impulse response (MR795) |
| ph\_disp.tab | ph\_imp\_low | 40 | phase dispersion impulse response (MR475 - MR67) |
| ph\_disp.tab | ph\_imp\_mid | 40 | phase dispersion impulse response (MR475 - MR67) |
| pow2.tab | table | 33 | table used in 2 to the power computation |
| q\_plsf\_3.tab | past\_rq\_init | 80 | initialization table for the MA predictor in DTX |
| q\_plsf\_3.tab | mean\_lsf | 10 | LSF means (not in MR122) |
| q\_plsf\_3.tab | pred\_fac | 10 | LSF prediction factors (not in MR122) |
| q\_plsf\_3.tab | dico1\_lsf | 3\*256 | 1st LSF quantizer (not in MR122 and MR795) |
| q\_plsf\_3.tab | dico2\_lsf | 3\*512 | 2nd LSF quantizer (not in MR122) |
| q\_plsf\_3.tab | dico3\_lsf | 4\*512 | 3rd LSF quantizer (not in MR122, MR515 and MR475) |
| q\_plsf\_3.tab | mr515\_3\_lsf | 4\*128 | 3rd LSF quantizer (MR515 and MR475) |
| q\_plsf\_3.tab | mr795\_1\_lsf | 3\*512 | 1st LSF quantizer (MR795) |
| q\_plsf\_5.tab | mean\_lsf | 10 | LSF means (MR122) |
| q\_plsf\_5.tab | dico1\_lsf | 4\*128 | 1st LSF quantizer (MR122) |
| q\_plsf\_5.tab | dico2\_lsf | 4\*256 | 2nd LSF quantizer (MR122) |
| q\_plsf\_5.tab | dico3\_lsf | 4\*256 | 3rd LSF quantizer (MR122) |
| q\_plsf\_5.tab | dico4\_lsf | 4\*256 | 4th LSF quantizer (MR122) |
| q\_plsf\_5.tab | dico5\_lsf | 4\*64 | 5th LSF quantizer (MR122) |
| qgain475.tab | table\_gain\_MR475 | 4\*256 | gain quantization table (MR475) |
| qua\_gain.tab | table\_gain\_highrates | 128\*4 | gain quantization table (MR67, MR74 and MR102) |
| qua\_gain.tab | table\_gain\_lowrates | 64\*4 | gain quantization table (MR515 and MR59) |
| R\_fft.c | phs\_tbl | 128 | sine/cosine phase table |
| R\_fft.c | ii\_table | 8 | indexing table |
| sqrt\_l | table | 49 | table to compute sqrt(x) |
| Vad1.c | ch\_tbl | 2\*16 | channel energy combination table |
| Vad1.c | ch\_tbl\_sh | 16 | channel energy scaling table |
| Vad1.c | vm\_tbl | 90 | voice metric table |
| Vad1.c | hangover\_table | 20 | used to determine hangover as a function of SNR |
| Vad1.c | burstcount\_table | 20 | used to determine burst count threshold as a function of SNR |
| Vad1.c | vm\_thresh\_table | 20 | used to determine the voice metric threshold as a function of SNR |
| Vad1.c | energy state tables | 2\*6 | constants as a function of scaling state |
| window.tab | window\_200\_40 | 240 | LP analysis window (not in MR122) |
| window.tab | window\_160\_80 | 240 | 1st LP analysis window (MR122) |
| window.tab | window\_232\_8 | 240 | 2nd LP analysis window (MR122) |

### 4.5.3 Static variables used in the C-code

In this section two tables that specify the static variables for the speech encoder and decoder respectively are shown. All static variables are declared within a C **struct.**

Table 7: Speech encoder static variables

| Struct name | Variable | Type[Length] | Description |
| --- | --- | --- | --- |
| Speech\_Encode\_ FrameState | cod\_amr\_state | cod\_amrState | see below in this table |
|  | pre\_state | Pre\_ProcessState | see below in this table |
|  | dtx | Flag | Is set if DTX functionality is used |
|  | complexityCounter | int | Used for wMOPS counting |
| Pre\_ProcessState | y2\_hi | Word16 | filter state, upper word |
|  | y2\_lo | Word16 | filter state, lower word |
|  | y1\_hi | Word16 | filter state, upper word |
|  | y1\_lo | Word16 | filter state, lower word |
|  | x0 | Word16 | filter state |
|  | x1 | Word16 | filter state |
| cod\_amrState | old\_speech | Word16[320] | speech buffer |
|  | speech | Word16\* | pointer to current frame in old\_speech |
|  | p\_window | Word16\* | pointer to LPC analysis window in old\_speech |
|  | p\_window\_12k2 | Word16\* | pointer to LPC analysis window with no lookahead in old\_speech (MR122) |
|  | new\_speech | Word16\* | pointer to the last 160 speech samples in old\_speech |
|  | old\_wsp | Word16[303] | buffer holding spectral weighted speech |
|  | wsp | Word16\* | pointer to the current frame in old\_wsp |
|  | old\_lags | Word16[5] | open loop LTP states |
|  | ol\_gain\_flg | Word16[2] | enables open loop pitch lag weighting (MR102) |
|  | old\_exc | Word16[314] | excitation vector |
|  | exc | Word16\* | current excitation |
|  | ai\_zero | Word16[51] | history of weighted synth. filter followed by zero vector |
|  | zero | Word16\* | zero vector |
|  | h1 | Word16\* | impulse response of weighted synthesis filter |
|  | hvec | Word16[80] | zero vector followed by impulse response |
|  | lpcSt | lpcState | see below in this table |
|  | lspSt | lspState | see below in this table |
|  | clLtpSt | clLtpState | see below in this table |
|  | gainQuantSt | gainQuantState | see below in this table |
|  | pitchOLWghtSt | pitchOLWghtState | see below in this table |
|  | tonStabSt | tonStabState | see below in this table |
|  | vadSt | vadState1 | see below in this table |
|  | vadSt | vadState2 | see below in this table |
|  | dtx | Flag | is set if DTX functionality is used |
|  | dtx\_encSt | dtx\_encState | see below in this table |
|  | mem\_syn | Word16[10] | synthesis filter memory |
|  | mem\_w0 | Word16[10] | weighting filter memory (applied to error signal) |
|  | mem\_w | Word16[10] | weighting filter memory (applied to input signal) |
|  | mem\_err | Word16[50] | filter memory for production of error vector |
|  | error | Word16\* | error signal (input minus synthesized speech) |
|  | sharp | Word16 | pitch sharpening gain |
| vadState1 | bckr\_est | Word16[9] | background noise estimate |
|  | ave\_level | Word16[9] | averaged input components for stationary estimation |
|  | old\_level | Word16[9] | input levels of the previous frame |
|  | sub\_level | Word16[9] | input levels calculated at the end of a frame (lookahead) |
|  | a\_data5 | Word16[6] | memory for the filter bank |
|  | a\_data3 | Word16[5] | memory for the filter bank |
|  | burst\_count | Word16 | counts length of a speech burst |
|  | hang\_count | Word16 | hangover counter |
|  |  |  |  |
|  | stat\_count | Word16 | stationary counter |
|  | vadreg | Word16 | 15 flags for intermediate VAD decisions |
|  | pitch | Word16 | 15 flags for pitch detection |
|  | tone | Word16 | 15 flags for tone detection |
|  | complex\_high | Word16 | flags for complex detection |
|  | complex\_low | Word16 | flags for complex detection |
|  | oldlag\_count | Word16 | variables for pitch detection |
|  | oldlag | Word16 | variables for pitch detection |
|  | complex\_hang\_count | Word16 | complex hangover counter, used by VAD |
|  | complex\_hang\_timer | Word16 | hangover initiator, used by CAD |
|  |  |  |  |
|  | best\_corr\_hp | Word16 | filtered value |
|  | speech\_vad\_decision | Word16 | final decision |
|  | complex\_warning | Word16 | complex background warning |
|  | sp\_burst\_count | Word16 | counts length of a speech burst incl HO addition |
|  | corr\_hp\_fast | Word16 | filtered value |
| vadState2 | pre\_emp\_mem | Word16 | input pre-emphasis memory |
|  | update\_cnt | Word16 | noise update counter |
|  | hyster\_cnt | Word16 | hysteresis counter |
|  | last\_update\_cnt | Word16 | noise update counter value for last frame |
|  | ch\_enrg\_long\_db | Word16[16] | long term channel energy in dB |
|  | Lframe\_cnt | Word32 | 10 ms frame counter |
|  | Lch\_enrg | Word32[16] | channel energy estimate |
|  | Lch\_noise | Word32[16] | channel noise estimate |
|  | last\_normb\_shift | Word16 | block shift factor for last frame, used for pre\_emp\_mem |
|  | tsnr | Word16 | total estimated peak SNR in dB |
|  | hangover | Word16 | VAD hangover |
|  | burstcount | Word16 | number of consecutive voice active frames |
|  | fupdate\_flag | Word16 | A flag to control a forced update of the noise estimate |
|  | negSNRvar | Word16 | SNR variability |
|  | negSNRbias | Word16 | sensitivity bias |
|  | shift\_state | Word16 | indicates scaling state of channel energy estimate |
|  | L\_R0 | Word32 | LTP energy |
|  | L\_Rmax | Word32 | LTP max correlation |
|  | LTP\_flag | Flag | set when open loop pitch prediction gain > threshold |
| dtx\_encState | lsp\_hist | Word16[80] | LSP history (8 frames) |
|  | log\_en\_hist | Word16[8] | logarithmic frame energy history (8 frames) |
|  | hist\_ptr | Word16 | pointer to the cyclic history vectors |
|  | log\_en\_index | Word16 | Index for logarithmic energy |
|  |  |  |  |
|  | init\_lsf\_vq\_index | Word16 | initial index for lsf predictor |
|  | lsp\_index | Word16[3] | lsp indecies to the three code books |
|  | dtxHangoverCount | Word16 | is decreased in DTX hangover period |
|  | decAnaElapsedCount | Word16 | counter for elapsed speech frames in DTX |
| lpcState | LevinsonSt | LevinsonState | see below |
| LevinsonState | old\_A | Word16[11] | last frames direct form coefficients |
| lspState | lsp\_old | Word16[10] | old LSP vector |
|  | lsp\_old\_q | Word16[10] | old quantized LSP vector |
|  | qSt | Q\_plsfState | see below in this table |
| Q\_plsfState | past\_rq | Word16[10] | past quantized LSF prediction error |
| clLtpState | pitchSt | Pitch\_frState | see below in this table |
| tonStabState | count | Word16 | count consecutive (potential) resonance frames |
|  | gp | Word16[7] | pitch gain history |
| Pitch\_frState | T0\_prev\_subframe | Word16 | integer. pitch lag of previous subframe |
| gainQuantState | sf0\_exp\_gcode0 | Word16 | subframe 0/2 codebook gain exponent |
|  | sf0\_frac\_gcode0 | Word16 | subframe 0/2 codebook gain fraction |
|  | sf0\_exp\_target\_en | Word16 | subframe 0/2 target energy exponent |
|  | sf0\_frac\_target\_en | Word16 | subframe 0/2 target energy fraction |
|  | sf0\_exp\_coeff | Word16[5] | subframe 0/2 energy coefficient exponents |
|  | sf0\_frac\_coeff | Word16[5] | subframe 0/2 energy coefficient fractions |
|  | gain\_idx\_ptr | Word16\* | pointer to gain index value in parameter frame |
|  | gc\_predSt | gc\_predState | see below in this table |
|  | gc\_predUncSt | gc\_predState | see below in this table |
|  | adaptSt | GainAdaptState | see below in this table |
| gc\_predState | past\_qua\_en | Word16[4] | MA predictor memory (20\*log10(pred. error)) |
|  | past\_qua\_en\_MR122 | Word16[4] | MA predictor memory, 12.2 style (log2(pred. error)) |
| GainAdaptState | onset | Word16 | onset counter |
|  | prev\_alpha | Word16 | previous adaptor output |
|  | prev\_gc | Word16 | previous codebook gain |
|  | ltpg\_mem | Word16[5] | pitch gain history |
| pitchOLWghtState | old\_T0\_med | Word16 | weighted open loop pitch lag |
|  | ada\_w | Word16 | weigthing level depeding on open loop pitch gain |
|  | wght\_flg | Word16 | switches lag weighting on and off |

Table 8: Speech decoder static variables

| Struct name | Variable | Type[Length] | Description |
| --- | --- | --- | --- |
| Speech\_Decode\_FrameState | decoder\_amrState | Decoder\_amrState | see below in this table |
|  | post\_state | Post\_FilterState | see below in this table |
|  | postHP\_state | Post\_ProcessState | see below in this table |
|  |  |  |  |
|  | ComplexityCounter | int | Used for wMOPS counting |
| Decoder\_amrState | old\_exc | Word16[194] | excitation vector |
|  | exc | Word16\* | current excitation |
|  | lsp\_old | Word16[10] | LSP vector of previous frame |
|  | mem\_syn | Word16[10] | synthesis filter memory |
|  | sharp | Word16 | pitch sharpening gain |
|  | old\_T0 | Word16 | pitch sharpening lag |
|  | prev\_bf | Word16 | previous value of "bad frame" flag |
|  |  |  |  |
|  | prev\_pdf | Word16 | previous value of "pot. dangerous frame" flag |
|  | state | Word16 | ECU state (0..6) |
|  | excEnergyHist | Word16[9] | excitation energy history |
|  | T0\_lagBuff | Word16 | received pitch lag for ECU |
|  | inBackgroundNoise | Word16 | background noise flag |
|  | voicedHangover | Word16 | hangover flag |
|  | ltpGainHistory | Word16[9] | pitch gain history |
|  | background\_state | Bgn\_scdState | see below in this table |
|  | Cb\_gain\_averState | Cb\_gain\_averageState | see below in this table |
|  | lsp\_avg\_st | lsp\_avgState | see below in this table |
|  | lsfState | D\_plsfState | see below in this table |
|  | ec\_gain\_p\_st | ec\_gain\_pitchState | see below in this table |
|  | ec\_gain\_c\_st | ec\_gain\_codeState | see below in this table |
|  | pred\_state | gc\_predState | see table 7 |
|  | nodataSeed | Word16 | seed for CN generator |
|  | ph\_disp\_st | ph\_dispState | see below in this table |
|  | dtxDecoderState | dtx\_decState | see below in this table |
| dtx\_decState | since\_last\_sid | Word16 | number of frames since last SID frame |
|  | true\_sid\_period\_inv | Word16 | inverse of true SID update rate |
|  | log\_en | Word16 | logarithmic frame energy |
|  | old\_log\_en | Word16 | previous value of log\_en |
|  | L\_pn\_seed\_rx | Word32 | random number generator seed |
|  | lsp | Word16[10] | LSP vector |
|  | lsp\_old | Word16[10] | previous LSP vector |
|  | lsf\_hist | Word16[80] | LSF vector history (8 frames) |
|  | lsf\_hist\_ptr | Word16 | index to beginning of LSF history |
|  | lsf\_hist\_mean | Word16[80] | mean-removed LSF history (8 frames) |
|  |  |  |  |
|  | log\_pg\_mean | Word16 | mean-removed logarithmic prediction gain |
|  | log\_en\_hist | Word16[8] | logarithmic frame energy history |
|  | log\_en\_hist\_ptr | Word16 | index to beginning of log, frame energy history |
|  | log\_en\_adjust | Word16 | mode-dependent frame energy adjustment |
|  | dtxHangoverCount | Word16 | counts down in hangover period |
|  | decAnaElapsedCount | Word16 | counts elapsed speech frames after DTX |
|  | sid\_frame | Word16 | flags SID frames |
|  | valid\_data | Word16 | flags SID frames containing valid data |
|  | dtxHangoverAdded | Word16 | flags hangover period at end of speech |
|  | dtxGlobalState | enum DTXStateType | DTX state flags |
|  | data\_updated | Word16 | flags CNI updates |
| Bgn\_scdState | frameEnergyHist | Word16[60] | history of synthesis frame energy |
|  | bgHangover | Word16 | number of frames since last speech frame |
| Cb\_gain\_averageState | cbGainHistory | Word16[7] | codebook gain history |
|  | hangVar | Word16 | counts length of talkspurt in subframes |
|  | hangCount | Word16 | number of subframes since last talkspurt |
| lsp\_avgState | lsp\_meanSave | Word16[10] | averaged LSP vector |
| D\_plsfState | past\_r\_q | Word16[10] | past quantized LSF prediction vector |
|  | past\_lsf\_q | Word16[10] | past dequantized LSF vector |
| ec\_gain\_pitchState | pbuf | Word16[5] | pitch gain history |
|  | past\_gain\_pit | Word16 | previous pitch gain (limited to 1.0) |
|  | prev\_gp | Word16 | previous good pitch gain |
| ec\_gain\_codeState | gbuf | Word16[5] | codebook gain history |
|  | past\_gain\_code | Word16 | previous codebook gain |
|  | prev\_gc | Word16 | previous good codebook gain |
| ph\_dispState | gainMem | Word16[5] | pitch gain history |
|  | prevState | Word16 | previously used impulse response |
|  | prevCbGain | Word16 | previous codebook gain |
|  | lockFull | Word16 | force maximum phase dispersion |
|  | onset | Word16 | onset counter |
| Post\_FilterState | res2 | Word16[40] | LP residual |
|  | mem\_syn\_pst | Word16[10] | synthesis filter memory |
|  | synth\_buf | Word16[170] | synthesis filter work area |
|  | agc\_state | agcState | see below in this table |
|  | preemph\_state | preemphasisState | see below in this table |
| agcState | past\_gain | Word16 | past agc gain |
| preemphasisState | mem\_pre | Word16 | filter state |
| Post\_ProcessState | y2\_hi | Word16 | filter state, upper word |
|  | y2\_lo | Word16 | filter state, lower word |
|  | y1\_hi | Word16 | filter state, upper word |
|  | y1\_lo | Word16 | filter state, lower word |
|  | x0 | Word16 | filter state |
|  | x1 | Word16 | filter state |

# 5 Homing procedure

The principles of the homing procedures are described in [2]. This specification only includes a detailed description of the 8 decoder homing frames. For each AMR codec mode, the corresponding decoder homing frame has a fixed set of speech parameters shown in table 9a-9h. The bit allocation within these parameters is identical to the corresponding bit allocation of the source encoder output parameters given in [2].

In the following tables, the following naming convention is used for the individual parameters. Letters in *italics* indicate numbers.

LPC\_*n* index of *n*th LSF submatrix.

LTP-LAG *m* adaptive codebook index for subframe *m.*

LTP-GAIN *m* adaptive codebook gain index in subframe *m.*

FCB-GAIN *m* fixed codebook gain index in subframe *m.*

GAIN\_VQ *m* codebook gain VQ index in subframe *m* (subframe *m* and *m+1* for MR475).

POS *m*\_*n* position index of *n*th pulse in subframe m.

POS *m*\_*n*\_*k* position index of *n*th and *k*th pulse in subframe *m.*

POS *m*\_*n\_k\_l\_j* position index of *n*th, *k*th, *l*th, and *j*th pulse in subframe *m.*

SIGN *m*\_*n*\_*k* sign information for *n*th and *k*th pulse in subframe *m.*

SIGN *m*\_ *n\_k\_l\_j* sign information for *n*th, *k*th, *l*th, and *j*th pulse in subframe *m.*

SIGN\_*m\_n\_k*\_POS\_*m\_n* sign information for *n*th and *k*th pulse and position index for *n*th pulse in subframe *m.*

Table 9a: Parameter values for the decoder homing frame (MR475)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00F8 |
| LPC 2 | 0x009D |
| LPC 3 | 0x001C |
| LTP-LAG 1 | 0x0066 |
| POS 1\_1\_2 | 0x0000 |
| SIGN\_1\_1\_2 | 0x0003 |
| GAIN-VQ 1 | 0x0028 |
| LTP-LAG 2 | 0x000F |
| POS 2\_1\_2 | 0x0038 |
| SIGN\_2\_1\_2 | 0x0001 |
| LTP-LAG 3 | 0x000F |
| POS 3\_1\_2 | 0x0031 |
| SIGN\_3\_1\_2 | 0x0002 |
| GAIN-VQ 3 | 0x0008 |
| LTP-LAG 4 | 0x000F |
| POS 4\_1\_2 | 0x0026 |
| SIGN\_4\_1\_2 | 0x0003 |

Table 9b: Parameter values for the decoder homing frame (MR515)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00F8 |
| LPC 2 | 0x009D |
| LPC 3 | 0x001C |
| LTP-LAG 1 | 0x0066 |
| POS 1\_1\_2 | 0x0000 |
| SIGN\_1\_1\_2 | 0x0003 |
| GAIN-VQ 1 | 0x0037 |
| LTP-LAG 2 | 0x000F |
| POS 2\_1\_2 | 0x0000 |
| SIGN\_2\_1\_2 | 0x0003 |
| GAIN-VQ 2 | 0x0005 |
| LTP-LAG 3 | 0x000F |
| POS 3\_1\_2 | 0x0037 |
| SIGN\_3\_1\_2 | 0x0003 |
| GAIN-VQ 3 | 0x0037 |
| LTP-LAG 4 | 0x000F |
| POS 4\_1\_2 | 0x0023 |
| SIGN\_4\_1\_2 | 0x0003 |
| GAIN-VQ 4 | 0x001F |

Table 9c: Parameter values for the decoder homing frame (MR59)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00F8 |
| LPC 2 | 0x00E3 |
| LPC 3 | 0x002F |
| LTP-LAG 1 | 0x00BD |
| POS 1\_1\_2 | 0x0000 |
| SIGN\_1\_1\_2 | 0x0003 |
| GAIN-VQ 1 | 0x0037 |
| LTP-LAG 2 | 0x000F |
| POS 2\_1\_2 | 0x0001 |
| SIGN\_2\_1\_2 | 0x0003 |
| GAIN-VQ 2 | 0x000F |
| LTP-LAG 3 | 0x0060 |
| POS 3\_1\_2 | 0x00F9 |
| SIGN\_3\_1\_2 | 0x0003 |
| GAIN-VQ 3 | 0x0037 |
| LTP-LAG 4 | 0x000F |
| POS 4\_1\_2 | 0x0000 |
| SIGN\_4\_1\_2 | 0x0003 |
| GAIN-VQ 4 | 0x0037 |

Table 9d: Parameter values for the decoder homing frame (MR67)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00F8 |
| LPC 2 | 0x00E3 |
| LPC 3 | 0x002F |
| LTP-LAG 1 | 0x00BD |
| POS 1\_1\_2\_3 | 0x0002 |
| SIGN\_1\_1\_2\_3 | 0x0007 |
| GAIN-VQ 1 | 0x0000 |
| LTP-LAG 2 | 0x000F |
| POS 2\_1\_2\_3 | 0x0098 |
| SIGN\_2\_1\_2\_3 | 0x0007 |
| GAIN-VQ 2 | 0x0061 |
| LTP-LAG 3 | 0x0060 |
| POS 3\_1\_2\_3 | 0x05C5 |
| SIGN\_3\_1\_2\_3 | 0x0007 |
| GAIN-VQ 3 | 0x0000 |
| LTP-LAG 4 | 0x000F |
| POS 4\_1\_2\_3 | 0x0318 |
| SIGN\_4\_1\_2\_3 | 0x0007 |
| GAIN-VQ 4 | 0x0000 |

Table 9e: Parameter values for the decoder homing frame (MR74)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00F8 |
| LPC 2 | 0x00E3 |
| LPC 3 | 0x002F |
| LTP-LAG 1 | 0x00BD |
| POS 1\_1\_2\_3\_4 | 0x0006 |
| SIGN\_1\_1\_2\_3\_4 | 0x000F |
| GAIN-VQ 1 | 0x0000 |
| LTP-LAG 2 | 0x001B |
| POS 2\_1\_2\_3\_4 | 0x0208 |
| SIGN\_2\_1\_2\_3\_4 | 0x000F |
| GAIN-VQ 2 | 0x0062 |
| LTP-LAG 3 | 0x0060 |
| POS 3\_1\_2\_3\_4 | 0x1BA6 |
| SIGN\_3\_1\_2\_3\_4 | 0x000F |
| GAIN-VQ 3 | 0x0000 |
| LTP-LAG 4 | 0x001B |
| POS 4\_1\_2\_3\_4 | 0x0006 |
| SIGN\_4\_1\_2\_3\_4 | 0x000F |
| GAIN-VQ 4 | 0x0000 |

Table 9f: Parameter values for the decoder homing frame (MR795)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00C2 |
| LPC 2 | 0x00E3 |
| LPC 3 | 0x002F |
| LTP-LAG 1 | 0x00BD |
| POS\_1\_1\_2\_3\_4 | 0x0006 |
| SIGN\_1\_1\_2\_3\_4 | 0x000F |
| LTP-GAIN 1 | 0x000A |
| FCB-GAIN 1 | 0x0000 |
| LTP-LAG 2 | 0x0039 |
| POS\_2\_1\_2\_3\_4 | 0x1C08 |
| SIGN\_2\_1\_2\_3\_4 | 0x0007 |
| LTP-GAIN 2 | 0x000A |
| FCB-GAIN 2 | 0x000B |
| LTP-LAG 3 | 0x0063 |
| POS\_3\_1\_2\_3\_4 | 0x11A6 |
| SIGN\_3\_1\_2\_3\_4 | 0x000F |
| LTP-GAIN 3 | 0x0001 |
| FCB-GAIN 3 | 0x0000 |
| LTP-LAG 4 | 0x0039 |
| POS\_4\_1\_2\_3\_4 | 0x09A0 |
| SIGN\_4\_1\_2\_3\_4 | 0x000F |
| LTP-GAIN 4 | 0x0002 |
| FCB-GAIN 4 | 0x0001 |

Table 9g: Parameter values for the decoder homing frame (MR102)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC 1 | 0x00F8 |
| LPC 2 | 0x00E3 |
| LPC 3 | 0x002F |
| LTP-LAG 1 | 0x0045 |
| SIGN\_1\_1\_5 | 0x0000 |
| SIGN\_1\_2\_6 | 0x0000 |
| SIGN\_1\_3\_7 | 0x0000 |
| SIGN\_1\_4\_8 | 0x0000 |
| POS\_1\_1\_2\_5 | 0x0000 |
| POS\_1\_3\_6\_7 | 0x0000 |
| POS\_1\_4\_8 | 0x0000 |
| GAIN-VQ\_1 | 0x0000 |
| LTP-LAG 2 | 0x001B |
| SIGN\_2\_1\_5 | 0x0000 |
| SIGN\_2\_2\_6 | 0x0001 |
| SIGN\_2\_3\_7 | 0x0000 |
| SIGN\_2\_4\_8 | 0x0001 |
| POS\_2\_1\_2\_5 | 0x0326 |
| POS\_2\_3\_6\_7 | 0x00CE |
| POS\_2\_4\_8 | 0x007E |
| GAIN-VQ\_2 | 0x0051 |
| LTP-LAG 3 | 0x0062 |
| SIGN\_3\_1\_5 | 0x0000 |
| SIGN\_3\_2\_6 | 0x0000 |
| SIGN\_3\_3\_7 | 0x0000 |
| SIGN\_3\_4\_8 | 0x0000 |
| POS\_3\_1\_2\_5 | 0x015A |
| POS\_3\_3\_6\_7 | 0x0359 |
| POS\_3\_4\_8 | 0x0076 |
| GAIN-VQ\_3 | 0x0000 |
| LTP-LAG 4 | 0x001B |
| SIGN\_4\_1\_5 | 0x0000 |
| SIGN\_4\_2\_6 | 0x0000 |
| SIGN\_4\_3\_7 | 0x0000 |
| SIGN\_4\_4\_8 | 0x0000 |
| POS\_4\_1\_2\_5 | 0x017C |
| POS\_4\_3\_6\_7 | 0x0215 |
| POS\_4\_4\_8 | 0x0038 |
| GAIN-VQ\_4 | 0x0030 |

Table 9h: Parameter values for the decoder homing frame (MR122)

|  |  |
| --- | --- |
| **Parameter** | **Value (LSB=b0)** |
| LPC1 | 0x0004 |
| LPC2 | 0x002A |
| LPC3 | 0x00DB |
| LPC4 | 0x0096 |
| LPC5 | 0x002A |
| LTP-LAG 1 | 0x0156 |
| LTP-GAIN 1 | 0x000B |
| SIGN\_1\_1\_6\_POS\_1\_1 | 0x0000 |
| SIGN\_1\_2\_7\_POS\_1\_2 | 0x0000 |
| SIGN\_1\_3\_8\_POS\_1\_3 | 0x0000 |
| SIGN\_1\_4\_9\_POS\_1\_4 | 0x0000 |
| SIGN\_1\_5\_10\_POS\_1\_5 | 0x0000 |
| POS 1\_6 | 0x0000 |
| POS 1\_7 | 0x0000 |
| POS 1\_8 | 0x0000 |
| POS 1\_9 | 0x0000 |
| POS 1\_10 | 0x0000 |
| FCB-GAIN 1 | 0x0000 |
| LTP-LAG 2 | 0x0036 |
| LTP-GAIN 2 | 0x000B |
| SIGN\_2\_1\_6\_POS\_2\_1 | 0x0000 |
| SIGN\_2\_2\_7\_POS\_2\_2 | 0x000F |
| SIGN\_2\_3\_8\_POS\_2\_3 | 0x000E |
| SIGN\_2\_4\_9\_POS\_2\_4 | 0x000C |
| SIGN\_2\_5\_10\_POS\_2\_5 | 0x000D |
| POS 2\_6 | 0x0000 |
| POS 2\_7 | 0x0001 |
| POS 2\_8 | 0x0005 |
| POS 2\_9 | 0x0007 |
| POS 2\_10 | 0x0001 |
| FCB-GAIN 2 | 0x0008 |
| LTP-LAG 3 | 0x0024 |
| LTP-GAIN 3 | 0x0000 |
| SIGN\_3\_1\_6\_POS\_3\_1 | 0x0001 |
| SIGN\_3\_2\_7\_POS\_3\_2 | 0x0000 |
| SIGN\_3\_3\_8\_POS\_3\_3 | 0x0005 |
| SIGN\_3\_4\_9\_POS\_3\_4 | 0x0006 |
| SIGN\_3\_5\_10\_POS\_3\_5 | 0x0001 |
| POS 3\_6 | 0x0002 |
| POS 3\_7 | 0x0004 |
| POS 3\_8 | 0x0007 |
| POS 3\_9 | 0x0004 |
| POS 3\_10 | 0x0002 |
| FCB-GAIN 3 | 0x0003 |
| LTP-LAG 4 | 0x0036 |
| LTP-GAIN 4 | 0x000B |
| SIGN\_4\_1\_6\_POS\_4\_1 | 0x0000 |
| SIGN\_4\_2\_7\_POS\_4\_2 | 0x0002 |
| SIGN\_4\_3\_8\_POS\_4\_3 | 0x0004 |
| SIGN\_4\_4\_9\_POS\_4\_4 | 0x0000 |
| SIGN\_4\_5\_10\_POS\_4\_5 | 0x0003 |
| POS 4\_6 | 0x0006 |
| POS 4\_7 | 0x0001 |
| POS 4\_8 | 0x0007 |
| POS 4\_9 | 0x0006 |
| POS 4\_10 | 0x0005 |
| FCB-GAIN 4 | 0x0000 |

# 6 File formats

This section describes the file formats used by the encoder and decoder programs. The test sequences defined in [1] also use the file formats described here.

## 6.1 Speech file (encoder input / decoder output)

Speech files read by the encoder and written by the decoder consist of 16-bit words where each word contains a 13-bit, left aligned speech sample. The byte order depends on the host architecture (e.g. MSByte first on SUN workstations, LSByte first on PCs etc.). Both the encoder and the decoder program process complete frames (of 160 samples) only.

This means that the encoder will only process *n* frames if the length of the input file is *n\*160 + k* words, while the files produced by the decoder will always have a length of *n\*160* words.

## 6.2 Mode control file (encoder input)

The encoder program can optionally read in a mode control file which specifies the encoding mode for each frame of speech processed. The file is a text file containing one line per speech frame. Each line contains one of the mode names from the list {MR475, MR515, MR59, MR67, MR74, MR795, MR102, MR122}.

## 6.3 Parameter bitstream file (encoder output / decoder input)

The files produced by the speech encoder/expected by the speech decoder contain an arbitrary number of frames in the following format.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| FRAME\_TYPE | B1 | B2 | … | B244 | MODE\_INFO | *unused1* | … | *unused4* |

Each box corresponds to one Word16 value in the bitstream file, for a total of 250 words or 500 bytes per frame. The fields have the following meaning:

FRAME\_TYPE transmit frame type, which is one of   
TX\_SPEECH (0x0000)  
TX\_SID\_FIRST (0x0001)  
TX\_SID\_UPDATE (0x0002)  
TX\_NO\_DATA (0x0003)

B0…B244 speech encoder parameter bits (i.e. the bitstream itself). Each B*x* either has the value 0x0000 or 0x0001. Only mode MR122 really uses all 244 bits; for the other modes, only the first *n* bits are used (35  n204). The remaining bits are unused (written as 0x0000)

MODE\_INFO encoding mode information, which is one of  
MR475 (0x0000)  
MR515 (0x0001)  
MR59 (0x0002)  
MR67 (0x0003)  
MR74 (0x0004)  
MR795 (0x0005)  
MR102 (0x0006)  
MR122 (0x0007)

*unused1…4* unused, written as 0x0000

As indicated in section 6.1 above, the byte order depends on the host architecture.

By using a preprocessor definition the encoder output and decoder input can optionally use format described in [7], sections 5.1 and 5.3.

Annex A (informative):  
Change History

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| SMG# | Tdoc SMG | Spec | CR | Cat | PH | Vers | New Version | Subject |
| SA6 | [SP-99560](../../../../../../../../../DOCUME~1/usai/LOCALS~1/Temp/zip/SP-99560.zip) | 26.073 |  |  |  |  | 3.0.0 | Approved at TSG-SA#6 |
| SA7 | SP-000025 | 26.073 | 001 | A | R99 | 3.0.0 | 3.1.0 | Avoidance of pulse cancellation in FCB excitation |
| SA11 | SP-010100 | 26.073 | 003 | A | R99 | 3.1.0 | 3.2.0 | Correction of potential bug in AMR decoder due to usage of standard C abs() function |
| SA11 | SP-010100 | 26.073 | 005 | A | R99 | 3.1.0 | 3.2.0 | Correction of comfort noise parameter interpolation bug of AMR decoder |
| SA11 | SP-010100 | 26.073 | 007 | A | R99 | 3.1.0 | 3.2.0 | Correction of mode state bug in AMR decoder |
| SA11 | SP-010100 | 26.073 | 009 | A | R99 | 3.1.0 | 3.2.0 | Correction of TX\_TYPE and RX\_TYPE identifiers |
| SA11 | SP-010100 | 26.073 | 011 | A | R99 | 3.1.0 | 3.2.0 | Correction of potential bug in AMR decoder due to the usage of standard C abs() function (VAD option\_2) |
| SA11 | SP-010100 | 26.073 | 004 | A | Rel-4 | 3.1.0 | 4.0.0 | Correction of potential bug in AMR decoder due to usage of standard C abs() function |
| SA11 | SP-010100 | 26.073 | 006 | A | Rel-4 | 3.1.0 | 4.0.0 | Correction of comfort noise parameter interpolation bug of AMR decoder |
| SA11 | SP-010100 | 26.073 | 008 | A | Rel-4 | 3.1.0 | 4.0.0 | Correction of mode state bug in AMR decoder |
| SA11 | SP-010100 | 26.073 | 010 | A | Rel-4 | 3.1.0 | 4.0.0 | Correction of TX\_TYPE and RX\_TYPE identifiers |
| SA11 | SP-010100 | 26.073 | 012 | A | Rel-4 | 3.1.0 | 4.0.0 | Correction of potential bug in AMR decoder due to the usage of standard C abs() function (VAD option\_2) |
| SA14 | SP-010696 | 26.073 | 014 | A | Rel-4 | 4.0.0 | 4.1.0 | Correction of RX-DTX handling of NO\_DATA frames in AMR decoder |
| SA14 | SP-010697 | 26.073 | 016 | A | Rel-4 | 4.0.0 | 4.1.0 | Correction in AMR decoder to avoid division by zero in RX-DTX Handling |
| SA16 |  |  |  |  | Rel-5 | 4.1.0 | 5.0.0 | Version for Release 5 |
| SA19 | SP-030085 | 26.073 | 017 |  | Rel-5 | 5.0.0 | 5.1.0 | MMS compatible input/output option |
| SA21 | SP-030444 | 26.073 | 018 |  | Rel-5 | 5.1.0 | 5.2.0 | Correction of the MMS\_IO flag  Note. The following line (missing in the approved CR) was added for the ANSI-C code to compile correctly:  +const char sp\_enc\_id[] = "@(#)$Id $" sp\_enc\_h; |
| SA23 | SP-040197 | 26.073 | 019 |  | Rel-5 | 5.2.0 | 5.3.0 | Correction of AMR DTX functionality |
| SA26 |  |  |  |  | Rel-6 | 5.3.0 | 6.0.0 | Version for Release 6 |
| SA36 | SP-070321 | 26.073 | 0020 | 1 | Rel-7 | 6.0.0 | 7.0.0 | Bit order of Mode Indication in AMR comfort noise frames |
| SA42 |  |  |  |  | Rel-8 | 7.0.0 | 8.0.0 | Version for Release 8 |
| SA46 |  |  |  |  | Rel-9 | 8.0.0 | 9.0.0 | Version for Release 9 |
| SA51 |  |  |  |  | Rel-10 | 9.0.0 | 10.0.0 | Version for Release 10 |
| SA57 |  |  |  |  | Rel-11 | 10.0.0 | 11.0.0 | Version for Release 11 |
| SA65 |  |  |  |  | Rel-12 | 11.0.0 | 12.0.0 | Version for Release 12 |
| SA70 |  |  |  |  | Rel-13 | 12.0.0 | 13.0.0 | Version for Release 13 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2017-03 | 75 |  |  |  |  | Version for Release 14 | 14.0.0 |
| 2018-06 | 80 |  |  |  |  | Version for Release 15 | 15.0.0 |
| 2020-07 | - | - | - | - | - | Update to Rel-16 version (MCC) | **16.0.0** |

1. 1 Option to call one or the other VAD option [↑](#footnote-ref-2)
2. 2 Specific to VAD option 1 [↑](#footnote-ref-3)
3. 3 Specific to VAD option 2 [↑](#footnote-ref-4)