INTERNATIONAL STANDARD
ISO/IEC 14496-3:2001/Amd.1:2003/Cor.1:2004(E)

TECHNICAL CORRIGENDUM 1

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Information technology — Coding of audio-visual objects —

Part 3:
Audio

AMENDMENT 1: Bandwidth extension

TECHNICAL CORRIGENDUM 1

Technologies de l'information — Codage des objets audiovisuels —

Partie 3: Codage audio

AMENDEMENT 1: Extension de largeur de bande

RECTIFICATIF TECHNIQUE 1

Technical Corrigendum 1 to ISO/IEC 14496-3:2001/Amd.1:2003 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

NOTE This document specifies the first corrigendum to ISO/IEC 14496-3:2001/Amd.1:2003. With the exception of the correction for Table 4.54 which is only relevant for multi-channel decoding of ER streams, all the corrections strive to correct errors in the standard text and thus aligning the standard text with the reference software.

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In ISO/IEC 14496-3:2001/Amd.1, 4.4.2.8 Payloads for the audio object type SBR, replace Table 4.54 by the table below (modified parts are marked in gray):

Table 4.54A – Syntax of sbr_extension_data()

Syntax	No. of bits	Mnemonic
sbr_extension_data(id_aac, crc_flag)		
{		
num_sbr_bits = 0;		
if (crc_flag) {		
bs_sbr_crc_bits;	**10**	**uimsbf**
num_sbr_bits += 10;		
}		
if (sbr_layer != SBR_STEREO_ENHANCE) {		Note 1
num_sbr_bits += 1;		
if (**bs_header_flag**)	**1**	
num_sbr_bits += sbr_header();		Note 2
}		
num_sbr_bits += sbr_data(id_aac, bs_amp_res);		Note 2
num_align_bits = (8*cnt - 4 - num_sbr_bits) % 8;		
bs_fill_bits;	num_align _bits	**uimsbf**
return ((num_sbr_bits + num_align_bits + 4) / 8)		
}		
Note 1: When the SBR tool is used with a non-scalable AAC core coder, the value of the helper variable sbr_layer is SBR_NOT_SCALABLE. When the SBR tool is used with a scalable AAC core coder, the value of the helper variable sbr_layer depends on the current layer and the scalability configuration of the AAC core coder as defined in Table 4.86 in subclause 4.5.2.8.2.4. Note 2: sbr_header() and sbr_data() return the number of bits read (cnt is a parameter in extension_payload()).		

In ISO/IEC 14496-3:2001/Amd.1:2003, subclause 4.4.2.8 Payloads for the Audio Object Type SBR, Table 4.55A, replace:

Note 3: If this bit is not set the default values for the underlying bitstream elements should be used.

by:

Note 3: If this bit is not set the default values for the underlying bitstream elements shall be used disregarded any previous value.

In ISO/IEC 14496-3:2001/Amd.1, 4.4.2.8 Payloads for the audio object type SBR, Table 4.58, Table 4.59, and Table 4.60, add the part marked in gray:

if (**bs_extended_data**) {	**1**	
cnt = **bs_extension_size**;	**4**	**uimsbf**
if (cnt == 15)		
cnt += **bs_esc_count**;	**8**	**uimsbf**
num_bits_left = 8 * cnt;		
while (num_bits_left > 7) {		
bs_extension_id;	**2**	**uimsbf**
num_bits_left -= 2;		
sbr_extension(bs_extension_id, num_bits_left);		Note 1
}		
bs_fill_bits	num_bits_left	
}		

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.5.2.8.2.3 SBR Extension Payload for the Audio Object Types ER AAC LC and ER AAC LTP replace:

The extension payload shall not include both DRC extension elements and SBR extension elements simultaneously. If SBR extension elements are used, DRC extension elements are prohibited.

by:

The SBR extension elements shall be placed after any other extension elements.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.5.2.8.2.4 SBR Extension Payload for the Audio Object Types AAC Scalable and ER AAC Scalable, replace:

The scalable SBR data is embedded into the MPEG-4 stream in the same way as for non-scalable SBR data elements, by means of using the extension_payload().

by:

The scalable SBR data is embedded into the MPEG-4 stream in the same way as for non-scalable SBR data elements, by means of using the extension_payload(). The SBR extension elements shall be placed after any other extension elements.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.2.2 SBR specific notation, replace:

$$\mathbf{Q}_{Mapped}\left(m-lsb,l\right)=\mathbf{Q}_{Orig}\left(i,k\left(l\right)\right),\mathbf{f}_{TableNoise}(i)\le m<\mathbf{f}_{TableNoise}(i+1),0\le i<N_Q,0\le l<L_E$$

where $k\left(l\right)$ is defined by $\mathbf{t}\left(l\right)\ge\mathbf{t}_Q\left(k\left(l\right)\right),\mathbf{t}\left(l+1\right)\le\mathbf{t}_Q\left(k\left(l\right)+1\right)$

should be interpreted as follows. $\mathbf{Q}_{Mapped}\left(m-lsb,l\right)$ equals $\mathbf{Q}_{Orig}\left(i,k\left(l\right)\right)$

by:

$$\mathbf{Q}_{Mapped}\left(m-k_x,l\right)=\mathbf{Q}_{Orig}\left(i,k\left(l\right)\right),\mathbf{f}_{TableNoise}(i)\le m<\mathbf{f}_{TableNoise}(i+1),0\le i<N_Q,0\le l<L_E$$

where $k\left(l\right)$ is defined by $\mathbf{t}\left(l\right)\ge\mathbf{t}_Q\left(k\left(l\right)\right),\mathbf{t}\left(l+1\right)\le\mathbf{t}_Q\left(k\left(l\right)+1\right)$

should be interpreted as follows. $\mathbf{Q}_{Mapped}\left(m-k_x,l\right)$ equals $\mathbf{Q}_{Orig}\left(i,k\left(l\right)\right)$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.2.5 Constants, replace:

ε	A constant to avoid division by zero, e.g. 96 dB below maximum signal input.

by:

$\varepsilon=1$	A constant to avoid division by zero, e.g. 96 dB below maximum signal input.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.2.6, add:

$\mathbf{W}$	is the subband matrix where the QMF filtered subband samples are stored.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.4 and 4.6.18.8.2, replace all instances (in text flowcharts and pictures) of

$\mathbf{X}_{Low}$

by:

$\mathbf{W}$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.4.3 Down sampled synthesis filterbank, in Figure 4.44, where it says "127", it should say "127.5", hence replace it by the following figure:

```
Start
( for QMF subsample l )
```

```
for( n = 639; n >= 64; n--) {
    v[n] = v[n -64]
}
```

```
for( n = 0; n <= 63; n++) {
    v[n] = Real( X[0][l] / 64 * exp( i * π / 64 * ( 0.5 ) * ( 2 * n - 127.5 ) ))
    for( k = 1; k <= 31; k++) {
        v[n] = v[n] + Real( X[k][l] /64 * exp( i * π / 64 * ( k + 0.5 )*(2 *n -127.5) ))
    }
}
```

```
for( n = 0; n <= 4; n++) {
    for( k = 0; k <= 31; k++) {
        g[64 * n + k]        =  v[128 * n + k]
        g[64 * n + 32 + k]   =  v[128 * n + 96 + k]
    }
}
```

```
for( n = 0; n <= 319; n++) {
    w[n] = g[n] * c[2*n]
}
```

```
for( k = 0; k <= 31; k++) {
    temp = w[k]
    for( n = 1; n <= 9; n++) {
        temp = temp + w[32*n + k]
    }
    nextOutputAudioSample = temp
}
```

```
Done
```

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.5 SBR tool overview, replace:

start-up l_{Temp}, lsb' and $bsco'$ are set to zero. And where $bsco = \max\left(INT\left(maxAACLine \cdot 32 / frameLength\right) - lsb, 0\right)$, and where

by:

start-up l_{Temp}, k_x' and $bsco'$ are set to zero. Where $bsco = 0$ unless a scalable core coder is used, for which $bsco = \max\left(INT\left(maxAACLine \cdot 32 / frameLength\right) - k_x, 0\right)$, and where

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.5 SBR Tool overview, replace:

The output from the filtering is stored in the matrix:

$$\mathbf{X}_{Low}\left(k,\ l + t_{HFGen}\right),\ 0 \le k < 32,\ 0 \le l < numTimeSlots \cdot RATE$$

by:

The subband filtered low band is defined by $\mathbf{X}_{Low}$ according to:

$$\mathbf{X}_{Low}\left(k,\ l\right) = \begin{cases} \mathbf{W}(k, l - t_{HFGen}) & ,\ 0 \le k < k_x,\ t_{HFGen} \le l < l_f + t_{HFGen} \\ 0 & ,\ k_x \le k < 32,\ t_{HFGen} \le l < l_f + t_{HFGen} \\ \mathbf{W}'(k, l + l_f - t_{HFGen}) & ,\ 0 \le k < k'_x,\ 0 \le l < t_{HFGen} \\ 0 & ,\ k'_x \le k < 32,\ 0 \le l < t_{HFGen} \end{cases}$$

where $\mathbf{W'}$ is the $\mathbf{W}$ matrix from the previous frame, and k'_x is the k_x value from the previous frame, and where $l_f = numTimeSlots \cdot RATE$. If scalable SBR is used the following apply instead of the equation above:

$$\mathbf{X}_{Low}\left(k,\ l\right) = \begin{cases} \mathbf{W}(k, l - t_{HFGen}) & ,\ 0 \le k < 32,\ t_{HFGen} \le l < l_f + t_{HFGen} \\ \mathbf{W}'(k, l + l_f - t_{HFGen}) & ,\ 0 \le k < 32,\ 0 \le l < t_{HFGen} \end{cases}$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.5 SBR Tool overview, replace:

$$\mathbf{X}(k,l) = \begin{cases} \mathbf{X}_{Low}\left(k, l + t_{HFAdj}\right) & ,\ 0 \le k < k_x' + bsco',\ 0 \le l < l_{Temp} \\ \mathbf{X}_{Low}\left(k, l + t_{HFAdj}\right) & ,\ 0 \le k < k_x + bsco,\ l_{Temp} \le l < numTimeSlots \cdot RATE \\ \mathbf{Y}\left(k, l + t_{HFAdj}\right) & ,\ k_x' + bsco' \le k < k_x + M,\ 0 \le l < l_{Temp} \\ \mathbf{Y}\left(k, l + t_{HFAdj}\right) & ,\ k_x + bsco \le k < k_x + M,\ l_{Temp} \le l < numTimeSlots \cdot RATE \\ 0 & ,\ \max\left(k_x + bsco, k_x + M\right) + M \le k < 64,\ 0 \le l < numTimeSlots \cdot RATE \end{cases} \quad "$$

by:

$$\mathbf{X}(k,l)=\begin{cases}\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0 \le k < k_x'+bsco',\ 0 \le l < l_{Temp}\\ \mathbf{Y}'\left(k,l+t_{HFAdj}+l_f\right) & ,k_x'+bsco' \le k < k_x'+M',\ 0 \le l < l_{Temp}\\ 0 & ,\max\left(k'_x+bsco',k'_x+M'\right)\le k < 64,\ 0 \le l < l_{Temp}\\ \mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0 \le k < k_x+bsco,\ l_{Temp} \le l < l_f\\ \mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k_x+bsco \le k < k_x+M,\ l_{Temp} \le l < l_f\\ 0 & ,\max\left(k_x+bsco,k_x+M\right)\le k < 64,\ l_{Temp} \le l < l_f\end{cases}$$

where

$$l_f = numTimeSlots \cdot RATE$$

and

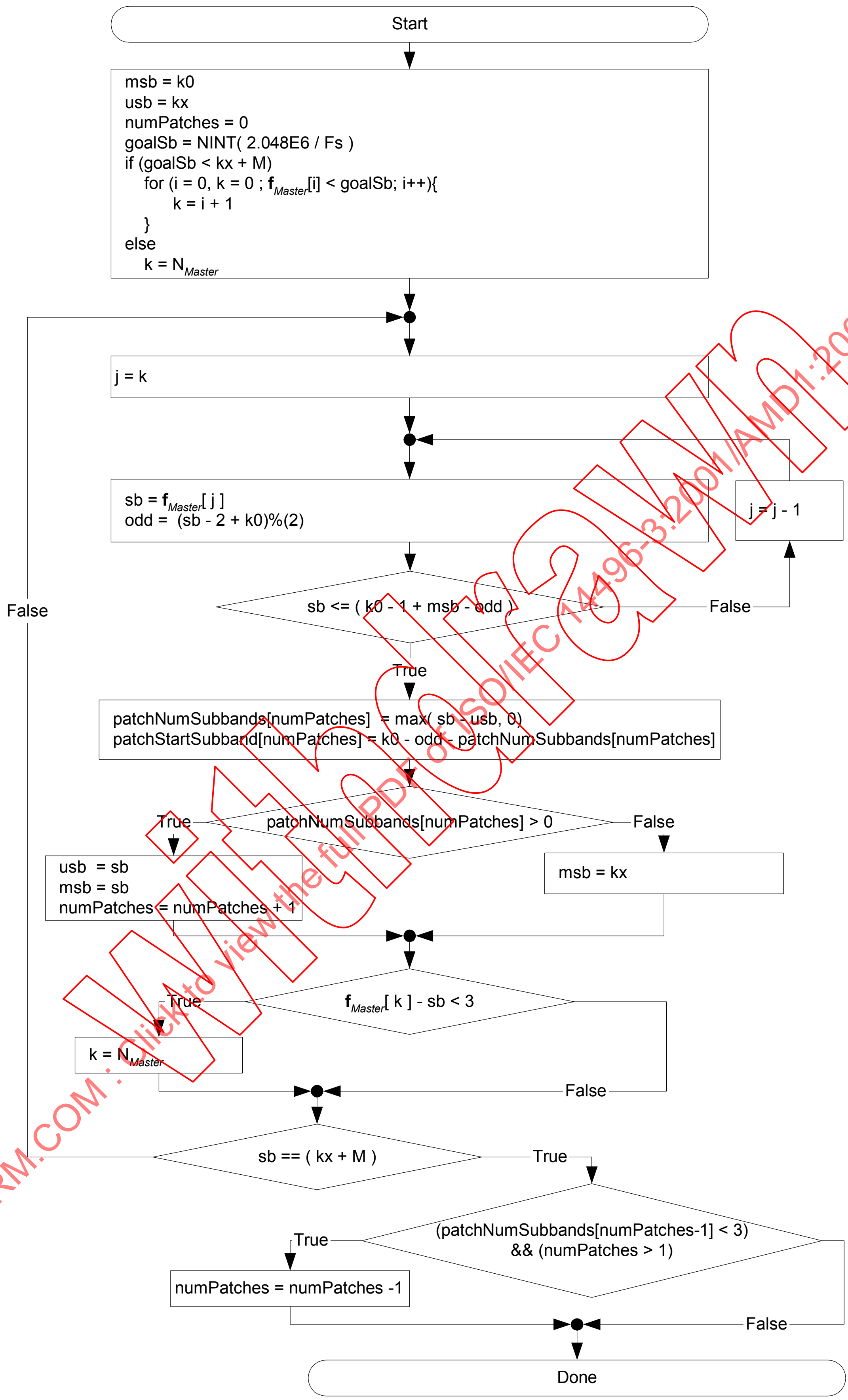
In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.6.2 Inverse filtering , replace:

where **bs_invf_mode´** are the **bs_invf_mode** values from the previous SBR frame.

by:

where **bs_invf_mode´** are the **bs_invf_mode** values from the previous SBR frame, and are assumed to be zero for the first frame.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.6.3 HF generator, replace Figure 4.46 by the following figure:


Start
msb = k0
usb = kx
numPatches = 0
goalSb = NINT(2.048E6 / Fs)
if (goalSb < kx + M)
for (i = 0, k = 0 ; $\mathbf{f}_{Master}$[i] < goalSb; i++){
k = i + 1
}
else
k = N_{Master}
j = k
sb = $\mathbf{f}_{Master}$[j]
odd = (sb - 2 + k0)%(2)
j = j - 1
sb <= (k0 - 1 + msb - odd)
False
True
patchNumSubbands[numPatches] = max(sb - usb, 0)
patchStartSubband[numPatches] = k0 - odd - patchNumSubbands[numPatches]
patchNumSubbands[numPatches] > 0
True
False
usb = sb
msb = sb
numPatches = numPatches + 1
msb = kx
$\mathbf{f}_{Master}$[k] - sb < 3
True
k = N_{Master}
False
sb == (kx + M)
False
True
(patchNumSubbands[numPatches-1] < 3)
&& (numPatches > 1)
True
numPatches = numPatches -1
False
Done

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.2 Mapping, replace:

$$\mathbf{S}_{IndexMapped}\left(m-k_x,l\right)=\begin{cases}0 & if\ \ m\neq INT\left(\dfrac{\mathbf{f}_{TableHigh}\left(i+1\right)+\mathbf{f}_{TableHigh}\left(i\right)}{2}\right)\\ \mathbf{S}_{Index}\left(i\right)\cdot\delta_{Step}\left(i,l\right) & if\ \ m=INT\left(\dfrac{\mathbf{f}_{TableHigh}\left(i+1\right)+\mathbf{f}_{TableHigh}\left(i\right)}{2}\right)\end{cases}$$

for $\mathbf{f}_{TableHigh}\left(i\right)\leq m<\mathbf{f}_{TableHigh}\left(i+1\right),\ 0\leq i<N_{High}\ ,0\leq l<L_E$

where

$$\delta_{Step}\left(i,l\right)=\begin{cases}1 & if\ \left(l\geq l_A\right)OR\left(\mathbf{S}'_{Index}\left(i\right)=1\right)\\ 0 & otherwise\end{cases},$$

by:

$$\mathbf{S}_{IndexMapped}\left(m-k_x,l\right)=\begin{cases}0 & if\ \ m\neq INT\left(\dfrac{\mathbf{f}_{TableHigh}\left(i+1\right)+\mathbf{f}_{TableHigh}\left(i\right)}{2}\right)\\ \mathbf{S}_{Index}\left(i\right)\cdot\delta_{Step}\left(m-k_x,l\right) & if\ \ m=INT\left(\dfrac{\mathbf{f}_{TableHigh}\left(i+1\right)+\mathbf{f}_{TableHigh}\left(i\right)}{2}\right)\end{cases}$$

for $\mathbf{f}_{TableHigh}\left(i\right)\leq m<\mathbf{f}_{TableHigh}\left(i+1\right),\ 0\leq i<N_{High}\ ,0\leq l<L_E$

where

$$\delta_{Step}\left(m,l\right)=\begin{cases}1 & if\ \left(l\geq l_A\right)OR\left(\mathbf{S}'_{IndexMapped}\left(m,L'_E-1\right)=1\right)\\ 0 & otherwise\end{cases},$$

and replace:

and $\mathbf{S}'_{Index}\left(i\right)$ is $\mathbf{S}_{Index}\left(i\right)$ of the previous SBR frame.

by:

and $\mathbf{S}'_{IndexMapped}$ is $\mathbf{S}_{IndexMapped}$ of the previous SBR frame for the same frequency range. If the frequency range is larger for the current frame, the entries for the QMF subbands not covered by the previous $\mathbf{S}_{IndexMapped}$ are assumed to be zero.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.2 Mapping, replace:

$$\mathbf{S}_{Mapped}\left(m-k_x,l\right)=\delta_S\left(i,l\right),\ l_i\leq m<u_i,\begin{cases}u_i=\mathbf{F}\left(k\left(i+1,l\right),\mathbf{r}\left(l\right)\right)\\ l_i=\mathbf{F}\left(k\left(i,l\right),\mathbf{r}\left(l\right)\right)\end{cases}$$

for $0 \le i < N_{High}$, $0 \le l < L_E$ where $k(i,l)$ is defined by

$$\begin{cases} \mathbf{F}(i,HI) \ge \mathbf{F}(k(i,l),LO), \mathbf{F}(i+1,HI) \le \mathbf{F}(k(i,l)+1,LO) & ,\mathbf{r}(l) = LO \\ k(i,l) = i & ,\mathbf{r}(l) = HI \end{cases}$$

and where

$$\delta_S(i,l) = \begin{cases} 1 & ,1 \in \{\mathbf{S}_{IndexMapped}(k,l): \quad \mathbf{F}(k(i,l),\mathbf{r}(l)) \le k < \mathbf{F}(k(i+1,l),\mathbf{r}(l))\} \\ 0 & ,otherwise \end{cases}.$$

In order to handle the varying frequency resolution of the envelope scalefactors, $k(i,l)$ is introduced. For a given high frequency resolution band, $k(i,l)$ gives the proper indices to the corresponding low frequency resolution band of which the former is a subset, if the current SBR envelope is of low frequency resolution. Finally, the $\delta_S(i,l)$ function returns one if any entry in the $\mathbf{S}_{IndexMapped}$ matrix is one within the given boundaries, i.e. if an additional sinusoid is present within the present frequency band.

by:

$$\mathbf{S}_{Mapped}(m-k_x,l) = \delta_S(i,l), l_i \le m < u_i, \begin{cases} u_i = \mathbf{F}(i+1,\mathbf{r}(l)) \\ l_i = \mathbf{F}(i,\mathbf{r}(l)) \end{cases}$$

for $0 \le i < \mathbf{n}(\mathbf{r}(l))$, $0 \le l < L_E$

where

$$\delta_S(i,l) = \begin{cases} 1 & ,1 \in \{\mathbf{S}_{IndexMapped}(j-k_x,l): \quad \mathbf{F}(i,\mathbf{r}(l)) \le j < \mathbf{F}(i+1,\mathbf{r}(l))\} \\ 0 & ,otherwise \end{cases}.$$

The $\delta_S(i,l)$ function returns one if any entry in the $\mathbf{S}_{IndexMapped}$ matrix is one within the given boundaries, i.e. if an additional sinusoid is present within the present frequency band. The $\mathbf{S}_{Mapped}$ matrix is hence one for all QMF subbands in the scalefactor bands where an additional sinusoid shall be added.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.6 Calculation of Additional HF Signal Components, replace the equation:

$$\mathbf{S}_M(m,l) = \sqrt{\mathbf{E}_{OrigMapped}(m,l) \cdot \frac{\mathbf{S}_{Mapped}(m,l)}{1+\mathbf{Q}_{Mapped}(m,l)}}, \quad 0 \le m < M, 0 \le l < L_E$$

by:

$$\mathbf{S}_M(m,l)=\sqrt{\mathbf{E}_{OrigMapped}(m,l)\cdot\frac{\mathbf{S}_{IndexMapped}(m,l)}{1+\mathbf{Q}_{Mapped}(m,l)}}\ ,\quad 0\le m<M\ ,0\le l<L_E$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.5 Calculation of gain, replace the equation:

$$\mathbf{G}(m,l)=\begin{cases}\sqrt{\dfrac{\mathbf{E}_{OrigMapped}(m,l)}{\left(\varepsilon+\mathbf{E}_{Curr}(m,l)\right)\cdot\left(1+\delta(l)\cdot\mathbf{Q}_{Mapped}(m,l)\right)}} & if\quad \mathbf{S}_M(m,l)=0\\ \sqrt{\dfrac{\mathbf{E}_{OrigMapped}(m,l)}{\left(\varepsilon+\mathbf{E}_{Curr}(m,l)\right)}\cdot\dfrac{\mathbf{Q}_{Mapped}(m,l)}{\left(1+\mathbf{Q}_{Mapped}(m,l)\right)}} & if\quad \mathbf{S}_M(m,l)\ne 0\end{cases}\ ,0\le m<M\ ,0\le l<L_E$$

by:

$$\mathbf{G}(m,l)=\begin{cases}\sqrt{\dfrac{\mathbf{E}_{OrigMapped}(m,l)}{\left(\varepsilon+\mathbf{E}_{Curr}(m,l)\right)\cdot\left(1+\delta(l)\cdot\mathbf{Q}_{Mapped}(m,l)\right)}} & if\quad \mathbf{S}_{Mapped}(m,l)=0\\ \sqrt{\dfrac{\mathbf{E}_{OrigMapped}(m,l)}{\left(\varepsilon+\mathbf{E}_{Curr}(m,l)\right)}\cdot\dfrac{\mathbf{Q}_{Mapped}(m,l)}{\left(1+\mathbf{Q}_{Mapped}(m,l)\right)}} & if\quad \mathbf{S}_{Mapped}(m,l)\ne 0\end{cases}\ ,0\le m<M\ ,0\le l<L_E$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.5 Calculation of gain, replace the equation:

$$\mathbf{G}_{Max_{Temp}}(k,l)=\sqrt{\frac{\varepsilon_0+\sum\limits_{i=\mathbf{f}_{TableLim}(k)}^{\mathbf{f}_{TableLim}(k+1)-1}\mathbf{E}_{OrigMapped}(i,l)}{\varepsilon_0+\sum\limits_{i=\mathbf{f}_{TableLim}(k)}^{\mathbf{f}_{TableLim}(k+1)-1}\mathbf{E}_{Curr}(i,l)}}\cdot\mathbf{limGain}(bs\_limiter\_gains),\quad 0\le k<N_L\ ,0\le l<L_E$$

$$\mathbf{G}_{Max}(m,l)=\min\left(\mathbf{G}_{Max_{Temp}}\left(k(m),l\right),10^5\right),\quad 0\le m<M\ ,0\le l<L_E$$

where $k(m)$ is defined by $\mathbf{f}_{TableLim}\left(k(m)\right)\le m<\mathbf{f}_{TableLim}\left(k(m)+1\right)$,

by:

$$\mathbf{G}_{Max_{Temp}}(k,l)=\sqrt{\frac{\varepsilon_0+\sum\limits_{i=\mathbf{f}_{TableLim}(k)-k_x}^{\mathbf{f}_{TableLim}(k+1)-1-k_x}\mathbf{E}_{OrigMapped}(i,l)}{\varepsilon_0+\sum\limits_{i=\mathbf{f}_{TableLim}(k)-k_x}^{\mathbf{f}_{TableLim}(k+1)-1-k_x}\mathbf{E}_{Curr}(i,l)}}\cdot\mathbf{limGain}(bs\_limiter\_gains),\quad 0\le k<N_L\ ,0\le l<L_E$$

$$\mathbf{G}_{Max}(m,l)=\min\left(\mathbf{G}_{Max_{Temp}}\left(k(m),l\right),10^5\right),\quad 0\le m<M\ ,0\le l<L_E$$

where $k(m)$ is defined by $\mathbf{f}_{TableLim}\left(k(m)\right)\le m+k_x<\mathbf{f}_{TableLim}\left(k(m)+1\right)$, *In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.5 Calculation of Gain, replace:*

for $0 \le k < N_L, 0 \le l < L_E$ where, $\delta(\mathbf{S}_M(i,l),l) = \begin{cases} 0 & , \mathbf{S}_M(i,l) \ne 0 \; OR \; l = l_A \\ 1 & , otherwise \end{cases}$.

by:

for $0 \le k < N_L, 0 \le l < L_E$ where, $\delta(\mathbf{S}_M(i,l),l) = \begin{cases} 0 & , \mathbf{S}_M(i,l) \ne 0 \; OR \; l = l_A \; OR \; l = l_{APrev} \\ 1 & , otherwise \end{cases}$.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.5 Calculation of gain, replace the equation

$$\mathbf{G}_{Boost_{Temp}}(k,l) = \sqrt{\frac{\varepsilon_0 + \sum_{i=\mathbf{f}_{TableLim}(k)}^{\mathbf{f}_{TableLim}(k+1)-1} \mathbf{E}_{OrigMapped}(i,l)}{\varepsilon_0 + \sum_{i=\mathbf{f}_{TableLim}(k)}^{\mathbf{f}_{TableLim}(k+1)-1} \left(\mathbf{E}_{Curr}(i,l) \cdot \mathbf{G}^2_{Lim}(i,l) + \mathbf{S}^2_M(i,l) + \delta(\mathbf{S}_M(i,l),l) \cdot \mathbf{Q}^2_M(i,l)\right)}}$$

$$\mathbf{f}_{TableLim}(k(m)) \le m < \mathbf{f}_{TableLim}(k(m)+1)$$

by:

$$\mathbf{G}_{Boost_{Temp}}(k,l) = \sqrt{\frac{\varepsilon_0 + \sum_{i=\mathbf{f}_{TableLim}(k)-k_x}^{\mathbf{f}_{TableLim}(k+1)-1-k_x} \mathbf{E}_{OrigMapped}(i,l)}{\varepsilon_0 + \sum_{i=\mathbf{f}_{TableLim}(k)-k_x}^{\mathbf{f}_{TableLim}(k+1)-1-k_x} \left(\mathbf{E}_{Curr}(i,l) \cdot \mathbf{G}^2_{Lim}(i,l) + \mathbf{S}^2_M(i,l) + \delta(\mathbf{S}_M(i,l),l) \cdot \mathbf{Q}^2_{M_{Lim}}(i,l)\right)}}$$

$$\mathbf{f}_{TableLim}(k(m)) \le m + k_x < \mathbf{f}_{TableLim}(k(m)+1)$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.6 Assembling HF signals, replace the equation:

$$\mathbf{G}_{Filt}(m,i) = \begin{cases} \sum_{j=0}^{h_{SL}} \mathbf{G}_{Temp}(m, i - j + h_{SL}) \cdot \mathbf{h}_{Smooth}(j) & if\ l \ne l_A\ AND\ h_{SL} \ne 0 \\ \mathbf{G}_{Temp}(m, i + h_{SL}) & otherwise \end{cases}$$

$$rate \cdot \mathbf{t}_E(l) \le i < rate \cdot \mathbf{t}_E(l+1), 0 \le m < M, 0 \le l < L_E$$

by:

$$\mathbf{G}_{Filt}(m,i) = \begin{cases} \sum_{j=0}^{h_{SL}} \mathbf{G}_{Temp}(m, i - j + h_{SL}) \cdot \mathbf{h}_{Smooth}(j) & if\ l \ne l_A\ AND\ h_{SL} \ne 0\ AND\ l \ne l_{APrev} \\ \mathbf{G}_{Temp}(m, i + h_{SL}) & otherwise \end{cases}$$

$$RATE \cdot \mathbf{t}_E(l) \le i < RATE \cdot \mathbf{t}_E(l+1), 0 \le m < M, 0 \le l < L_E$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.6 Assembling HF signals, replace the equation:

$$\mathbf{W}_1(m,i) = \mathbf{G}_{Filt}(m,i) \cdot \mathbf{X}_{High}(m + lsb, i + t_{HfAdj}), \quad RATE \cdot \mathbf{t}_E(0) \le i < RATE \cdot \mathbf{t}_E(L_E), 0 \le m < M$$

by:

$$\mathbf{W}_1(m,i) = \mathbf{G}_{Filt}(m,i) \cdot \mathbf{X}_{High}(m + k_x, i + t_{HfAdj}), \quad RATE \cdot \mathbf{t}_E(0) \le i < RATE \cdot \mathbf{t}_E(L_E), 0 \le m < M$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.6 Assembling HF signals, replace the equation:

$$\mathbf{Q}_{Filt}(m,i) = \begin{cases} \sum_{j=0}^{h_{SL}} \mathbf{Q}_{Temp}(m, i - j + h_{SL}) \cdot \mathbf{h}_{Smooth}(j) & if\ l \ne l_A\ AND\ l \ne l_{APrev}\ AND\ \mathbf{S}_{MBoost}(m,l) = 0 \\ 0 & otherwise \end{cases}$$

by:

$$\mathbf{Q}_{Filt}(m,i) = \begin{cases} \mathbf{Q}_{Temp}(m,i) & if\ l \ne l_A\ AND\ l \ne l_{APrev}\ AND\ \mathbf{S}_{MBoost}(m,l) = 0\ AND\ h_{SL} = 0 \\ \sum_{j=0}^{h_{SL}} \mathbf{Q}_{Temp}(m, i - j + h_{SL}) \cdot \mathbf{h}_{Smooth}(j) & if\ l \ne l_A\ AND\ l \ne l_{APrev}\ AND\ \mathbf{S}_{MBoost}(m,l) = 0\ AND\ h_{SL} \ne 0 \\ 0 & otherwise \end{cases}$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.6 Assembling HF signals, replace the equations:

$$\boldsymbol{\psi}_{Re}(m,l,i) = \mathbf{S}_{IndexMapped}(m,l) \cdot \mathbf{S}_{MBoost}(m,l) \cdot \boldsymbol{\varphi}_{Re,sin}\left(f_{IndexSine}(i)\right)$$

$$\boldsymbol{\psi}_{Im}(m,l,i) = \mathbf{S}_{IndexMapped}(m,l) \cdot \mathbf{S}_{MBoost}(m,l) \cdot (-1)^{m+lsb} \cdot \boldsymbol{\varphi}_{Im,sin}\left(f_{IndexSine}(i)\right)$$

by:

$$\boldsymbol{\psi}_{Re}(m,l,i) = \mathbf{S}_{MBoost}(m,l) \cdot \boldsymbol{\varphi}_{Re,sin}\left(f_{IndexSine}(i)\right)$$

$$\boldsymbol{\psi}_{Im}(m,l,i) = \mathbf{S}_{MBoost}(m,l) \cdot (-1)^{m+k_x} \cdot \boldsymbol{\varphi}_{Im,sin}\left(f_{IndexSine}(i)\right)$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.7.6 Assembling HF signals, replace:

and $index_{Noise}$ is the last $f_{IndexNoise}$ from the previous SBR frame, unless the reset-flag is set ($reset=1$) for which case $f_{IndexNoise} = 0$.

by:

and $index_{Noise}$ is the last $f_{IndexNoise}$ from the previous SBR frame, unless the reset-flag is set ($reset=1$) for which case $index_{Noise} = 0$.

and replace:

$$f_{IndexSine}(i) = (index_{Sine} + i)\bmod(4)$$

by:

$$f_{IndexSine}(i) = (index_{Sine} + i - RATE \cdot \mathbf{t}_E(0))\bmod(4)$$

and replace:

$index_{Sine}$ is the last $f_{IndexSine}$ from the previous SBR frame.

by:

$index_{Sine} = (\text{the last } f_{IndexSine} \text{ from the previous SBR frame} + 1)\bmod(4)$, or $index_{Sine} = 0$ for the first frame.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.8.2 replace all instances (in text, flowcharts and pictures) of

$\mathbf{X}_{Low}$

by:

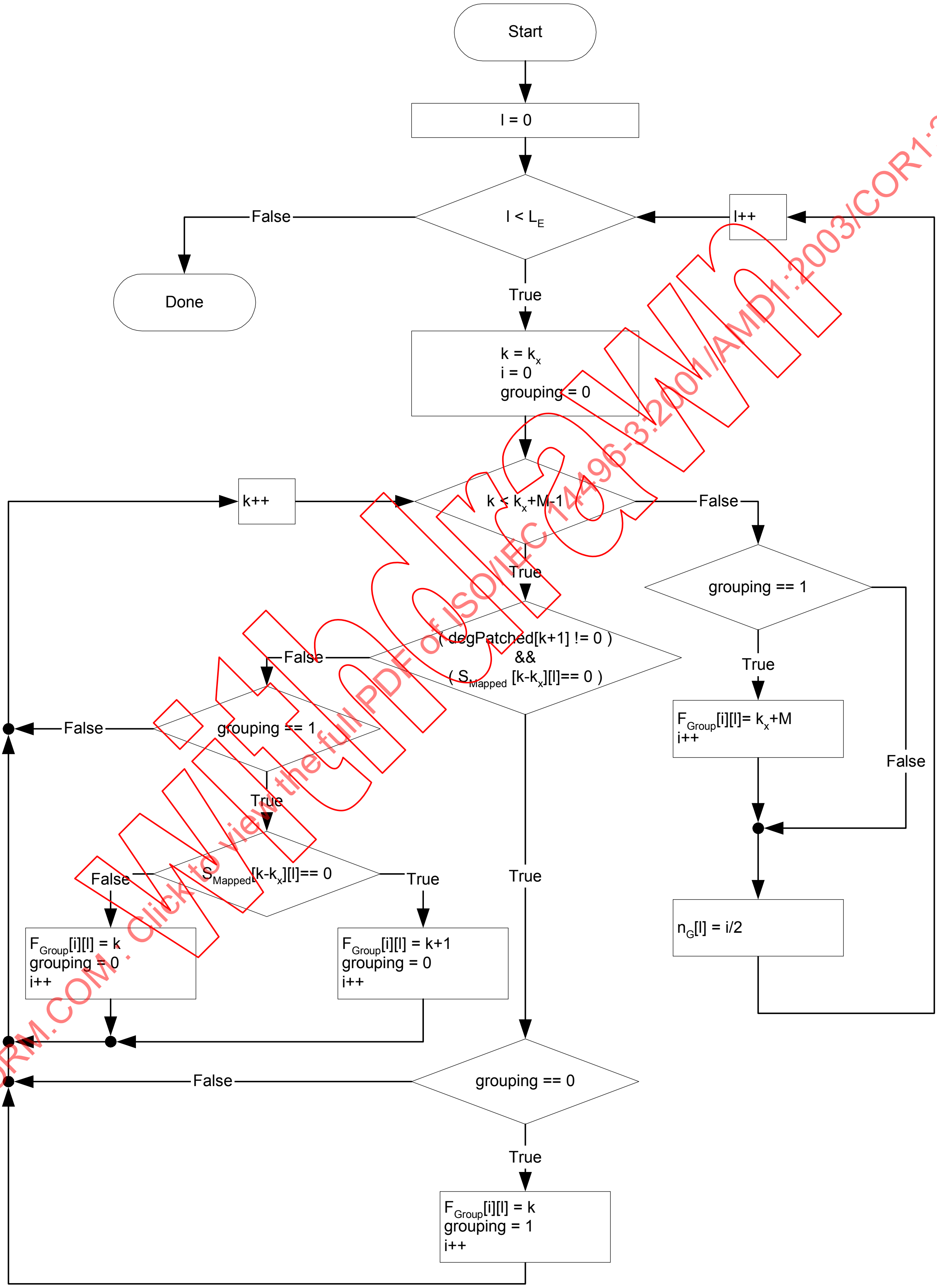
$\mathbf{W}$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.8.3 Aliasing detection, add the following after the definition of degPatched:

Since the patch information may not cover the whole SBR range, the degree of aliasing in the frequency region from where the patch ends to where the SBR range ends is defined by:

$$\mathbf{degPatched}(k) = 0, \quad k_x + \sum_{q=0}^{numPatches-1} \mathbf{patchNumSubbands}(q) \le k < k_x + M$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.8.3 Aliasing detection, replace Figure 4.53 by the following figure:



In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.8.5 Aliasing Reduction, replace:

$$\boldsymbol{\psi}_{Re}(m,l,i) = \mathbf{S}_{IndexMapped}(m,l)\cdot\mathbf{S}_{MBoost}(m,l)\cdot\boldsymbol{\varphi}_{Re,sin}\left(f_{IndexSine}(i)\right)$$

$$\boldsymbol{\psi}_{Im}(m,l,i) = \mathbf{S}_{IndexMapped}(m,l)\cdot\mathbf{S}_{MBoost}(m,l)\cdot(-1)^{m+lsb}\cdot\boldsymbol{\varphi}_{Im,sin}\left(f_{IndexSine}(i)\right)$$

by:

$$\boldsymbol{\psi}_{Re}(m,l,i) = \mathbf{S}_{MBoost}(m,l)\cdot\boldsymbol{\varphi}_{Re,sin}\left(f_{IndexSine}(i)\right)$$

$$\boldsymbol{\psi}_{Im}(m,l,i) = \mathbf{S}_{MBoost}(m,l)\cdot(-1)^{m+k_x}\cdot\boldsymbol{\varphi}_{Im,sin}\left(f_{IndexSine}(i)\right)$$

and replace:

$$rate\cdot\mathbf{t}_E(l) \le i < rate\cdot\mathbf{t}_E(l+1), 0 \le l < L_E$$

$$\boldsymbol{\psi}_m(m,l,i) = \boldsymbol{\psi}_{Re}(m,l,i) - 0.00815\cdot(-1)^{m+lsb}\cdot\left(\boldsymbol{\psi}_{Re}(m-1,l,i-1)+\boldsymbol{\psi}_{Re}(m+1,l,i+1)\right)$$

$$\boldsymbol{\psi}_{Re}(m,l,i) = \mathbf{S}_{IndexMapped}(m,l)\cdot\mathbf{S}_{MBoost}(m,l)\cdot\boldsymbol{\varphi}_{Re,sin}\left(f_{IndexSine}(i)\right)$$

and where

$\mathbf{S}_{IndexMapped}(m,l) = 0$, for $m < 0$ or $m \ge M$.

by:

$$RATE\cdot\mathbf{t}_E(l) \le i < RATE\cdot\mathbf{t}_E(l+1), 0 \le l < L_E$$

$$\boldsymbol{\psi}_m(m,l,i) = \boldsymbol{\psi}_{Re}(m,l,i) - 0.00815\cdot(-1)^{m+k_x}\cdot\left(\boldsymbol{\psi}_{Re}(m-1,l,i-1)+\boldsymbol{\psi}_{Re}(m+1,l,i+1)\right)$$

$$\boldsymbol{\psi}_{Re}(m,l,i) = \mathbf{S}_{MBoost}(m,l)\cdot\boldsymbol{\varphi}_{Re,sin}\left(f_{IndexSine}(i)\right)$$

and where

$\mathbf{S}_{MBoost}(m,l) = 0$, for $m < 0$ or $m \ge M$.

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.6.18.8.5 Aliasing Reduction, replace:

Furthermore, since a signal, according to the above, may be added to $\mathbf{Y}(k_x-1,i)$, i.e. the lowband, or $\mathbf{Y}(k_x+M,i)$, i.e. one QMF subband above the SBR range, the following equation in subclause 4.6.18.5 needs to be modified:

$$\mathbf{X}(k,l)=\begin{cases}\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0\le k<k_x'+bsco',\ 0\le l<l_{Temp}\\ \mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0\le k<k_x+bsco,\ l_{Temp}\le l<numTimeSlots\cdot RATE\\ \mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k_x'+bsco'\le k<k_x+M,\ 0\le l<l_{Temp}\\ \mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k_x+bsco\le k<k_x+M,\ l_{Temp}\le l<numTimeSlots\cdot RATE\\ 0 & ,\max\left(k_x+bsco,k_x+M\right)+M\le k<64,\ 0\le l<numTimeSlots\cdot RATE\end{cases}$$

The above is replaced by

$$\mathbf{X}(k,l)=\begin{cases}\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0\le k<k_x'-1+bsco',\ 0\le l<l_{Temp}\\ \mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right)+\mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k=k_x'-1+bsco',\ 0\le l<l_{Temp}\\ \mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0\le k<k_x-1+bsco,\ l_{Temp}\le l<numTimeSlots\cdot RATE\\ \mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right)+\mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k=k_x-1+bsco,\ l_{Temp}\le l<numTimeSlots\cdot RATE\\ \mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k_x'+bsco'\le k\le\min\left(k_x+M,63\right),\ 0\le l<l_{Temp}\\ \mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,\begin{cases}k_x+bsco\le k\le\min\left(k_x+M,63\right)\\ l_{Temp}\le l<numTimeSlots\cdot RATE\end{cases}\\ 0 & ,\begin{cases}\max\left(k_x+bsco,k_x+M\right)<k<64\\ 0\le l<numTimeSlots\cdot RATE\end{cases}\end{cases}$$

by:

Furthermore, since a signal, according to the above, may be added to $\mathbf{Y}\left(k_x-1,i\right)$, i.e. the lowband, or $\mathbf{Y}\left(k_x+M,i\right)$, i.e. one QMF subband above the SBR range, the following equation in subclause 4.6.18.5 needs to be modified:

$$\mathbf{X}(k,l)=\begin{cases}\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0\le k<k_x'+bsco',\ 0\le l<l_{Temp}\\ \mathbf{Y}'\left(k,l+t_{HFAdj}+l_f\right) & ,k_x'+bsco'\le k<k_x'+M',\ 0\le l<l_{Temp}\\ 0 & ,\max\left(k'_x+bsco',k'_x+M'\right)\le k<64,\ 0\le l<l_{Temp}\\ \mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,0\le k<k_x+bsco,\ l_{Temp}\le l<l_f\\ \mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,k_x+bsco\le k<k_x+M,\ l_{Temp}\le l<l_f\\ 0 & ,\max\left(k_x+bsco,k_x+M\right)\le k<64,\ l_{Temp}\le l<l_f\end{cases}$$

The above is replaced by

$$
\mathbf{X}(k,l)=\begin{cases}
\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,\ 0\le k<k_x'-1+bsco',\ 0\le l<l_{Temp}\\
\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right)+\mathbf{Y}'\left(k,l+t_{HFAdj}+l_f\right) & ,\ k=k_x'-1+bsco',\ 0\le l<l_{Temp}\\
\mathbf{Y}'\left(k,l+t_{HFAdj}+l_f\right) & ,\ k_x'+bsco'\le k\le\min\left(k_x'+M',63\right),\ 0\le l<l_{Temp}\\
0 & ,\begin{cases}\max\left(k_x'+bsco',k_x'+M'\right)<k<64\\ 0\le l<l_{Temp}\end{cases}\\
\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right) & ,\ 0\le k<k_x-1+bsco,\ l_{Temp}\le l<l_f\\
\mathbf{X}_{Low}\left(k,l+t_{HFAdj}\right)+\mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,\ k=k_x-1+bsco,\ l_{Temp}\le l<l_f\\
\mathbf{Y}\left(k,l+t_{HFAdj}\right) & ,\begin{cases}k_x+bsco\le k\le\min\left(k_x+M,63\right)\\ l_{Temp}\le l<l_f\end{cases}\\
0 & ,\begin{cases}\max\left(k_x+bsco,k_x+M\right)<k<64\\ l_{Temp}\le l<l_f\end{cases}
\end{cases}
$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.B.18.4 Envelope Estimation, replace:

$$
\mathbf{E}\left(k-k_x,l\right)=\frac{\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}\left(i,j\right)\right|^2}{\left(RATE\cdot\mathbf{t}_E\left(l+1\right)-RATE\cdot\mathbf{t}_E\left(l\right)\right)\cdot\left(k_h-k_l\right)},\quad k_l\le k<k_h,\begin{cases}k_l=\mathbf{F}\left(p,\mathbf{r}(l)\right)\\ k_h=\mathbf{F}\left(p+1,\mathbf{r}(l)\right)\end{cases},0\le p<\mathbf{n}\left(\mathbf{r}(l)\right),0\le l<L_E
$$

$$
\mathbf{E}_{Left}\left(k-k_x,l\right)=\frac{\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}_{left}\left(i,j\right)\right|^2+\left|\mathbf{X}_{Right}\left(i,j\right)\right|^2}{2\cdot\left(RATE\cdot\mathbf{t}_E\left(l+1\right)-RATE\cdot\mathbf{t}_E\left(l\right)\right)\cdot\left(k_h-k_l\right)}
$$

$$
\mathbf{E}_{Right}\left(k-k_x,l\right)=\frac{\varepsilon+\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}_{Left}\left(i,j\right)\right|^2}{\varepsilon+\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}_{Right}\left(i,j\right)\right|^2}
$$

by:

$$
\mathbf{E}\left(k-k_x,l\right)=\frac{\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}\left(j,i\right)\right|^2}{\left(RATE\cdot\mathbf{t}_E\left(l+1\right)-RATE\cdot\mathbf{t}_E\left(l\right)\right)\cdot\left(k_h-k_l\right)},\quad k_l\le k<k_h,\begin{cases}k_l=\mathbf{F}\left(p,\mathbf{r}(l)\right)\\ k_h=\mathbf{F}\left(p+1,\mathbf{r}(l)\right)\end{cases},0\le p<\mathbf{n}\left(\mathbf{r}(l)\right),0\le l<L_E
$$

$$
\mathbf{E}_{Left}\left(k-k_x,l\right)=\frac{\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left(\left|\mathbf{X}_{Left}\left(j,i\right)\right|^2+\left|\mathbf{X}_{Right}\left(j,i\right)\right|^2\right)}{2\cdot\left(RATE\cdot\mathbf{t}_E\left(l+1\right)-RATE\cdot\mathbf{t}_E\left(l\right)\right)\cdot\left(k_h-k_l\right)}
$$

$$\mathbf{E}_{Right}\left(k-k_x,l\right)=\frac{\varepsilon+\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}_{Left}\left(j,i\right)\right|^2}{\varepsilon+\sum_{i=RATE\cdot\mathbf{t}_E(l)}^{RATE\cdot\mathbf{t}_E(l+1)-1}\sum_{j=k_l}^{k_h-1}\left|\mathbf{X}_{Right}\left(j,i\right)\right|^2}$$

In ISO/IEC 14496-3:2001/Amd.1, subclause 4.B.18.7 Envelope Coding, replace:

choice indicated in **bs_dt_env***(l)* below. The **bs_dt_env** elements

by:

choice indicated in **bs_df_env***(l)* below. The **bs_df_env** elements

In ISO/IEC14496-3:2001/Amd. 1, add the following:

"

In ISO/IEC14496-3:2001, after 4.5.2.7.4, add the following subclause:

"

4.5.2.7.5 Usage of DRC with audio object type SBR

If DRC is used with the SBR audio object type, the process shall be applied to the spectral data in the SBR QMF domain. It is mandatory for a High Efficiency AAC Profile decoder to be able to parse the DRC extension element. The ability to decode and apply DRC data is optional for a High Efficiency AAC Profile decoder. However, if it is implemented, the implementation outlined here shall be used. The DRC for High Efficiency AAC (SBR) is fully backwards compatible with DRC for AAC without SBR.

The following pseudo code and equations show how the DRC factors are stored for use in the SBR QMF domain. The borders of the DRC bands are quantized to match the frequency resolution of the SBR QMF filterbank. In order to ensure proper backwards compatibility, the delay between the MDCT synthesis and the QMF synthesis must be considered. Hence, the DRC parameters applied to the SBR QMF subsamples shall be delayed by the same amount of time as the signal between the MDCT synthesis and QMF synthesis.

The DRC factors are stored in the matrix factorQMF[l][k], where 'l' indicates which QMF subsample the values correspond to. Since the DRC band borders relate to 1024 MDCT lines (or 960 MDCT lines for 960-framing), the borders are mapped to corresponding borders in the 32 subbands of the lower part of the SBR QMF.

For short AAC window sequences no interpolation of the DRC factors is used. For other AAC window sequences the DRC factors are interpolated over time in order to avoid zipper noise. For the DRC used with the High Efficiency AAC decoder, it is possible to signal the temporal border between the DRC factors. Hence, it is possible to control transient behaviour of the DRC without having to rely on short AAC window sequences. This is accomplished with the drc_interpolation_scheme bitstream element.

The bands covered by the DRC data covers only the frequency range of the AAC MDCT, i.e., up to half of the sampling frequency of the AAC. The DRC data for the frequency range above that up to half of the sampling frequency of the output signal, is the same as the highest transmitted DRC band.

In the pseudo code below the differences compared to DRC application without SBR are marked by bold letters.

```
#define FRAME_SIZE 1024 /* Change to 960 for 960-framing.*/
```