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Universal Mobile Telecommunications System (UMTS);  
LTE;  
General audio codec audio processing functions;  
Enhanced aacPlus general audio codec;  
Fixed-point ANSI-C code  
(3GPP TS 26.411 version 15.0.0 Release 15)**



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# Contents

|  |           |
|--|-----------|
| Intellectual Property Rights .....                             | 2         |
| Foreword.....  | 2         |
| Modal verbs terminology.....                                   | 2         |
| Foreword.....  | 4         |
| 1 Scope .....  | 5         |
| 2 References .....   | 5         |
| 3 Definitions and abbreviations.....                           | 5         |
| 3.1 Definitions .....  | 5         |
| 3.2 Abbreviations .....  | 5         |
| 4 Fixed point ANSI-C code structure.....                       | 6         |
| 4.1 Contents of the fixed point ANSI-C source code .....       | 6         |
| 4.2 Program execution.....                                     | 8         |
| 4.3 Memory requirements .....                                  | 9         |
| 4.3.1 Constants and tables.....                                | 9         |
| 4.3.2 Static memory .....                                      | 14        |
| 4.3.3 Dynamic memory .....                                     | 15        |
| 4.3.4 Maximum stack size .....                                 | 16        |
| 5 File formats .....   | 23        |
| 5.1 Audio input file (encoder input/decoder output) .....      | 23        |
| 5.2 Bitstream file format (encoder output/decoder input) ..... | 23        |
| 5.3 Error pattern file (decoder input).....                    | 23        |
| <b>Annex A (informative): Weighted MOPS .....</b>              | <b>24</b> |
| <b>Annex B (informative): Change history .....</b>             | <b>25</b> |
| History .....  | 26        |

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# 1 Scope

The present document contains an electronic copy of the ANSI-C code for the Fixed-point Enhanced aacPlus codec [1].

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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. 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] 3GPP TS 26.401: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; General description".
  - [2] 3GPP TS 26.403: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Encoder specification; Advanced Audio Coding (AAC) part".
  - [3] 3GPP TS 26.404: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Encoder specification; Spectral Band Replication (SBR) part".
  - [4] 3GPP TS 26.405: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Encoder specification; Parametric stereo part".
  - [5] ISO/IEC 14496-3 (2001): "Information technology - Coding of audio-visual objects - Part 3: Audio".
  - [6] ISO/IEC 14496-3:2001/Amd.1:2003: "Bandwidth Extension".
  - [7] ISO/IEC 14496-3:2001/Amd.1:2003/Cor 1:2004.
  - [8] ISO/IEC 14496-3:2001/ Amd.2:2004: "Parametric coding for high quality audio".
  - [9] 3GPP TS 26.402: "General audio codec audio processing functions; Enhanced aacPlus general audio codec; Additional decoder tools".
  - [10] 3GPP TS 26.244: "Transparent end-to-end streaming service; 3GPP file format (3GP)".
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# 3 Definitions and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TS 26.401 [1], 3GPP TS 26.403 [2], 3GPP TS 26.404 [3], 3GPP TS 26.405 [4] and 3GPP TS 26.402 [9] apply.

## 3.2 Abbreviations

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

|                  |  |
|------------------|--|
| AAC              | Advanced Audio Coding  |
| aacPlus          | Combination of MPEG-4 AAC and MPEG-4 Bandwidth extension (SBR)                           |
| ANSI             | American National Standards Institute  |
| Enhanced aacPlus | Combination of MPEG-4 AAC, MPEG-4 Bandwidth extension (SBR) and MPEG-4 Parametric Stereo |
| GSM              | Global System for Mobile communications  |

|      |                                    |
|------|------------------------------------|
| I/O  | Input/Output                       |
| MDCT | Modified Discrete Cosine Transform |
| QMF  | Quadrature Mirror Filter           |
| RAM  | Random Access Memory               |
| ROM  | Read Only Memory                   |
| SBR  | Spectral Band Replication          |

## 4 Fixed point ANSI-C code structure

This clause gives an overview of the structure of the fixed point ANSI-C code and provides an overview of the contents and organization of the C code attached to the present document.

The C code has been verified on the following systems:

- IBM PC/AT compatible computers with Windows XP, 2000 and Microsoft Visual C++ v.6.0 compiler.
- IBM PC/AT compatible computers with Linux OS and GCC v.3.3 compiler.

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

### 4.1 Contents of the fixed point ANSI-C source code

The C code distribution is organized in two directories for encoder and decoder and further into several subdirectories, reflecting the major building blocks of the Enhanced AAC Plus codec. The file descriptions on root level as well as the directory structure is given as follows.

**Table 1: Source code directory structure for the encoder (ETSI\_aacPlusenc)**

| Directory          | Description                        |
|--------------------|------------------------------------|
| README.txt         | information on how to compile      |
| Makefile           | UNIX style encoder Makefile        |
| enhAacPlusenc.dsw  | Win32 MSVC 6.0 encoder workspace   |
| enhAacPlusenc.dsp  | Win32 MSVC 6.0 encoder makefile    |
| src/               | directory for the encoder frontend |
| etsiop_fastaacenc/ | AAC encoder library                |
| etsiop_resamplib/  | resampler library                  |
| etsiop_sbrenclib/  | SBR encoder library                |

**Table 2: Source code directory structure for the decoder (ETSI\_aacPlusdec)**

| Directory         | Description                        |
|-------------------|------------------------------------|
| README.txt        | information on how to compile      |
| Makefile          | UNIX style decoder Makefile        |
| enhAacPlusdec.dsw | Win32 MSVC 6.0 decoder workspace   |
| src/              | directory for the decoder frontend |
| etsiop_aacdec     | AAC decoder library                |
| etsiop_sbrdeclib/ | SBR decoder library                |

**Table 3: Source code directory structure common for encoder and decoder**

| Directory      | Description  |
|----------------|--|
| etsiop_bitbuf/ | bitstream reading/writing library                                  |
| etsiop_ffrlib/ | general purpose functionalities                                    |
| etsioplib/     | ETSI operators implementation                                      |
| 3g_lib/        | precompiled libraries for audio and bitstream file format handling |

The distributed files with suffix "c" contain the source code and the files with suffix "h" are the header files. Within the respective libraries, the RAM data is contained in "xxx\_ram" files with suffix "c", the ROM data is contained in "xxx\_rom" files with suffix "c". Makefiles are provided for the platforms in which the C code has been verified (listed above).

A list of source code files is given below:

**Table 4: Encoder source code files**

| Directory          | Module              |
|--------------------|---------------------|
| src/               | main.c              |
|                    | mp4file.c           |
| etsiop_fastaacenc/ | qc_main.c           |
|                    | aacenc.c            |
|                    | ms_stereo.c         |
|                    | spreading.c         |
|                    | interface.c         |
|                    | bit_cnt.c           |
|                    | adj_thr.c           |
|                    | quantize.c          |
|                    | psy_configuration.c |
|                    | sf_estim.c          |
|                    | tns_param.c         |
|                    | grp_data.c          |
|                    | pre_echo_control.c  |
|                    | stprepro.c          |
|                    | tns.c               |
|                    | dyn_bits.c          |
|                    | psy_main.c          |
|                    | channel_map.c       |
|                    | block_switch.c      |
|                    | band_nrg.c          |
|                    | transform.c         |
|                    | bitenc.c            |
|                    | line_pe.c           |
| stat_bits.c        |                     |
| etsiop_sbrenc/     | qmf_enc.c           |
|                    | ton_corr.c          |
|                    | fram_gen.c          |
|                    | env_bit.c           |
|                    | env_est.c           |
|                    | mh_det.c            |
|                    | hybrid.c            |
|                    | bit_sbr.c           |
|                    | ps_bitenc.c         |
|                    | sbr_main.c          |
|                    | tran_det.c          |
|                    | sbr_misc.c          |
|                    | code_env.c          |
|                    | nf_est.c            |
|                    | freq_sca.c          |
| invf_est.c         |                     |
| ps_enc.c           |                     |
| etsiop_resamplib/  | downsample_FIR.c    |



**Table 5: Decoder source code files**

| Directory         | Module             |
|-------------------|--------------------|
| src/              | main.c             |
|                   | fileifc.c          |
|                   | spline_resampler.c |
| etsiop_aacdec/    | aacdecoder.c       |
|                   | streaminfo.c       |
|                   | channelinfo.c      |
|                   | stereo.c           |
|                   | longblock.c        |
|                   | shortblock.c       |
|                   | pulsedata.c        |
|                   | block.c            |
|                   | pns.c              |
|                   | imdct.c            |
|                   | tns.c              |
|                   | bitstream.c        |
|                   | channel.c          |
|                   | conceal.c          |
| datastream.c      |                    |
| etsiop_sbrdeclib/ | env_dec.c          |
|                   | aacpluscheck.c     |
|                   | env_calc.c         |
|                   | lpp_tran.c         |
|                   | sbrdecoder.c       |
|                   | sbr_dec.c          |
|                   | sbr_crc.c          |
|                   | hybrid.c           |
|                   | ps_bitdec.c        |
|                   | env_extr.c         |
|                   | freq_sca.c         |
|                   | ps_dec.c           |
|                   | qmf_dec.c          |

**Table 6: Common source code files**

| Directory      | Module             |
|----------------|--------------------|
| etsiop_bitbuf/ | bitbuffer.c        |
| etsiop_ffrlib/ | fft_32x32.c        |
|                | transcendent.c     |
|                | transcendent_enc.c |
|                | intrinsic.c        |
|                | vector.c           |

## 4.2 Program execution

The Enhanced AAC Plus codec is implemented in two programs:

- enhAacPlusEnc.exe.
- enhAacPlusDec.exe.

The programs should be called like:

- enhAacPlusEnc.exe <wav\_file> <bitstream\_file> <bitrate> <(m)ono/(s)tereo>.
- enhAacPlusDec.exe <bitstream\_file> <wav\_file> <mode> [error\_pattern\_file].

The audio files contain 16-bit linear encoded PCM samples with wav header, the bitstream files are of 3GPP type and the error pattern file is a ASCII file, see clause 5.

The encoder and decoder command line handling is also explained by running the applications without input arguments.

## 4.3 Memory requirements

The data types of variables and tables used in the fixed-point implementation are defined by the ETSI operator data types, the following types are used:

- Word8.
- Word16.
- Word32.
- Flag.

### 4.3.1 Constants and tables

This clause contains a listing of all constants and tables contributing to the ROM requirements of the encoder and decoder.

**Table 7: Encoder constants and tables**

| Name                     | Data type             | Size [16-bit word] | Allocated in Source File | Description   |
|--------------------------|-----------------------|--------------------|--------------------------|---|
| LongWindowSine           | Word16                | 1 024              | aac_rom.c                | Window coefficients   |
| ShortWindowSine          | Word16                | 128                | aac_rom.c                | Window coefficients   |
| LongWindowKBD            | Word16                | 1 024              | aac_rom.c                | Window coefficients   |
| fftTwiddleTable          | Word16                | 513                | aac_rom.c                | FFT twiddle coefficients  |
| formfac_sqrttable        | Word32                | 192                | aac_rom.c                | Lookup table for efficient sqrt implementation                    |
| mTab_3_4                 | Word32                | 1 024              | aac_rom.c                | Quantizer table, used for efficient pow () implementation         |
| mTab_4_3                 | Word32                | 1 024              | aac_rom.c                | Inverse quantizer table, used for efficient pow () implementation |
| pow2tominusNover16       | Word16                | 17                 | aac_rom.c                | Lookup table for efficient pow() implementation                   |
| specExpMantTableComb_enc | Word32                | 128                | aac_rom.c                | Lookup table for efficient inverse quantizer implementation       |
| specExpTableComb_enc     | Word8                 | 32                 | aac_rom.c                | Lookup table for efficient inverse quantizer implementation       |
| quantBorders             | Word16                | 16                 | aac_rom.c                | Lookup table for efficient distortion calculation implementation  |
| quantBorders             | Word16                | 12                 | aac_rom.c                | Lookup table for efficient distortion calculation implementation  |
| p_8000_mono_long         | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_8000_stereo_long       | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_8000_mono_short        | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_8000_stereo_short      | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_16000_mono_long        | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_16000_stereo_long      | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_16000_mono_short       | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_16000_stereo_short     | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_24000_mono_long        | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_24000_stereo_long      | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_24000_mono_short       | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_24000_stereo_short     | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |

| Name                        | Data type             | Size [16-bit word] | Allocated in Source File | Description   |
|-----------------------------|-----------------------|--------------------|--------------------------|---|
| p_32000_mono_long           | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_32000_stereo_long         | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_32000_mono_short          | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| p_32000_stereo_short        | TNS_CONFIG_T ABULATED | 5                  | aac_rom.c                | TNS tuning parameters   |
| m_log2_table                | Word32                | 64                 | aac_rom.c                | Lookup table for efficient ld() implementation                |
| tnsCoeff3                   | Word32                | 16                 | aac_rom.c                | TNS filter coefficients                                       |
| tnsCoeff3Borders            | Word32                | 16                 | aac_rom.c                | TNS filter borders  |
| tnsCoeff4                   | Word32                | 32                 | aac_rom.c                | TNS filter coefficients                                       |
| tnsCoeff4Borders            | Word32                | 32                 | aac_rom.c                | TNS filter borders  |
| tnsInfoTab                  | TNS_INFO_TAB          | 20                 | aac_rom.c                | TNS bitrate to tuning mapping table                           |
| tnsMaxBandsTab              | TNS_MAX_TAB_ENTRY     | 12                 | aac_rom.c                | max. TNS bands per sampling rate table                        |
| huff_ltab1_2                | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ltab3_4                | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ltab5_6                | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ltab7_8                | Word16                | 64                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ltab9_10               | Word16                | 169                | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ltab11                 | Word16                | 289                | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ltabscf                | Word16                | 121                | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab1                  | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab2                  | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab3                  | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab4                  | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab5                  | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab6                  | Word16                | 81                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab7                  | Word16                | 64                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab8                  | Word16                | 64                 | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab9                  | Word16                | 169                | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab10                 | Word16                | 169                | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctab11                 | Word16                | 289                | aac_rom.c                | Huffman codeword table AAC                                    |
| huff_ctabscf                | Word32                | 242                | aac_rom.c                | Huffman codeword table AAC                                    |
| sfb_16000_long_1024         | Word8                 | 22                 | aac_rom.c                | Scalefactor band table  |
| sfb_16000_short_128         | Word8                 | 8                  | aac_rom.c                | Scalefactor band table  |
| sfb_22050_long_1024         | Word8                 | 24                 | aac_rom.c                | Scalefactor band table  |
| sfb_22050_short_128         | Word8                 | 8                  | aac_rom.c                | Scalefactor band table  |
| sfb_24000_long_1024         | Word8                 | 24                 | aac_rom.c                | Scalefactor band table  |
| sfb_24000_short_128         | Word8                 | 8                  | aac_rom.c                | Scalefactor band table  |
| p4_13                       | Word32                | 26                 | sbr_rom.c                | Hybrid filterbank coefficients                                |
| p8_13                       | Word32                | 26                 | sbr_rom.c                | Hybrid filterbank coefficients                                |
| sbr_cos_twiddle_L32_enc     | Word16                | 16                 | sbr_rom.c                | QMF filterbank twiddle table                                  |
| sbr_cos_twiddle_L64_enc     | Word16                | 32                 | sbr_rom.c                | QMF filterbank twiddle table                                  |
| sbr_sin_twiddle_L32_enc     | Word16                | 16                 | sbr_rom.c                | QMF filterbank twiddle table                                  |
| sbr_sin_twiddle_L64_enc     | Word16                | 32                 | sbr_rom.c                | QMF filterbank twiddle table                                  |
| sbr_alt_sin_twiddle_L32_enc | Word16                | 17                 | sbr_rom.c                | QMF filterbank twiddle table                                  |
| sbr_alt_sin_twiddle_L64_enc | Word16                | 33                 | sbr_rom.c                | QMF filterbank twiddle table                                  |
| sbr_qmf_64_640_enc          | Word16                | 330                | sbr_rom.c                | QMF window coefficients                                       |
| aBookPslidTimeCode          | Word32                | 58                 | sbr_rom.c                | Huffman codeword table Parametric Stereo                      |
| aBookPslidFreqCode          | Word32                | 58                 | sbr_rom.c                | Huffman codeword table Parametric Stereo                      |
| aHybridResolution           | Word16                | 3                  | sbr_rom.c                | Number of hybrid bands in each QMF band                       |
| hiResBandBorders            | Word8                 | 11                 | sbr_rom.c                | Borders of Parametric Stereo bins                             |
| groupBordersMix             | Word8                 | 15                 | sbr_rom.c                | Borders of Parametric Stereo groups                           |
| bins2groupMap               | Word32                | 58                 | sbr_rom.c                | Mapping of Parametric Stereo bins to Parametric Stereo groups |
| iidQuantLeft                | Word32                | 14                 | sbr_rom.c                | IID quant values for Parametric Stereo                        |
| iidQuantRight               | Word32                | 14                 | sbr_rom.c                | IID quant values for Parametric Stereo                        |
| iccQuant                    | Word32                | 16                 | sbr_rom.c                | ICC quant values for Parametric Stereo                        |
|                             |                       |                    |                          |   |

| Name                     | Data type   | Size [16-bit word] | Allocated in Source File | Description                                     |
|--------------------------|-------------|--------------------|--------------------------|---|
| v_Huff_envelopeLevelC10T | Word32      | 242                | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_envelopeLevelC10F | Word32      | 242                | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceC10F    | Word32      | 98                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceC10T    | Word32      | 98                 | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_envelopeLevelC11T | Word32      | 126                | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_NoiseLevelC11T    | Word32      | 126                | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceC11T    | Word32      | 50                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrNoiseBalanceC11T  | Word32      | 50                 | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_envelopeLevelC11F | Word32      | 126                | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceC11F    | Word32      | 50                 | sbr_rom.c                | Huffman codeword table SBR                      |
| aBookPslidTimeLength     | Word8       | 15                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslidFreqLength     | Word8       | 15                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslccFreqLength     | Word8       | 8                  | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslccTimeLength     | Word8       | 8                  | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslccFreqCode       | Word16      | 15                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslccTimeCode;      | Word16      | 15                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| v_Huff_envelopeLevelL10T | Word8       | 61                 | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_envelopeLevelL10F | Word8       | 61                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceL10F    | Word8       | 25                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceL10T    | Word8       | 25                 | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_envelopeLevelL11T | Word8       | 32                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceL11T    | Word8       | 13                 | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_NoiseLevelL11T    | Word8       | 32                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrNoiseBalanceL11T  | Word8       | 13                 | sbr_rom.c                | Huffman codeword table SBR                      |
| v_Huff_envelopeLevelL11F | Word8       | 32                 | sbr_rom.c                | Huffman codeword table SBR                      |
| bookSbrEnvBalanceL11F    | Word8       | 13                 | sbr_rom.c                | Huffman codeword table SBR                      |
| logDualisTable           | Word16      | 65                 | transcenden<br>t.c       | Lookup table for efficient log() implementation |
| pow2Table                | Word32      | 512                | transcenden<br>t_enc.c   | Lookup table for efficient pow() implementation |
| FIRenc_band24            | Word16      | 49                 | downsample<br>_FIR.c     | FIR filter coefficients for 2:1 resampling      |
| FIRenc_band63            | Word16      | 127                | downsample<br>_FIR.c     | FIR filter coefficients for 3:2 resampling      |
| tuningTable              | tuningTable | 294                | sbr_main.c               | SBR tuning parameters                           |
| <b>Sum</b>               |             | <b>11282</b>       |                          |   |

Table 8: Decoder constants and tables

| Name                | Data type | Size [16-bit word] | Allocated in Source File | Description                                 |
|---------------------|-----------|--------------------|--------------------------|---|
| tnsCoeff3           | Word16    | 8                  | aac_rom.c                | TNS filter coefficients                     |
| tnsCoeff4           | Word16    | 16                 | aac_rom.c                | TNS filter coefficients                     |
| trigData            | Word16    | 513                | aac_rom.c                | Sine table, used for efficient sin(), cos() |
| OnlyLongWindowKBD   | Word16    | 1 024              | aac_rom.c                | Window coefficients                         |
| OnlyShortWindowKBD  | Word16    | 128                | aac_rom.c                | Window coefficients                         |
| OnlyLongWindowSine  | Word16    | 1 024              | aac_rom.c                | Window coefficients                         |
| OnlyShortWindowSine | Word16    | 128                | aac_rom.c                | Window coefficients                         |
| sfb_48_1024         | Word16    | 50                 | aac_rom.c                | Scalefactor band table                      |
| sfb_48_128          | Word16    | 15                 | aac_rom.c                | Scalefactor band table                      |
| sfb_32_1024         | Word16    | 51                 | aac_rom.c                | Scalefactor band table                      |
| sfb_24_1024         | Word16    | 49                 | aac_rom.c                | Scalefactor band table                      |
| sfb_24_128          | Word16    | 16                 | aac_rom.c                | Scalefactor band table                      |
| sfb_16_1024         | Word16    | 44                 | aac_rom.c                | Scalefactor band table                      |
| sfb_16_128          | Word16    | 16                 | aac_rom.c                | Scalefactor band table                      |
| sfb_8_1024          | Word16    | 41                 | aac_rom.c                | Scalefactor band table                      |
| sfb_8_128           | Word16    | 16                 | aac_rom.c                | Scalefactor band table                      |
| HuffmanCodeBook_1   | Word16    | 204                | aac_rom.c                | Huffman codeword table AAC                  |
| HuffmanCodeBook_2   | Word16    | 156                | aac_rom.c                | Huffman codeword table AAC                  |
| HuffmanCodeBook_3   | Word16    | 156                | aac_rom.c                | Huffman codeword table AAC                  |
| HuffmanCodeBook_4   | Word16    | 152                | aac_rom.c                | Huffman codeword table AAC                  |

| Name                            | Data type              | Size [16-bit word] | Allocated in Source File | Description   |
|---------------------------------|------------------------|--------------------|--------------------------|---|
| HuffmanCodeBook_5               | Word16                 | 164                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_6               | Word16                 | 160                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_7               | Word16                 | 124                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_8               | Word16                 | 124                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_9               | Word16                 | 336                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_10              | Word16                 | 328                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_11              | Word16                 | 544                | aac_rom.c                | Huffman codeword table AAC  |
| HuffmanCodeBook_SCL             | Word16                 | 260                | aac_rom.c                | Huffman codeword table AAC  |
| SamplingRateInfoTable           | Word16                 | 45                 | aac_rom.c                | Sampling rate to scalefactor mapping table AAC  |
| HuffmanCodeBooks                | mixed                  | 52                 | aac_rom.c                | Huffman codeword table AAC  |
| specExpTableComb                | Word8                  | 52                 | aac_rom.c                | Lookup table for efficient exponent implementation  |
| specExpTableMant                | Word32                 | 104                | aac_rom.c                | Lookup table for efficient exponent implementation, mantissa  |
| InverseQuantTable               | Word32                 | 514                | aac_rom.c                | Lookup table for efficient inverse quantizer implementation   |
| sgn_mask                        | Word16                 | 3                  | aac_rom.c                | Helper vector for efficient bit-wise operations in the TNS module   |
| neg_mask                        | Word16                 | 3                  | aac_rom.c                | Helper vector for efficient bit-wise operations in the TNS module   |
| tns_max_bands_tbl               | Word8                  | 18                 | aac_rom.c                | max. TNS bands per sampling rate table  |
| sbr_limGains_m                  | Word16                 | 4                  | sbr_rom.c                | SBR limiter gain values, mantissa   |
| sbr_limGains_e                  | Word16                 | 4                  | sbr_rom.c                | SBR limiter gain values, exponent   |
| sbr_limiterBandsPerOctaveDiv4   | Word16                 | 4                  | sbr_rom.c                | Number of SBR limiter bands, divided by 4   |
| sbr_smoothFilter                | Word16                 | 4                  | sbr_rom.c                | Smoothing filter for gain values  |
| sbr_invIntTable                 | Word16                 | 49                 | sbr_rom.c                | Table of 1/x function   |
| sbr_randomPhase                 | Word16<br>or<br>Word32 | 1 120              | sbr_rom.c                | Random numbers for SBR noise addition and PNS. Note: for mono only case the data type Word16 can be used. |
| sbr_qmf_64_640                  | Word16                 | 340                | sbr_rom.c                | QMF window coefficients   |
| sbr_ralt_sin_twiddle_L64        | Word16                 | 64                 | sbr_rom.c                | FFT twiddle table   |
| sbr_ralt_sin_twiddle_L32        | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table   |
| sbr_cos_twiddle_L64             | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_cos_twiddle_L32             | Word16                 | 16                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_sin_twiddle_L64             | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_sin_twiddle_L32             | Word16                 | 16                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_alt_sin_twiddle_L64         | Word16                 | 33                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_cos_twiddle_ds_L32          | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_sin_twiddle_ds_L32          | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_t_cos_L32                   | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| sbr_t_sin_L32                   | Word16                 | 32                 | sbr_rom.c                | FFT twiddle table, obsolete for mono only decoder   |
| pHybridResolution               | Word16                 | 3                  | sbr_rom.c                | Parametric Stereo hybrid filterbank resolution  |
| groupShift                      | Word16                 | 6                  | sbr_rom.c                | Parametric Stereo shift bits for uppermost frequency groups   |
| aRevLinkDecaySer                | Word16                 | 3                  | sbr_rom.c                | Parametric Stereo all-pass filter coefficients  |
| aFractDelayPhaseFactorReQmf     | Word16                 | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor   |
| aFractDelayPhaseFactorImQmf     | Word16                 | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor   |
| aFractDelayPhaseFactorReSubQmf  | Word16                 | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor   |
| aFractDelayPhaseFactorImSubQmf  | Word16                 | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor   |
| aFractDelayPhaseFactorSerReQmf0 | Word16                 | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor   |
| aFractDelayPhaseFactorSerReQmf1 | Word16                 | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor   |

| Name                               | Data type | Size [16-bit word] | Allocated in Source File | Description                                     |
|------------------------------------|-----------|--------------------|--------------------------|---|
| aFractDelayPhaseFactorSerReQmf2    | Word16    | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerImQmf0    | Word16    | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerImQmf1    | Word16    | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerImQmf2    | Word16    | 20                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerReSubQmf0 | Word16    | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerReSubQmf1 | Word16    | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerReSubQmf2 | Word16    | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerImSubQmf0 | Word16    | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerImSubQmf1 | Word16    | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aFractDelayPhaseFactorSerImSubQmf2 | Word16    | 10                 | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aaFractDelayPhaseFactorSerReQmf    | Word16    | 3                  | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aaFractDelayPhaseFactorSerImQmf    | Word16    | 3                  | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aaFractDelayPhaseFactorSerReSubQmf | Word16    | 3                  | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| aaFractDelayPhaseFactorSerImSubQmf | Word16    | 3                  | sbr_rom.c                | Parametric Stereo phase rotation factor         |
| scaleFactors                       | Word16    | 15                 | sbr_rom.c                | Parametric Stereo quantization table            |
| scaleFactorsFine                   | Word16    | 31                 | sbr_rom.c                | Parametric Stereo quantization table            |
| alphas                             | Word16    | 8                  | sbr_rom.c                | Parametric Stereo quantization table            |
| p2_6                               | Word16    | 6                  | sbr_rom.c                | Hybrid filterbank coefficients                  |
| p8_13                              | Word16    | 13                 | sbr_rom.c                | Hybrid filterbank coefficients                  |
| sbr_start_freq_16                  | Word8     | 16                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_start_freq_22                  | Word8     | 16                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_start_freq_24                  | Word8     | 16                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_start_freq_32                  | Word8     | 16                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_start_freq_44                  | Word8     | 16                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_start_freq_48                  | Word8     | 16                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_frame_info1_16                 | Word16    | 18                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_frame_info2_16                 | Word16    | 18                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_frame_info4_16                 | Word16    | 18                 | sbr_rom.c                | SBR frequency scale index                       |
| sbr_huffBook_EnvLevel10T           | Word16    | 120                | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvLevel10F           | Word16    | 120                | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvBalance10T         | Word16    | 48                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvBalance10F         | Word16    | 48                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvLevel11T           | Word16    | 62                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvLevel11F           | Word16    | 62                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvBalance11T         | Word16    | 24                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_EnvBalance11F         | Word16    | 24                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_NoiseLevel11T         | Word16    | 62                 | sbr_rom.c                | Huffman codeword table SBR                      |
| sbr_huffBook_NoiseBalance11T       | Word16    | 24                 | sbr_rom.c                | Huffman codeword table SBR                      |
| aRevLinkDelaySer                   | Word16    | 3                  | sbr_rom.c                | Parametric Stereo all-pass delay line lengths   |
| groupBorders                       | Word16    | 23                 | sbr_rom.c                | Borders of Parametric Stereo groups             |
| aGroupToBin                        | Word16    | 22                 | sbr_rom.c                | Parametric Stereo group to bin table            |
| aHybridToBin                       | Word16    | 12                 | sbr_rom.c                | Parametric Stereo hybrid to bin table           |
| aDelayToBin                        | Word16    | 20                 | sbr_rom.c                | Parametric Stereo delay to bin table            |
| aBookPslidTimeDecode               | Word16    | 28                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslidFreqDecode               | Word16    | 28                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslccTimeDecode               | Word16    | 14                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslccFreqDecode               | Word16    | 14                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslidFineTimeDecode           | Word16    | 60                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| aBookPslidFineFreqDecode           | Word16    | 60                 | sbr_rom.c                | Huffman codeword table Parametric Stereo        |
| sbr_defaultHeader                  | mixed     | 22                 | sbr_rom.c                | Default SBR header data                         |
| logDualisTable                     | Word16    | 65                 | transcendent.c           | Lookup table for efficient log() implementation |
| invTable                           | Word16    | 256                | transcendent.c           | Lookup table for efficient 1/x implementation   |
| <b>Sum</b>                         |           | <b>10222</b>       |                          |   |

NOTE: All Parametric Stereo related coefficients which are marked as such in the table above are obsolete for mono only capable decoders.

### 4.3.2 Static memory

This clause contains a listing of all static buffers contributing to the RAM requirements of the encoder and decoder.

**Table 9: Encoder static memory**

| Name                         | Data type         | Size [16-bit word] | Allocated in Source File | Description   |
|------------------------------|-------------------|--------------------|--------------------------|---|
| mdctDelayBuffer              | Word16            | 3200               | aac_ram.c                | Time domain input signal delay , only half the size for mono only encoder               |
| quantSpec                    | Word16            | 2048               | aac_ram.c                | Quantized spectrum, only half the size for mono only encoder                            |
| scf                          | Word16            | 120                | aac_ram.c                | Scalefactors, only half the size for mono only encoder                                  |
| maxValueInSfb                | Word16            | 120                | aac_ram.c                | Max. value per calefactor, only half the size for mono only encoder                     |
| sideInfoTabLong              | Word16            | 52                 | aac_ram.c                | Table lookup for side information, long blocks  |
| sideInfoTabShort             | Word16            | 16                 | aac_ram.c                | Table lookup for side information, short blocks   |
| aacEncoder                   | AAC_ENCODER       | 6 851              | aacenc.c                 | AAC encoder instance, can be reduced to 3809 for mono only encoder                      |
| sbr_QmfStatesAnalysis        | Word16            | 1 280              | sbr_ram.c                | QMF filterbank states buffer, only half the size for mono only encoder                  |
| sbr_QmfStatesSynthesis       | Word32            | 640                | sbr_ram.c                | QMF filterbank states buffer, not needed for mono only encoder                          |
| sbr_envYBuffer               | Word32            | 8 192              | sbr_ram.c                | QMF band energy buffer, only half the size for mono only encoder                        |
| sbr_quotaMatrix              | Word32            | 1 024              | sbr_ram.c                | Tonality values. only half the size for mono only encoder                               |
| sbr_thresholds               | Word32            | 256                | sbr_ram.c                | Detector parameters, only half the size for mono only encoder                           |
| sbr_toncorrBuff              | Word32            | 2 160              | sbr_ram.c                | Detector value buffer, only half the size for mono only encoder                         |
| ps_lccDataBuffer             | Word32            | 40                 | sbr_ram.c                | ICC buffer, not needed for mono only encoder  |
| ps_lidDataBuffer             | Word32            | 40                 | sbr_ram.c                | lid buffer, not needed for mono only encoder  |
| ps_histQmfBuffer             | Word16            | 1 608              | sbr_ram.c                | QMF history buffer, not needed for mono only encoder                                    |
| sbr_freqBandTableLO          | Word16            | 14                 | sbr_ram.c                | SBR frequency band table, low resolution  |
| sbr_freqBandTableHI          | Word16            | 28                 | sbr_ram.c                | SBR frequency band table, high resolution   |
| sbr_v_k_master               | Word16            | 28                 | sbr_ram.c                | SBR frequency band table index  |
| sbr_guideScfb                | Word16            | 54                 | sbr_ram.c                | Additional sine detection parameter, only half the size for mono only encoder           |
| sbr_detectionVectors         | Word16            | 108                | sbr_ram.c                | Additional sine detection parameter, only half the size for mono only encoder           |
| sbr_prevEnvelopeCompensation | Word16            | 54                 | sbr_ram.c                | Additional sine detection parameter, only half the size for mono only encoder           |
| sbr_guideVectorDetected      | Word16            | 108                | sbr_ram.c                | Additional sine detection parameter, only half the size for mono only encoder           |
| sbrEncoder                   | SBR_ENCODER       | 3 650              | sbr_main.c               | SBR encoder instance, can be reduced to 1722 for mono only encoder                      |
| outputBuffer                 | Word8             | 384                | main.c                   | Bitstream output buffer   |
| inputBuffer                  | Word16            | 8 234              | main.c                   | Time domain input signal buffer, only half the size for mono only encoder               |
| up2Sampler                   | RESAMPLER_FIR_2_1 | 144                | main.c                   | 1:2 FIR resampler instance (includes states) , only half the size for mono only encoder |
| down3Sampler                 | RESAMPLER_FIR_3_2 | 208                | main.c                   | 3:2 FIR resampler instance (includes states) , only half the size for mono only encoder |

| Name         | Data type         | Size [16-bit word] | Allocated in Source File | Description   |
|--------------|-------------------|--------------------|--------------------------|---|
| down2Sampler | RESAMPLER_FIR_2_1 | 144                | main.c                   | 2:1 FIR resampler instance (includes states) , only half the size for mono only encoder |
| <b>Sum</b>   |                   | <b>40 643</b>      |                          |   |

Table 10: Decoder static memory

| Name                               | Data type                    | Size [16-bit word] | Allocated in Source File | Description  |
|------------------------------------|------------------------------|--------------------|--------------------------|--|
| OverlapBuffer[nChan]               | Word16                       | 1 024              | aac_ram.c                | Delay buffer for overlap and add, only half the size for mono only decoder     |
| AacDecoderInstance                 | AAC_DECODER_INSTANCE         | 12                 | aacdecoder.c             | AAC decoder instance   |
| sbrPayloadBuffer                   | Word8                        | 540                | aacdecoder.c             | SBR payload buffer   |
| StreamInfo                         | CStreamInfo                  | 7                  | aac_ram.c                | Bitstream information  |
| AacDecoderStaticChannelInfo[nChan] | CaacDecoderStaticChannelInfo | 16                 | aac_ram.c                | Channel information, only half the size for mono only decoder                  |
| PnsStaticInterChannelData          | Word16                       | 2                  | aac_ram.c                | PNS static data  |
| ConcealmentInfoInstance            | CConcealmentInfo             | 4 127              | aac_ram.c                | Concealment static data  |
| sbr_CodecQmfStatesAnalysis         | Word16                       | 640                | sbr_ram.c                | QMF analysis filter bank states  |
| sbr_GainSmooth_m                   | Word16                       | 96                 | sbr_ram.c                | Gain smoothing filter states, mantissa   |
| sbr_GainSmooth_e                   | Word16                       | 96                 | sbr_ram.c                | Gain smoothing filter states, exponent   |
| sbr_NoiseSmooth_m                  | Word16                       | 96                 | sbr_ram.c                | Noise level smoothing filter states, mantissa                                  |
| sbr_QmfStatesSynthesis             | Word16                       | 2 560              | sbr_ram.c                | QMF synthesis filter bank states   |
| sbr_OverlapBuffer                  | Word32                       | 3 072              | sbr_ram.c                | SBR delay buffer, only half the size for mono only decoder                     |
| sbr_LpcFilterStatesReal            | Word32                       | 256                | sbr_ram.c                | LPC filter states  |
| sbr_LpcFilterStatesImag            | Word32                       | 256                | sbr_ram.c                | LPC filter states, obsolete for mono only decoder                              |
| sbr_TransposerSettings             | TRANSPOSER_SETTINGS          | 61                 | sbr_ram.c                | Transposer configuration parameters  |
| FreqBandData                       | FREQ_BAND_DATA               | 164                | sbr_ram.c                | SBR Frequency band information   |
| PrevFrameData[nChan]               | SBR_PREV_FRAME_DATA          | 120                | sbr_ram.c                | SBR previous frame data, only half the size for mono only decoder              |
| sbrDecoderInstance                 | SBR_DECODER_INSTANCE         | 797                | sbrdecoder.c             | SBR decoder instance   |
| timeData                           | Word16                       | 4 096              | main.c                   | Output buffer for time-domain signal, only half the size for mono only decoder |
| inBuffer                           | short                        | 768                | main.c                   | Input buffer for bitstream   |
| splineResamplerInstance            | SPLINE_RESAMPLER             | 19                 | spline_resampler.c       | Spline resampler instance  |
| <b>Sum</b>                         |                              | <b>18825</b>       |                          |  |

### 4.3.3 Dynamic memory

This clause contains a listing of all dynamic buffers contributing to the RAM requirements of the encoder and decoder. Dynamic memory can be re-used outside of the encoder or decoder application.



**Table 11: Encoder dynamic memory**

| <b>Name</b>      | <b>Data type</b> | <b>Size<br/>[16-bit<br/>word]</b> | <b>Allocated in<br/>Source File</b> | <b>Description</b>  |
|------------------|------------------|-----------------------------------|-------------------------------------|---|
| ps_tempQmfBuffer | Word16           | 1 608                             | sbr_ram.c                           | NOTE: reused in AAC encoder, not needed for mono only encoder |
| sbr_envRBuffer   | Word16           | 4 096                             | sbr_ram.c                           | NOTE: reused in AAC encoder                                   |
| sbr_envIBuffer   | Word16           | 4 096                             | sbr_ram.c                           | NOTE: reused in AAC encoder                                   |
| sbr_transients   | Word32           | 384                               | sbr_ram.c                           | NOTE: reused in AAC encoder                                   |
| <b>Sum</b>       |                  | <b>10 184</b>                     |                                     |   |

**Table 12: Decoder dynamic memory**

| <b>Name</b>    | <b>Data type</b> | <b>Size<br/>[16-bit<br/>word]</b> | <b>Allocated in<br/>Source File</b> | <b>Description</b>                          |
|----------------|------------------|-----------------------------------|-------------------------------------|---|
| WorkBufferCore | Word32           | 4 096                             | aac_ram.c                           | NOTE: reused in SBR decoder                 |
| WorkBuffer1    | Word32           | 4 096                             | sbr_ram.c                           | Work buffer, obsolete for mono only decoder |
| <b>Sum</b>     |                  | <b>8 192</b>                      |                                     |   |

#### 4.3.4 Maximum stack size

This clause contains tables for the encoder and the decoder which describe the call stack that results in the maximum stack size usage.

**Table 13: Encoder call stack**



| Function            | Local variables / Function call arguments  | Stack used<br>[16-bit<br>words]  |
|---------------------|--|--|
| AdjustThresholds    | ADJ_THR_STATE *adjThrState;<br>ATS_ELEMENT *AdjThrStateElement;<br>PSY_OUT_CHANNEL psyOutChannel[MAX_CHANNELS_PER_ELEM];<br>PSY_OUT_ELEMENT *psyOutElement;<br>Word16 *chBitDistribution;<br>Word16 logSfbEnergy[MAX_CHANNELS_PER_ELEM][MAX_GROUPED_SFB];<br>Word16 sfbNRelevantLines[MAX_CHANNELS][MAX_GROUPED_SFB];<br>const Word16 nChannels;<br>QC_OUT_ELEMENT *qcOE;<br>const Word16 avgBits;<br>const Word16 bitresBits;<br>const Word16 maxBitresBits;<br>const Word16 maxBitFac;<br>const Word16 sideInfoBits;<br>Word16 noRedPe, grantedPe, grantedPeCorr;<br>Word16 curWindowSequence;<br>PE_DATA peData;<br>Word16 bitFactor;<br>Word16 ch; | 1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>2<br>1<br>667<br>1<br>1<br>=686 |
| adaptThresholdsToPe | PSY_OUT_CHANNEL psyOutChannel[MAX_CHANNELS_PER_ELEM];<br>PSY_OUT_ELEMENT *psyOutElement;<br>Word16 logSfbEnergy[MAX_CHANNELS_PER_ELEM][MAX_GROUPED_SFB];<br>PE_DATA *peData;<br>const Word16 nChannels;<br>const Word16 desiredPe;<br>AH_PARAM *ahParam;<br>MINSNR_ADAPT_PARAM *msaParam;<br>Word16 noRedPe, redPe, redPeNoAH;<br>Word16 constPart, constPartNoAH;<br>Word16 nActiveLines, nActiveLinesNoAH;<br>Word16 desiredPeNoAH;<br>Word32 redVal, avgThrExp;<br>Word16 iter;   | 1<br>1<br>1<br>1<br>1<br>1<br>1<br>4<br>2<br>2<br>1<br>4<br>1<br>=22                   |
| correctThresh       | PSY_OUT_CHANNEL psyOutChannel[MAX_CHANNELS_PER_ELEM];<br>Word16 ahFlag[MAX_CHANNELS][MAX_GROUPED_SFB];<br>PE_DATA *peData;<br>Word32 thrExp[MAX_CHANNELS][MAX_GROUPED_SFB];<br>const Word32 redVal;<br>const Word16 nChannels;<br>const Word32 deltaPe;<br>Word16 ch, sfb, sfbGrp;<br>PSY_OUT_CHANNEL *psyOutChan;<br>PE_CHANNEL_DATA *peChanData;<br>Word32 deltaSfbPe;<br>Word32 sfbPeFactors[MAX_CHANNELS][MAX_GROUPED_SFB], normFactor;<br>Word32 sfbEn, sfbThr;<br>Word32 sfbThrReduced;<br>Word32 thrFactor;   | 1<br>1<br>1<br>1<br>2<br>1<br>2<br>3<br>1<br>1<br>2<br>242<br>4<br>2<br>2<br>=266      |
| ffr_pow2_xy         | Word32 x, Word32 y;<br>Word32 iPart, fPart;<br>Word32 res;<br>Word32 tmp, tmp2;<br>Word16 shift, shift2;<br>Word16 denom_h, denom_l;   | 4<br>4<br>2<br>4<br>2<br>2<br>=18  |
|                     | <b>Sum</b>   | <b>992</b>   |

**Table 14: Decoder call stack**



| Function                    | Local variables / Function call arguments  | Stack used<br>[16-bit<br>words]   |
|-----------------------------|--|---|
| sbr_dec()                   | HANDLE_SBR_DEC hSbrDec,<br>Word16 *timeIn,<br>Word16 *timeOut,<br>HANDLE_SBR_HEADER_DATA hHeaderData,<br>HANDLE_SBR_FRAME_DATA hFrameData,<br>HANDLE_SBR_PREV_<br>FRAME_DATA hPrevFrameData,<br>HANDLE_PS_DEC hPS,<br>HANDLE_SBR_QMF_FILTER_BANK hSynthesisQmfBankRight,<br>SBR_SCALE_FACTOR *sbrScaleFactorRight,<br>Flag applyProcessing,<br>Flag bUseLP<br>Word32 i, k;<br>Word16 slot, reserve;<br>Word16 saveLbScale;<br>Word16 ov_len;<br>Word32 *QmfBufferReal[MAX_ENV_COLS];<br>Word32 *QmfBufferImag[MAX_ENV_COLS];<br>Word32 *ptr;<br>Word16 noCols;   | 1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>4<br>2<br>1<br>1<br>38<br>38<br>1<br>1<br>= 98                   |
| cplxSynthesisQmfFiltering() | Word32 **qmfReal,<br>Word32 **qmfImag,<br>Word32 splitSlot,<br>SBR_SCALE_FACTOR *sbrScaleFactor,<br>Word16 *timeOut,<br>HANDLE_SBR_QMF_FILTER_BANK qmfBank,<br>HANDLE_PS_DEC hPS,<br>Flag active,<br>Flag bUseLP<br>Word16 i, j;<br>Word16 codScalefactor;<br>Word16 sbrScalefactor;<br>Word16 outScalefactor;<br>Word16 scaleFactorLowBand;<br>Word16 scaleFactorHighBand;<br>Word16 *filterStates;<br>Word32 qmfReal2[NO_SYNTHESIS_CHANNELS];<br>Word16 no_synthesis_channels;<br>Word32 qmfRealTmp[NO_SYNTHESIS_CHANNELS];<br>Word32 *qmfImagTmp;<br>Word8 env;<br>Word16 scaleFactorLowBandSplit;<br>Word32 *imagSlot; | 1<br>1<br>2<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>128<br>1<br>128<br>1<br>1<br>1<br>= 277 |
| inverseModulationLP()       | Word32 *qmfReal,<br>Word32 *qmfReal2,<br>const Word16 scaleFactorLowBand,<br>const Word16 scaleFactorHighBand,<br>HANDLE_SBR_QMF_FILTER_BANK synQmf<br>Word16 i;<br>const Word16 L;<br>const Word16 M;<br>Word32 timeOut[2*NO_SYNTHESIS_CHANNELS];   | 1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>256<br>= 264  |
| dct2 ()                     | Word32 *data,<br>Word32 *tmp,<br>Word32 L,<br>HANDLE_SBR_QMF_FILTER_BANK qmfBank<br>Word16 cosphi,sinphi;<br>Word16 i;<br>Word32 M;<br>Word32 N;<br>Word32 a1,a2,a3,a4,a5,a6;  | 1<br>1<br>2<br>1<br>2<br>1<br>2<br>12<br>= 24   |

| Function        | Local variables / Function call arguments   | Stack used<br>[16-bit<br>words]   |
|-----------------|---|-----------------------------------|
| DSP_fft32x32s() | Word32 npoints<br>Word32 *ptr_x   | 2<br>1<br>= 3                     |
| __fft32()       | Word32 x[]<br>Word16 m;<br>Word32 re, ie, ro, io, rx, ix ;<br>Word32 *x1m, *x2m, *x1mm, *x2mm;  | 2<br>1<br>12<br>4<br>= 19         |
| __fft2x16()     | Word32 x[]<br>Word16 sch, sh, ch;<br>Word32 a0, a1, a2, a3, a00, a10, a20, a30 ;<br>Word32 tr, ti, vr, vi ;<br>Word32 even [32], odd [32] ; | 2<br>3<br>16<br>8<br>128<br>= 157 |
| fixmul_32x16b() | Word32 a;<br>Word16 b;<br>Word16 hi1 lo1  | 2<br>1<br>2<br>= 5                |
|                 | <b>Sum</b>  | <b>919</b>                        |

## 5 File formats

This clause describes the file formats used by the encoder and decoder programs.

### 5.1 Audio input file (encoder input/decoder output)

The audio input files read by the encoder and written by the decoder are 16-bit PCM wave files. For convenient handling of wave files a precompiled audio-file format library is used.

### 5.2 Bitstream file format (encoder output/decoder input)

The encoder program writes and the decoder program reads raw frames packetized in access units as described by 3GPP TS 26.244 [10]. For packetization the ISO media library is used. A precompiled library is used.

### 5.3 Error pattern file (decoder input)

The decoder program can optionally process an additional input file which describes an error pattern. The format of the error pattern file is 1 character per line. Each line corresponds to one frame, where a "0" indicates that the respective frame has been transmitted without errors, while a "1" indicates that the corresponding frame has been lost and error concealment shall be applied by the decoder.



## Annex A (informative): Weighted MOPS

The complexity numbers for the Enhanced aacPlus audio codec can be found in the following tables, the numbers have been derived using the "allcat.wav" item, which holds all the material from the selection test concatenated in one single item. For every test case the average and worst frame weighted MOPS figure has been derived. The worst case wMOPS figure over all test cases has been marked in **blue**.

The fixed-point C-code contains a pre-compiler directive named "ACCOUNT\_ETSIOP\_OVERHEAD\_SPLITWORD32". If this pre-compiler directive is set during compilation, the complexity figures will be as given in Table 15. If this pre-compiler directive is not set during compilation, the complexity figures will be as given in Table 16. Regarding the details of the corresponding difference in the fixed-point C-code, please see the comments in the SplitWord32() function in intrinsics.c.

**Table A.1: Weighted MOPS figures with ACCOUNT\_ETSIOP\_OVERHEAD\_SPLITWORD32 set**

|  | Test Case | Mono Encoder  | Stereo Encoder       | Decoder              | Decoder, mono only |
|--|-----------|---------------|----------------------|----------------------|--------------------|
| <b>wMOPS<br/>[average /<br/>worst frame]</b> | 14m       | 26.51 / 28.87 | 26.50 / 31.61        | 19.15 / 21.20        | 14.73 / 16.80      |
|  | 18s       | ---           | 61.38 / 65.25        | 35.18 / 38.04        | 15.14 / 17.39      |
|  | 24m       | 29.51 / 34.28 | 29.51 / 34.26        | 20.98 / 23.84        | 15.93 / 18.74      |
|  | 24s       | ---           | 63.47 / 68.17        | 37.35 / 40.98        | 15.93 / 18.72      |
|  | 32s       | ---           | 64.61 / 71.02        | <b>38.39 / 42.28</b> | 16.47 / 19.60      |
|  | 48s       | ---           | <b>64.17 / 77.63</b> | 32.65 / 38.46        | 21.96 / 26.83      |

**Table A.2: Weighted MOPS figures with ACCOUNT\_ETSIOP\_OVERHEAD\_SPLITWORD32 not set**

|  | Test Case | Mono Encoder  | Stereo Encoder       | Decoder              | Decoder, mono only |
|--|-----------|---------------|----------------------|----------------------|--------------------|
| <b>wMOPS<br/>[average /<br/>worst frame]</b> | 14m       | 23.80 / 25.41 | 23.79 / 29.04        | 15.86 / 17.73        | 12.38 / 14.38      |
|  | 18s       | ---           | 51.14 / 53.92        | 29.35 / 32.07        | 12.77 / 14.95      |
|  | 24m       | 26.52 / 29.60 | 26.52 / 29.66        | 17.53 / 20.13        | 13.51 / 16.21      |
|  | 24s       | ---           | 53.08 / 56.06        | 31.17 / 34.64        | 13.57 / 16.22      |
|  | 32s       | ---           | 54.11 / 58.39        | <b>32.08 / 35.75</b> | 14.05 / 17.09      |
|  | 48s       | ---           | <b>57.46 / 65.89</b> | 27.88 / 33.43        | 18.53 / 23.22      |

## Annex B (informative): Change history

| Change history |         |           |      |     |   |        |        |
|----------------|---------|-----------|------|-----|---|--------|--------|
| Date           | TSG SA# | TSG Doc.  | CR   | Rev | Subject/Comment   | Old    | New    |
| 2005-03        | 27      | SP-050146 |      |     | Approved at TSG SA#27   | 1.0.0  | 6.0.0  |
| 2005-06        | 28      | SP-050251 | 001  |     | Correction to C-code: Corrections to ETSI operator usage  | 6.0.0  | 6.1.0  |
| 2005-06        | 28      | SP-050251 | 002  |     | Correction to C-code: Avoid reading of non-initialized variable   | 6.0.0  | 6.1.0  |
| 2005-06        | 28      | SP-050251 | 003  |     | Correction to C-code: fixes for error concealment   | 6.0.0  | 6.1.0  |
| 2005-09        | 29      | SP-050426 | 0004 |     | Correction to C-code: enable 44.1 kHz input material encoding (fixed-point code)                        | 6.1.0  | 6.2.0  |
| 2005-09        | 29      | SP-050426 | 0005 |     | Correction to C-Code: Bitrate dependency of AAC block switching threshold                               | 6.1.0  | 6.2.0  |
| 2005-09        | 29      | SP-050426 | 0006 |     | Correction to C-Code: prevent overflow in parameter estimation of Parametric Stereo IID value           | 6.1.0  | 6.2.0  |
| 2005-09        | 29      | SP-050426 | 0007 |     | Correction to C-Code: smoothing of SBR noise values   | 6.1.0  | 6.2.0  |
| 2005-09        | 29      | SP-050426 | 0008 |     | Correction to C-Code: removal of obsolete table (fixed-point code)                                      | 6.1.0  | 6.2.0  |
| 2005-09        | 29      | SP-050426 | 0009 |     | Correction to C-Code: rounding in TNS parcor coefficient calculation                                    | 6.1.0  | 6.2.0  |
| 2005-12        | 30      | SP-050786 | 0011 |     | Correction to C-code: encoder tuning table entry for 44.1 kHz was wrong                                 | 6.2.0  | 6.3.0  |
| 2005-12        | 30      | SP-050786 | 0012 |     | Correction to C-code: encoder bitrate switching simulation toolset                                      | 6.2.0  | 6.3.0  |
| 2006-09        | 33      | SP-060595 | 0015 | 1   | Correction of written specification: correct memory tables (fixed-point code)                           | 6.3.0  | 6.4.0  |
| 2006-09        | 33      | SP-060601 | 0013 | 2   | Modification of C-code: Change of encoder bitrate border for Parametric Stereo usage (fixed-point code) | 6.4.0  | 7.0.0  |
| 2006-12        | 34      | SP-060849 | 0016 |     | Correction to C-code: Correct the maximum possible SBR payload size (fixed point code)                  | 7.0.0  | 7.1.0  |
| 2007-03        | 35      | SP-070030 | 0018 |     | Bugfix for the Enhanced aacPlus fixed point arithmetic library  | 7.1.0  | 7.2.0  |
| 2007-09        | 37      | SP-070628 | 0020 | 1   | Adding safety code to avoid encoder runtime-assertion   | 7.2.0  | 7.3.0  |
| 2007-09        | 37      | SP-070628 | 0022 | 1   | Prevent arithmetic overflow during estimation of perceptual entropy in AAC encoder                      | 7.2.0  | 7.3.0  |
| 2007-09        | 37      | SP-070628 | 0024 | 1   | Prevent out-of-bounds memory access of encoder in parametric stereo mode                                | 7.2.0  | 7.3.0  |
| 2008-12        | 42      |           |      |     | Version for Release 8   | 7.3.0  | 8.0.0  |
| 2009-12        | 46      |           |      |     | Version for Release 9   | 8.0.0  | 9.0.0  |
| 2011-03        | 51      |           |      |     | Version for Release 10  | 9.0.0  | 10.0.0 |
| 2012-09        | 57      |           |      |     | Version for Release 11  | 10.0.0 | 11.0.0 |
| 2014-09        | 65      |           |      |     | Version for Release 12  | 11.0.0 | 12.0.0 |
| 2015-12        | 70      |           |      |     | Version for Release 13  | 12.0.0 | 13.0.0 |

| 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      |

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# History

| <b>Document history</b> |           |             |
|-------------------------|-----------|-------------|
| V15.0.0                 | July 2018 | Publication |
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|                         |           |             |