UHD World Association
世界超高清视频产业联盟

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T/UWA 009.1-2022

三维声音技术规范 第 1 部分：编码分发与呈现

3D Audio Technology Specification: Part 1: Coding, Distribution and Presentation

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世界超高清视频产业联盟

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前　言

本文件按照 GB/T1.1-2020《标准化工作导则 第 1 部分：标准文件的结构和起草规则》给出的规则起草。

本文件是T/UWA 0012《三维声音技术规范》的第1部分，T/UWA 0012已经发布了以下部分：

——第1部分：编码分发与呈现；

本文件由世界超高清视频产业联盟提出并归口。

本文件主要起草单位：中国电子技术标准化研究院、华为技术有限公司、清华大学、北京字跳网络技术有限公司、赛因芯微(北京) 电子科技有限公司、北京理工大学、中关村视听产业技术创新联盟、清华大学天津电子信息研究院、小米通讯技术有限公司、北京大学、博华超高清创新中心、上海海思技术有限公司、杭州当虹科技股份有限公司、咪咕文化科技有限公司、广州视源电子科技股份有限公司、北京市博汇科技股份有限公司、北京百度网讯科技有限公司、北京小米电子产品有限公司、TCL科技集团股份有限公司、中国移动集团有限公司、中国联合网络通信集团有限公司、中国电信集团有限公司、广东广播电视台、湖南广播电视台、浙江广播电视集团、浙江华策影视股份有限公司、中图集团中途云创智能科技（北京）有限公司、国家广播电视总局广播电视科学研究院、国家广播电视总局广播电视规划院。

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引 言

本文件由世界高清视频产业联盟和中关村视听产业技术创新联盟联合制定。

目前，本文件的核心技术已实现在超高清音频内容制作、编码、接收、解码、播放等端到端的全产业链布局,以“Audio Vivid”自有品牌名称开展产业化推广。

本文件的发布机构提请注意如下事实,声明符合本文件时,可能涉及到通用全码率音频编解码技术、无损音频编解码技术和渲染技术相关的专利的使用。

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202110865328.X，一种音频信号的编解码方法和装置；202110654037.6，编解码方法、装置、设备、存储介质及计算机程序；202110700570.1，一种三维音频信号的处理方法和装置；202110680341.8，三维音频信号编码方法、装置、编码器和系统；202110595367.2，多声道音频信号的编码方法和装置；202110559102.7，编解码方法、装置、设备、存储介质及计算机程序；202110530309.1，一种音频编码、解码方法及装置；202110596023.3，音频数据编解码方法和相关装置及计算机可读存储介质；202110602507.4，一种场景信号分类方法；202110536623.0，三维音频信号编码方法、装置和编码器；202110536631.5，三维音频信号编码方法、装置和编码器；202110535832.3，三维音频信号编码方法、装置和编码器；202110536634.9，三维音频信号编码方法、装置和编码器；202110247466.1，虚拟扬声器集合确定方法和装置；202110246382.6，HOA系数的获取方法和装置；202011377433.0，一种音频编解码方法和装置；202011377320.0，一种音频编解码方法和装置；202010699711.8，多声道音频信号编解码方法和装置；202010699775.8，多声道音频信号编码方法和装置；202010699706.7，多声道音频信号的编解码方法和装置；200910169403.8，频带扩展方法及装置；201010187426.4，信号处理方法及系统；201180003043.X，用于重构源信号的方法和解码器；201110289391.X，一种下混信号生成、还原的方法和装置；201610877571.2，一种音频信号重建方法及装置；201610879165.X，一种音频信号的重建方法和装置；201610252268.3，一种音频信号的采样和重建方法、装置及系统；200710135833.9，立体声音频编/解码方法及编/解码器；200810106460.7，立体声信号编解码方法、装置及编解码系统；200980154599.1，一种立体声编码方法和装置。

本文件的发布机构提请注意，声明符合本文件，可能涉及到5项与立体声编解码技术相关的专利的使用。

200710175993.6，编码集成系统和方法与解码集成系统和方法；200710135833.9，立体声音频编/解码方法及编/解码器；200710304486.8，音频信号的编码方法和装置与解码方法和装置；200810106460.7，立体声信号编解码方法、装置及编解码系统；201410573759.9，一种立体声编解码方法。

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ZL201010281033.X，一种基于整形小波变换的音频无损压缩编码、解码方法；201110263485.X，后向块自适应Golomb-Rice编解码方法及装置;201410721299.X,多声道无损音频混合编解码方法及装置；PCT/CN2021/133722，一种立体声音频信号处理方法、装置、编码设备、解码设备及存储介质。

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202110984837.4，一种音频制作模型和生成方法、电子设备及存储介质；202111102045.6，音频节目元数据和产生方法、电子设备及存储介质；202111100818.7，音频内容元数据和产生方法、电子设备及存储介质；202111102038.6，音频对象元数据和产生方法、电子设备及存储介质；202111205630.9，音轨唯一标识元数据和生成方法、电子设备及存储介质；202111204386.4，一种音频轨道元数据和生成

方法、电子设备及存储介质；202111202898.7，一种音频流元数据和生成方法、电子设备及存储介质；

202111308422.1，基于音床音频包格式元数据和产生方法、设备及介质；202111308431.0，基于矩阵音频包格式元数据和产生方法、设备及存储介质；202111308430.6，基于对象音频包格式元数据和产生方法、设备及介质；202111306844.5，基于场景音频包格式元数据和产生方法、设备及存储介质；202111308421.7，基于双耳音频包格式元数据和产生方法、设备及介质；202111021068.4，基于音床音频通道元数据和生成方法、设备及存储介质；202111021067.X，基于矩阵音频通道元数据和生成方法、设备及存储介质；202111020417.0，基于对象音频通道元数据和生成方法、设备及存储介质；202111021066.5，基于场景音频通道元数据和生成方法、设备及存储介质；202111021039.8，基于双耳音频通道元数据和生成方法、设备及存储介质；202111425628.2，串行音频元数据帧生成方法、装置、设备及存储介质；202111425590.9，传输音轨格式串行元数据生成方法、装置、设备及介质；202111424251.9，串行音频块格式元数据生成方法、装置、设备及介质；202111424254.2串行音频元数据生成方法、装置、设备及存储介质；202111675350.4，一种基于串行数字音频接口的数据传输方法、装置、设备；202111678505.X，一种基于实时传输协议的网络数据传输方法、装置及设备；202111678518.7，一种数字音频网络传输方法、装置、设备及存储介质；202111666346.1，一种广播音频格式文件生成方法、装置、设备及存储介质；202111660310.2，音频元数据通道分配区块生成方法、装置、设备及存储介质；PCT/CN2021/100076，音频渲染系统、方法和电子设备；PCT/CN2021/100062，用于音频渲染的音频信号编码方法、装置和电子设备；PCT/CN2021/114366，音频元数据的处理方法和装置；PCT/CN2021/121135，声音路径能量的淡入淡出方法、电子设备和介质；PCT/CN2021/121718，一种动态估计场景近似长方体房间的方法；PCT/CN2021/104309，混响时长的估计方法、音频信号的渲染方法和电子设备；PCT/CN2021/115130，用于音频渲染的信号处理方法、装置和电子设备；PCT/CN2021/121729，用于空间音频渲染的系统、方法和电子设备。

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三维声音技术要求

第 1 部分： 编码分发与呈现

1 范围

本文件规定了三维声音频技术的编码、分发与呈现方法，同时支持单声道、双声道立体声、多声道、三维声、HOA、元数据编解码。

本文件适用于广播流媒体、网络电视、数字电影、实时通信、虚拟现实和增强现实、视频监控、数字存储媒体等领域。

2 规范性引用文件

下列文件对于本文件的应用是必不可少的。凡是注日期的引用文件，仅注日期的版本适用于本文件。凡是不注日期的引用文件，其最新版本（包括所有的修改单）适用于本文件。

GB/T 4880.2—2000 语种名称代码 第2部分：3字母代码

GB/T 5271.1 信息技术 词汇 第1部分：基本术语（GB/T 5271.1-2000 eqv ISO/IEC 2382-1：1993）

GB/T 5271.4 信息技术 词汇 第4部分：数据的组织（GB/T 5271.4-2000 eqv ISO/IEC 2382-4：1987）

GB/T 5271.9 信息技术 词汇 第9部分：数据通信（GB/T 5271.9-2001 eqv ISO/IEC 2382-9：1995）

GB/T 5271.34-2006 信息技术 词汇 第34部分：人工智能 神经网络

GB/T 17975.1-2010 信息技术 运动图像及其伴音信息的通用编码 第1部分：系统（eqv ISO/IEC 13818-1：2007）

GB/T 33475.3-2018 信息技术 高效多媒体编码 第3部分：音频

ITU-R BS.2076-2（10/2019）音频定义模型

ITU-R BS.1770-4 (10/2015) 测量音频节目响度和真正峰值音频电平的算法

3 术语和定义

GB/T 5271.1、GB/T 5271.4、GB/T 5271.9和GB/T 5271.34界定的以及下列术语和定义适用于本文件。

3.1

保留 reserved

在定义编码位流中的暂时未被使用的字段，可能在将来的标准扩展中被用到。

3.2

比特率 bitrate

编码位流传输到解码器输入端的速率。

3.3

位流 bitstream

用作数据编码表示的有一定次序的一组比特。

3.4

编码 coding

读入音频采样流，并产生一个符合本部分的有效位流。

3.5

编码器 coder

编码处理的实体。

3.6

编码表示 coded representation

以其编码形式表示的数据单元。

3.7

编码音频位流 coded audio bitstream

音频信号的编码表示。

3.8

边信息 side information

位流中控制解码的必要信息。

3.9

采样频率 sampling frequency（fs）

每秒从连续信号中提取离散信号的采样个数，可简称采样率。

注：单位为赫兹（Hz）。

3.10

解码 decoding

在本部分中定义的一种数据处理，即读入编码位流并输出音频采样值的过程。

3.11

解码器 decoder

解码处理的实体。

3.12

谱系数 spectral coefficient

分析滤波器组中输出的离散频谱域数据。

3.13

熵编码 entropy coding

信号数字表示中的一种变长无损编码，用以减少统计特性上的冗余。

3.14

声道 channel

声音在录制或播放时在不同空间位置采集或回放的相互独立的音频信号。

3.15

数据单元 data element

编码前的和编码后的数据项的表示。

3.16

字节 byte

8个比特的序列。

3.17

字节对齐 byte alignment

在编码位流中，如果某一比特的位置是8的倍数，则该比特就称为字节对齐。

3.18

神经网络 neural network

由加权链路且权值可调整连接的基本处理元素的网络，通过把非线性函数作用到其输入值上使每个单元产生一个值，并把它传送给其他单元或把它表示成输出值。

4 符号和缩略语

本部分中使用的数学运算符和优先级与C语言使用的类似。但对整型除法和算术移位操作进行了特定的定义。除特别说明外，约定编号和计数从0开始。

4.1 算术运算符

下列算术运算符适用于本文件。

+	加
−	减（二元运算符）或取反（一元前缀运算符）
×	乘
a^b	幂，表示a的b次幂，也可表示上标。
∧	幂
%	取模算符，仅对正整数定义。
/	整数除法，结果向0取整。例如，7/4和-7/-4取整为1，-7/4和7/-4取整为-1。
$\frac{a}{b}$	除法运算，不做取整或四舍五入。
| |	绝对值 |x|=x 当x>0

		|x|=0	当x=0
		|x|=-x	当x<0
abs	绝对值		
	取符号	sign(x)=1	当x>0
sign()		sign(x)=0	当x=0
		sign(x)=-1	当x<0
$\sqrt{x}$	平方根		
$\sum_{i=a}^{b} f(i)$	自变量i取由a到b（含b）的所有整数值时，函数f(i)的累加和。		
$\log_{10}$	以10为底的对数		
$\log_{2}$	以2为底的对数		

4.2 逻辑运算符

下列逻辑运算符适合于本文件。

||	逻辑或
&&	逻辑与
!	逻辑非

4.3 关系运算符

下列关系运算符适用于本文件。

>	大于
≥	大于或等于
<	小于
≤	小于或等于
==	等于
≠	不等于
max[,……,]	参数表中的最大值
min[,……,]	参数表中的最小值

4.4 位运算符

下列位运算符适用于本文件。

&	与
|	或
~	取反
a >> b	将a以2的补码整数表示的形式向右移b位。仅当b取正数时定义此运算。向右移至最高有效位时，其值与a 移位运算前的最高有效位相等。
a << b	将a以2的补码整数表示的形式向左移b位。仅当b取正数时定义此运算。向左移至最低有效位时，其值等于0。

4.5 赋值

下列赋值运算适用于本文件。

=	赋值运算符
x = a..b	x取从a至b（含b）的值，其中x、a和b是整数。

++ 自加，x++相当于x=x+1。当用于数组下标时，在自加运算前先求变量值。
-- 自减，x--相当于x=x-1。当用于数组下标时，在自减运算前先求变量值。
+= 自加指定值，例如，x+=3相当于x=x+3，x+=(-3)相当于x=x+(-3)。
-= 自减指定值，例如，x-=3相当于x=x+(-3)，x-=(-3)相当于x=x－(-3)。

4.6 助记符

下列助记符适用于本文件。

rpchof 多项式余数，高阶在先；
bslbf 位串，左位在前，这里“左”是按GB/T 17191中写的位串的顺序。位串是带单引号的1和0串。如‘1000 0001’。位串内的空格是便于阅读的，无特殊意义。（bitstream left bit first）
uimsbf 无符号整数，最高有效位优先。（unsigned integer, most significant bit first）
bsmbf 位串是带引号的1和0串，右位在前，如先编码一个5比特的数值6，然后编码一个3比特的数值2，那么编码位串为‘010 00110’。

4.7 缩略语

下列缩略语适用于本文件。

AASF AVS音频存储格式 （AVS Audio Storage Format）
AATF AVS音频传输格式 （AVS Audio Transport Format）
AllRAD 全向空间解码器 (All Round Ambisonic Decoder)
BWE 高频带宽扩展 （Bandwidth Extension）
CBR 恒定比特率 （Constant Bit Rate）
CNN 卷积神经网络 （Convolutional Neural Network）
CRC 循环冗余校验 （Cylic Redundancy Check）
FFT 快速傅立叶变换 （Fast Fourier Transform）
FOA 一阶Ambisonics技术 （First Order Ambisonics）
HOA 高阶Ambisonics技术 （Higher Order Ambisonics）
ILD 声道间强度差 （Inter-channel Level Difference）
IMDCT 修正离散余弦反变换 （Inverse Modified Discrete Cosine Transform）
LFE 低频效果音 （Low Frequence Effect）
LPC 线性预测系数 （Linear Prediction Coefficients）
LSF 线谱频率 （Line Spectral Frequencies）
LSP 线谱对 （Line Spectral Pairs）
MCR 极大相关旋转 （Maximum Correlation Rotation）
MDCT 修正离散余弦变换 （Modified Discrete Cosine Transform）
M/S 和差立体声 （Middle/Side）
OLA 叠接相加 （Overlap and Add）
SFB 尺度因子带 （Scale Factor Band）
TNS 时域噪声整形 （Temporal Noise Shaping）
VQ 矢量量化 （Vector Quantization）

5 位流语法规则

位流中的每一个数据项用黑体。通过名字、按位的长度及其类型和传输顺序的助记符来描述。

位流中被解码的数据元素所导致的操作依赖于该数据的值及以前解码的数据元素。下面的语法结构表示数据元素以标准类型出现时的情形。

注1：如无特殊说明，本部分中的“位”指二进制位。

注2：本部分语法用“C”代码规定，变量或表达式为非零值时等价于条件为真，变量或表达式为零值时等价于条件为非真。

```
while(condition){
  data_element
  …
}
```

若条件为真，则数据元素组紧接着数据流产生，如此重复直到条件为非真。

```
do{
  data_element
  …
}while(condition)
```

若条件为真，则数据元素组紧接着数据流产生，如此重复直到条件为非真。

```
if(condition){
  data_element
  …
} else{
  data_element
  …
}
```

若条件为真，在数据流中产生第一组数据元素，若条件为非真，在数据流中产生第二组数据元素。

```
for(expr1;expr2  ; expr3){
  data_element
  …
}
```

expr1是指定循环初始状态表达式，通常它指定了计数器的初始状态，expr2是指定的每次循环前的测试条件。条件为非真时循环终止，expr3是每次循环结束时执行的表达式，一般是增加计数器。

注3：本结构的最通常用法为

```
for(i=0;i<n;i++){
  data_element
  …
}
```

数据元素组产生 n 次。数据元素组内的条件结构可能依赖循环控制变量 i 的值。第一次出现时被置为‘0’，第二次增加到‘1’，如此往复。

```
switch(expr){
  case constcase1:
    data_element1
    break
  case constcase2:
    data_element2
    break
```

根据表达式expr的值，产生对应的数据元素。expr的值为constcase1时产生数据元素data_element1，expr的值为constcase2时产生数据元素data_element2，以此类推，expr的值为constcasen时产生数据元素data_elementn。当expr的值不等于constcase1, constcase2, …, constcasen中的任何一个值时，产生数据元素data_elementdefault

```
    …
    case constcasen:
      data_elementn
      break
    default:
      data_elementdefault
      break
}
```

本结构的一类变体是在case后不出现break，如

```
switch(expr){
  case constcase1:
    data_element1
  case constcase2:
    data_element2
    break
    …
  case constcasen:
    data_elementn
    break
  default:
    data_elementdefault
    break
}
```

expr的值constcasex时，从对应的case constcasex开始产生数据元素，直到break出现。

expr的值constcase1时产生数据元素data_element1和data_element2，expr的值为constcasen时产生数据元素data_elementn

注4：数据元素组中可能含有嵌套结构。为简便起见，当后面只有一个数据元素时“[]”省略。

data_element[ ]	data_element是一数组数据，数据元素的个数由上下文而定；
data_element[n]	data_element[n]是数组数据的第n＋1个元素；
data_element[m][n]	data_element[m][n]是二维数组的第m＋1，n+1个元素；
data_element[l][m][n]	data_element[l][m][n]是三维数组的第l+1，m+1，n+1个元素；
data_element[m…n]	data_element[m…n]是位m到位n之间包括的位。

虽然语法用过程项表示，但不能认为条款实现了可靠的解码过程。它只是定义了一个无错误的位流输入。

byte_alignment函数的定义：

如当前位置在字节的边界，则byte_alignment()函数返回‘1’，即位流中的下一位是一个字节的起始位，否则返回‘0’。

nextbits函数的定义：

函数nextbits()将位串与位流中将要解码的下一比特进行比较。

6 三维声音频系统框架

6.1 概述

三维声音频编码系统支持声道信号编码、对象信号编码、HOA 信号编码、元数据编码、扬声器渲染和双耳渲染。三维声音频解码系统框架如下图 1 所示。

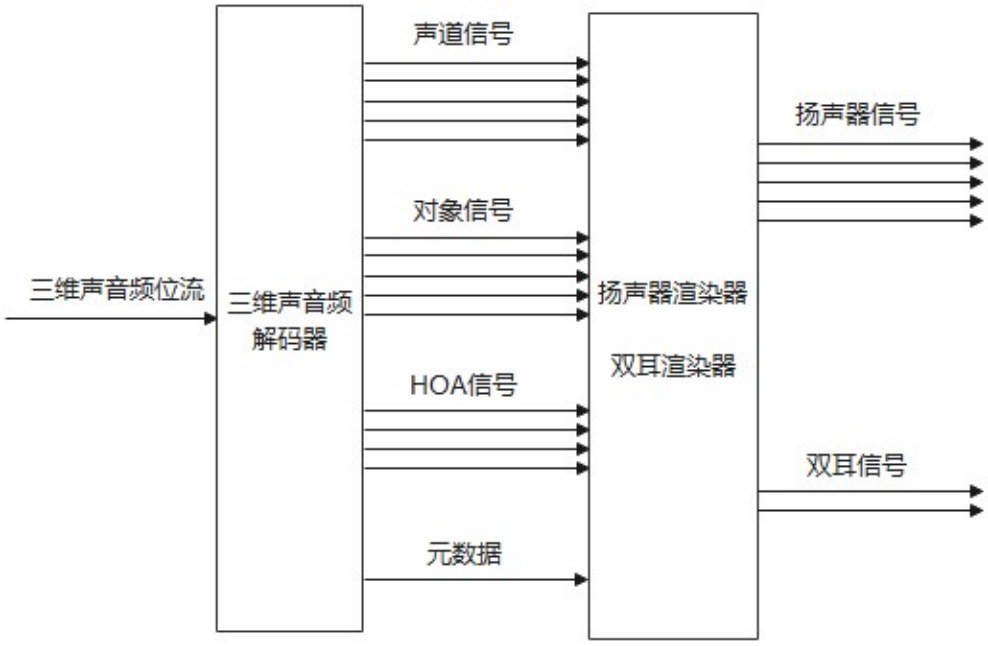

图1　三维声音频解码系统框架示意图

三维声音频编码器由多种编码工具构成，如图 2 所示，包括：通用全码率音频编码工具和无损音频编码工具。三维声音频编码系统复用 GB/T 33475.3-2018 及其修改单码流封装的存储格式 AASF 和传输格式 AATF。在 GB/T 33475.3-2018 的 AASF 和 AATF 码流封装语法语义规范中，新增的通用全码率音频编码工具被定义为 audio_codec_id=2，见附录 A。

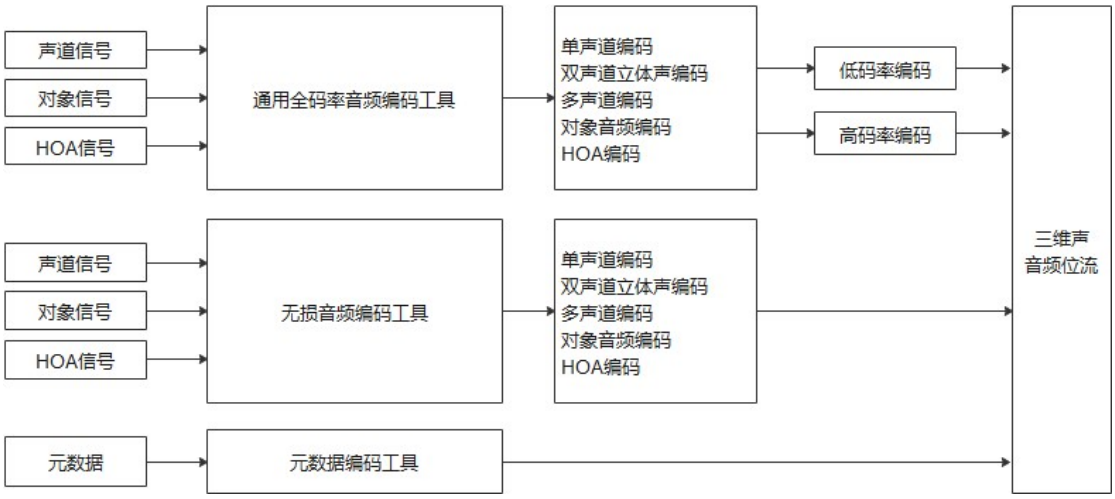

图2　三维声音频编码器示意图

如图 2 所示，针对不同特征的音频信号或不同的应用场景，用户可以根据输入类型和码率范围，选择使用通用全码率音频编码、无损音频编码工具和元数据编码工具。

本部分描述了用于高质量音频信号传输和解码的工具集。6.2简要介绍了通用全码率音频编解码工具；6.3简要介绍了无损音频编码工具以及引用GB/T 33475.3的情况，6.4简要介绍了元数据编码工具，6.5简要介绍了渲染器。每种工具的数据流定义、位流语法、语义和解码过程等详细定义参见具体章节。三维声音频基本流在传输流中的复用定义见附录C。

6.2　通用全码率音频编码工具

第 7 章描述了通用全码率音频编码的表示方法及其解码方法。通用全码率音频编码工具采用神经网络变换、量化和熵编码技术，基于声道相关性的多声道下混和比特分配技术，基于虚拟扬声器的 HOA 空间编码技术等，适用于单声道、双声道立体声、多声道编码、对象音频编码、混合音频编码、HOA 编码。

支持采样率 32kHz～192kHz，支持 16 比特和 24 比特采样精度。支持编码输出位流为：单声道 32、44、56、64、72、80、96、128、144、164、192kb/s；双声道立体声 32、48、64、80、96、128、144、192、256、320kb/s；5.1 多声道：96、128、144、160、192、256、320、384、448、512、640、720kb/s；7.1 多声道：128、160、192、256、384、480、576、640kb/s；5.1.4 多声道：176、256、384、448、576、704kb/s；7.1.4 多声道：240、384、512、608、832kb/s；FOA：96、128、192、256kb/s；2 阶 HOA：192、256、320、384、480、512、640kb/s；3 阶 HOA：256、320、384、512、640、896kb/s。

6.3 无损音频编码工具

无损音频编码工具引用GB/T 33475.3-2018的第8章“无损音频编码”的语法、语义和解码过程及其修改单中序号11-序号17的技术性修改。

支持最多128声道、任意采样频率。并支持8比特、16比特和24比特采样精度。

6.4 元数据编码工具

第8章描述了元数据编码的表示方法及其解码方法。

6.5 渲染器

渲染器可根据应用场景选择扬声器渲染器或双耳渲染器，具体内容见附录 C。

7 通用全码率音频编码工具

7.1 概述

通用全码率音频编解码包括单声道编解码、双声道立体声编解码、多声道编解码、对象编解码、混合编解码、HOA 编解码。

通用全码率音频编码器的基本构架如图 3 所示。通用全码率音频核心编码器由暂态检测、窗型判断、时频变换、频域噪声整形、时域噪声整形、频带扩展、下混、神经网络变换、量化和区间编码等构成，将声道信号和对象信号编码为位流。HOA 空间编码器和核心编码器将 HOA 信号编码为位流。

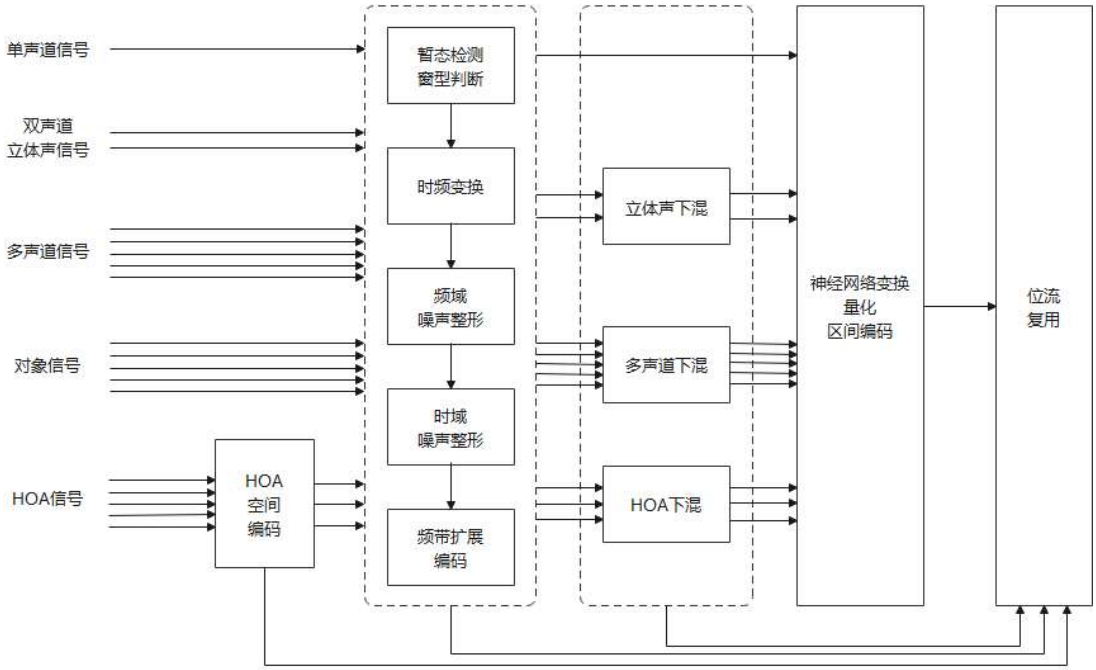

图3　通用全码率音频编码器框架

通用全码率音频解码器的基本构架如图 4 所示。通用全码率音频解码器由区间解码、逆量化、神经网络逆变换、频带扩展解码、逆时域噪声整形、逆频域噪声整形、上混和逆时频变换等构成了核心解码器，将位流解码为声道信号和对象信号。HOA 空间解码器和核心解码器将位流解码为 HOA 信号。

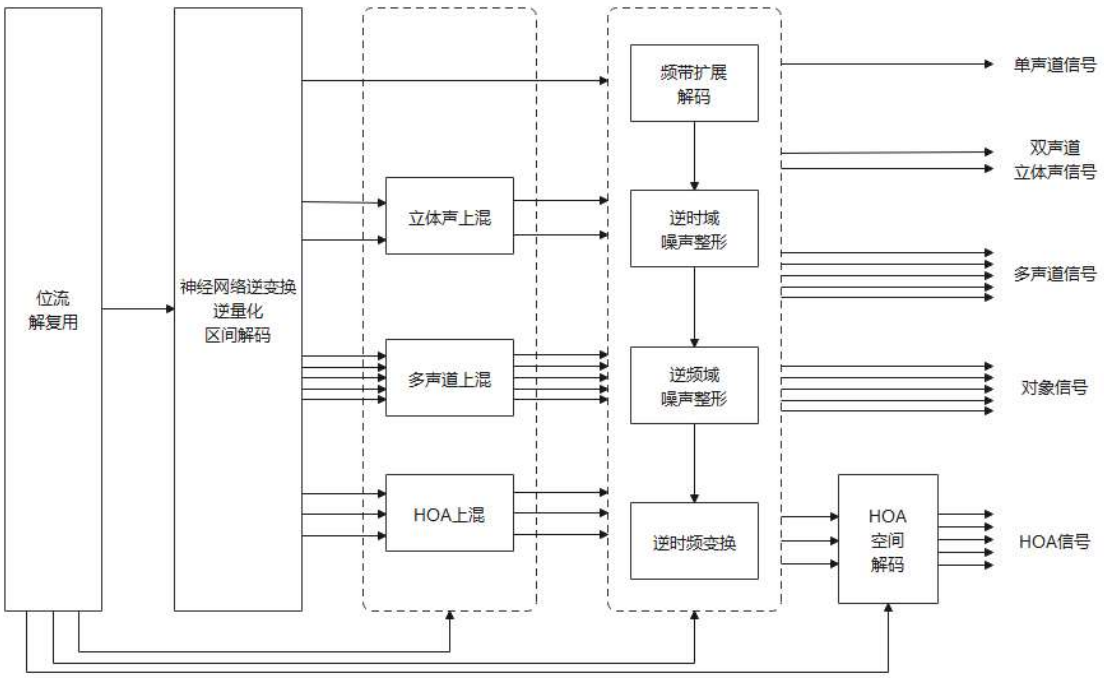

图4　通用全码率音频解码器框架

7.2　通用全码率音频编码原始位流数据

7.2.1　语法

通用全码率音频编码原始位流数据语法见表1。

表1 ga_co_raw_data_block()语法

语法	比特数	助记符
ga_co_raw_data_block() {		
Avs3MetadataDec()		
switch(codecFormat) {		
case 0x0: Avs3MonoDec()		
case 0x1: Avs3StereoDec()		
case 0x2: Avs3McDec()		
case 0x3: Avs3HoaDec()		
}		
}		

单声道解码语法见表2。

表2 Avs3MonoDec()语法

语法	比特数	助记符
Avs3MonoDec() {		
DecodeCoreSideBits()		
DecodeGroupBits()		
DecodeQcBits()		
Avs3InverseQC()		
Avs3PostSynthesis()		
}		

双声道立体声解码语法见表3。

表3 Avs3StereoDec()语法

语法	比特数	助记符
Avs3StereoDec() {		
for(ch = 0; ch < 2; ch++) {		
DecodeCoreSideBits()		
}		
for(ch = 0; ch < 2; ch++) {		
DecodeGroupBits()		
}		
DecodeStereoSideBits()		
StereoBitsAllocation()		
for(ch = 0; ch < 2; ch++) {		

表 3. Avs3StereoDec()语法（续）

语法	比特数	助记符
DecodeQcBits()		
}		
Avs3InverseQC()		
StereoInvMsProcess()		
for(ch = 0; ch < 2; ch++) {		
Avs3PostSynthesis()		
}		
}		

多声道解码语法见表4。

表4 Avs3McDec()语法

语法	比特数	助记符
Avs3McDec() {		
for(ch = 0; ch < numChans; ch++) {		
DecodeCoreSideBits()		
}		
for(ch = 0; ch < numChans; ch++) {		
DecodeGroupBits()		
}		
DecodeMcSideBits()		
McBitsAllocation()		
for(ch = 0; ch < numChans; ch++) {		
DecodeQcBits()		
}		
Avs3InverseQC()		
Avs3McacDec()		
for(ch = 0; ch < numChans; ch++) {		
Avs3PostSynthesis()		
}		
}		

HOA解码语法见表5。

表5 Avs3HoaDec()语法

语法	比特数	助记符
Avs3HoaDec() {		
for(ch = 0; ch < numChans; ch++) {		
DecodeCoreSideBits()		
}		
for(ch = 0; ch < numChans; ch++) {		
DecodeGroupBits()		
}		
DecodeHoaSideBits()		
HoaSplitBytesGroup()		
for(ch = 0; ch < numChans; ch++) {		
DecodeQcBits()		
}		
Avs3InverseQC()		
Avs3HoaInverseDMX()		
for(ch = 0; ch < numChans; ch++) {		
Avs3PostSynthesis()		
}		
HoaPostSynthesisFilter()		
}		

7.2.2 语义

Avs3MetadataDec() 元数据解码
Avs3MonoDec() 单声道解码
Avs3StereoDec() 双声道立体声解码
Avs3McDec() 多声道解码
Avs3HoaDec() HOA 解码
DecodeCoreSideBits() 解析核心解码器边信息
DecodeGroupBits() 频谱逆分组处理
DecodeStereoSideBits() 解析双声道立体声边信息
DecodeMcSideBits() 解析多声道边信息
DecodeHoaSideBits 解析 HOA 边信息
StereoBitsAllocation() 双声道立体声比特分配
McBitsAllocation() 多声道比特分配
HoaSplitBytesGroup() HOA 比特分配
StereoInvMsProcess() 双声道立体声上混处理
Avs3McacDec() 多声道解码处理
Avs3HoaInverseDMX HOA 解码处理
DecodeQcBits() 解析量化编码边信息
Avs3InverseQC() 区间解码和逆量化
Avs3PostSynthesis() 解码后处理
HoaPostSynthesisFilter() HOA 空间解码

codecFormat	表示解码模式，根据附录 A 中表 A.8 声道数索引（channel_number_index）决定，当声道配置为单声道时，codecFormat 为 0，当声道配置为双声道立体声时，codecFormat 为 1，当声道配置为多声道配置时，codecFormat 为 2
numChans	音频信号的声道数，当 coding_profile 为 0 时，复用附录 A 中表 A.8 声道数索引（channel_number_index）中的 channel_number

7.2.3 通用信息

通用全码率音频编码器可以分为编码预处理、各模式信号下混、神经网络变换、量化和区间编码。编码预处理将每个声道信号由时域变换到频域并进行预处理。信号下混根据不同编码模式对预处理后的频域信号进行下混，去除声道间的相关性。神经网络变换、量化和区间编码采用神经网络对每个下混后的声道进行变换和编码。通用全码率音频解码器可以分为编码后处理、各模式信号上混、神经网络逆变换、逆量化和区间解码三部分。解码是编码的逆过程。以下对各个模式编解码模块进行介绍：

a) 通用全码率音频单声道编码

图5和图6给出了通用全码率音频单声道编码的基本结构。单声道编码器将时域单声道信号经过编码预处理得到处理后的MDCT系数，经过神经网络变换得到变换域系数，最后经过量化和区间编码得到位流。编码预处理模块包括暂态检测和窗型判断模块，频域噪声整形模块，时域噪声整形模块和频带扩展编码模块。

1） 暂态检测和窗型判断

暂态检测模块根据输入时域信号的能量判断当前帧是否存在暂态信号，窗型判断模块根据暂态信号检测结果获得当前帧的窗型控制参数，窗型控制参数包括 2048 点正弦窗，256 点正弦窗和 2048 点切换窗。

——输入：时域单声道信号

——输出：窗型控制参数

2） MDCT 变换

MDCT 变换模块根据窗型控制参数对输入时域信号加窗和 MDCT 变换。

——输入：单声道时域信号，窗型控制参数

——输出：单声道信号 MDCT 系数

3） 频域噪声整形

频域噪声整形模块根据输入时域信号获得量化后的谱包络信息，根据量化后的谱包络信息对 MDCT 系数进行调整，实现 MDCT 频谱整形，从而控制量化噪声在频域上的分布。

——输入：单声道信号 MDCT 系数

——输出：频域噪声整形后的单声道信号 MDCT 系数、频域噪声整形参数

4） 时域噪声整形

时域噪声整形模块根据频域噪声整形后的 MDCT 系数获得时域噪声整形参数，根据时域噪声整形参数对 MDCT 系数进行整形，从而控制量化噪声在时域上的分布。

——输入：频域噪声整形后的单声道信号 MDCT 系数

——输出：时域噪声整形后的单声道信号 MDCT 系数、时域噪声整形参数

5） 频带扩展编码

频带扩展编码模块根据时域噪声整形后的 MDCT 系数获得频带扩展参数，用来表示信号 MDCT 频谱高低频的相关性，以辅助解码端恢复高频成分。

——输入：时域噪声整形后的单声道信号 MDCT 系数

——输出：频带扩展参数

6） 神经网络变换

神经网络变换模块利用神经网络对编码预处理后的 MDCT 系数进行变换，进一步去除谱系数中的信息冗余，神经网络输出称为变换域系数，变换域系数用于量化和区间编码。

——输入：预处理后的单声道信号 MDCT 系数

——输出：变换域系数

7） 量化和区间编码

量化模块对神经网络变换所得的变换域系数进行线性标量量化，编码模块对量化结果进行区间编码以得到位流。

——输入：变换域系数

——输出：位流

b) 通用全码率音频单声道解码

图 7 和图 8 给出了通用全码率音频单声道解码的基本结构。单声道解码器通过区间解码和逆量化从位流中解析得到 MDCT 系数对应的变换域系数，经过神经网络逆变换得到重构 MDCT 系数，最后经过解码后处理得到时域单声道信号。解码后处理模块包括频带扩展解码模块，逆时域噪声整形模块，逆频域噪声整形模块和逆 MDCT 变换模块。

1） 区间解码和逆量化

从位流中获取与 MDCT 谱系数编码相关的位流信息，进行区间解码和逆量化处理以得到与 MDCT 系数对应的变换域系数，并作为神经网络逆变换的输入。

——输入：位流

——输出：MDCT 系数对应的变换域系数

2） 神经网络逆变换

将与 MDCT 谱系数对应的变换域系数经神经网络逆变换，得到重构 MDCT 系数。

——输入：MDCT 系数对应的变换域系数

——输出：重构 MDCT 系数

3） 频带扩展解码

频带扩展解码模块根据位流中解码得到的频带扩展参数对重构 MDCT 系数中的低频部分进行能量调整和频谱细节调整，获得高频频谱成分。

——输入：重构 MDCT 系数，频带扩展参数

——输出：单声道信号 MDCT 系数

4） 逆时域噪声整形

逆时域噪声整形模块是编码端的逆过程，用以恢复时域噪声整形前的 MDCT 系数。

——输入：单声道信号 MDCT 系数，时域噪声整形参数

——输出：逆时域噪声整形后的单声道信号 MDCT 系数

5） 逆频域噪声整形

逆频域噪声整形模块是编码端的逆过程，用以恢复频域噪声整形前的 MDCT 系数。

——输入：逆时域噪声整形后的单声道信号 MDCT 系数，频域噪声整形参数

——输出：逆频域噪声整形后的单声道信号 MDCT 系数

6） 逆 MDCT 变换

逆 MDCT 变换模块根据位流中解析的窗型控制参数将 MDCT 系数变换到时域信号。

——输入：逆频域噪声整形后的单声道信号 MDCT 系数，窗型控制参数

——输出：时域单声道信号

图5　通用全码率音频单声道编码器

图6　通用全码率音频编码预处理

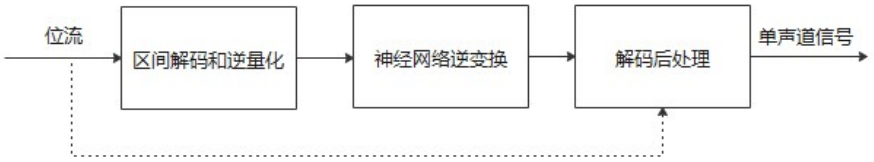

图7　通用全码率音频单声道解码器

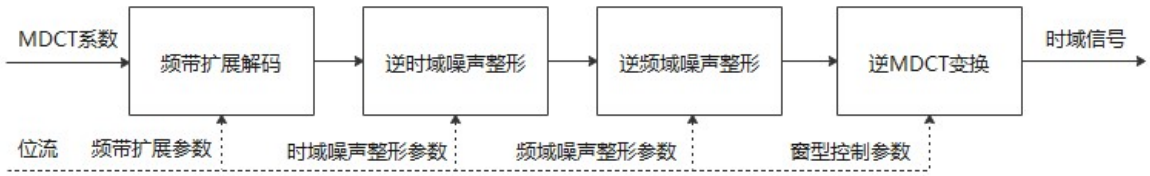

图8　通用全码率音频解码后处理

c)　通用全码率音频双声道立体声编码

图 9 是通用全码率音频双声道立体声编码的基本结构。双声道立体声编码器将时域双声道立体声信号经过双声道立体声编码预处理得到处理后的双声道立体声 MDCT 系数，经过双声道立体声下混和比特分配模块得到下混后的双声道立体声 MDCT 系数，经过神经网络变换得到变换域系数，最后经过量化和区间编码得到位流。双声道立体声编码预处理模块包括暂态检测和窗型判断模块，频域噪声整形模块，时域噪声整形模块和频带扩展编码模块。

下面对各个编码模块具体介绍：

1）　双声道立体声编码预处理

双声道立体声编码预处理模块对双声道立体声每个声道分别进行编码预处理，包括暂态检测和窗型判断模块，频域噪声整形模块，时域噪声整形模块和频带扩展编码模块。

——输入：时域双声道立体声信号

——输出：预处理的双声道立体声信号 MDCT 系数和窗型控制参数、频域噪声整形参数、时域噪声整形参数和频带扩展参数

2）　双声道立体声下混和比特分配

双声道立体声下混和比特分配模块根据双声道立体声信号特征对左右声道 MDCT 系数进行 MCR 或 M/S 下混和比特分配。

——输入：预处理后的双声道立体声信号 MDCT 系数

——输出：下混声道 MDCT 系数，比特分配参数

3） 神经网络变换

——输入：下混声道 MDCT 系数

——输出：下混声道变换域系数

4） 量化和区间编码

——输入：下混声道变换域系数

——输出：位流

d) 通用全码率音频双声道立体声解码

图 10 是通用全码率音频双声道立体声解码的基本结构。双声道立体声解码器通过区间解码和逆量化从位流中解析得到 MDCT 系数对应的变换域系数，经过神经网络逆变换得到重构的下混声道 MDCT 系数，经过双声道立体声上混得到重构的左右声道 MDCT 系数，最后经过双声道立体声解码后处理得到时域双声道立体声信号。解码后处理模块包括频带扩展解码模块，逆时域噪声整形模块，逆频域噪声整形模块和逆 MDCT 变换模块。

1） 区间解码和逆量化

——输入：位流

——输出：MDCT 系数对应的下混声道变换域系数

2） 神经网络逆变换

——输入：MDCT 系数对应的下混声道变换域系数

——输出：重构下混声道 MDCT 系数

3） 双声道立体声上混

双声道立体声上混模块根据位流中解析得到的下混参数对下混声道 MDCT 系数进行上混，得到左右声道信号。

——输入：重构的下混声道 MDCT 系数，下混参数

——输出：重构的左右声道 MDCT 系数

4） 双声道立体声解码后处理

双声道立体声解码后处理模块对每个声道分别进行解码后处理。

——输入：重构的左右声道 MDCT 系数，频带扩展参数、时域噪声整形参数、频域噪声整形参数和窗型控制参数

——输出：时域双声道立体声信号

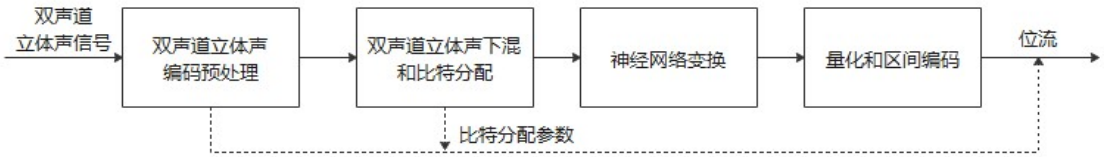

图9 通用全码率音频双声道立体声编码器

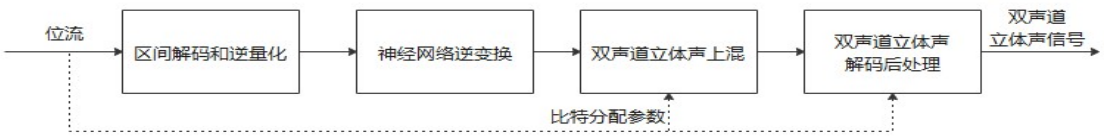

图10 通用全码率音频双声道立体声解码器

e) 通用全码率音频多声道编码

图 11 是通用全码率音频多声道编码的基本结构。多声道编码器将时域多声道信号经过编码预处理得到处理后的 MDCT 系数，经过多声道模式判断模块得到多声道下混参数，经过多声道下混和比特分配模块得到下混后的多声道 MDCT 系数，经过神经网络变换得到变换域系数，最后经过量化和区间编码得到位流。编码预处理模块包括暂态检测和窗型判断模块，频域噪声整形模块，时域噪声整形模块和频带扩展编码模块。

1） 多声道编码预处理

多声道编码预处理模块对每个声道分别进行编码预处理。

——输入：时域多声道信号

——输出：预处理的多声道信号 MDCT 系数和窗型控制参数、频域噪声整形参数、时域噪声整形参数和频带扩展参数

2） 多声道模式判断

多声道模式判断模块根据多声道信号特征和信号相关性确定多声道信号编码模式参数。

——输入：预处理后的多声道信号 MDCT 系数

——输出：多声道信号编码模式参数

3） 多声道下混和比特分配

多声道信号下混模块根据多声道信号编码模式参数对预处理后的多声道信号 MDCT 系数进行多声道下混,根据组对参数将每组中两个声道 MDCT 系数进行 M/S 下混;比特分配模块用于确定比特分配参数。

——输入：预处理后的多声道信号 MDCT 系数，多声道信号编码模式参数

——输出：下混多声道 MDCT 系数，比特分配参数

4） 神经网络变换

——输入：下混多声道 MDCT 系数

——输出：下混多声道变换域系数

5） 量化和区间编码

——输入：下混多声道变换域系数

——输出：位流

f) 通用全码率音频多声道解码

图 12 是通用全码率音频多声道解码的基本结构。多声道解码器通过区间解码和逆量化从位流中解析得到 MDCT 系数对应的变换域系数，经过神经网络逆变换得到重构的下混声道 MDCT 系数，经过多声道参数解码得到多声道上混参数，经过多声道上混得到重构的多声道 MDCT 系数，最后经过多声道解码后处理得到时域多声道信号。解码后处理模块包括频带扩展解码模块，逆时域噪声整形模块，逆频域噪声整形模块和逆 MDCT 变换模块。

1） 区间解码和逆量化

——输入：位流

——输出：MDCT 系数对应的下混多声道变换域系数

2） 神经网络逆变换

——输入：MDCT 系数对应的下混多声道变换域系数

——输出：重构下混多声道 MDCT 系数

3） 多声道参数解码

多声道参数解码模块从位流中解析得到多声道信号编码模式参数。

——输入：位流

——输出：多声道信号编码模式参数

4） 多声道上混

多声道上混模块根据多声道信号编码模式参数对重构下混多声道 MDCT 系数进行上混得到重构的多

声道信号 MDCT 系数。

——输入：重构下混多声道 MDCT 系数，多声道信号编码模式参数

——输出：重构的多声道信号 MDCT 系数

5） 多声道解码后处理

多声道解码后处理模块对每个声道分别进行解码后处理。

——输入：重构的多声道信号 MDCT 系数，频带扩展参数、时域噪声整形参数、频域噪声整形参数和窗型控制参数

——输出：时域多声道信号

图11 通用全码率音频多声道编码器

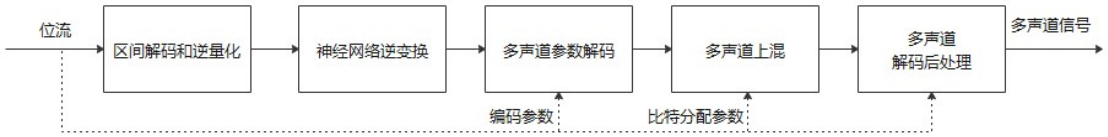

图12 通用全码率音频多声道解码器

g) 通用全码率音频 HOA 编码

图 13 和图 14 是通用全码率音频 HOA 编码的基本结构。HOA 信号经过 HOA 空间编码得到传输通道信号，再经过传输通道编码预处理得到处理后的 MDCT 系数，经过 HOA 下混和比特分配模块得到下混后的传输通道 MDCT 系数，经过神经网络变换得到变换域系数，最后经过量化和编码得到位流。HOA 空间编码包括声场成分分析模块，声场成分合成模块和其余成分计算模块。编码预处理模块包括暂态检测和窗型判断模块，频域噪声整形模块，时域噪声整形模块和频带扩展编码模块。

1） 声场成分分析

声场成分分析模块通过线性分解对 HOA 信号进行声场成分分析，确定声场分布特征，如声源数量、声源的方向性和声源的弥散度等特征。

——输入：HOA 信号

——输出：声场分析参数

2） 声场成分合成

声场成分合成模块根据声场分析参数和其他配置参数对编码器进行配置，根据 HOA 信号的主要声场成分确定声场成分参数，通过线性可逆变换合成传输通道信号。其中，声场成分参数包括虚拟扬声器属性信息，传输通道信号包括虚拟扬声器信号。

——输入：HOA 信号，声场分析参数

——输出：声场成分参数，传输通道信号

3） 其余成分计算

其余成分计算模块根据声场分析参数和其他配置参数对编码器进行配置，根据 HOA 信号、虚拟扬声器信号和声场成分参数确定传输通道信号和其余成分参数。其中，传输通道信号包括残差信号。

——输入：HOA 信号，声场分析参数，声场成分参数

——输出：传输通道信号，其余成分参数

4） 传输通道编码预处理

传输通道编码预处理模块对每个通道分别进行编码预处理，包括暂态检测和窗型判断模块，频域噪声整形模块，时域噪声整形模块和频带扩展编码模块。

——输入：时域传输通道信号

——输出：预处理的传输通道信号 MDCT 系数和窗型控制参数、频域噪声整形参数、时域噪声整形参数和频带扩展参数

5） 传输通道模式判断

传输通道模式判断模块根据传输通道信号特征和声场分析参数确定传输通道信号编码模式参数，例如分组参数、带宽参数、下混参数和初始比特分配参数等。

——输入：预处理后的传输通道信号 MDCT 系数，声场分析参数

——输出：传输通道编码模式参数

6） HOA 下混和比特分配

HOA 下混和比特分配模块对传输通道 MDCT 系数进行下混和比特分配。

——输入：预处理后的传输通道信号 MDCT 系数，传输通道编码模式参数

——输出：下混声道 MDCT 系数，比特分配参数

7） 神经网络变换

——输入：下混声道 MDCT 系数

——输出：下混声道变换域系数

8） 量化和编码

——输入：下混声道变换域系数

——输出：位流

h) 通用全码率音频 HOA 解码

图 15 和图 16 是通用全码率音频 HOA 解码的基本结构。HOA 解码器通过解码和逆量化从位流中解析得到 MDCT 系数对应的变换域系数，经过神经网络逆变换得到重构的下混声道 MDCT 系数，经过传输通道参数解码得到 HOA 上混参数，经过 HOA 上混得到重构的传输通道信号 MDCT 系数，经过传输通道解码后处理得到时域传输通道信号，最后经过 HOA 空间解码得到重建 HOA 信号。解码后处理模块包括频带扩展解码模块，逆时域噪声整形模块，逆频域噪声整形模块和逆 MDCT 变换模块。HOA 空间解码包括声场成分合成模块和 HOA 信号合成模块。

1） 解码和逆量化

——输入：位流

——输出：MDCT 系数对应的下混声道变换域系数

2） 神经网络逆变换

——输入：MDCT 系数对应的下混声道变换域系数

——输出：重构下混声道 MDCT 系数

3） 传输通道参数解码

传输通道参数解码模块从位流中解析得到传输通道信号编码模式参数。

——输入：位流

——输出：传输通道信号编码模式参数

4） HOA 上混

HOA 上混模块根据传输通道信号编码模式参数对重构的下混声道 MDCT 系数进行上混得到重构的传输通道信号 MDCT 系数。

——输入：重构的下混声道 MDCT 系数，传输通道信号编码模式参数

——输出：重构的传输通道信号 MDCT 系数

5） 传输声道解码后处理

传输声道解码后处理模块对每个通道分别进行解码后处理。

——输入：重构的传输通道信号 MDCT 系数，频带扩展参数、时域噪声整形参数、频域噪声整形参数和窗型控制参数

——输出：时域传输通道信号

6） 声场成分合成

声场成分合成模块根据配置参数对解码器进行配置，根据位流中解析的声场成分参数确定虚拟扬声器的系数，再根据传输通道信号中的虚拟扬声器信号合成主要声场信号。

——输入：传输通道信号，声场成分参数

——输出：主要声场信号

7） HOA 信号合成

HOA 信号合成模块根据传输通道信号中的残差信号，位流中解析的其余成分参数和主要声场信号合成 HOA 信号。

——输入：传输通道信号，主要声场信号，其余成分参数

——输出：HOA 信号

图13 通用全码率音频 HOA 空间编码

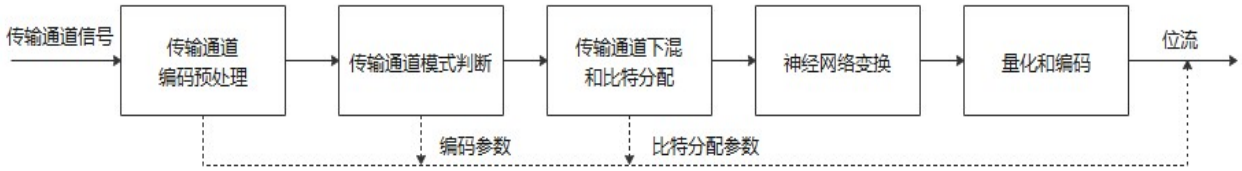

图14 通用全码率音频 HOA 编码器

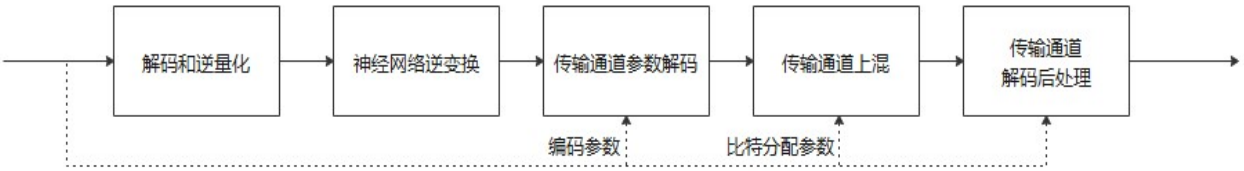

图15 通用全码率音频 HOA 解码器

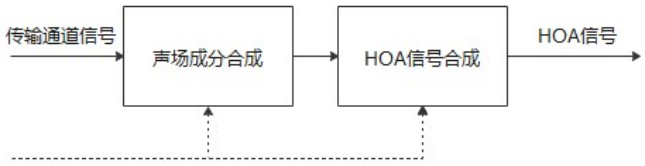

图16 通用全码率音频 HOA 空间解码

7.2.4 解码过程

通用全码率音频编码原始位流数据（ga_co_raw_data_block）是构成AASF和AATF编码位流的基本单位，解码ga_co_raw_data_block可获得一帧的音频样本，解码帧头可获得当前帧比特率。AASF和AATF格式具体内容见附录A。

解码器首先解析元数据Avs3MetadataDec()，再解析音频数据，解码器从aasf_frame_header()或aatf_frame_header()中解析参数并选择音频数据解码模式，具体如下：

当coding_profile为0且channel_number_index为1时解码器选择单声道解码，codecFormat为0。单声道解码，Avs3MonoDec()首先解析核心解码器边信息DecodeCoreSideBits()和频谱逆分组处理DecodeGroupBits()，然后解析量化编码边信息DecodeQcBits()，进行区间解码和逆量化Avs3InverseQC()，最后进行解码后处理Avs3PostSynthesis()，得到解码单声道信号。

当coding_profile为0且channel_number_index为0时解码器选择双声道立体声解码，codecFormat为1。双声道立体声解码,Avs3StereoDec()首先对每个声道解析核心解码器边信息DecodeCoreSideBits()和频谱逆分组处理DecodeGroupBits()，然后解析双声道立体声边信息DecodeStereoSideBits()，进行双声道立体声比特分配StereoBitsAllocation(),接着对每个声道解析量化编码边信息DecodeQcBits()，进行区间解码和逆量化Avs3InverseQC()，然后进行双声道立体声上混处理StereoInvMsProcess()，最后对每个声道进行解码后处理Avs3PostSynthesis()，得到解码双声道立体声信号。

当coding_profile为0且channel_number_index为2时解码器选择多声道解码，codecFormat为2。多声道解码，Avs3McDec()首先对每个声道解析核心解码器边信息DecodeCoreSideBits()和频谱逆分组处理DecodeGroupBits()，然后解析多声道边信息DecodeMcSideBits()，进行多声道比特分配McBitsAllocation()，接着对每个声道解析量化编码边信息DecodeQcBits()，进行区间解码和逆量化Avs3InverseQC()，然后进行多声道解码处理Avs3McacDec()，最后对每个声道进行解码后处理Avs3PostSynthesis()，得到解码多声道信号。

当coding_profile为1且soundBedType为0时解码器选择对象解码， object_channel_number为0时codecFormat为0；object_channel_number为1时codecFormat为1，object_channel_number大于1时codecFormat为2。对象解码复用声道解码，即对象声道数为1时复用单声道解码，对象声道数为2时复用双声道立体声解码，对象声道数大于2时复用多声道解码。

当coding_profile为1且soundBedType为1时解码器选择混合解码， channel_number_index对应的channel_number与object_channel_number的总数为1时codecFormat为1;channel_number_index对应的channel_number与object_channel_number的总数量大于1时codecFormat为2。混合解码复用声道解码，即声床声道数与对象声道数的总数为2时复用双声道立体声解码，声床声道数与对象声道数的总数大于2时复用多声道解码。

当coding_profile为2时解码器选择HOA解码，codecFormat为3。HOA解码由两部分耦合而成，分别为核心解码器和空间解码器，核心解码器解码虚拟扬声器信号和残差信号，空间解码器对虚拟扬声器信号和残差信号解码得到解码HOA信号。Avs3HoaDec()首先对每个虚拟扬声器信号和残差信号解析核心解码器边信息DecodeCoreSideBits()和频谱逆分组处理DecodeGroupBits()，然后解析虚拟扬声器信号和残差信号边信息DecodeHoaSideBits()，执行虚拟扬声器信号和残差信号比特分配HoaSplitBytesGroup()，接着对每个声道解析量化编码边信息DecodeQcBits()，进行区间解码和逆量化Avs3InverseQC()，然后进行虚拟扬声器信号和残差信号解码处理Avs3HoaInverseDMX()，对每个虚拟扬声器信号和残差信号进行解码后处理Avs3PostSynthesis()，最后进行HOA空间解码HoaPostSynthesisFilter()，得到解码HOA信号。

7.3 核心解码器边信息

7.3.1 语法

核心解码器边信息语法见表6。

表6 DecodeCoreSideBits()语法

语法	比特数	助记符
DecodeCoreSideBits() {		
transformType	2	uimsbf
DecodeFdShapingSideBits()		
DecodeTnsSideBits()		
if(bwePresent == 1) {		
DecodeBweSideBits()		
}		
}		

窗型控制参数配置表见表7。

表7 窗型控制参数配置表

transformType	窗型控制参数
0x0	长窗
0x1	短窗
0x2	切入窗
0x3	切出窗

7.3.2 语义

transformType　2 比特，表示窗型控制参数，见表 7，短窗是长度 256 的正弦窗，长窗是长度 2048 的正弦窗，切入窗的前 1024 点与长窗相同，后 1024 点由 448 点的 1，128 点的短窗和 448 点的 0 构成，切出窗的前 1024 点由 448 点的 0，128 点的短窗和 448 点的 1 构成，后 1024 点和长窗相同

DecodeFdShapingSideBits()　解析频域噪声整形边信息

DecodeTnsSideBits()　解析时域噪声整形边信息

DecodeBweSideBits()　解析频带扩展解码边信息

bwePresent　bwePresent 为频带扩展开启标志，见 7.7.3.4 章节频带扩展开启条件

7.3.3 解码过程

DecodeCoreSideBits()从位流中解析核心解码器边信息，包括窗型控制参数，频域噪声整形参数，时域噪声整形参数，当频带扩展开启时解析频带扩展解码参数，核心解码器边信息用于后续解码模块解码。

7.4 解码后处理

7.4.1 语法

解码后处理语法见表 8。

表8 Avs3PostSynthesis()语法

语法	比特数	助记符
Avs3PostSynthesis() {		
if(bwePresent == 1) {		
BweApplyDec()		
}		
TnsDec()		
Avs3FdInvSpectrumShaping()		
if(transformType == 0x1) {		
MdctSpectrumDeinterleave()		
}		
Avs3InverseMdctDecoder()		
}		

7.4.2 语义

BweApplyDec()	频带扩展解码处理
TnsDec()	时域噪声整形解码处理
Avs3FdInvSpectrumShaping()	频域噪声整形解码处理
MdctSpectrumDeinterleave()	短帧 MDCT 频谱解交织处理
Avs3InverseMdctDecoder()	MDCT 反变换

7.4.3 解码过程

Avs3PostSynthesis()当频带扩展开启时进行频带扩展解码处理，然后时域噪声整形解码处理，频域噪声整形解码处理，当窗型控制参数为短窗时进行 MDCT 频谱的解交织处理，最后进行 MDCT 反变换得到时域重建信号。

7.5 区间解码和神经网络逆变换

7.5.1 语法

量化编码边信息语法见表 9。

表9 DecodeQcBits()语法

语法	比特数	助记符
DecodeQcBits() {		
isFeatAmplified	1	uimsbf
scaleQIdx	7	uimsbf
if(numGroups == 1) {		
nfParamQIdx[0]	3	uimsbf
}else if(numGroups == 2) {		
nfParamQIdx[0]	3	uimsbf

表 9. DecodeQcBits()语法（续）

语法	比特数	助记符
nfParamQIdx[1]	3	uimsbf
}		
contextNumBytes	8	uimsbf
contextBitstream	注1	uimsbf
baseBitstream	注2	uimsbf
}		
注1：contextBitstream字节数为contextNumBytes		
注2：baseBitstream字节数为(channelBytes-contextNumBytes)		

7.5.2 语义

isFeatAmplified　1 比特，用于表示在进行量化前，神经网络变换所得的变换域系数是否进行了放大处理，0 表示进行了缩小处理，1 表示进行了放大处理

scaleQIdx　7 比特，用于表示神经网络变换所得的变换域系数的尺度调整因子的量化索引，由此变量可获得反量化的调整因子的值

nfParamQIdx　3 比特，用于表示两个 Group 的变换域系数各自对应的噪声填充参数的量化索引，由此变量可获得反量化的噪声填充参数

contextNumBytes　8 比特，用于表示区间编码位流中，上下文部分所占的字节数

contextBitstream　区间编码位流中，上下文部分的位流，所占字节数为 contextNumBytes

baseBitstream　区间编码位流中，基础部分的位流，所占字节数为 channelBytes - contextNumBytes

numGroups　MDCT 频谱的分组数量，最大分组数量为 2，在 7.6.1 章节 DecodeGroupBits()语法中解析

channelBytes　当前声道位流分配的字节数

7.5.3 解码过程

7.5.3.1 概述

区间解码模块的主要功能是根据位流信息，通过区间解码获得量化后的神经网络变换的变换域系数。主要流程包括：上下文信息的区间解码和逆量化、上下文信息的神经网络逆变换、基于上下文信息的基础神经网络变换域系数的区间解码、逆量化，以及基于基础解码神经网络的逆变换。

解码过程示意图如图 17 所示，神经网络变换的变换域系数的区间编码分为两个部分，即上下文部分和基础部分。首先对上下文部分进行区间解码和逆量化，而后经过上下文解码神经网络处理，获得解码的上下文信息，在上下文信息指导下选择基础部分区间编码的码表，并对基础部分的区间编码位流进行区间解码和逆量化，获得解码后的变换域系数，再经过噪声填充和尺度调整，最后由基础解码神经网络进行逆变换，得到解码 MDCT 系数。

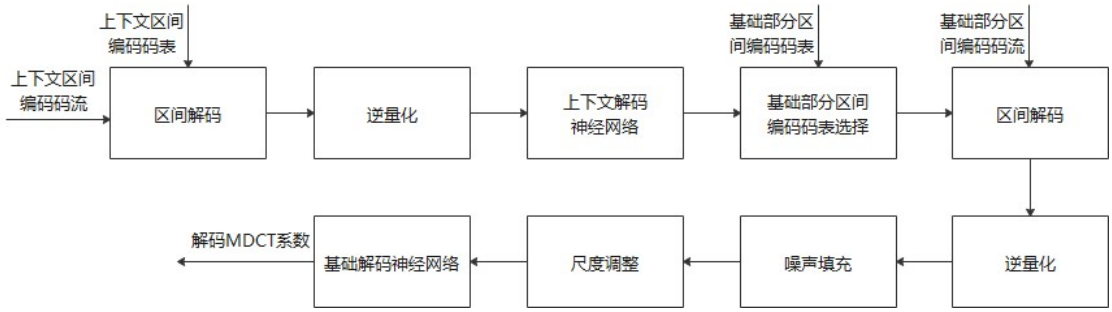

图17　区间解码和神经网络逆变换流程图

7.5.3.2　上下文部分的区间解码

根据上下文区间编码码表，对区间编码位流中的上下文部分（contextBitstream）进行解码，获得上下文神经网络变换域系数的量化索引。其中，上下文区间编码码表是预先训练获得的，见附录 B 表 B.23。

7.5.3.3　上下文神经网络变换域系数的逆量化

对上下文神经网络变换域系数的量化索引进行逆量化，获得量化后的上下文神经网络的变换域系数。采用的量化方法是线性标量量化。

7.5.3.4　上下文解码神经网络

将量化后的上下文神经网络的变换域系数输入到上下文解码神经网络进行逆变换，获得解码的上下文信息。上下文解码神经网络的基本结构为 CNN。

7.5.3.5　基础部分区间编码的码表选择

根据解码的上下文信息，从基础部分区间编码的若干码表中选择对应的码表，对基础部分的区间编码位流（baseBitstream）进行区间解码，获得量化后的基础神经网络的变换域系数。基础部分区间编码使用的码表为预先训练的若干个固定码表，见附录 B 表 B.22。

7.5.3.6　基础部分的区间解码

根据上一节选定的基础部分编码码表，对区间编码位流中的基础部分（baseBitstream）进行解码，获得基础神经网络变换域系数的量化索引。

7.5.3.7　基础神经网络变换域系数的逆量化

对基础神经网络变换域系数的量化索引进行逆量化，获得量化后的基础神经网络的变换域系数。采用的量化方法是线性标量量化。

7.5.3.8　噪声填充

噪声填充算法的作用是在解码端获得的量化后的基础神经网络变换域系数中添加适当强度的噪声 ，以补偿量化过程中引入的量化噪声。

对每帧的每个声道，噪声填充参数的量化索引 nfParamQIdx 可能为一个或两个值。当 MDCT 频谱的分组数量为 1 时，nfParamQIdx 为一个值，分组数量为 2 时，nfParamQIdx 为两个值。

对每个分组对应的基础神经网络的变换域系数，执行如下的噪声填充算法：

产生[-1, 1]范围内随机分布的噪声成分 noise；

将噪声成分 noise 与噪声填充参数 nfParamQ 相乘，获得调整后的噪声成分。其中噪声填充参数

nfParamQ 由量化索引 nfParamQIdx 解量化得到，过程如下：

$$nfParamQ = nfParamQIdx / 23.34 \quad (1)$$

对量化为 0 的基础神经网络的变换域系数，填充调整后的噪声成分。

7.5.3.9 尺度调整

噪声填充后的基础神经网络的变换域系数需要进行尺度调整，尺度调整后的变换域系数作为基础解码神经网络的输入。

尺度调整的基本过程如下

根据特征放大标志 isFeatAmplified 和尺度因子量化索引 scaleQIdx，得到解量化后的尺度调整因子 featureScale。此过程的伪代码如下：

```
if (isFeatAmplified == 0){
    featureScale = scaleQIdx / 127.0
}else {
    featureScale = pow(10.0, scaleQIdx / 86.0);
}
```

将基础神经网络的变换域系数与尺度因子 featureScale 相除，获得尺度调整后的变换域系数。

7.5.3.10 基础解码神经网络

将尺度调整后的基础神经网络的变换域系数作为基础解码神经网络的输入，即可计算得到解码端重建的 MDCT 频谱。基础解码神经网络的基本结构为 CNN。

对量化后的基础神经网络的变换域系数进行逆量化。基础神经网络的变换域系数采用的是线性标量量化。

7.5.3.11 基础编码神经网络

基础编码神经网络（BaseEncoder）的作用是对输入 MDCT 谱系数进行神经网络变换，得到变换域系数，用于后续量化编码处理。基础编码神经网络的基本构成单元是 CNN。

基础编码神经网络结构配置见表 10。

表10 基础编码神经网络结构配置

CNN 层数	4
卷积核大小	5 5 5 5
Stride	2 2 2 2
CNN 通道数量	2 4 8 16
激活函数	GDN GDN GDN None
HasBias	1 1 1 0

表 10 中，Stride 为 CNN 卷积的步长参数，HasBias 表示是否有偏置参数，“1”表示当前层有偏置参数，“0”表示当前层无偏置参数，激活函数采用 GDN（Generalized Divisive Normalization），None 表示当前层无激活函数。

基础编码神经网络的输入为长度 1024 的 MDCT 频谱，经神经网络变换后，得到的变换域系数维度为 16 声道，每个声道 64 个系数。

7.5.3.12 上下文编码神经网络

上下文编码神经网络（ContextEncoder）的作用是从尺度调整的变换域系数中提取区间编码的上下

文信息(称为基础区间编码码表选择信息),用以指导基础编码神经网络输出的变换域系数的区间编码。上下文编码神经网络的输入为尺度调整的基础编码神经网络变换域系数的绝对值。上下文编码神经网络的构成单元为 CNN。

上下文编码神经网络结构配置见表 11。

表11　上下文编码神经网络结构配置

CNN 层数	3
卷积核大小	3 3 3
Stride	1 2 2
声道数量	16 16 16
激活函数	ReLu ReLu None
HasBias	1 1 0

表 11 中，Stride 为 CNN 卷积的步长参数，HasBias 表示是否有偏置参数，“1”表示当前层有偏置参数，“0”表示当前层无偏置参数，激活函数采用 ReLu（Rectified Linear Unit），None 表示当前层无激活函数。

上下文编码神经网络的输入为 16 声道，每个声道 64 维的变换域系数，经神经网络变换后，得到的上下文编码神经网络的变换域系数，声道数为 16，每个声道 16 维。

7.5.3.13　上下文解码神经网络

上下文解码神经网络（ContextDecoder）的作用是对解码解量化的上下文神经网络变换域系数进行神经网络的逆变换，得到基础区间编码码表选择信息。上下文解码神经网络的输入为解码解量化的上下文神经网络变换域系数。上下文解码神经网络的构成单元为转置 CNN.

转置 CNN 结构配置见表 12。

表12　转置 CNN 结构配置

CNN 层数	3
卷积核大小	3 3 3
Stride	2 2 1
CNN 通道数量	16 16 16
激活函数	ReLu ReLu None
HasBias	1 1 1

表 12 中，Stride 为 CNN 卷积的步长参数，HasBias 表示是否有偏置参数，“1”表示当前层有偏置参数，“0”表示当前层无偏置参数，激活函数采用 ReLu（Rectified Linear Unit），None 表示当前层无激活函数。

上下文解码神经网络的输入为 16 声道，每个声道 16 维的变换域系数，输出为 16 声道，每个声道 64 维的基础区间编码码表选择信息。

7.6　频谱逆分组处理

7.6.1　语法

频谱逆分组处理量化语法见表 13。

表13　DecodeGroupBits()语法

语法	比特数	助记符
DecodeGroupBits() {		
if(transformType == 0x1) {		
numGroups	**1**	**uimsbf**
numGroups += 1		
if(numGroups == 2) {		
for (i = 0; i < 8; i++) {		
groupIndicator[i]	**1**	**uimsbf**
}		
}		
} else {		
numGroups = 1		
for (i = 0; i < 8; i++) {		
groupIndicator[i] = 0		
}		
}		
}		

7.6.2 语义

numGroups　　1 比特，用于表示当前帧 MDCT 频谱的分组数量

groupIndicator　　1 比特，用于表示当前短帧第 i 个 block 的分组归属，0 表示属于暂态组，1 表示属于其他组

7.6.3 解码过程

MDCT 频谱分组处理的基本思路是：当窗型控制参数为短窗时，将 8 个短块的 MDCT 频谱分为两个组，一组是包含暂态短块的暂态组，另一组是不包含暂态短块的其他组。两个组的 MDCT 频谱分别进行交织并拼接为长度 1024 的 MDCT 频谱（与长帧频谱长度一致），并进行神经网络变换、量化和区间编码处理。

解码端频谱逆分组处理的过程是：对短帧，如果当前帧的分组数量 numGroups 等于 2，则将解码获得的交织并拼接的两个组的 MDCT 频谱进行解交织，并按照 groupIndicator 标识的位置放置回原本的短块位置。

举例描述如下：

若当前短帧的 numGroups 等于 2，groupIndicator 为[1, 1, 1, 0, 0, 0, 1, 1]，即当前帧 8 个短块的第 4、5、6 个短块为暂态块，1、2、3、7、8 短块为其他块。

则解码获得的分组的 MDCT 频谱是按[4, 5, 6, 1, 2, 3, 7, 8]的顺序排列的，即暂态组（4、5、6 短块）的频谱在前，其他组（1、2、3、7、8 短块）的频谱在后。

恢复正常顺序的频谱（即每个短块的频谱按时间顺序排列），需要按 groupIndicator 指示的顺序，将解码获得的分组的 MDCT 频谱重新排列，以获得按短块顺序 1-8 排列的谱系数。

频谱逆分组处理后的 MDCT 频谱作为各模式上混处理的输入。

7.7 频带扩展解码

7.7.1 语法

频带扩展解码边信息语法见表 14。

表14 DecodeBweSideBits()语法

语法	比特数	助记符
DecodeBweSideBits() {		
for(i = 0; i < numSfb; i++) {		
sfbEnvQIdx	**7**	**uimsbf**
}		
for(i = 0; i < numTiles; i++) {		
flag_whiten_ONOFF	**1**	**uimsbf**
if(flag_whiten_ONOFF == 0) {		
whiteningLevel[i] = BWE_WHITENING_OFF		
} else {		
flag_whiten_MID_HIGH	**1**	**uimsbf**
if(flag_whiten_MID_HIGH == 0) {		
whiteningLevel[i] = BWE_WHITENING_MID		
} else {		
whiteningLevel[i] = BWE_WHITENING_STRONG		
}		
}		
}		
}		

7.7.2 语义

sfbEnvQIdx　7 比特，用于表示频带扩展频段中每个 SFB 的包络参数的量化索引，由此变量可获得频带扩展频段每个 SFB 的包络参数

flag_whiten_ONOFF　1 比特，用于表示频带扩展频段中每个频率区域的白化处理是否开启，0 表示不开启白化处理，1 表示开启白化处理

flag_whiten_MID_HIGH　1 比特，用于表示频带扩展频段中每个频率区域的白化处理等级是中（MID）或高（HIGH），0 表示白化处理等级为中等，1 表示白化处理等级为高等

numSfb　频带扩展频段中的总 SFB 数量，见 6.7.3.5 频带扩展配置参数

numTiles　频带扩展频段中的总频率区域数量

whiteningLevel[i]　频带扩展频段中第 i 个频率区域的白化处理等级参数

7.7.3 解码过程

7.7.3.1 概述

解码端频带扩展算法的主要作用是根据解码获得的核心带 MDCT 频谱和解码获得的频带扩展参数，恢复高频频带扩展频段的 MDCT 频谱。解码端频带扩展算法的主要步骤包括：频带扩展频谱准备、白化

处理和包络调整。以下分别进行描述。

7.7.3.2 频带扩展频谱准备

设解码所得的核心带 MDCT 频谱为 mdctSpectrum，频带扩展频段 MDCT 频谱为 bweSpectrum，频带扩展频带中各个目标频率区域对应的源频率区域的起点为 srcTiles[numTiles]，频带扩展频谱中各个目标频率区域的边界为 targetTiles[numTiles+1]。

频谱准备的基本过程是：以 srcTiles 为起点，将解码所得的核心带 MDCT 频谱复制到高频频带扩展频段对应的频率区域中（频率区域的边界为 targetTiles）。

频谱复制的过程如以下伪代码所示：

```
for (tileIdx = 0; tileIdx < numTiles; tileIdx++){
    srcLineIdx = srcTiles[tileIdx]
    for (i = targetTiles[tileIdx]; i < targetTiles[tileIdx+1]; i++){
        bweSpectrum[i] = mdctSpectrum[srcLineIdx]
        srcLineIdx++
  }
}
```

7.7.3.3 白化处理

频谱白化处理的作用是，在源频率区域和目标频率区域的频谱特征不同时，需要对频谱复制所得的高频频谱成分进行不同程度的白化处理，以使得频带扩展频段中的频谱特征更接近原始高频频谱的特征（如频谱成分更接近谐波特性，或更接近噪声特性）。

频谱白化处理共分为 BWE_WHITENING_OFF、BWE_WHITENING_MID 和 BWE_WHITENING_HIGH 三个等级，对应的频谱处理方式如下：

记白化处理后的 MDCT 频谱为 whitenedSpectrum。

BWE_WHITENING_OFF：表示不进行白化处理，即将频谱复制所得的频谱（即 bweSpectrum）直接作为白化处理后的频谱。

BWE_WHITENING_MID：表示白化处理等级为中等。中等频谱白化处理的基本方式是利用滑动平均算法对 bweSpectrum 进行处理，以得到白化处理后的 MDCT 频谱。

滑动平均算法可以表示为：

$$whitenedSpectrum[i] = \left(\frac{1}{2*AvgSize+1}\sum_{i-AvgSiz}^{i+AvgSize}(bweSpectrum[i])^2\right)^{1/2} \quad \text{.....(2)}$$

其中 AvgSize 代表滑动平均处理的邻域大小，对频点 i 的滑动平均处理实际上是对[*i-AvgSize, i+AvgSize*]范围内的频点计算平均幅度值。

BWE_WHITENING_HIGH：表示白化处理等级为高等。高等频谱白化处理的方式是产生一定幅度的随机噪声以替代频谱复制得到的 bweSpectrum，以获得噪声特性较强的高频频谱成分。

7.7.3.4 包络调整

包络调整算法的作用是，根据位流中解码获得的高频段每个 SFB 的包络信息，对白化处理后频谱的幅度进行调整，使得频带扩展模块恢复所得的高频频谱的能量与原始高频频谱的能量保持一致。

对频带扩展频谱的每个 SFB，包络调整算法的基本步骤描述如下：

计算频带宽度，即：

```
sfbWidth = sfbTable[sfbIdx+1] - sfbTable[sfbIdx]
```

.....(3)

其中 sfbTable 为频带扩展频段的频带划分表，sfbIdx 为频带序号。

计算当前 SFB 的白化频谱能量，即：

$$\text{currEner} = \frac{1}{\text{sfbWidth}}\sum_{\text{i=sfbStar}}^{\text{sfbEnd}-1}(\text{whitenedSpectrum[i]})^2 \quad (4)$$

其中，sfbStart 为当前 SFB 起点，sfbEnd 为当前 SFB 终点，取值分别为：

sfbStart = sfbTable[sfbIdx] ..... (5)

sfbEnd = sfbTable[sfbIdx+1] ..... (6)

利用位流中传输的 SFB 包络参数计算当前 SFB 的目标频谱能量，即：

$$targetEner = pow\left(2.0, \frac{sfbEnvQIdx[sfbIdx]}{4.24966} - 4.0\right) \quad (7)$$

其中，pow 为指数运算。

利用白化频谱能量和目标频谱能量，计算当前 SFB 的频谱增益，伪代码：

```
if (currEner != 0.0){
    gainSfb = sqrt(targetEner / currEner)
}else{
    gainSfb = 1.0
}
```

将当前 SFB 的频谱增益与白化频谱相乘，获得频带扩展算法恢复的高频频谱。

7.7.3.5 频带扩展开启条件

频带扩展针对单声道、双声道立体声、多声道等信号形式的开启条件有所不同。

单声道模式：编码码率小于等于 96kb/s 时开启。

双声道立体声模式：编码码率小于等于 128kb/s 时开启。

多声道模式：等效双声道立体声编码码率小于等于 128kb/s 时开启。等效双声道立体声编码码率的计算方式是，除 LFE 声道外的平均编码码率乘以 2，折算为双声道立体声编码码率。

7.7.3.6 频带扩展配置参数

频带扩展将高频频谱划分为若干 SFB，一个或多个 SFB 构成一个频率区域。每一个高频频率区域或称为目标频率区域有一个对应的低频频率区域或称为源频率区域，用于在解码端从低频带拷贝频谱到高频带。

根据以上算法框架，频带扩展的配置参数包括以下几项：

1. SFB 划分方式，表 15-表 18
2. 目标频率区域划分方式，表 19-表 22
3. 源频率区域划分方式，表 23-表 26
4. 高频频带构成目标频率区域的方式，表 27-表 30

以上配置表的含义距离解释如下：

以单声道 32kb/s 及以下码率的配置为例。

参考表 15，高频频谱共划分为 6 个 SFB，第 1 个 SFB 对应的频率范围的起点是 352（即第 352 个 MDCT 频点），终点是 415（即表格中 416 减 1）；第 2 个 SFB 对应的频率范围的起点是 416，终点是 479（即表格中 480 减），以此类推。

参考表 19，高频频谱划分为 3 个目标频率区域，第 1 个目标频率区域对应的频率范围的起点是 352（即第 352 个 MDCT 频点），终点是 479（即表格中 480 减 1）；第 2 个目标频率区域对应的频率范围的起点是 480，终点是 607（即表格中 608 减 1），以此类推。

参考表 23，与高频频率区域对应的源频率区域的数量同样是 3 个，第 1 个源频率区域的起点是 64（即第 64 个 MDCT 频点），第 2 个源频率区域的起点是 96。源频率区域的频率宽度与对应的目标频率区域相同。

参考表 27，目标频率区域和高频频带的对应关系为：第 1 个目标频率区域包括第 0、1 个 SFB，第 2 个目标频率区域包括第 2、3 个 SFB，第 3 个目标频率区域包括第 4、5 个 SFB。

单声道高频 SFB 配置见表 15。

表15　单声道高频 SFB 配置表

比特率（kb/s）	SFB 数量	第 1 个 SFB 起点	第 2 个 SFB 起点	第 3 个 SFB 起点	第 4 个 SFB 起点	第 5 个 SFB 起点	第 6 个 SFB 起点	第 7 个 SFB 起点
<=32	6	352	416	480	544	608	672	768
44，56	6	448	496	544	608	672	736	832
64，72	4	544	608	672	736	832		
80，96	2	672	736	832				

双声道立体声高频 SFB 配置见表 16。

表16　双声道立体声高频 SFB 配置表

比特率（kb/s）	SFB 数量	第 1 个 SFB 起点	第 2 个 SFB 起点	第 3 个 SFB 起点	第 4 个 SFB 起点	第 5 个 SFB 起点	第 6 个 SFB 起点	第 7 个 SFB 起点
<=48	6	352	416	480	544	608	672	768
(48，64]	6	352	416	480	544	608	672	768
(64，96]	4	544	608	672	736	832		
(96，128]	2	672	736	832				

多声道高频 SFB 配置见表 17。

表17　多声道高频 SFB 配置表

比特率（kb/s）折算到声道对上	SFB 数量	第 1 个 SFB 起点	第 2 个 SFB 起点	第 3 个 SFB 起点	第 4 个 SFB 起点	第 5 个 SFB 起点	第 6 个 SFB 起点	第 7 个 SFB 起点
<=56	6	352	400	448	512	576	672	768
(56，75]	5	400	448	512	576	672	768	
(75，108]	4	544	608	672	736	832		
(108，128]	2	672	736	832				

HOA 高频 SFB 配置见表 18。

表18　HOA 高频 SFB 配置表

比特率（kb/s）	SFB	第 1 个	第 2 个	第 3 个	第 4 个	第 5 个	第 6 个	第 7 个

	数量	SFB 起点	SFB 起点	SFB 起点	SFB 起点	SFB 起点	SFB 起点	SFB 起点
192(2 阶 HOA)	4	352	416	480	544	736		
<=128(FOA) 256(2 阶 HOA) [256, 384](3 阶 HOA)	6	384	448	512	576	672	736	832
192(FOA) 320(2 阶 HOA) 512(3 阶 HOA)	4	544	608	672	736	832		
256(FOA) [384, 480] (2 阶 HOA) [640, 896] (3 阶 HOA)	2	672	736	832				

单声道目标频率区域配置见表 19。

表19　单声道目标频率区域配置表

比特率（kb/s）	目标频率区域数量	第 1 个目标频率区域起点	第 2 个目标频率区域起点	第 3 个目标频率区域起点	第 4 个目标频率区域起点
<=32	3	352	480	608	768
44, 56	3	448	544	672	832
64, 72	2	544	672	832	
80, 96	1	672	832		

双声道立体声目标频率区域配置见表 20。

表20　双声道立体声目标频率区域配置表

比特率（kb/s）	目标频率区域数量	第 1 个目标频率区域起点	第 2 个目标频率区域起点	第 3 个目标频率区域起点	第 4 个目标频率区域起点
<=48	3	352	480	608	768
(48, 64]	3	352	480	608	768
(64, 96]	2	544	672	832	
(96, 128]	1	672	832		

多声道目标频率区域配置见表 21。

表21　多声道目标频率区域配置表

比特率（kb/s）折算到	目标频率区	第 1 个目标频率	第 2 个目标频率	第 3 个目标频率	第 4 个目标频率

声道对上	域数量	区域起点	区域起点	区域起点	区域起点
<=56	3	352	448	576	768
(56, 75]	3	400	512	672	768
(75, 108]	2	544	672	832	
(108, 128]	1	672	832		

HOA 目标频率区域配置见表 22。

表22 HOA 目标频率区域配置表

比特率（kb/s）	目标频率区域数量	第 1 个目标频率区域起点	第 2 个目标频率区域起点	第 3 个目标频率区域起点	第 4 个目标频率区域起点
192(2 阶 HOA)	2	352	480	736	
<=128(FOA) 256(2 阶 HOA) [256, 384](3 阶 HOA)	3	384	512	672	832
192(FOA) 320(2 阶 HOA) 512(3 阶 HOA)	2	544	672	832	
256(FOA) [384, 480] (2 阶 HOA) [640, 896] (3 阶 HOA)	1	672	832		

单声道源频率区域配置见表 23。

表23 单声道源频率区域配置表

比特率（kb/s）	第 1 个源频率区域起点	第 2 个源频率区域起点	第 3 个源频率区域起点	第 4 个源频率区域起点
<=32	64	96	144	
44, 56	96	144	192	
64, 72	144	192		
80, 96	192			

双声道立体声源频率区域配置见表 24。

表24 双声道立体声源频率区域配置表

比特率	第 1 个源频率区域起	第 2 个源频率区域起	第 3 个源频率区域起	第 4 个源频率区域起

（kb/s）	点	点	点	点
<=48	64	96	144	
(48, 64]	64	96	144	
(64, 96]	144	192		
(96, 128]	192			

多声道源频率区域配置见表 25。

表25　多声道源频率区域配置表

比特率（kb/s）折算到声道对上	第 1 个源频率区域起点	第 2 个源频率区域起点	第 3 个源频率区域起点	第 4 个源频率区域起点
<=56	64	96	144	
(56, 75]	64	96	144	
(75, 108]	144	192		
(108, 128]	192			

HOA 源频率区域配置见表 26。

表26　HOA 源频率区域配置表

比特率（kb/s）	第 1 个源频率区域起点	第 2 个源频率区域起点	第 3 个源频率区域起点	第 4 个源频率区域起点
192(2 阶 HOA)	64	96		
<=128(FOA) 256(2 阶 HOA) [256, 384](3 阶 HOA)	96	144	192	
192(FOA) 320(2 阶 HOA) 512(3 阶 HOA)	144	192		
256(FOA) [384, 480] (2 阶 HOA) [640, 896] (3 阶 HOA)	192			

单声道高频频带构成目标频率区域的 SFB 序号配置见表 27。

表27　单声道高频频带构成目标频率区域的 SFB 序号配置表

比特率（kb/s）	第 1 个目标频率区域起点对应的 SFB 序号	第 2 个目标频率区域起点对应的 SFB 序号	第 3 个目标频率区域起点对应的 SFB 序号	第 4 个目标频率区域起点对应的 SFB 序号
<=32	0	2	4	6
44, 56	0	2	4	6
64, 72	0	2	4	
80, 96	0	2		

双声道立体声高频频带构成目标频率区域的 SFB 序号配置见表 28。

表28　双声道立体声高频频带构成目标频率区域的 SFB 序号配置表

比特率（kb/s）	第 1 个目标频率区域起点对应的 SFB 序号	第 2 个目标频率区域起点对应的 SFB 序号	第 3 个目标频率区域起点对应的 SFB 序号	第 4 个目标频率区域起点对应的 SFB 序号
<=48	0	2	4	6
(48, 64]	0	2	4	6
(64, 96]	0	2	4	
(96, 128]	0	2		

多声道高频频带构成目标频率区域的 SFB 序号配置见表 29。

表29　多声道高频频带构成目标频率区域的 SFB 序号配置表

比特率（kb/s）折算到声道对上	第 1 个目标频率区域起点对应的 SFB 序号	第 2 个目标频率区域起点对应的 SFB 序号	第 3 个目标频率区域起点对应的 SFB 序号	第 4 个目标频率区域起点对应的 SFB 序号
<=56	0	2	4	6
(56, 75]	0	2	4	5
(75, 108]	0	2	4	
(108, 128]	0	2		

HOA 高频频带构成目标频率区域的 SFB 序号配置见表 30。

表30　HOA 高频频带构成目标频率区域的 SFB 序号配置表

比特率（kb/s）	第 1 个目标频率区域起点对应的 SFB 序号	第 2 个目标频率区域起点对应的 SFB 序号	第 3 个目标频率区域起点对应的 SFB 序号	第 4 个目标频率区域起点对应的 SFB 序号
192(2 阶 HOA)	0	2	4	
<=128(FOA) 256(2 阶 HOA) [256, 384](3 阶 HOA)	0	2	4	6
192(FOA) 320(2 阶 HOA) 512(3 阶 HOA)	0	2	4	
256(FOA) [384, 480] (2 阶 HOA) [640, 896] (3 阶 HOA)	0	2		

7.8　逆时域噪声整形

7.8.1　语法

时域噪声整形边信息语法见表 31。

表31　DecodeTnsSideBits()语法

语法	比特数	助记符
DecodeTnsSideBits() {		
for (i = 0; i < 2; i++) {		
tnsEnable[i]	1	uimsbf
if(tnsEnable[i] == 1) {		
tnsOrder[i]	3	uimsbf
tnsOrder[i] += 1		
for (j = 0; j < tnsOrder[i]; j++) {		
tnsHuffCode[i][j]	注1	uimsbf
}		
}		
}		
}		
注1：TNS滤波器系数采用哈夫曼编码，比特数参考附录B中表B.15-B.22中比特数		

7.8.2 语义

tnsEnable[i] 1 比特，用于表示第 i 个 TNS 滤波器是否开启，0 表示不开启，1 表示开启

tnsOrder[i] 3 比特，用于表示第 i 个 TNS 滤波器的阶数，滤波器最大阶数为 8

tnsHuffCode[i][j] 表示第 i 个 TNS 滤波器第 j 阶的滤波器系数的哈夫曼编码结果， tns 参数的最大阶数（即 tnsOrder[i]）的最大值为 8，对每一阶 tns 参数有对应的哈夫曼码表，第 0 阶到第 7 阶 tns 参数的哈夫曼码表(包括码字和比特数)参考附录 B 中表 B.15-B.22

7.8.3 解码过程

7.8.3.1 概述

时域噪声整形的基本过程是：首先对滤波器系数的哈夫曼编码结果进行区间解码和逆量化，获得滤波器系数；而后对每个 TNS 滤波器对应的频段进行滤波处理，以得到逆时域噪声整形后的 MDCT 频谱。

7.8.3.2 滤波器系数的区间解码和逆量化

时域噪声整形滤波器由一组反射系数表示，滤波器最大阶数为 8 阶，每帧滤波器的实际阶数小于或等于最大阶数。编码端反射系数经量化后进行哈夫曼编码，每一维滤波器系数均有对应的哈夫曼码书（参见附录 B 中表 B.15 至表 B.22）。

滤波器系数量化索引的哈夫曼解位流程为：对当前帧第 i 个 TNS 滤波器的第 j 个滤波器系数，选择对应的哈夫曼码表，将位流中的哈夫曼码字 tnsHuffCode[i][j]解码为量化索引。

根据滤波器系数的标量量化码表和解码所得量化索引，获得量化后的滤波器系数。此处使用的标量量化码表为非均匀标量量化码表，参见附录 B 表 B.14。

7.8.3.3 逆时域噪声整形滤波

时域噪声整形最多使用两组滤波器，两组滤波器对应的频率范围分别是[660Hz, 5400Hz]和[5400Hz,

20000Hz]。

若第 i 组滤波器的开启标志 tnsEnable[i]等于 1，则对第 i 组滤波器对应的频率范围进行逆时域噪声整形滤波。

滤波算法的输入是解码所得 MDCT 频谱和对应的滤波器系数，根据基于反射系数的线性预测滤波算法对 MDCT 频谱进行频率域上的滤波处理，滤波算法为业界通用 IIR 滤波算法，其原理此处不再赘述。

7.9 逆频域噪声整形

7.9.1 语法

频域噪声整形边信息语法见表 32。

表32 DecodeFdShapingSideBits ()语法

语法	比特数	助记符
DecodeFdShapingSideBits() {		
if(lsfLbrFlag == 0) {		
lsfVqIndex[0]	8	uimsbf
lsfVqIndex[1]	8	uimsbf
lsfVqIndex[2]	7	uimsbf
lsfVqIndex[3]	7	uimsbf
lsfVqIndex[4]	6	uimsbf
lsfVqIndex[5]	5	uimsbf
lsfVqIndex[6]	5	uimsbf
} else {		
lsfVqIndex[0]	8	uimsbf
lsfVqIndex[1]	8	uimsbf
lsfVqIndex[2]	7	uimsbf
lsfVqIndex[3]	7	uimsbf
lsfVqIndex[4]	6	uimsbf
}		
}		

7.9.2 语义

lsfVqIndex[i] 用于表示 LSF 参数矢量量化中第 i 个子矢量的量化索引

lsfLbrFlag 低精度 LSF 量化编码标志，当每个声道平均码率大于 32kb/s 时，lsfLbrFlag 为 0，当每个声道平均码率小于等于 32kb/s 时，lsfLbrFlag 为 1，为 0 表示采用高精度 LSF 量化编码，为 1 表示采用低精度 LSF 量化编码

7.9.3 解码过程

7.9.3.1 概述

频域噪声整形采用一种基于 LPC 谱包络的频谱量化噪声整形技术。在编码端计算基于 LPC 的谱包络，并对待编码的 MDCT 频谱进行整形处理；解码端根据位流中解码得到的 LPC 参数计算对应的谱包络

信息，并进行逆整形处理。

逆频域噪声整形的主要步骤包括：LSF 参数的解量化、LSF 参数转换为 LPC 参数、根据 LPC 参数计算谱包络和逆整形处理等。以下分别进行介绍。

7.9.3.2 LSF 参数逆量化

LSF 参数的量化编码采用矢量量化技术，矢量量化码书的结构为多级分裂矢量量化，针对不同编码码率采用高精度和低精度两套矢量量化码书。当 lsfLbrFlag 为 0 时，选择高精度码书；当 lsfLbrFlag 为 1 时，选择低精度码书。

LSF 参数的维度为 16 维。

高精度码书结构为：第一级将 LSF 矢量分为两个子矢量，维度分别为 9 和 7，码书比特数为 8 和 8，参见附录表 B.2、附录表 B.2；第二级将第一级量化的残差矢量分为 5 个子矢量，维度分别为 3、3、3、3、4，码书比特数为 7、7、6、5、5，参见附录 B 表 B.3 至表 B.7。

低精度码书结构为：第一级将 LSF 矢量分为两个子矢量，维度分别为 9 和 7，码书比特数为 8 和 8，参见附录表 B.9、附录表 B.11；第二级将第一级量化的残差矢量分为 3 个子矢量，维度分别为 5、4、7，码书比特数为 7、7、6，参见附录 B 表 B.11 至表 B.13。

根据位流中获得的 lsfVqIndex 参数和对应的矢量量化码书，可以解码得到第一级和第二级矢量，将其相加即可得到逆量化的 LSF 参数。

7.9.3.3 LSF 参数转换

首先将 LSF 参数转换为 LSP 参数，而后利用切比雪夫多项式方法将 LSP 参数转换为 LPC 参数。LSF 转 LSP、LSP 转 LPC 方法均为业界常用算法。

7.9.3.4 逆整形处理

逆频域噪声整形处理分为 LPC 谱包络计算和逆整形两个步骤。LPC 谱包络计算的基本流程是：

第一步由 LPC 参数计算每个频点的 LPC 谱包络，表示为：

$$lpcEnv[k] = \frac{1}{\left|1-\sum_{i=1}^{p} a_i e^{\frac{2\pi j k}{N} i}\right|} \quad (8)$$

其中 $lpcEnv[k]$为第 k 个频点的 LPC 谱包络，ai 为第 i 个 LPC 系数。

上式可采用 FFT 实现，FFT 长度为 2048，lpcEnv 长度为 1024。

第二步根据频点 LPC 谱包络计算子带 LPC 谱包络

将 MDCT 频谱分为若干个不等长度的子带，在每个子带中计算频点 LPC 谱包络的平均值，作为子带 LPC 谱包络。当前使用的子带数量为 49。

逆整形处理的方法是：将前面计算得到的 LPC 谱包络与 MDCT 频谱相乘，得到逆频域噪声整形后的 MDCT 频谱。

7.10 逆 MDCT 变换

7.10.1 解码过程

7.10.1.1 概述

逆 MDCT 变换模块的作用是根据位流中解析得到的窗型控制参数和解码得到的各声道的 MDCT 系数，进行逆 MDCT，从而获得重建的时域音频信号。

根据窗型控制参数的不同，逆 MDCT 变换的处理方式可分为以下几种：

若窗型控制参数等于 0x0 或 0x2，即当前帧为长窗或切入窗，则对 MDCT 频谱进行长度为 2048 的反变换，得到当前帧的重建时域信号，将重建时域信号的前半帧与 OLA 历史叠加，作为当前帧的输出信

号。

若窗型控制参数等于 0x3，即当前帧为切出窗，则对 MDCT 频谱进行长度为 2048 的反变换，得到当前帧的重建时域信号，将重建时域信号前半帧中，与前一帧的最后一个短帧叠接的部分与 OLA 历史叠加，从而得到当前帧的输出信号。

若窗型控制参数等于 0x1，即当前帧为短窗，则对反交织后的 MDCT 频谱中包括的 8 个短帧的 MDCT 系数分别进行长度为 256 的反变换，得到的 8 个短窗时域信号进行叠接相加，得到当前帧的输出信号。

7.10.1.2 窗型定义

各窗类型的形式如下：

1）长窗：LONG_SHORT_TRANS_WINDOW，为长度 2048 的正弦窗。

2）切入窗：LONG_SHORT_TRANS_WINDOW，由长度 1024 的左半正弦窗、长度 448 的取值为 1 的部分、长度 128 的右半正弦窗、长度 448 的取值为 0 的部分构成。

3）切出窗：SHORT_LONG_TRANS_WINDOW，由长度 448 的取值为 0 的部分、长度未 128 的左半正弦窗、长度为 448 的取值为 1 的部分和长度 1024 的右半正弦窗构成。

4）短窗：ONLY_SHORT_WINDOW，为长度 256 的正弦窗，每帧加 8 个短窗。

7.11 双声道立体声比特分配和上混

7.11.1 语法

双声道立体声边信息语法见表 33。

表33 DecodeStereoSideBits()语法

语法	比特数	助记符
DecodeStereoSideBits() {		
if(useMcr == 0) {		
isMs	**1**	**uimsbf**
if(isMs == 1) {		
ILD	**4**	**uimsbf**
}		
bitsRatio	**3**	**uimsbf**
}		
if(useMcr == 1) {		
for(i = 0; i < vqVecNum[isShortWin]; i++) {		
vqIdx[0][i]	**注1**	**uimsbf**
vqIdx[1][i]	**注1**	**uimsbf**
}		
}		
}		
注1：vqIdx[0][i]和vqIdx[1][i]比特数等于vqNumBits[isShortWin]		

7.11.2 语义

useMcr　　表示是否使用 MCR 双声道立体声处理，双声道立体声码率小于等于 32kb/s 时 useMcr 等于 1，双声道立体声码率大于

	32kb/s 时 useMcr 等于 0
isMs	1 比特，用于表示当前帧是否开启 M/S 双声道立体声处理
ILD	4 比特，用于表示左右声道间的幅度差
bitsRatio	3 比特，用于表示下混后两个声道的比特分配比例
isShortWin	表示左声道的窗型是否为短窗，左声道为短窗时 isShortWin 等于 1，左声道不为短窗时 isShortWin 等于 0
vqVecNum[isShortWin]	表示 MCR 旋转角度参数矢量量化中的子矢量数量，根据左声道是否为短窗的标志 isShortWin 确定
vqIdx[0][i]	表示偶数 MDCT 频谱对应的 MCR 旋转角度参数矢量中，第 i 个子矢量的矢量量化索引
vqIdx[1][i]	表示奇数 MDCT 频谱对应的 MCR 旋转角度参数矢量中，第 i 个子矢量的矢量量化索引

7.11.3 解码过程

7.11.3.1 概述

双声道立体声模式上混模块包括 MCR 上混模式和 M/S 上混模式。MCR 上混模式包括 MCR 边信息解码和 MCR 上混，M/S 上混模式包括 M/S 比特分配和 M/S 上混。MCR 上混模式，位流中传输的 MDCT 频谱信息仅为MCR 旋转处理后一个声道的MDCT 频谱信息,需要根据位流中传输的MCR 双声道立体声模式边信息，恢复两个声道的 MDCT 频谱。M/S 上混模式，根据位流中传输的双声道立体声模式边信息，获取当前帧是否开启 M/S 下混的标志、左右声道间的幅度差和下混后声道的比特分配比例等信息。根据比特分配比例信息和当前帧去除其他边信息后剩余的用于量化编码部分的总比特数，可以计算得到下混后两个声道各自的比特分配结果 channelBytes。将比特分配结果与区间解码、逆量化和神经网络逆变换得到下混声道的解码 MDCT 系数。结合 isMs 标志完成 M/S 上混，并依据 ILD 信息完成能量调整，从而得到左右声道的解码 MDCT 系数。以下对两种上混模式分别介绍。

7.11.3.2 MCR 边信息解码

MCR边信息为核心带奇偶频谱的MCR旋转角度参数。MCR上混模式中，仅对左右声道核心带的MDCT频谱进行MCR处理，解码过程引用GB/T 33475.3中7.4 couple_channel_element()解码。将左右声道的MDCT频谱分为奇频谱和偶频谱两部分，各分为18个子带，子带边界和子带频点数量定义如表34和表35所示。例如，第1个子带从子带边界序号0开始，到子带边界序号1结束，对应子带边界为从第0个频点到第3个频点，子带频点数量为4。

MCR 子带边界配置见表 34。

表34 MCR 子带边界配置

子带边界序号	子带边界
0	0
1	4
2	8
3	12
4	16
5	22

表 34 MCR 子带边界配置（续）

子带边界序号	子带边界
6	28
7	34
8	40
9	48
10	56
11	64
12	76
13	88
14	100
15	116
16	132
17	154
18	176

MCR 子带频点数量配置见表 35。

表35　MCR 子带频点数量配置

子带序号	子带频点数量
1	4
2	4
3	4
4	4
5	6
6	6
7	6
8	6
9	8
10	8
11	8
12	12
13	12
14	12
15	16
16	16
17	22
18	22

对每个子带的奇偶频谱可以获得对应的MCR旋转角度参数，在MCR旋转角度参数的矢量量化中，将18个子带的旋转角度参数分为6个子矢量（即vqVecNum等于6），每个子矢量包含3个子带的旋转角度参数。旋转角度参数的矢量量化分为两种配置，分别对应当前帧左声道的窗类型为短窗和非短窗（包括长窗和切入窗、切出窗），即isShortWin等于1和等于0两种情况。isShortWin等于1时，每个旋转角度参数子

矢量的矢量量化比特数为8（即vqIdx[0][i]和vqIdx[1][i]的比特数为8），即矢量量化码书大小为256，矢量量化码书引用GB/T 33475.3附录B中表B.154；isShortWin等于0时，每个旋转角度参数子矢量的矢量量化比特数为9（即vqIdx[0][i]和vqIdx[1][i]的比特数为9），即矢量量化码书大小为512，矢量量化码书引用GB/T 33475.3-2018附录B中表B.155。

7.11.3.3 MCR 上混

MCR上混采用参数立体声方式，仅传输MCR变换后一个声道的核心带MDCT系数，解码过程需要根据解码得到的一个声道的核心带MDCT系数和MCR边信息进行上混，以获得左右声道的核心带解码MDCT系数。

首先将位流中解码得到的一个声道的MCR变换后的MDCT频谱进行复制，获得左右声道的MCR变换后的MDCT频谱。MCR反变换引用GB/T 33475.3中7.4 couple_channel_element()解码，得到左右声道的核心带解码MDCT频谱。

7.11.3.4 M/S 比特分配

M/S 比特分配模块的主要作用是根据位流中解码获得的比特分配比例参数，将去除其他边信息后的剩余可用比特数分配给两个下混声道，从而完成后续的区间解码、逆量化和神经网络逆变换步骤。

首先需要计算当前帧扣除其他边信息后剩余的可用比特数，记为 availableBits。计算 availableBits 的通用算法表示为如下的伪代码：

```
availableBits = bitsPerFrame - bitsUsed - nChans * (nbits_isFeatAmplified + nbits_featureScale + nbits_contextNumBytes)
for (i = 0; i < nChans; i++){
  if (numGroups[i] == 1){
      availableBits -= nbits_nfParam
  }else if (numGroups[i] == 2){
      availableBits -= 2 * nbits_nfParam
  }
}
```

其中 bitsPerFrame 为当前帧的总编码比特数，bitsUsed 为当前帧已用的边信息比特数，nChans 为声道数量（对双声道立体声模式，声道数量为 2），nbits_isFeatAmplified 为 isFeatAmplified 参数的比特数（固定为 1），nbits_featureScale 为 nfParamQIdx 参数的比特数（固定为 7），nbits_contextNumBytes 为所述 contextNumBytes 参数的比特数（固定为 8），numGroups 为当前帧 MDCT 频谱的分组数量，nbits_nfParam 为噪声填充参数的比特数（固定为 3）。

而后根据 availableBits 和 bitsRatio 获得下混声道的比特分配结果：

当前方案采用的区间编码以字节为最小单位，因此需将 availableBits 转换为可用的字节数，即：availableBytes = floor(availableBits / 8)。

双声道立体声模式下，两个下混声道的字节数计算如下：

```
channelBytes[0] = bitsRatio * floor(availableBytes / (1<<3))
channelBytes[1] = availableBytes - channelBytes[0]
```

其中，(1<<3)表示双声道立体声模式下比特分配的份数，即可用比特数会被划分成 8 份，将其中的若干份分配给其中一个下混声道，其余比特数分配给另一个下混声道。

7.11.3.5 M/S 上混

若当前帧是否开启 M/S 双声道立体声处理的标志 isMs 为 1，则需要对解码得到的下混声道进行 M/S 上混处理，以获得解码的左右声道 MDCT 频谱。

M/S 上混处理如下式：

$$mdctSpectrum\_L = \frac{\sqrt{2}}{2}(mdctSpectrum\_M + mdctSpectrum\_S) \quad (12)$$

$$mdctSpectrum\_R = \frac{\sqrt{2}}{2}(mdctSpectrum\_M - mdctSpectrum\_S) \quad (13)$$

其中，mdctSpectrum_M 和 mdctSpectrum_S 分别为两个下混声道的解码 MDCT 频谱，mdctSpectrum_L 和 mdctSpectrum_R 分别为 M/S 上混后得到的左右声道的解码 MDCT 频谱。

M/S 上混后，需要对左右声道的 MDCT 频谱进行逆 ILD 处理，以恢复左右声道的幅度差异，逆 ILD 处理的过程如下：

由位流中解码所得的 ILD 参数恢复左右声道的幅度比 levelRatio：

levelRatio = (1 << 4) / ild - 1 ..... (14)

其中，(1<<4)为 ild 参数的最大取值范围。

左右声道的幅度调整方式如下伪代码所示：

```
if (levelRatio > 1.0) {
  mdctSpectrum_R = levelRatio * mdctSpectrum_R
}else {
  mdctSpectrum_L = (1.0 / levelRatio) * mdctSpectrum_L
}
```

7.12 多声道比特分配和上混

7.12.1 语法

多声道边信息语法见表 36。

表36 DecodeMcSideBits()语法

语法	比特数	助记符
DecodeMcSideBits() {		
pairCnt	4	uimsbf
for(i = 0; i < pairCnt; i++) {		
channelPairIndex	注1	uimsbf
mcIld[ch1]	4	uimsbf
mcIld[ch2]	4	uimsbf
scaleFlag[ch1]	1	uimsbf
scaleFlag[ch2]	1	uimsbf
}		
for (i = 0; i < coupleChNum; i++) {		
chBitRatios[i]	4	uimsbf
}		
}		
注1：channelPairIndex的比特数由参与组对的声道数量coupleChNum确定， 计算方式：floor(log2(coupleChNum * (coupleChNum-1) / 2 - 1)) + 1		

7.12.2 语义

pairCnt　　4 比特，用于表示当前帧的声道组对数量

channelPairIndex	比特数与总声道数量有关，见上表注 1。用于表示声道对的索引,可解析得到当前声道对中的两个声道的索引值，即 ch1 和 ch2
mcIld[ch1], mcIld[ch2]	4 比特，当前声道对中每个声道的声道间幅度差参数，用于恢复解码频谱的幅度
scaleFlag[ch1], scaleFlag[ch2]	1 比特，表示当前声道对中每个声道的缩放标志参数，表示当前声道的幅度是被缩小或放大
chBitRatios	4 比特，表示每个声道的比特分配比例

7.12.3 解码过程

7.12.3.1 概述

多声道模式比特分配和声道上混模块的主要作用是根据位流中传输的多声道模式边信息，获取当前帧所有声道中的组对数量、组对索引、声道间的幅度差和下混后声道的比特分配比例等信息。根据比特分配比例信息和当前帧去除其他边信息后剩余的用于量化和区间编码部分的总比特数，可以计算得到下混后所有声道各自的比特分配结果 channelBytes。将比特分配结果、区间解码、逆量化和神经网络逆变换得到下混声道的解码 MDCT 系数。结合组对数量、组对索引等信息完成多声道上混，并依据 ILD 信息完成能量调整，从而得到各声道的解码 MDCT 系数。

多声道比特分配和声道上混模块主要包括比特分配和多声道上混两个主要步骤，描述如下。

7.12.3.2 比特分配

比特分配模块的主要作用是根据位流中解码获得的比特分配比例参数，将去除其他边信息后的剩余可用比特数分配给多声道中的各个下混声道，从而完成后续的区间解码、逆量化和神经网络逆变换步骤。

当前帧扣除其他边信息后剩余的可用字节数记为 availableBytes。多声道模式可能存在 LFE 声道，一般情况下 LFE 声道的有效频谱信息较少，不需要参与多声道模式的比特分配过程，预先分配固定的比特数即可。LFE 声道的预分配比特数量与编码码率有关。记声道对平均码率为 cpeRate，cpeRate 为总编码码率折算到一个声道对的结果。若 cpeRate<64kb/s,LFE 声道分配的字节数为 10;若 cpeRate<96kb/s，LFE 声道分配的字节数为 15；若 cpeRate>=96kb/s，则 LFE 声道分配的字节数为 20。若 LFE 声道存在，则将 LFE 声道的预分配字节数从可用字节数 availableBytes 中扣除，扣除后剩余的字节数再分配给除 LFE 声道外的其他声道。

可用字节数 availableBytes 分配给其余声道的过程分为四个步骤，如下：

第一步根据 chBitRatios 将比特分配给各个声道

每个声道的字节数可表示为：

$$channelBytes[i] = availableBytes * chBitRatios[i] / (1<<4) \quad (15)$$

其中，(1<<4)表示声道比特分配比例 chBitRatios 的最大取值范围。

第二步若步骤 1 中未将所有字节分配完毕，则将剩余的字节数按 chBitRatios[i]表示的比例再次分配给各个声道。

第三步若步骤 2 结束后仍有比特剩余，则将剩余比特分配给步骤 1 中分配字节最多的声道。

第四步若某些声道分配的字节数超过单个声道字节数的上限，则将超过的部分分配给其余声道。

7.12.3.3 上混

对声道对索引 channelPairIndex 指示的已组对的两个声道 ch1 和 ch2，进行 M/S 上混，上混方式与双声道立体声模式 M/S 上混一致。

M/S 上混后，需要对上混后声道的 MDCT 频谱进行逆 ILD 处理，以恢复声道的幅度差异，逆 ILD 处

理的过程如下：

```
if (scaleFlag[i] == 1){
  factor = mcIld[i] / (1<<4)
}else {
  factor = (1<<4) / mcIld[i]
}
mdctSpectrum[i] = factor * mdctSpectrum[i]
```

其中，factor 为第 i 个声道 ILD 参数对应的幅度调整因子，(1<<4)为 mcIld 的最大量化值范围，mdctSpectrum[i]表示第 i 个声道的 MDCT 系数矢量。

7.13 HOA 比特分配和上混

7.13.1 语法

HOA 边信息语法见表 37。

表37 DecodeHoaSideBits()语法

语法	比特数	助记符
DecodeHoaSideBits() {		
sceneType	4	uimsbf
spatialAnalysis	1	uimsbf
if(spatialAnalysis == 1) {		
numVL	4	uimsbf
for(i = 0; i < numVL; i++) {		
basisIdx[i]	12	uimsbf
}		
}		
for(groupIdx = 0; groupIdx < nTotalChanGroups; groupIdx++) {		
pairIdx[groupIdx]	4	uimsbf
if(pairIdx[groupIdx] > 0) {		
for(i = 0; i < pairIdx[groupIdx]; i++) {		
chIdx[groupIdx][i]	注1	uimsbf
dmxMode[groupIdx][i]	1	uimsbf
if(dmxMode[groupIdx][i]== 1) {		
for(sfb = 0; sfb < N_SFB_HOA_LBR - 1; sfb++){		
sfbMask[groupIdx][i][sfb]	1	uimsbf
}		
}		
for(i = 0; i < groupChans[groupIdx]; i++) {		
flagNrg[i]	1	uimsbf
groupILD[i]	4	uimsbf
}		

表 37 DecodeHoaSideBits()语法（续）

语法	比特数	助记符
}		
groupBitsRatio[groupIdx]	**4**	**uimsbf**
for(i = 0; i < groupChans[groupIdx]; i++) {		
bitsRatio[groupIdx][i]	**4**	**uimsbf**
}		
}		
}		
注1：chIdx比特数为($\log_{10}$ (groupChans×(groupChans-1)/2-1)/ $\log_{10}$2)+1的值向下取整		

7.13.2 语义

sceneType　4比特，表示声场类型

spatialAnalysis　1比特，表示空间分析类型

numVL　4比特，表示虚拟扬声器信号数量

basisIdx　12比特，表示虚拟扬声器索引

pairIdx　4比特，表示通道配对数量

chIdx　表示通道配对索引，chIdx比特数为($\log_{10}$ (groupChans×(groupChans-1)/2-1)/ $\log_{10}$2)+1的值向下取整

flagNrg　1比特，表示能量调节方向参数

groupILD　4比特，表示组内ILD参数

groupBitsRatio　4比特，表示组间比特分配比例参数

bitsRatio　4比特，表示组内比特分配比例参数

dmxMode　1比特，表示下混模式，当dmxMode为0时表示全频带M/S下混，当dmxMode为1时表示子带M/S下混

sfbMask　1比特，表示当前子带是否下混，当sfbMask为0时表示当前子带不进行下混，当sfbMask为1时表示当前子带进行下混

nTotalChanGroups　预设值，表示传输通道分组数量，见表38-表40

N_SFB_HOA_LBR　预设值，表示子带数量，定义为22

groupChans　预设值，表示每组内包含通道数量，见表38-表40

FOA nTotalChanGroups 和 groupChans 值定义见表 38。

表38　FOA nTotalChanGroups 和 groupChans 值定义

比特率 (kb/s)	nTotalChanGroups 值	groupChans 值
96	1	4
128	1	4
192	1	4
256	1	4

2 阶 HOA nTotalChanGroups 和 groupChans 值定义见表 39。

表39　2 阶 HOA nTotalChanGroups 和 groupChans 值定义

比特率 (kb/s)	nTotalChanGroups 值	groupChans 值
192	1	9
256	1	9
320	1	9
384	1	9
480	1	9
512	1	9
640	1	9

3 阶 HOA nTotalChanGroups 和 groupChans 值定义见表 40。

表40　3 阶 HOA nTotalChanGroups 和 groupChans 值定义

比特率 (kb/s)	nTotalChanGroups 值	groupChans 值
256	2	2, 6
320	2	2, 7
384	2	2, 9
512	2	2, 10
608	2	2,12
896	1	16

7.13.3　解码过程

7.13.3.1　概述

HOA 比特分配和通道上混在核心解码器中进行。在 HOA 解码时，核心解码器从位流解析核心解码器边信息、虚拟扬声器信号和残差信号，然后对虚拟扬声器信号和残差信号比特分配 HoaSplitBytesGroup()。接着进行虚拟扬声器信号和残差信号进行 HOA 上混处理 Avs3HoaInverseDMX()。最后对上混信号进行解码后处理，包括对虚拟扬声器信号和残差信号的频带扩展，时域噪声整形解码，频域噪声整形解码和 MDCT 反变换等，得到时域传输通道。由于虚拟扬声器信号和残差信号与多声道信号不同,因此根据虚拟扬声器信号和残差信号特征的频带扩展配置可以显著提高中低速率下重建 HOA 信号的质量，在保证核心带解码质量的同时，更好的重建高频信息。下面对虚拟扬声器信号和残差信号比特分配 HoaSplitBytesGroup(),和虚拟扬声器信号和残差信号解码处理 Avs3HoaInverseDMX()进行详细说明。

7.13.3.2　比特分配

核心解码器解码得到的传输通道由虚拟扬声器信号和残差信号组成，并划分成了nTotalChanGroups 组。在解码过程中，从位流中解析以下两个参数：groupBitsRatio 和 bitsRatio，其中，groupBitsRatio 占用 4 比特，表示组间比特分配比例参数，组间比特分配比例参数包括：虚拟扬声器信号组的比特分配占比和残差信号组的比特分配占比。bitsRatio 占用 4 比特，表示组内比特分配比例参数，组内比特分配比例参数包括：每个虚拟扬声器信号组在所有虚拟扬声器信号组内的比特分配占比，每个残差信号组在所有残差信号组内的比特分配占比。

比特分配的主要作用是根据码流中解码获得的比特分配比例参数，将去除其他边信息后的剩余可用比特数分配给各个传输通道，其中，其它边信息的编码也会占用比特数。

首先，需要计算当前帧扣除其他边信息后剩余的可用比特数，记为 availableBits。计算availableBits 的通用算法表示为如下方式：

availableBits = bitsPerFrame - bitsUsed

其中，bitsPerFrame 为每帧初始比特数，bitsUsed 为比特分配前已占用的比特数。

HOA 比特分配 HoaSplitBytesGroup()计算过程如下。

首先，根据总的可用比特数 availableBits 和 groupBitsRatio 计算每组通道的比特数 groupBytes，如下式：

$$\text{groupBytes} = \text{availableBits} \cdot \text{groupBitsRatio} / \sum_{0}^{\text{nTotalChanG}} \text{groupBitsRatio} \quad (16)$$

其中，$\text{groupBitsRatio} / \sum_{0}^{\text{nTotalChanGroup}}$ groupBitsRatio，可以表示虚拟扬声器信号组在所有传输通道信号中的比特分配占比，或者，可以表示残差信号组在所有传输通道信号中的比特分配占比。

然后，根据 bitsRatio 计算每个通道的比特数 bytesChannels，如下式：

$$\text{bytesChannels} = \text{groupBytes} \cdot \text{bitsRatio} / \sum_{0}^{\text{groupChans[groupIdx]}-1} \text{bitsRatio} \quad (17)$$

groupBytes 表示虚拟扬声器信号组的总分配比特数。$\text{bitsRatio} / \sum_{0}^{\text{groupChans[groupIdx]}-1}$ bitsRatio表示每个虚拟扬声器信号组在所有虚拟扬声器信号组内的比特分配占比，bytesChannels 表示每个虚拟扬声器信号组的比特数。

又如，groupBytes 表示残差信号组的总分配比特数。$\text{bitsRatio} / \sum_{0}^{\text{groupChans[groupIdx]}-1}$ bitsRatio表示每个残差信号组在所有残差信号组内的比特分配占比，bytesChannels 表示每个残差信号组的比特数。

通过上述过程，可以计算出每组通道的比特数。

7.13.3.3 上混

通道上混 Avs3HoaInverseDMX()首先根据 chIdx 解码通道组对信息，chIdx 为通道两两组对构成的上三角矩阵元素的序号（不包括主对角线元素），因此可以通过 chIdx 确定组对通道。例如当通道个数 ch 为 4 时，该 Matrix 矩阵如下式：

$$\text{Matrix} = \begin{bmatrix} (ch0ch1) & (ch0ch2) & (ch0ch3) & (ch0ch4) \\ & (ch1ch2) & (ch1ch3) & (ch1ch4) \\ & & (ch2ch3) & (ch2ch4) \\ & & & (ch3ch4) \end{bmatrix} \quad (18)$$

$$\mathrm{chIdx} = \begin{bmatrix} 0\,1\,2\,3 \\ 4\,5\,6 \\ 7\,8 \\ 9 \end{bmatrix} \quad (19)$$

当 chIdx = 0 时，解析得到 ch0 和 ch1 组对。

当 dmxMode 为全频带 M/S 下混时，令每个子带的 sfbMask 值为 1；当 dmxMode 为子带 M/S 下混时，子带 sfbMask 值由码流中解析得到。当子带 sfbMask 值为 1 时，进行上混处理，得到上混通道 Y1 和 Y2。上混处理如下式：

$$\mathrm{Y1} = \frac{\sqrt{2}}{2}(\mathrm{ch0} + \mathrm{ch1}) \quad (20)$$

$$\mathrm{Y2} = \frac{\sqrt{2}}{2}(\mathrm{ch0} - \mathrm{ch1}) \quad (21)$$

最后对上混通道进行逆 ILD 处理。

重复上述过程，得到经逆 ILD 处理的上混虚拟扬声器信号和逆 ILD 处理的上混残差信号。再通过解码后处理 Avs3PostSynthesis()得到虚拟扬声器信号和残差信号。虚拟扬声器信号和残差信号作为 HOA 空间解码器的输入。

7.14 HOA 空间解码

7.14.1 语法

HOA 空间解码语法见表 41。

表41 HoaPostSynthesisFilter()语法

语法	比特数	助记符
HoaPostSynthesisFilter() {		
if(spatialAnalysis == 1) {		
HoaCoreDec()		
}		
}		

7.14.2 语义

spatialAnalysis　　表示空间分析类型，见 7.13.2 中 spatialAnalysis 语义

HoaCoreDec()　　声场成分合成和 HOA 合成解码

7.14.3 解码过程

7.14.3.1 概述

HOA 空间解码器的原理是将编码端生成的虚拟扬声器信号和残差信号以及对应的虚拟扬声器属性信息通过解码后处理 Avs3PostSynthesis()进行重建，得到解码 HOA 信号。

7.14.3.2 虚拟扬声器重建声场原理

根据 HOA 描述声场原理可以利用虚拟扬声器对声场重建。假设声场 p，在球坐标下声场 p 可以表示为：

$$p(r,\theta,\varphi,k) = \sum_{m=0}^{\infty} j^m j_m^{kr}(kr) \sum_{0\le n\le m,\sigma=\pm 1} B_{m,n}^{\sigma} Y_{m,n}^{\sigma}(\theta,\varphi) \quad (22)$$

其中，r 表示球半径，θ 表示方位角，Φ 表示俯仰角，k 表示波速，m 表示 HOA 阶数序号，$j^m j_m^{kr}(kr)$ 表示球贝塞尔函数，亦称作径向基函数，j 是虚数单位，$Y_{m,n}^{\sigma}(\theta,\varphi)$是 θ 和 φ 对应的球谐函数，$B_{m,n}^{\sigma}$ 为 HOA 系数。可以通过 m 阶 HOA 系数作为对声场的近似描述，将球谐函数按照 HOA 信号的一个采样点对应的系数进行叠加，就能实现该采样点对应的空间声场的重构。因此 HOA 空间解码器利用虚拟扬声器 HOA 系数对声场重构。

7.14.3.3 虚拟扬声器

HOA 空间编解码中采用的是非均匀虚拟扬声器分布。虚拟扬声器分布表包括 K 个虚拟扬声器的位置信息，该位置信息包括俯仰角索引和水平角索引，K 为大于 1 的正整数。设定 K 个虚拟扬声器分布于预设球面上。该预设球面包括 X 个纬线圈，Y 个经线圈，虚拟扬声器位于所述 X 个纬线圈和所述 Y 个经线圈的交汇点上。图 18 为预设球面的一个示例性的示意图，预设球面包含 L（L＞1）个纬度区域，第 m 个纬度区域包含 T_m 个纬线圈，K 个虚拟扬声器中分布于第 m_i 个纬线圈上的相邻虚拟扬声器之间的水平角度差为 α_m，$1 \leqslant m \leqslant L$，$T_m$ 为正整数，$1 \leqslant m_i \leqslant Tm$。当 $T_m > 1$ 时，第 m 个纬度区域中的任意两个相邻纬线圈的俯仰角度差为 α_m。

K 个虚拟扬声器分布于各个纬度区域中的一个或多个纬线圈上，位于同一个纬线圈上的相邻虚拟扬声器之间的距离通过水平角度差表示，且同一个纬线圈上的所有相邻虚拟扬声器之间的水平角度差相等。$\alpha_c < \alpha_m$，α_c 为 K 个虚拟扬声器中分布于第 m_c 个纬线圈上的相邻虚拟扬声器之间的水平角度差，第 m_c 个纬线圈是 L 个纬度区域中包含赤道纬线圈的纬度区域中的任意一个纬线圈。L 个纬度区域中，包含了赤道纬线圈的纬度区域内的相邻虚拟扬声器之间的水平角度差是最小的，L 个纬度区域中，包含了赤道纬线圈的纬度区域内的虚拟扬声器是分布最密集的。图 19 为 1314 个虚拟扬声器的示例性的分布图。

通过索引的方式表示虚拟扬声器分布表中的 K 个虚拟扬声器的位置，索引可以包括俯仰角索引和水平角索引。在任意一个纬线圈上，将分布其上的其中一个虚拟扬声器的水平角度设置为 0，然后根据预设的水平角度与水平角索引之间的转换公式转换获得对应的水平角索引；由于纬线圈上的任意相邻虚拟扬声器之间的水平角差值是相等的，因此可以获得该纬线圈上的其他虚拟扬声器的水平角度，从而根据上述转换公式获得所述其他虚拟扬声器各自的水平角索引。

俯仰角度和俯仰角索引的转换公式：

上述 K 个虚拟扬声器中的第 k 个虚拟扬声器，其俯仰角度 Φ_k 和俯仰角索引 Φ_k’ 满足如下公式：

$$\varphi_k{}' = \mathrm{round}\left(\frac{\varphi_k}{2\pi r_k \times N}\right) \quad (23)$$

其中，r_k 表示第 k 个虚拟扬声器所在经线圈的半径，round()表示取整。

水平角度和水平角索引的转换公式：

上述 K 个虚拟扬声器中的第 k 个虚拟扬声器，其水平角度 θ_k 和水平角索引 θ_k’ 满足如下公式：

$$\theta_k{}' = \mathrm{round}\left(\frac{\theta_k}{2\pi r_k \times M}\right) \quad (24)$$

其中，r_k 表示第 k 个虚拟扬声器所在纬线圈的半径，round()表示取整。

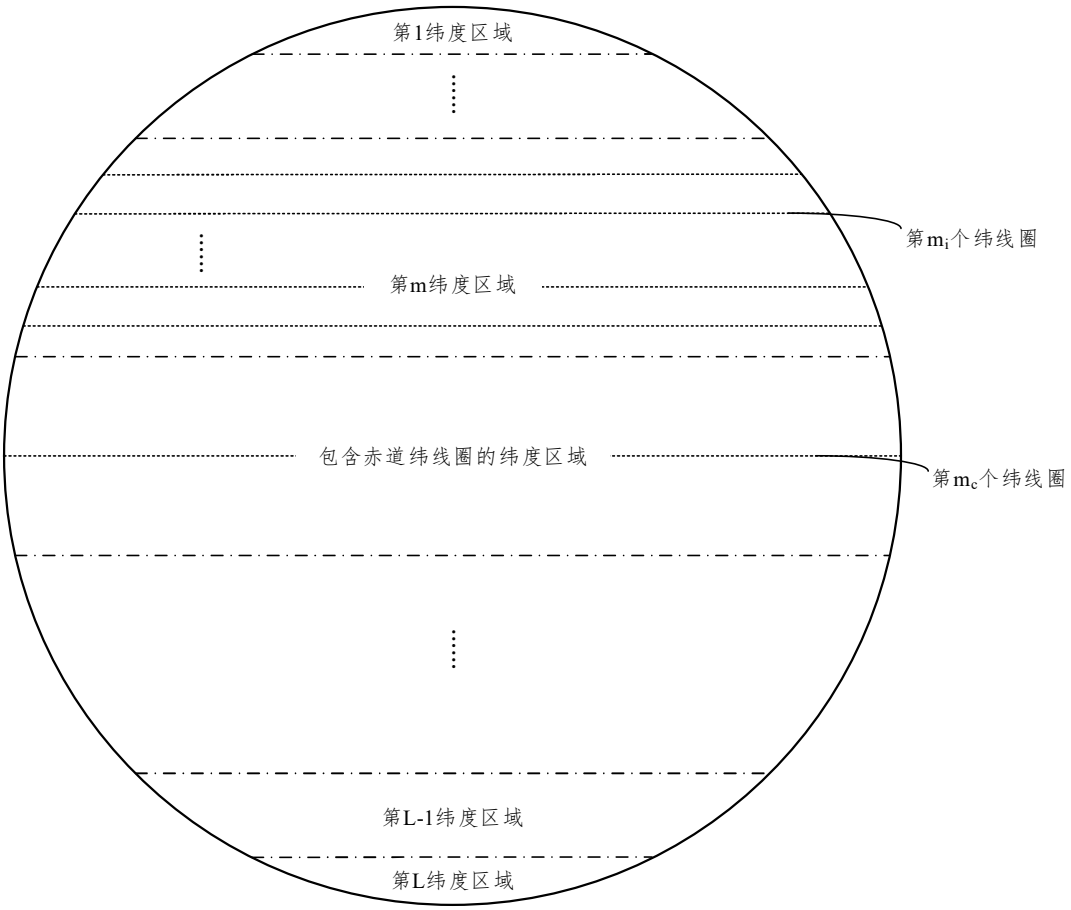

图18　虚拟扬声器区域划分示意图

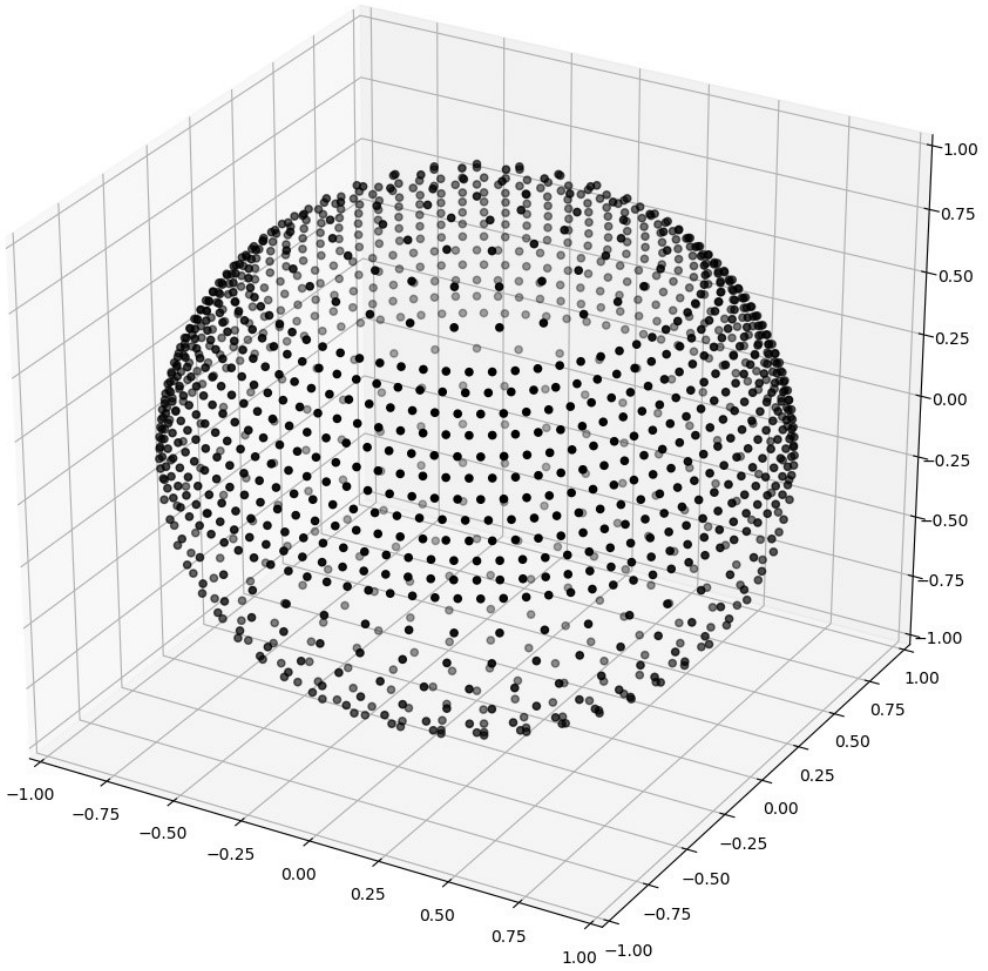

图19　虚拟扬声器非均匀分布示意图

7.14.3.4　虚拟扬声器 HOA 系数计算

首先对虚拟扬声器属性信息进行解析，虚拟扬声器属性信息包括虚拟扬声器索引。HoaCoreDec()从位流中解析虚拟扬声器索引 basisIdx，通过虚拟扬声器预设值获取虚拟扬声器角度索引 anglePair，anglePair 包含两个索引值，分别为方位角索引 anglePair[0]和俯仰角索引 anglePair[1]。虚拟扬声器预设值见附录表 B.24。

然后 HoaCoreDec()器根据 anglePair 计算虚拟扬声器 HOA 系数。计算 HOA 系数时需要得到方位角索引和俯仰角索引对应的三角函数值，采用以下公式：

可以按照以下规则获取虚拟扬声器俯仰角索引对应的正弦函数值和余弦函数值：

$$\sin(\varphi) = \begin{cases} \text{sin\_table}(\varphi') & \varphi' < \lceil N/4 \rceil \\ \text{sin\_table}(N/2 - \varphi') & \lceil N/4 \rceil \le \varphi' < \lceil N/2 \rceil \\ -\text{sin\_table}(\varphi' - N/2) & \lceil N/2 \rceil \le \varphi' < \lceil 3N/4 \rceil \\ -\text{sin\_table}(N - \varphi') & \lceil 3N/4 \rceil \le \varphi' < N \end{cases} \quad \cdots\cdots\cdots\cdots\cdots\cdots (25)$$

$$\cos(\varphi) = \begin{cases} \sin\_table(N/4 - \varphi') & \varphi' < \lceil N/4 \rceil \\ -\sin\_table(\varphi' - N/4) & \lceil N/4 \rceil \le \varphi' < \lceil N/2 \rceil \\ -\sin\_table(3N/4 - \varphi') & \lceil N/2 \rceil \le \varphi' < \lceil 3N/4 \rceil \\ \sin\_table(\varphi' - 3N/4) & \lceil 3N/4 \rceil \le \varphi' < N \end{cases} \quad \cdots\cdots\cdots\cdots\cdots\cdots (26)$$

可以按照以下规则获取虚拟扬声器水平角索引对应的正弦函数值和余弦函数值：

$$\sin(\theta) = \begin{cases} \sin\_table(\theta') & \theta' < \lceil N/4 \rceil \\ \sin\_table(N/2 - \theta') & \lceil N/4 \rceil \le \theta' < \lceil N/2 \rceil \\ -\sin\_table(\theta' - N/2) & \lceil N/2 \rceil \le \theta' < \lceil 3N/4 \rceil \\ -\sin\_table(N - \theta') & \lceil 3N/4 \rceil \le \theta' < N \end{cases} \quad \cdots\cdots\cdots\cdots\cdots\cdots (27)$$

$$\cos(\theta) = \begin{cases} \sin\_table(N/4 - \theta') & \theta' < \lceil N/4 \rceil \\ -\sin\_table(\theta' - N/4) & \lceil N/4 \rceil \le \theta' < \lceil N/2 \rceil \\ -\sin\_table(3N/4 - \theta') & \lceil N/2 \rceil \le \theta' < \lceil 3N/4 \rceil \\ \sin\_table(\theta' - 3N/4) & \lceil 3N/4 \rceil \le \theta' < N \end{cases} \quad \cdots\cdots\cdots\cdots\cdots\cdots (28)$$

其中，N 为 257，正弦函数表 sin_table_N 见附录 B 表 B.25。

表 42 给出根据虚拟扬声器方位角和虚拟扬声器俯仰角计算虚拟扬声器的 HOA 系数的方法。HOA 系数表达式见表 42。

表42　1-3 阶 HOA 系数表达式

n	l	HOA 系数表达式
0	0	$\frac{1}{2\sqrt{\pi}}$
1	0	$\frac{1}{2}\sqrt{\frac{3}{\pi}}\cos\theta$
	+1	$\frac{1}{2}\sqrt{\frac{3}{\pi}}\sin\theta\cos\varphi$
	−1	$\frac{1}{2}\sqrt{\frac{3}{\pi}}\sin\theta\sin\varphi$
2	0	$\frac{1}{4}\sqrt{\frac{5}{\pi}}(3cos^2\theta - 1)$
	+1	$\frac{1}{2}\sqrt{\frac{15}{\pi}}\sin\theta\cos\theta\cos\varphi$
	−1	$\frac{1}{2}\sqrt{\frac{15}{\pi}}\sin\theta\cos\theta\sin\varphi$

表 42　1-3 阶 HOA 系数表达式（续）

n	l	HOA 系数表达式
	+2	$\frac{1}{4}\sqrt{\frac{15}{\pi}}sin^2\theta\cos 2\varphi$
	-2	$\frac{1}{4}\sqrt{\frac{15}{\pi}}sin^2\theta\sin 2\varphi$
3	0	$\frac{1}{4}\sqrt{\frac{7}{\pi}}(5cos^3\theta-3\cos\theta)$
	+1	$\frac{1}{4}\sqrt{\frac{21}{2\pi}}(5cos^2\theta-1)\sin\theta\cos\varphi$
	-1	$\frac{1}{4}\sqrt{\frac{21}{2\pi}}(5cos^2\theta-1)\sin\theta\sin\varphi$
	+2	$\frac{1}{4}\sqrt{\frac{105}{\pi}}\cos\theta\,sin^2\theta\cos 2\varphi$
	-2	$\frac{1}{4}\sqrt{\frac{105}{\pi}}\cos\theta\,sin^2\theta\sin 2\varphi$
	+3	$\frac{1}{4}\sqrt{\frac{35}{2\pi}}sin^3\theta\cos 3\varphi$
	-3	$\frac{1}{4}\sqrt{\frac{35}{2\pi}}sin^3\theta\sin 3\varphi$

表 42 中 θ 表示虚拟扬声器在预设球面上的位置信息的方位角信息，Φ 表示虚拟扬声器在预设球面上的位置信息的俯仰角信息，n 表示 HOA 阶数取值，l 表示每一阶中的方向参数。

7.14.3.5　声场成分合成和 HOA 信号合成

HOA 空间解码将解码后处理得到的虚拟扬声器信号和残差信号以及上述计算得到的虚拟扬声器 HOA 系数进行重建，得到解码 HOA 信号。

HoaCoreDec()将虚拟扬声器信号和虚拟扬声器 HOA 系数合成声场成分 recoverySignal。recoverySignal 通过虚拟扬声器 HOA 系数和虚拟扬声器信号相乘得到。

$$\text{recoverySignal} = \mathrm{A}\cdot\mathrm{w} \quad \text{(29)}$$

其中，A 表示虚拟扬声器 HOA 系数矩阵。矩阵 A 的大小为(M×C)，C 表示代表虚拟扬声器的数量，M 表示 N 阶的 HOA 系数个数，w 表示虚拟扬声器信号向量，w 维度为虚拟扬声器信号的数量。

最后将 recoverySignal 和残差信号相加得到解码 HOA 信号。

8 元数据编码工具

8.1 概述

三维声音频元数据兼容 ITU-R BS.2076 音频定义模型标准，并增加扩展元数据。以下对元数据编码语法、语义和解码过程详细介绍。

8.2 元数据编码原始位流数据

8.2.1 语法

元数据编码原始位流数据语法见表 43。

表43 Avs3MetadataDec()语法

语法	比特数	助记符
Avs3MetadataDec() {		
smFlag	1	uimsbf
if(smFlag == 1) {		
Avs3SmDec()		
}		
dmFlag	1	uimsbf
if(dmFlag == 1) {		
Avs3DmDec()		
}		
}		

8.2.2 语义

smFlag　　1 比特，表示当前帧是否存在静态元数据码流，0 表示不存在，1 表示存在

dmFlag　　1 比特，表示当前帧是否存在动态元数据码流，0 表示不存在，1 表示存在

Avs3SmDec()　　静态元数据的解码

Avs3DmDec()　　动态元数据的解码

8.3 Avs3SmDec()解码

8.3.1 语法

静态元数据解码语法见表44。

表44 Avs3SmDec()语法

语法	比特数	助记符
Avs3SmDec() {		

b_vrExt	1	uimsbf
basicLevel	3	uimsbf
if((basicLevel == 0) || (basicLevel == 1)) {		
BasicL1()		
}		
if(b_vrExt) {		
vrExtLevel	3	uimsbf
if(vrExtLevel == 0) {		
VrExtL1()		
}		
}		
}		

8.3.1 语义

vrExtLevel　　3比特，表示基本静态元数据的级别，‘0’：对应9.25章元数据定义“Level设定”的Level0，BasicL1()函数对应此级别，‘1’：对应9.25章元数据定义“Level设定”的Level1，BasicL1()函数对应此级别，‘2-7’：保留

vrExtLevel　　3比特，表示扩展静态元数据的级别，‘0’：当前扩展元数据使用的级别，VrExtL1()函数对应此级别，‘1-7’：保留

BasicL1()　　包括L0和L1级别的基本静态元数据解码

VrExtL1()　　L1级别的扩展静态元数据解码

8.4 Avs3DmDec()解码

8.4.1 语法

动态元数据解码语法见表45。

表45 Avs3DmDec()语法

语法	比特数	助记符
Avs3DmDec () {		
dmLevel	3	uimsbf
for(i = 0; i < numDmChans; i++) {		
muteFlag	1	uimsbf

表 45. Avs3DmDec()语法（续）

语法	比特数	助记符

transChRef	**5**	**uimsbf**
if(dmLevel == 0) {		
Avs3DmL1Dec()		
}		
if(dmLevel == 1) {		
Avs3DmL1Dec()		
Avs3DmL2Dec()		
}		
}		
}		

8.4.2 语义

dmLevel　　3 比特，表示动态元数据的级别
‘0’：Avs3DmL1Dec()对应此级别
‘1’：Avs3DmL1Dec()和 Avs3DmL2Dec()对应此级别

muteFlag　　1 比特，表示是否存在动态元数据，0 为存在，1 表示不存在

transChRef　　5 比特，表示动态元数据生效的物理通道索引

numDmChans　　对象声道的数量，复用附录 A.2 中 object_channel_number 语义

Avs3DmL1Dec()　　L1 级别的动态元数据解码

Avs3DmL2Dec()　　L2 级别的动态元数据解码

8.5 BasicL1()解码

8.5.1 语法

基本静态元数据解码语法见表46。

表46 BasicL1()语法

语法	比特数	助记符
BasicL1() {		
audioProgramme()		
numOfContents	2	uimsbf
numOfContents = numOfContents + 1		
for (i = 0; i < numOfContents; i++) {		
audioContent()		
}		
numOfObjects	3	uimsbf
numOfObjects = numOfObjects + 1		
for (i = 0; i < numOfObjects; i++) {		
audioObject()		
}		

表 46. BasicL1()语法（续）

语法	比特数	助记符

numOfPacks	3	uimsbf
numOfPacks = numOfPacks + 1		
for (i = 0; i < numOfPacks; i++) {		
AudioPackFormat ()		
}		
numOfChannels	5	uimsbf
numOfChannels = numOfChannels + 1		
for (i = 0; i < numOfChannels; i++) {		
AudioChannelFormat ()		
}		
}		

8.5.2 语义

AudioProgramme() AudioProgramme()解码，将所有的 AudioContent()结合在一起以形成完整的“混音”

AudioContent() AudioContent()解码，给出了对音频内容的描述，它有如语言（如果存在对话的话）和响度等这样的参数

AudioObject() AudioObject()解码，对象用来关联音频内容与格式

AudioPackFormat() AudioPackFormat() 解码，将一个或多个属于彼此的AudioChannelFormat()组织在一起（如一对立体声）

AudioChannelFormat() AudioChannelFormat()解码，是对单个音频波形的一种描述

numOfContents 2 比特，表示表示 BasicL1()里包含的 audioContent()个数

numOfObjects 3 比特，表示 BasicL1()里包含的 audioObject()个数

numOfPacks 3 比特，表示 BasicL1()里包含的 audioPackFormat()个数

numOfChannels 5 比特，表示 BasicL1()里包含的 audioChannelFormat()个数

8.6 AudioProgramme()解码

8.6.1 语法

基本静态元数据节目层解码语法见表47。

表47 AudioProgramme()语法

语法	比特数	助记符
AudioProgramme() {		
b_audioProgrammeLanguage	1	uimsbf
b_maxDuckingDepth	1	uimsbf
b_loudnessMetadata	1	uimsbf
b_audioProgrammeReferenceScreen	1	uimsbf
if (b_audioProgrammeLanguage) {		
audioProgrammeLanguage	4	uimsbf

表 47. AudioProgramme()语法（续）

语法	比特数	助记符
}		
if (b_maxDuckingDepth) {		
maxDuckingDepth	**5**	**uimsbf**
}		
if (b_loudnessMetadata) {		
LoudnessMetadata()		
}		
if (b_audioProgrammeReferenceScreen) {		
AudioProgrammeReferenceScreen()		
}		
numContents	**2**	**uimsbf**
numContents = numContents + 1		
for (i = 0; i < numContents; i++) {		
refContentIdx	**2**	**uimsbf**
}		
}		

8.6.2 语义

b_audioProgrammeLanguage　1 比特，表示 AudioProgramme()里是否存在 audioProgrammeLanguage 字段，0 表示不存在，1 表示存在

b_maxDuckingDepth　1 比特，表示 AudioProgramme()里是否存在 maxDuckingDepth，0 表示不存在，1 表示存在

b_loudnessMetadata　1 比特，表示 AudioProgramme()里是否存在 LoudnessMetadata()，0 表示不存在，1 表示存在

b_audioProgrammeReferenceScreen　1 比特，表示 AudioProgramme()里是否存在 AudioProgrammeReferenceScreen()，0 表示不存在，1 表示存在

audioProgrammeLanguage　4 比特，表示 AudioProgramme()里对话的语言
‘0’：汉语
‘1’：英语
‘2’：法语
‘3’：西班牙语
‘4’：葡萄牙语
‘5’：德语
‘6-15’：保留

maxDuckingDepth　5 比特，指明节目中对每个 AudioObject()允许的最大的自动回避量

numContents　2 比特，表示 AudioProgramme()里引用的 refContentIdx 的个数

refContentIdx　2 比特,表示 AudioProgramme()包含的 content 的索引

LoudnessMetadata()	响度解码接口，参考 ITU-R BS.1770 响度算法对音频进行修正
AudioProgrammeReferenceScreen()	屏幕尺寸解码接口，规范有关AudioProgramme()的参考/制作/监控屏幕尺寸

8.7 AudioContent()解码

8.7.1 语法

基本静态元数据内容层解码语法见表48。

表48 AudioContent()语法

语法	比特数	助记符
AudioContent () {		
contentIdx	2	uimsbf
b_audioContentLanguage	1	uimsbf
b_loudnessMetadata	1	uimsbf
b_dialogue	1	uimsbf
b_numComplementaryObjectGroup	1	uimsbf
if (b_audioContentLanguage) {		
audioContentLanguage	4	uimsbf
}		
if (b_loudnessMetadata) {		
loudnessMetadata()		
}		
if (b_dialogue) {		
Dialogue()		
}		
if(b_numComplementaryObjectGroup) {		
numComplementaryObjectGroup	2	uimsbf
numComplementaryObjectGroup=numComplementaryObjectGroup + 1		
for (i=0; i < numComplementaryObjectGroup; i++) {		
numComplementaryObject	3	uimsbf
numComplementaryObject= numComplementaryObject + 1		
for (j=0; j < numComplementaryObject; j++) {		
ComplementaryObjectIdx	3	uimsbf
}		
}		
}		
numObjects	3	uimsbf
numObjects = numObjects + 1		
for (i = 0; i < numObjects; i++) {		

表 48 AudioContent()语法（续）

语法	比特数	助记符
refObjectIdx	3	uimsbf
}		
}		

8.7.2 语义

contentIdx　2比特，表示AudioContent()的唯一索引值

b_audioContentLanguage　1比特，表示AudioContent()里是否存在audioContentLanguage字段，0表示不存在，1表示存在

b_loudnessMetadata　1比特，表示AudioContent()里是否存在LoudnessMetadata()，0表示不存在，1表示存在

b_dialogue　1比特，表示AudioContent()里是否存在dialogue字段，0表示不存在，1表示存在

b_numComplementaryObjectGroup　1比特，表示AudioContent()里是否存在numComplementaryObjectGroup字段，0表示不存在，1表示存在

audioContentLanguage　4比特，表示AudioContent()里对话的语言，‘0’：汉语，‘1’：英语，‘2’：法语，‘3’：西班牙语，‘4’：葡萄牙语，‘5’：德语，‘6-15’：保留

numComplementaryObjectGroup　2比特，表示AudioContent()里互斥对象组的个数

numComplementaryObject　2比特，表示ComplementaryObjectGroup里包含的互斥对象索引ComplementaryObjectIdx的个数

ComplementaryObjectIdx　3比特，表示指定ComplementaryObjectGroup里互斥对象的索引值

numObjects　3比特，表示AudioContent()里引用的refObjectIdx的个数

refObjectIdx　3比特，表示AudioContent()包含的object的索引

Dialogue()　对话解码接口，表示对内容类型的详细描述

LoudnessMetadata()　响度解码接口，参考ITU-R BS.1770响度算法对音频进行修正

8.8 AudioObject()解码

8.8.1 语法

基本静态元数据对象层解码语法见表49。

表49 AudioObject()语法

语法	比特数	助记符

AudioObject() {		
objectIdx	3	uimsbf
b_audioObjectLanguage	1	uimsbf
b_dialogue	1	uimsbf
b_audioObjectImportance	1	uimsbf
b_disableDucking	1	uimsbf
b_interact	1	uimsbf
b_gain	1	uimsbf
b_headLocked	1	uimsbf
b_mute	1	uimsbf
if (b_audioObjectLanguage) {		
audioObjectLanguage	4	uimsbf
}		
if (b_dialogue) {		
Dialogue()		
}		
if (b_audioObjectImportance) {		
audioObjectImportance	4	uimsbf
}		
if (b_interact) {		
for (i = 0; i < 24; i++) {		
ObjectName[i]	8	uimsbf
}		
audioObjectInteraction()		
}		
if (b_gain) {		
objectGainUnit	1	uimsbf
objectGainQFlag	1	uimsbf
objectGain	6	uimsbf
}		
numPacks	3	uimsbf
numPacks = numPacks + 1		
for (i = 0; i < numPacks; i++) {		
refPackFormatIdx	3	uimsbf
}		
}		

8.8.2 语义

objectIdx　　3比特，表示AudioObject()的唯一索引值

b_AudioObjectLanguage	1比特，表示AudioObject()里是否存在AudioObjectLanguage字段，0表示不存在，1表示存在
b_dialogue	1比特,表示AudioObject()里是否存在dialogue字段,0表示不存在，1表示存在
b_audioObjectImportance	1比特，表示AudioObject()里是否存在audioObjectImportance字段，0表示不存在，1表示存在
b_disableDucking	1比特，表示AudioObject()里是否存在disableDucking字段，0表示不存在，1表示存在
b_interact	1比特，表示AudioObject()里是否存在互动字段，0表示不存在，1表示存在
b_gain	1比特，表示AudioObject()里是否存在gain字段，0表示不存在，1表示存在
b_headLocked	1比特，表示AudioObject()里是否存在headLocked字段，0表示不存在，1表示存在
b_mute	1比特，表示AudioObject()里是否存在mute字段，0表示不存在，1表示存在
audioObjectLanguage	4比特，表示AudioObject()里对话的语言，‘0’：汉语，‘1’：英语，‘2’：法语，‘3’：西班牙语，‘4’：葡萄牙语，‘5’：德语，‘6-15’：保留
audioObjectImportance	4比特，表示AudioObject()的重要性，10表示重要性最高，0表示重要性最低
ObjectName	8比特，表示AudioObject()的名字
objectGainUnit	1比特，表示objectGain 的单位。0：线性 1：dB
objectGainQFlag	1比特，表示gain量化区间，当gainUnit=0, gainQFlag=0时量化区间为[0, 1]，当gainUnit=0, gainQFlag=1时量化区间为(1, 16)，当 gainUnit=1, gainQFlag=0 时量化区间为[-80, 0]，当gainUnit=1, gainQFlag=1时量化区间为(0, 24]
objectGain	6比特，表示应用于AudioObject()参考的所有音频样本的增益值
numPacks	3比特，表示AudioObject()()里引用refPackFormatIdx 的个数
refPackFormatIdx	3比特，表示AudioObject()包含的audioPackFormat的索引
Dialogue()	对话解码接口，表示对内容类型的详细描述

8.9 Dialogue()解码

8.9.1 语法

基本静态元数据对话字段解码语法见表50。

表50 Dialogue()语法

语法	比特数	助记符
Dialogue() {		
dialogueAttribute	2	uimsbf
dialogueType	3	uimsbf
}		

8.9.2 语义

dialogueAttribute　2 比特，表示对话内容类型，取值引用 ITU-R BS.2076-2 表 33

dialogueType　3 比特，表示 dialogueAttribute 包含的内容种类，取值引用 ITU-R BS.2076-2 表 34

8.10 AudioPackFormat()解码

8.10.1 语法

基本静态元数据封装层解码语法见表51。

表51 AudioPackFormat()语法

语法	比特数	助记符
AudioPackFormat () {		
packFormatIdx	3	uimsbf
b_audioPackFormatImportance	1	uimsbf
b_transChannelReuse	1	uimsbf
if (b_audioPackFormatImportance) {		
audioPackFormatImportance	4	uimsbf
}		
typeLabel	3	uimsbf
absoluteDistance	5	uimsbf
if (typeLabel == 1 || typeLabel == 2) {		
packFormatID	6	uimsbf
if (typeLabel == 2) {		
numMatrixOutputChannel	5	uimsbf
numMatrixOutputChannel = numMatrixOutputChannel + 1		
for (i = 0; i< numMatrixOutputChannel; i++) {		
DirectSpeakersPosition()		
}		

表 51 AudioPackFormat()语法（续）

语法	比特数	助记符
}		
}		
else if (typeLabel == 4) {		
normalization	**2**	**uimsbf**
nfcRefDist	**4**	**uimsbf**
screenRef	**1**	**uimsbf**
hoaOrder	**3**	**uimsbf**
}		
if (b_transChannelReuse == 0) {		
packFormatStartIdx	**5**	**uimsbf**
}		
numChannels	**5**	**uimsbf**
numChannels = numChannels + 1		
for (i = 0; i < numChannels; i++) {		
refChannelIdx	**5**	**uimsbf**
channelTypeLabel [refChannelIdx] = typeLabel		
if (typeLabel == 1 || typeLabel == 2) {		
channelPackFormatID[refChannelIdx] = packFormatID		
}		
if (typeLabel == 2) {		
channelNumMatrixOutputChannel[refChannelIdx] = numMatrixOutputChannel		
}		
if(b_transChannelReuse) {		
transChRef	**5**	**uimsbf**
}		
}		
}		

8.10.2 语义

packFormatIdx　　3比特，表示AudioPackFormat()的唯一索引值

b_audioPackFormatImportance　　1比特，表示AudioPackFormat()里是否存在audioPackFormatImportance字段，0表示不存在，1表示存在

b_transChannelReuse　　1比特，表示AudioPackFormat()里是否存在channelReuse字段，0表示不存在，1表示存在

audioPackFormatImportance　　4比特，表示audioObject的重要性。10表示重要性最高，0表示重要性最低

typeLabel	4比特，表示有关声道类型的描述，值的定义如表55所示
absoluteDistance	5比特，表示绝对距离
packFormatID	6比特，0-31复用ITU-R BS.2094-0建议书表2中AudioPackFormatID的低5比特，32-63由用户自定义
numMatrixOutputChannel	5比特，表示基于矩阵的矩阵输出channel个数
normalization	2比特，表示基于场景的归一化方式，‘0’：SN3D，‘1-3’：保留
nfcRefDist	4比特，表示在基于场景的音频制作过程中使用的参考距离（以米为单位）。该参考距离可用于近场补偿的音频渲染
screenRef	1比特，表示基于场景的程序是否与屏幕有关
hoaOrder	3比特，表示基于场景的最大阶数
packFormatStartIdx	5比特，表示AudioPackFormat()里首个channel的索引
numChannels	5比特，表示AudioPackFormat()里引用的refChannelIdx个数
refChannelIdx	5比特，表示AudioPackFormat()包含的AudioChannelFormat的索引
channelTypeLabel	本地变量，映射32个TypeLabel，AudioPackFormat()函数解析得到，在AudioChannelFormat函数使用
channelPackFormatID	本地变量，映射32个PackFormatID，AudioPackFormat()函数解析得到，在AudioChannelFormat函数使用
channelNumMatrixOutputChannel	本地变量，映射32个channelNumMatrixOutputChannel，AudioPackFormat()函数解析得到,在AudioChannelFormat函数使用

typeLabel 的定义见表 52。

表52 typeLabel 的定义

声道类型	typeLabel	描述
DirectSpeakers	1	对基于声道的音频，每个声道直接输入一个扬声器
Matrix	2	对所有其他 typeLabel，各信号共同组成矩阵，如中间、左/右
Objects	3	对基于对象的音频，声道代表音频对象（或对象的部分），故包括位置信息
HOA	4	对基于场景的音频，使用高保真环绕立体声系统和 HOA
Binaural	5	对双声道音频，在耳机中予以回放
User Custom	其他值	对用户自定义类型

8.11 AudioChannelFormat()解码

8.11.1 语法

基本静态元数据通道层解码语法见表53。

表53 AudioChannelFormat()语法

语法	比特数	助记符
AudioChannelFormat () {		
channelFormatIdx	5	uimsbf
b_channelGain	1	uimsbf
if(b_channelGain) {		
channelGainUnit	1	uimsbf
channelGain_QFlag	1	uimsbf
channelGain	6	uimsbf
}		
if(channelTypeLabel [channelFormatIdx]== 1) {		
if(channelPackFormatID[channelFormatIdx]== 0x3f) {		
DirectSpeakersPosition()		
}		
} else if(channelTypeLabel [channelFormatIdx]== 2) {		
for (i = 0; i< channelNumMatrixOutputChannel[channelFormatIdx]; i++) {		
matrixCoef[i]	8	uimsbf
}		
}		
}		

8.11.2 语义

channelFormatIdx　5比特，表示AudioChannelFormat()的唯一索引值

b_channelGain　1比特，表示AudioChannelFormat()里是否存在channelGain字段，0表示不存在，1表示存在

channelGainUnit　1比特，表示channelGain的单位。0：线性 1：dB

channelGain_QFlag　1比特，表示channelGain量化区间，当gainUnit=0, channelGainQFlag=0时量化区间为[0, 1]，当gainUnit=0, channelGainQFlag =1时量化区间为(1, 16]，当gainUnit=1, channelGainQFlag =0时量化区间为[-80, 0]，当gainUnit=1, channelGainQFlag =1时量化区间为(0, 24]

channelGain　6比特，表示应用于AudioChannelFormat()参考的所有音频样本的增益值

matrixCoef　8比特，表示基于矩阵类型的矩阵系数

transChRef　5比特，表示AudioChannelFormat()生效的物理通道索引

8.12 AudioObjectInteraction()解码

8.12.1 语法

基本静态元数据对象互动字段解码语法见表54。

表54 AudioObjectInteraction()语法

语法	比特数	助记符
AudioObjectInteraction() {		
onOffInteract	1	uimsbf
gainInteract	1	uimsbf
positionInteract	1	uimsbf
if(gainInteract) {		
gainInteractionUnit	1	uimsbf
gainInteractionRange_min	7	uimsbf
gainInteractionRange_max	7	uimsbf
}		
if(positionInteract) {		
cartesianInteraction	1	uimsbf
if (cartesianInteraction == 1) {		
positionInteractionRange_Xmin	8	uimsbf
positionInteractionRange_Xmax	8	uimsbf
positionInteractionRange_Ymin	6	uimsbf
positionInteractionRange_Ymax	6	uimsbf
positionInteractionRange_Zmin	4	uimsbf
positionInteractionRange_Zmax	4	uimsbf
} else {		
positionInteractionRange_azimuthMin	8	uimsbf
positionInteractionRange_azimuthMax	8	uimsbf
positionInteractionRange_elevationMin	6	uimsbf
positionInteractionRange_elevationMax	6	uimsbf
positionInteractionRange_distanceMin	4	uimsbf
positionInteractionRange_distanceMax	4	uimsbf
}		
}		
}		

8.12.2 语义

onOffInteract　1比特，若用户能开或关对象，则设为1，否则设为0

gainInteract　1比特，若用户能改变对象的增益，则设为1，否则设为0

positionInteract　1比特，若用户能改变对象的位置，则设为1，否则设为0

gainInteractionUnit　1比特，表示gainInteractionRange 的单位。0：线性 1：dB

gainInteractionRange_min　7比特，表示可能的用户增益互动的最小线性增益因子或对数增益偏差

gainInteractionRange_max　7比特，表示可能的用户增益互动的最大线性增益因子或对数增益偏差

cartesianInteraction	1比特，表示是否是笛卡尔坐标系
positionInteractionRange_Xmin	8比特，表示可能的用户位置交互的最小X轴偏移值
positionInteractionRange_Xmax	8比特，表示可能的用户位置交互的最大X轴偏移值
positionInteractionRange_Ymin	6比特，表示可能的用户位置交互的最小Y轴偏移值
positionInteractionRange_Ymax	6比特，表示可能的用户位置交互的最大Y轴偏移值
positionInteractionRange_Zmin	4比特，表示可能的用户位置交互的最小Z轴偏移值
positionInteractionRange_Zmax	4比特，表示可能的用户位置交互的最大Z轴偏移值
positionInteractionRange_azimuthMin	8比特，表示可能的用户位置交互的最小方位角偏移值
positionInteractionRange_azimuthMax	8比特，表示可能的用户位置交互的最大方位角偏移值
positionInteractionRange_elevationMin	6比特，表示可能的用户位置交互的最小高度偏移值
positionInteractionRange_elevationMax	6比特，表示可能的用户位置交互的最大高度偏移值
positionInteractionRange_distanceMin	4比特，表示可能的用户位置交互的最小归一化距离
positionInteractionRange_distanceMax	4比特，表示可能的用户位置交互的最大归一化距离

8.13 DirectSpeakersPosition()解码

8.13.1 语法

基本静态元数据扬声器位置解码语法见表55。

表55 DirectSpeakersPosition()语法

语法	比特数	助记符
DirectSpeakersPosition() {		
azimuth	8	uimsbf
elevation	6	uimsbf
distance	4	uimsbf
DirectSpeakerScreenEdgeLock	2	uimsbf
}		

8.13.2 语义

azimuth	8比特，表示扬声器准确的方位角位置
elevation	6比特，表示扬声器准确的高度位置

distance	4比特，表示扬声器自起点的、准确的归一化距离
DirectSpeakerscreenEdgeLock	2比特，表示在屏幕边缘定义一个扬声器位置。包括四个值：左、右、上、下，‘0’：左，‘1’：右，‘2’：上，‘3’：下

8.14 LoudnessMetadata()解码

8.14.1 语法

基本静态元数据响度字段解码语法见表56。

表56 LoudnessMetadata()语法

语法	比特数	助记符
LoudnessMetadata() {		
b_integratedLoudness	1	uimsbf
b_loudnessRange	1	uimsbf
b_maxTruePeak	1	uimsbf
b_maxMomentary	1	uimsbf
b_maxShortTerm	1	uimsbf
b_dialogueLoudness	1	uimsbf
if (b_integratedLoudness) {		
integratedLoudness	5	uimsbf
}		
if (b_loudnessRange) {		
loudnessRange	5	uimsbf
}		
if (b_maxTruePeak) {		
maxTruePeak	5	uimsbf
}		
if (b_maxMomentary) {		
maxMomentary	5	uimsbf
}		
if (b_maxShortTerm) {		
maxShortTerm	5	uimsbf
}		
if (b_dialogueLoudness) {		
dialogueLoudness	5	uimsbf
}		
}		

8.14.2 语义

b_integratedLoudness	1 比特，表示 loudness 里是否存在 integratedLoudness 字段，0 表示不存在，1 表示存在

b_loudnessRange	1 比特,表示 loudness 里是否存在 loudnessRange 字段，0 表示不存在，1 表示存在
b_maxTruePeak	1 比特，表示 loudness 里是否存在 maxTruePeak 字段，0 表示不存在，1 表示存在
b_maxMomentary	1 比特，表示 loudness 里是否存在 maxMomentary 字段，0 表示不存在，1 表示存在
b_maxShortTerm	1 比特，表示 loudness 里是否存在 maxShortTerm 字段，0 表示不存在，1 表示存在
b_dialogueLoudness	1 比特,表示 loudness 里是否存在 dialogueLoudness 字段，0 表示不存在，1 表示存在
integratedLoudness	5 比特，表示聚合响度值
loudnessRange	5 比特，表示响度范围
maxTruePeak	5 比特，表示最大真正峰值
maxMomentary	5 比特，表示最大瞬时响度
maxShortTerm	5 比特，表示最大短期响度
dialogueLoudness	5 比特，表示平均对话的响度

8.15 AudioProgrammeReferenceScreen()解码

8.15.1 语法

基本静态元数据节目参考屏幕字段解码语法见表57。

表57 AudioProgrammeReferenceScreen()语法

语法	比特数	助记符
AudioProgrammeReferenceScreen() {		
cartesianReferenceScreen	1	uimsbf
aspectRatio	3	uimsbf
if (cartesianReferenceScreen == 0) {		
screenCentrePosition_azimuth	8	uimsbf
screenCentrePosition_elevation	6	uimsbf
screenCentrePosition_distance	4	uimsbf
screenWidth_polar	7	uimsbf
} else {		
screenCentrePosition_X	8	uimsbf
screenCentrePosition_Y	6	uimsbf
screenCentrePosition_Z	4	uimsbf
screenWidth_cartesian	7	uimsbf
}		
}		

8.15.2 语义

cartesianReferenceScreen	1 比特，表示是否是笛卡尔坐标系
aspectRatio	3 比特，表示屏幕的宽高比的映射表

‘0’：16:9
‘1’：21:9
‘2-7’：保留

screenCentrePosition_azimuth 8 比特，表示屏幕中心的方位角
screenCentrePosition_elevation 6 比特，表示屏幕中心的高度
screenCentrePosition_distance 4 比特，表示至屏幕中心的归一化距离
screenWidth_polar 7 比特，表示极坐标形式的屏幕宽度
screenCentrePosition_X 8 比特，表示屏幕中心的 X 坐标
screenCentrePosition_Y 6 比特，表示屏幕中心的 Y 坐标
screenCentrePosition_Z 4 比特，表示屏幕中心的 Z 坐标
screenWidth_cartesian 7 比特，表示笛卡尔坐标系形式的屏幕宽度

8.16 VrExtL1()解码

8.16.1 语法

扩展静态元数据编码位流数据语法见表58。

表58 VrExtL1()语法

语法	比特数	助记符
VrExtL1() {		
b_acousticEnv	1	uimsbf
b_renderInfo	1	uimsbf
ambisonicOrder	3	uimsbf
if(b_acousticEnv) {		
acousticEnv()		
}		
if(b_renderInfo) {		
renderInfo()		
}		
}		

8.16.2 语义

b_acousticEnv 1 比特，表示 vrExtL1()里是否存在 acousticEnv 字段，0 表示不存在，1 表示存在
b_renderInfo 1 比特，表示 vrExtL1()里是否存在 renderInfo 字段，0 表示不存在，1 表示存在
ambisonicOrder 3 比特，表示球谐编码阶数，渲染器使用
AcousticEnv() 声学环境元数据解码接口
RenderInfo() 后期效果处理元数据解码接口

8.17 AcousticEnv()解码

8.17.1 语法

扩展静态元数据声学环境元数据解码语法见表59。

表59 AcousticEnv()语法

语法	比特数	助记符
AcousticEnv() {		
b_earlyReflectionGain	1	uimsbf
b_lateReverbGain	1	uimsbf
reverbType	2	uimsbf
if (b_earlyReflectionGain == 1) {		
earlyReflectionGain	7	uimsbf
}		
if (b_lateReverbGain == 1) {		
lateReverbGain	7	uimsbf
}		
lowFreqProFlag	1	uimsbf
if (reverbType == 2) {		
convolutionReverbType	5	uimsbf
}		
numSurface	3	uimsbf
numSurface = numSurface + 1		
for (i = 0; i < numSurface; i++) {		
Surface()		
}		
}		

8.17.2 语义

b_earlyReflectionGain 1 比特，表示 AcousticEnv()里是否存在 earlyReflectionGain 字段，0 表示不存在，1 表示存在

b_lateReverbGain 1 比特，表示 AcousticEnv()里是否存在 lateReverbGain 字段，0 表示不存在，1 表示存在

reverbType 2 比特，表示声学环境模型类型，0 代表“Physical（物理混响）”，1 代表“Artificial（人工混响）”，2 代表“Sample（采样混响）”，3 代表 “扩展类型”

earlyReflectionGain 7 比特，表示早期反射增益

lateReverbGain 7 比特，表示晚期反射增益

lowFreqProFlag 1 比特，表示低频分离处理。0 表示低频不做混响处理，保持清晰度

convolutionReverbType 5 比特，表示采样混响类型，{0,1,2…N}，例如 0 表示音乐厅采样混响，1 表示录音棚采样混响

numSurface 3 比特，表示 acousticEnv()里包含的 surface()个数，取值为{0,1,2,3,4,5}

Surface() 同种材质墙面元数据解码接口

8.18 Surface()解码

8.18.1 语法

扩展静态元数据同种材质墙面元数据解码语法见表60。

表60 Surface()语法

语法	比特数	助记符
Surface() {		
material	5	uimsbf
if(material == 0x1f) {		
for (i = 0; i < 8; i++) {		
absorption[i]	7	uimsbf
scattering[i]	7	uimsbf
}		
}		
numVertices	5	uimsbf
numVertices = numVertices + 1		
for (i = 0; i < numVerticesLimit; i++) {		
Vertex()		
}		
}		

8.18.2 语义

material 5比特，表示声学环境中的材质种类，vertex的子元素，{0,1,…,31}，支持31种材质，eg：brick、water，不同的材质有不同的散射率和吸收率。索引与每种材质的参考国标计划20214282-T-469《信息技术 虚拟现实内容表达 第3部分：音频》附录，31代表自定义材质

absorption 7比特，表示某一频带的吸收率，需要8个

scattering 7比特，表示散射率，需要8个

numVertices 4比特，表示Surface() 里包含的Vertex()个数

Vertex() 统一几何材质表面组成的三角形顶点坐标

numVerticesLimit 当numSurface为0时，当numVertices的值在[7,31]时，numVerticesLimit=numVertices+1；当numVertices的值小于7时，numVerticesLimit的值是8

当numSurface为1时，当numVertices的值在[3,17]时，numVerticesLimit=numVertices+1；当numVertices的值小于3时，numVerticesLimit的值是4；当numVertices的值大于17时，numVerticesLimit的值是18

当numSurface为2时，当numVertices的值在[2,11]时，numVerticesLimit=numVertices+1；当numVertices的值小于2时，numVerticesLimit的值是3；当numVertices的值大于11时，numVerticesLimit的值是12

当numSurface为3时，当numVertices的值在[1,8]时，numVerticesLimit=numVertices+1；当numVertices的值小于1时，

numVerticesLimit 的值是 2；当 numVertices 的值大于 8 时，numVerticesLimit 的值是 9
当 numSurface 为 4 时，当 numVertices 的值在[1,6]时，numVerticesLimit=numVertices+1；当 numVertices 的值小于 1 时，numVerticesLimit 的值是 2；当 numVertices 的值大于 6 时，numVerticesLimit 的值是 7
当 numSurface 为 5 时，当 numVertices 的值在[1,5]时，numVerticesLimit=numVertices+1；当 numVertices 的值小于 1 时，numVerticesLimit 的值是 2；当 numVertices 的值大于 5 时，numVerticesLimit 的值是 6

8.19 Vertex()解码

8.19.1 语法

扩展静态元数据统一几何材质表面组成的三角形顶点字段解码语法见表61。

表61 Vertex()语法

语法	比特数	助记符
Vertex() {		
x	7	uimsbf
y	7	uimsbf
z	7	uimsbf
}		

8.20 RenderInfo()解码

8.20.1 语法

扩展静态元数据后期效果处理解码语法见表62。

表62 RenderInfo()语法

语法	比特数	助记符
RenderInfo() {		
targetDevice	1	uimsbf
hrtfType	4	uimsbf
for (i = 0; i < 16; i++) {		
headphoneType[i]	7	uimsbf
}		
AudioEffect()		

8.20.2 语义

targetDevice　1 比特，表示制作意图，回放设备的种类。0：耳机　1：扬声器

hrtfType　4 比特，表示符合 SOFA（Spatially Oriented Format for Acoustics）标准的头相关传输函数数据，{0,1,…,5}索引分别对应[THK，MIT，SADIE，CIPIC，HUTUBS，自定义]

headphoneType[16]　7 比特，共 16 个，表示监听耳机类型，“ABCD…”，表示监听耳机

型号的字符串。

AudioEffect() EQ（Equalizer）、DRC（Dynamic Range Control）等后期处理元数据解码接口

8.21 AudioEffect()解码

8.21.1 语法

扩展静态元数据后期效果处理EQ和DRC字段解码语法见表63。

表63 AudioEffect()语法

语法	比特数	助记符
AudioEffect() {		
b_EQ_exist	1	uimsbf
b_DRC_exist	1	uimsbf
b_Gain_exist	1	uimsbf
if (b_EQ_exist || b_DRC_exist || b_Gain_exist) {		
effectChain	3	uimsbf
}		
if (b_EQ_exist) {		
numEqband	4	uimsbf
numEqband = numEqband + 1		
for (i= 0; i < numEqband; i++) {		
eqEffect ()		
}		
}		
if (b_DRC_exist) {		
attackTime	4	uimsbf
releaseTime	4	uimsbf
threshold	7	uimsbf
preGain	7	uimsbf
postGain	7	uimsbf
ratio	7	uimsbf
}		
if (b_Gain_exist) {		
effectGain	7	uimsbf
}		

8.21.2 语义

b_EQ_exist 1比特，表示AudioEffect()里是否存在EQ字段，0表示不存在，1表示存在

b_DRC_exist 1比特，表示AudioEffect()里是否存在DRC字段，0表示不存在，1表示存在

b_Gain_exist	1比特，表示AudioEffect()里是否存在Gain字段，0表示不存在，1表示存在
effectChain	3比特，表示EQ、DRC、Gain执行顺序，‘0’： Gain—> EQ—> DRC，‘1’： Gain—> DRC—> EQ，‘2’： EQ—>DRC—>Gain，‘3’：EQ—> Gain—> DRC，‘4’： DRC—> EQ—>Gain，‘5’： DRC—> Gain—> EQ
numEqband	4比特，表示AudioEffect()里包含的eqEffect个数，‘0-11’： 表示AudioEffect()里包含的eqEffect个数，‘12-15’：保留
attackTime	4比特，表示触发时间
releaseTime	4比特，表示释放时间
threshold	7比特，表示触发门限
preGain	7比特，表示前置增益
postGain	7比特，表示后置增益
ratio	7比特，表示压缩率
effectGain	7比特，表示预增益
EqEffect()	EQ属性效果参数解码接口

8.22 EqEffect()解码

8.22.1 语法

扩展静态元数据后期效果处理EQ属性效果参数字段解码语法见表64。

表64 eqEffect()语法

语法	比特数	助记符
EqEffect() {		
eqType	3	uimsbf
eqFc	7	uimsbf
eqQQFlag	1	uimsbf
eqQ	6	uimsbf
eqGain	7	uimsbf
}		

8.22.2 语义

eqType	3 比特，表示 EQ 的类型
eqFc	7 比特，表示滤波器截止频率
eqQQFlag	1 比特，表示 eqQ 量化区间，当 eqQQFlag=0 时量化区间为[0.1, 1]，当 eqQQFlag=1 时量化区间为(1, 12]
eqQ	6 比特，表示品质因子

eqGain　　7 比特，表示 EQ 的增益

8.23　Avs3DmL1Dec()解码

8.23.1　语法

动态元数据Level1解码语法见表65。

表65　Avs3DmL1Dec()语法

语法	比特数	助记符
Avs3DmL1Dec() {		
if(muteFlag == 0) {		
cartesianDm	1	uimsbf
if(cartesianDm == 0) {		
obj_position_azimuth	8	uimsbf
obj_position_elevation	6	uimsbf
obj_position_distance	4	uimsbf
obj_width_horizontal	7	uimsbf
obj_hight_vertical	5	uimsbf
obj_depth_distance	4	uimsbf
}		
else {		
obj_position_x	8	uimsbf
obj_position_y	6	uimsbf
obj_position_z	4	uimsbf
obj_width_x	7	uimsbf
obj_hight_y	5	uimsbf
obj_depth_z	4	uimsbf
}		
gain	7	uimsbf
diffuse	7	uimsbf
jumpPosition	1	uimsbf
importance	4	uimsbf
}		
}		

8.23.2　语义

cartesianDm　　1 比特，表示使用坐标系类型，0 为极坐标系，1 为笛卡尔坐标系

obj_position_azimuth　　8 比特，表示使用极坐标系时对象所在方位的水平角

obj_position_elevation　　6 比特，表示使用极坐标系时对象所在方位的俯仰角

obj_position_distance　　4 比特，表示使用极坐标系时对象所在位置的距离

obj_position_x　　8 比特，表示使用笛卡尔坐标系时对象所在方位的水平角

obj_position_y　　6 比特，表示使用笛卡尔坐标系时对象所在方位的俯仰角

obj_position_z　　4 比特，表示使用笛卡尔坐标系时对象所在位置的距离

obj_width_horizontal	7 比特，表示使用极坐标系时对象声源的宽度
obj_height_vertical	5 比特，表示使用极坐标系时对象声源的高度
obj_depth_distance	4 比特，表示使用极坐标系时对象声源的深度
obj_width_x	7 比特，表示使用笛卡尔坐标系时对象声源的宽度
obj_height_y	5 比特，表示使用笛卡尔坐标系时对象声源的高度
obj_depth_z	4 比特，表示使用笛卡尔坐标系时对象声源的深度
gain	7 比特，表示对象渲染的增益信息
diffuse	7 比特，表示对象的漫反射
jumpPosition	1 比特，表示当前帧内对象的位置是否发生跳变
importance	4 比特，表示对象的重要性

8.24 Avs3DmL2Dec()解码

8.24.1 语法

动态元数据Level2解码语法见表66。

表66 Avs3DmL2Dec()语法

语法	比特数	助记符
Avs3DmL2Dec() {		
if(muteFlag == 0) {		
hasChannelLock	1	uimsbf
if(hasChannelLock == 1) {		
channelLock	1	uimsbf
if(channelLock == 1) {		
channelLock_maxDistance	4	uimsbf
}		
}		
hasObjectDivergence	1	uimsbf
if(hasObjectDivergence == 1) {		
objectDivergence	4	uimsbf
if(objectDivergence != 0)		
objectDivergence_azimuthRange	6	uimsbf
}		
}		
hasObjectScreenRef	1	uimsbf
if(hasObjectScreenRef == 1) {		

表 66. Avs3DmL2Dec()语法（续）

语法	比特数	助记符
obj_screenRef	1	uimsbf
}		
hasScreenEdgeLock	1	uimsbf

if(hasScreenEdgeLock == 1) {		
screenEdgeLock	**2**	**uimsbf**
}		
}		
}		

8.24.2 语义

hasChannelLock 1 比特，表示是否存在 channelLock 元数据

channelLock 1 比特，表示通道锁定

channelLock_maxDistance 4 比特，表示通道锁定中的最大距离

hasObjectDivergence 1 比特，表示是否存在 objectDivergence 元数据

objectDivergence 4 比特，表示对象分裂

objectDivergence_azimuthRange 6 比特，表示对象分裂中的范围

hasObjectScreenRef 1 比特，表示是否存在屏幕相关元数据

obj_screenRef 1 比特，表示与屏幕相关

hasScreenEdgeLock 1 比特，表示是否存在 screenEdgeLock 元数据

screenEdgeLock 2 比特，表示屏幕边缘锁定

‘0’：左

‘1’：右

‘2’：上

‘3’：下

8.25 元数据系统

本文件的元数据系统由两部分组成——基础元数据部分<audioformatExtended>和扩展元数据部分<VRext>。其中，基础元数据部分引用ITU-R BS.2076-2标准，扩展元数据部分为本文件的新增定义。基于此架构，本文件的元数据系统既能前向兼容， 又能后向扩展，在满足元数据全球互联互通需求的同时， 又提供了足够的灵活性和可扩展性，能够为本文件的沉浸式音频系统提供强大的表征能力。该元数据系统架构见图20所示：

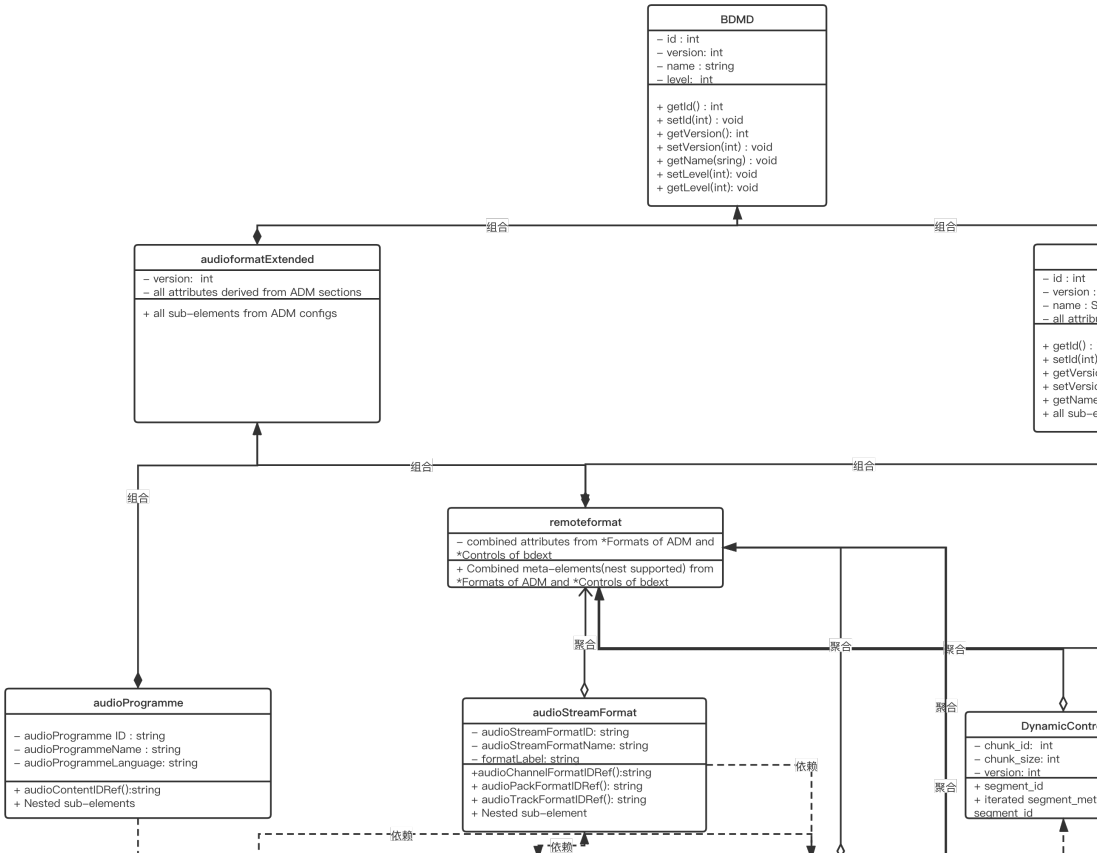

图20　元数据系统架构图

基础元数据部分复用了ITU-R BS.2076-2中针对内容和格式的属性和元素，用来传递和bed，Matrix，Object，HOA，Binaural等音频信号相关的内容和控制信息。此外，本文件对ITU-R BS.2076-2的部分属性或子元素做了一些特定的规范或限制，以便能使音频的制作，分发和渲染更加可控。以下描述仅体现本文件对特定基础元数据的规范限制，省略了对相关元数据的其它内容、规范或示例的描述，其具体内容、规范或示例的描述可参考ITU-R BS.2076-2。

audioProgramme相关规范限制见表67。

表67　audioProgramme 相关规范限制

属性/子元素	规范限制	必选/可选
audioProgrammeName	32 个字节以内，否则截断	必选
start	end-start 必须跟 audio file 时长一	可选
end	致，否则以 audio file 为准	可选

audioContent相关规范限制见表68。

表68　audioContent 相关规范限制

属性/子元素	规范限制	必选/可选
audioContentName	32 个字节以内，否则截断	必选

audioObject相关规范限制见表69。

表69 audioObject 相关规范限制

属性/子元素	规范限制	必选/可选
audioObjectName	24 个字节以内，否则截断	必选
audioObjectIDRef	嵌套其他 audioObject 的 ID，最大只支持 4 层	可选

audioStreamFormat相关规范限制见表70。

表70 audioStreamFormat 相关规范限制

属性/子元素	规范限制	必选/可选
audioStreamFormatName	32 个字节以内，否则截断	必选
formatLabel	0001 为 PCM 流	必选

audioTrackFormat相关规范限制见表71。

表71 audioTrackFormat 相关规范限制

属性/子元素	规范限制	必选/可选
audioTrackFormatName	32 个字节以内，否则截断	必选
formatLabel	0001 为 PCM 流	必选

audioPackFormat相关规范限制见表72。

表72 audioPackFormat 相关规范限制

属性/子元素	规范限制	必选/可选
audioPackFormatName	32 个字节以内，否则截断	必选

audioChannelFormat相关规范限制见表73。

表73 audioChannelFormat 相关规范限制

属性/子元素	规范限制	必选/可选
audioChannelFormatName	32 个字节以内，否则截断	必选

audioBlockFormat相关规范限制（HOA）见表74。

表74 audioBlockFormat 相关规范限制

属性/子元素	规范限制	必选/可选
order	最高支持到 7 阶	必选

扩展元数据部分提供ITU-R BS.2076-2中没有的元数据，用于增强渲染器的能力。

扩展元数据相关规范限制见表75。

表75　扩展元数据相关规范限制

<vrExt >	描述	
version	扩展元数据的版本号	0.0.1
name	扩展元数据的命名	vrExt
level	扩展元数据优先级	1
presenceInfo	扩展元数据内容相关部分	
staticControl	扩展元数据的静态内容	
dynamicControl	扩展元数据的动态内容	

presenceInfo是内容相关的扩展元数据，instance与audioChannelFormat对应，目的在于在不修改ITU-R BS.2076-2的情况下可以修改元数据内容。

presenceInfo相关规范限制见表76。

表76　presenceInfo 相关规范限制

属性	描述	规范
descriptor	对 presenceInfo 的描述	32 个字符以内
sampleRate	音频的采样率	整形，例如 44100
audioProgrammeReferID	与 ITU-R BS.2076-2 中的某个 AudioProgramme 关联	APR_1001
instanceReferID	与 ITU-R BS.2076-2 中某个 AudioChannelFormat 关联	INS_00010001
isEncoded	标识是否是编码过程	0/1，可选
avdataAligned	是否与视频帧对齐	0/1，可选
frameRate	帧率，用于视频同步	int，可选
renderMode	是否覆盖与 ITU-R BS.2076-2 相关部分，0 丢弃，1 覆盖	0/1
loudnessGain	响度线性增益	0-16，可选

instance相关规范限制见表77。

表77　instance 相关规范限制

属性	描述	规范
id	唯一标识该 instance	INS_0001_0001
type	对应的音频类型码	{0001, 0003, 0004}
typeLabel	对应的音频类型名称	{DirectSpeaker, Objects, HOA}
audioChannelFormatRefID	用来和 ITU-R BS.2076-2 元素匹配的 ID 索引	AC_00010001
unitInfo	对应 audioChannelFormat，可以有多个	

unitInfo相关规范限制见表78。

表78 unitInfo 相关规范限制

属性	描述	规范
id	唯一标识该unit	UNI_00010001
start	该unit的起始时间，Objects类型有效	00:00:00.00000
duration	该unit的持续时长，Objects类型有效	00:00:00.00000
	typeLabel==DirectSpeakers	
子元素	**描述**	**规范**
azimuth	水平角，单位度	-180-180
elevation	高度角，单位度	-90~90
distance	距离，单位米	0-50
gain	线性增益	0-16
	typeLabel==Objects，unitInfo的子元素可以包含多个unitInfo	
子元素	**描述**	**规范**
azimuth	水平角，单位度	-180-180
elevation	高度角，单位度	-90~90
distance	距离，单位米	0-50
gain	线性增益	0-16
	typeLabel==HOA	
子元素	**描述**	**规范**
order	对应通道的order	0-7
degree	对应通道的角度	-7~+7
normalization	归一化方式	{0,1…}
gain	线性增益	0-16

staticControl相关规范限制见表79。

表79 staticControl 相关规范限制

子元素	描述	规范
ambisonicOrder	球谐编码阶数	1-7
acousticEnv	声学环境相关	
rendererInfo	渲染相关后处理	

acousticEnv相关规范限制见表80。

表80　acousticEnv 相关规范限制

子元素	描述	规范
type	环境声学类型	{0, 1, 2}
typeLabel	环境声学类型标签	{Physical / Artificial / Sample}
earlyReflectionGain	早期反射增益	[0.0-1.0]
lateReverbGain	后期混响增益	[0.0-1.0]
lowFreqProFlag	低频分离处理	0/1，低频可选做或不做混响处理
convolutionReverbType	采样混响类型	{0, 1, 2…}
surface	几何空间的反射面	支持无限多个反射面组成的空间模型

surface相关规范限制见表81。

表81　surface 相关规范限制

子元素	描述	规范
material	声学环境中的材质类型，支持25种材质	{0, 1,2…24}
materialLabel	声学环境中的材质类型标签	{brick, water…}
vertex	几何模型顶点，三个点组成一个三角形，支持无限多个三角形	[x1, y1, z1]，[x2, y2, z2]…
absorption	不同频带的吸收率，需要8个，可选	[0.0-1.0]
scattering	不同频带的吸收率，需要8个，可选	[0.0-1.0]

rendererInfo相关规范限制见表82。

表82　rendererInfo 相关规范限制

子元素	描述	规范
targetDevice	回放设备的类型	{0, 1, 2…}
hrtfType	符合SOFA标准的hrtf类型	{0,1,…,N} 例如0表示THK，1表示MIT
headphoneType	耳机类型	{0, 1, 2…}
audioEffect	后处理音效	

audioEffect相关规范限制见表83。

表83 audioEffect 相关规范限制

子元素	描述	规范
EQ	EQ后处理	
DRC	DRC后处理	
Gain	增益后处理	

EQ相关规范限制见表84。

表84 EQ 相关规范限制

属性	描述	规范
Item	index	表示音效链路的顺序	{0, 1, 2…}
	type	滤波器类型	{0, 1, 2, 3, 4, 5, 6, 7}
	typeLabel	滤波器类型标签	{Lowpass, Highpass. Bandpass, BandReject, AllPass, LowShelving, HighShelving, Peaking}
	frequency	截止频率	20-16000
	gain	增益	[-40,-40]dB
	Q	品质因子	0.1-12

DRC相关规范限制见表85。

表85 DRC 相关规范限制

属性	描述	规范
index	表示音效链路的顺序	{0, 1, 2…}
attackTime	开始时间	[0-100]ms
releaseTime	释放时间	[50-300]ms
threshold	门限值	[-80 to 10]dB
preGain	前置增益	[-10 to 10]dB
postGain	后置增益	[0 to 20]dB
ratio	压缩率	1-100

gain相关规范限制见表86。

表86 gain 相关规范限制

属性	描述	规范

index	表示音效链路的顺序	{0, 1, 2…}
gain	增益	-20~20dB

为了保持设备兼容性，内容的互操作性和编解码、渲染系统的复杂度可控，本文件对元数据的数目和组合采用分层(level)控制的机制，定义5级： level 0 - level 4。Level 0 是为了保持跟存量音频内容互操作，主要支持“typeDefinitions=DirectSpeakers”且“SpeakerLabel=M+000/M+022/M-022”。level 1-3对若干音频内容元素的最大数目做了限制，level 4 支持无限数目的音频内容元素。

Level分级相关规范限制见表87。

表87 Level 分级表

<audioformatExtended> Element	描述	Level				
		0	1	2	3	4
audioProgramme	音频文件或音频流中音频节目数	1	1	4	8	Unlimited
audioContent	文件或者流中节目的音频内容数目	2	4	8	16	Unlimited
audioObject	文件或者流中音频源(相当于vrExt中的unit)	2	8	64	128	Unlimited
concurrentAudioObject	一个时间片同时存在的音频源数目	2	8	16	32	Unlimited
audioPackFormat	文件(不包含音频流)中音频格式组的数目	1	8	32	64	Unlimited
audioChannelFormat	文件(不包含音频流)中音频格式的数目	2	32	64	128	Unlimited
audioStreamFormat	文件(不包含音频流)中轨道组格式的数目	2	32	64	128	Unlimited
audioTrackFormat	文件(不包含音频流)归音频轨道格式的数目	2	32	64	128	Unlimited
audioTrackUID	音频文件或者音频流中唯一标识符数目	2	32	64	128	Unlimited
surface	同种材料的几何表面数目	1	6	16	64	Unlimited
vertex	组成每个surface的三角形顶点数目	8	8	16	32	Unlimited

8.26 元数据定义

元数据的取值范围在元数据编码和解码过程中使用，元数据编码和解码过程通过元数据的取值范围设置其量化步长和量化偏置从而确定量化精度。元数据量化步长和量化偏置详见 9.27 章。

元数据定义见表88。

表88 元数据定义表

序号	元数据名称	取值范围
1	maxDuckingDepth	[-62,0]
2	objectGain	线性[0,16] /dB[-80,24]
3	channelGain	线性[0,16] /dB[-80,24]

表 88 元数据定义表（续）

序号	元数据名称	取值范围

4	absoluteDistance	[0,16]
5	nfcRefDist	[0,16]
6	channelGain	线性[0,16] /dB[-80,24]
7	MatrixCoef	[0.1,10]
8	gainInteractionRange_min （线性）	[0,1]
9	gainInteractionRange_max（线性）	[1,16]
10	positionInteractionRange_Xmin	[-1,1]
11	positionInteractionRange_Xmax	[-1,1]
12	positionInteractionRange_Ymin	[-1,1]
13	positionInteractionRange_Ymax	[-1,1]
14	positionInteractionRange_Zmin	[-1,1]
15	positionInteractionRange_Zmax	[-1,1]
16	positionInteractionRange_azimuthMin	[-180,0]
17	positionInteractionRange_azimuthMax	[0,180]
18	positionInteractionRange_elevationMin	[-90,0]
19	positionInteractionRange_elevationMax	[0,90]
20	positionInteractionRange_distanceMin	[0,1]
21	positionInteractionRange_distanceMax	[0,1]
22	azimuth	[-180,180]
23	elevation	[-90,90]
24	distance	[0,1]
25	integratedLoudness	[-70,0]
26	loudnessRange	[10,70]
27	maxTruePeak	[-70,0]
28	maxMomentary	[-70,0]
29	maxShortTerm	[-70,0]
30	dialogueLoudness	[-70,0]
31	screenCentrePosition_azimuth	[-180,180]
32	creenCentrePosition_elevation	[0,90]
33	screenCentrePosition_distance	[0,1]
34	screenWidth_polar	[0,180]
35	screenCentrePosition_X	[-1,1]
36	screenCentrePosition_Y	[-1,1]
37	screenCentrePosition_Z	[-1,1]
38	screenWidth_cartesian	[0,1]
39	absorption	[0.0-1.0]
40	scattering	[0.0-1.0]
41	x	[-100,100]
42	y	[-100,100]

表 88 元数据定义表（续）

序号	元数据名称	取值范围

43	z	[-100,100]
44	eqQ	[0.1,12]
45	eqFc	[20,16000]
46	obj_position_azimuth	[-180,180]
47	obj_position_elevation	[-90,90]
48	obj_position_distance	[0,1]
49	obj_position_x	[-1,1]
50	obj_position_y	[-1,1]
51	obj_position_z	[-1,1]
52	gain	线性[0,6]
53	obj_width_horizontal	[0,360]
54	obj_height_vertical	[0,360]
55	obj_depth_distance	[0,1]
56	obj_width_x	[0,1]
57	obj_width_y	[0,1]
58	obj_width_z	[0,1]
59	diffuse	[0,1]
60	channelLock_maxDistance	[0,2]
61	objectDivergence	[0,1]
62	objectDivergence_azimuthRange	[0,180]
63	earlyReflectionGain	[0,1]
64	lateReverbGain	[0,1]
65	attackTime	[1,100]
66	releaseTime	[50,300]
67	threshold	[-80,10]
68	preGain	[-10,10]
69	postGain	[0,20]
70	effectGain	[-20,20]
71	ratio	[1,100]

8.27 解码过程

解码器从位流中解析得到元数据的量化索引，元数据反量化值由量化索引、量化步长和量化偏置计算得到，元数据反量化采用以下公式：

元数据反量化值 = 量化索引*量化步长 + 量化偏置

元数据量化参数见表89。

表89 元数据量化参数

AudioProgramme()

元数据名称	量化步长	量化偏置
maxDuckingDepth	2.0	0
AudioPackFormat ()		
元数据名称	量化步长	量化偏置
nfcRefDist	0.066666	0
LoudnessMetadata()		
元数据名称	量化步长	量化偏置
integratedLoudness	2.2580645	0
loudnessRange	1.935483	10.0
maxTruePeak	2.2580645	0
maxMomentary	2.2580645	0
maxShortTerm	2.2580645	0
dialogueLoudness	2.2580645	0
AudioProgrammeReferenceScreen()		
元数据名称	量化步长	量化偏置
screenCentrePosition_azimuth	1.411764	-180.0
screenCentrePosition_elevation	1.428571	0
screenCentrePosition_distance	0.066666	0
screenWidth_polar	1.417322	0
screenCentrePosition_X	0.007843	-1.0
screenCentrePosition_Y	0.031746	-1.0
screenCentrePosition_Z	0.133333	-1.0
screenWidth_cartesian	0.007874	0
AudioObjectInteraction()		
元数据名称	量化步长	量化偏置
gainInteractionRange_min (gainInteractionUnit 为 0)	0.007874	0
gainInteractionRange_min (gainInteractionUnit 为 1)	0.629921	0
gainInteractionRange_max (gainInteractionUnit 为 0)	0.118110	1.0
gainInteractionRange_max (gainInteractionUnit 为 1)	0.188976	0
positionInteractionRange_Xmin	0.007843	-1.0
positionInteractionRange_Xmax	0.007843	-1.0
positionInteractionRange_Ymin	0.031746	-1.0
positionInteractionRange_Ymax	0.031746	-1.0
positionInteractionRange_Zmin	0.133333	-1.0
positionInteractionRange_Zmax	0.133333	-1.0
positionInteractionRange_azimuthMin	0.705882	0

表 89 元数据量化参数（续）

positionInteractionRange_azimuthMax	0.705882	0

positionInteractionRange_elevationMin	1.428571	0
positionInteractionRange_elevationMax	1.428571	0
positionInteractionRange_distanceMin	0.066667	0
positionInteractionRange_distanceMax	0.066667	0
DirectSpeakersPosition()		
元数据名称	**量化步长**	**量化偏置**
azimuth	1.411764	0
elevation	2.85714	0
distance	0.066667	0
AudioObject()		
元数据名称	**量化步长**	**量化偏置**
objectGain (objectGainUnit 为 0,objectGainQFlag 为 0)	0.015873	0
objectGain (objectGainUnit 为 0,objectGainQFlag 为 1)	0.238095	1.0
objectGain (objectGainUnit 为 1,objectGainQFlag 为 0)	1.269841	0
objectGain (objectGainUnit 为 1,objectGainQFlag 为 1)	0.380952	0
AudioChannelFormat()		
channelGain (channelGainUnit 为 0, channelGain_QFlag 为 0)	0.015873	0
channelGain (channelGainUnit 为 0, channelGain_QFlag 为 1)	0.238095	1.0
channelGain (channelGainUnit 为 1, channelGain_QFlag 为 0)	1.269841	0
channelGain (channelGainUnit 为 1, channelGain_QFlag 为 1)	0.380952	0
MatrixCoef	0.038823	0.1
AudioPackFormat()		
$\text{absoluteDistance} = 10^{(\text{量化索引}\times\text{量化步长})} - 1.0$		
AcousticEnv()		
元数据名称	**量化步长**	**量化偏置**
earlyReflectionGain	0.007874	0
lateReverbGain	0.007874	0
Surface()		
元数据名称	量化步长	量化偏置
absorption	0.007874	0
scattering	0.007874	0
Vertex()		
元数据名称	量化步长	量化偏置
x	1.574803	-100.0
y	1.574803	-100.0
z	1.574803	-100.0

表 89 元数据量化参数（续）

AudioEffect()

元数据名称	量化步长	量化偏置
attackTime	6.6	1.0
releaseTime	16.66666	50.0
threshold	0.708661	-80.0
preGain	0.157480	-10.0
postGain	0.157480	0
ratio	0.779527	1.0
effectGain	0.314960	-20.0
eqEffect()		
元数据名称	量化步长	量化偏置
eqQ(eqQQFlag 为 0)	0.014285	0.1
eqQ(eqQQFlag 为 1)	0.174603	1.0
eqGain	0.314960	-20.0
$eqFc = 10^{((量化索引\times量化步长+20\times log10(20))/20)}$		
Avs3DmL1Dec()		
元数据名称	**量化步长**	**量化偏置**
obj_position_azimuth	1.411764	-180
obj_position_elevation	2.857142	-90
obj_position_distance	0.066666	0
obj_width_horizontal	2.834645	0
obj_hight_vertical	11.612903	0
obj_depth_distance	0.066666	0
obj_position_x	0.007843	-1.0
obj_position_y	0.031746	-1.0
obj_position_z	0.133333	-1.0
obj_width_x	0.007874	0
obj_hight_y	0.032258	0
obj_depth_z	0.066666	0
gain	0.047244	0
diffuse	0.007874	0
Avs3DmL2Dec()		
元数据名称	**量化步长**	**量化偏置**
channelLock_maxDistance	0.133333	0
objectDivergence	0.066666	0
objectDivergence_azimuthRange	2.857142	0

附 录 A
（规范性）
AASF 和 AATF 语法及语义

A.1 AASF和AATF语法

A.1.1 概述

三维声音频参考GB/T 33475.3-2018中AASF和AATF规范，给出三维声音频存储格式（AASF）和传输格式（AATF）语法及语义描述。三维声音频新增通用全码率音频编码工具定义audio_codec_id为2，三维声音频新增通用全码率音频编码工具语义复用GB/T 33475.3中AASF和AATF规范。

AASF包含音频序列的头信息及随后的原始数据块。AASF仅适用于定义了起始点而无需从音频数据流中间开始解码的系统。AASF包含所有解码和播放音频数据必需信息，是一种交换存储格式。

AATF包含同步字和解码必需的信息，是一种流传输格式。同步字使得解码器无需确定的起始点即可进行解码。

A.1.2 AASF语法

AASF包含音频序列的头信息及随后的原始数据块，其语法见表A.1。

表 A.1 aasf_sequence()语法

语法	比特数	助记符
aasf_sequence()		
{		
aasf_header()		
if (audio_codec_id < 2) {		
if (coding_profile == 0) {		
if (audio_codec_id == 1)		
ll_raw_data_stream()		
}		
if (coding_profile == 2)		
hoa_raw_data_stream()		
}		
else if (audio_codec_id == 2)		
ga_co_raw_data_stream()		
}		

AASF头描述了音频存储格式的头信息，包括AASF头数据存储格式标识、大小等。aasf_header()语法见表A.2。

表 A.2　aasf_header()语法

语法	比特数	助记符
aasf_header()		
{		
aasf_id	32	bslbf
header_size	24	bslbf
raw_stream_length	32	bslbf
audio_codec_id	4	bslbf
resolution	2	bslbf
coding_profile	3	bslbf
anc_data_index	1	bslbf
if(audio_codec_id==1)		
channel_number	{4;8}	bslbf
if(audio_codec_id==2){		
if(coding_profile ==0){		
channel_number_index	7	bslbf
}		
if(coding_profile ==1){		
soundBedType	2	uimsbf
if (soundBedType == 0){		
object_channel_number	7	uimsbf
bitrate_index_per_channel	4	uimsbf
} else if (soundBedType == 1){		
channel_number_index	7	uimsbf
bitrate_index	4	uimsbf
object_channel_number	7	uimsbf
bitrate_index_per_channel	4	uimsbf
}		
}		
if(coding_profile ==2){		
order	4	uimsbf
}		
}		
sampling_frequency_index	4	bslbf
if(audio_codec_id==1){		
if(sampling_frequency_index==0xf) {		
sampling_frequency	24	uimsbf
}		
}		
if(audio_codec_id==2 && coding_profile != 1){		
bitrate_index	4	bslbf

表 A.2　aasf_header()语法（续）

语法	比特数	助记符
}		
if(audio_codec_id==1) {		
if(coding_profile==1)		
3DVersion	4	bslbf
if(anc_data_index==1){		
anc_data_block()		
}		
}		
byte_alignment()		
}		

A.1.3　AATF语法

AATF包含同步字和解码必需的信息，其语法见表A.3。

表 A.3　aatf_sequence()语法

语法	比特数	助记符
aatf_sequence()		
{		
while (nextbits() == syncword) {		
aatf_frame()		
}		
}		

AATF帧描述了音频传输帧的位流序列，该序列由相应的解码头信息、信息头、错误校验和原始数据块组成。aatf_frame()语法见表A.4。

表 A.4　aatf_frame()语法

语法	比特数	助记符
aatf_frame()		
{		
syncword	12	bslbf
audio_codec_id	4	bslbf
anc_data_index	1	bslbf
if(audio_codec_id < 3){		
aatf_frame_header()		
byte_alignment()		
if (audio_codec_id < 2) {		
if (coding_profile == 0) {		

表 A.4 aatf_frame()语法（续）

语法	比特数	助记符
if (audio_codec_id == 1)		
ll_raw_data_block()		
}		
if (coding_profile == 1) {		
3DVersion	4	uimsbf
ob_raw_data_block()		
}		
if (coding_profile == 2)		
hoa_raw_data_block()		
}		
}		
else if (audio_codec_id == 2)		
ga_co_raw_data_block()		
}		
if (audio_codec_id == 1) {		
if (anc_data_index == 1) {		
anc_data_block()		
}		
}		
frame_error_check()		
}		

frame_error_check()位于attf帧的最后，用于查验每帧码流的完整性，当前帧的所有位根据其出现顺序进入CRC算法中。frame_error_check()语法见表A.5。

表 A.5 frame_error_check()语法

语法	比特数	助记符
frame_error_check()		
{		
crc_check	8	rpchof
}		

AATF解码头描述了解码头信息，由同步字、采样率索引等组成。aatf_frame_header()语法见表A.6。

表 A.6 aatf_frame_header()语法

语法	比特数	助记符
aatf_frame_header()		
{		
coding_profile	3	uimsbf
sampling_frequency_index	4	uimsbf
if(audio_codec_id==1) {		
if (sampling_frequency_index==0xf) {		
sampling_frequency	24	uimsbf
}		
}		
aatf_error_check()		
if(audio_codec_id==1)		
channel_number	{4; 8}	bslbf
if(audio_codec_id==2){		
if(coding_profile ==0){		
channel_number_index	7	bslbf
}		
if(coding_profile ==1){		
soundBedType	2	uimsbf
if (soundBedType == 0){		
object_channel_number	7	uimsbf
bitrate_index_per_channel	4	uimsbf
} else if (soundBedType == 1){		
channel_number_index	7	uimsbf
bitrate_index	4	uimsbf
object_channel_number	7	uimsbf
bitrate_index_per_channel	4	uimsbf
}		
}		
if(coding_profile ==2){		
order	4	uimsbf
}		
}		
resolution	2	uimsbf
if(audio_codec_id==2 && coding_profile != 1){		
bitrate_index	4	uimsbf
}		
}		

AATF 错误校验描述了AATF的CRC数据。在aatf_frame_header()中，为在传输过程中快速查验码流正确性，减少延时，定义aatf_error_check()用于查验帧头的全部位以及所有原始数据块的前半部分，

即其查验长度为 raw_frame_length/2。aatf_error_check()语法见表 A.7。在aatf_frame()中，为在传输过程中查验码流完整性，添加frame_error_check()用于查验当前帧的所有位。所有查验位根据其出现顺序进入CRC算法中。frame_error_check()语法见表 A.5。

表 A.7 aatf_error_check()语法

语法	比特数	助记符
aatf_error_check()		
{		
crc_check	8	rpchof
}		

A.2 AASF和AATF语义

ll_raw_data_stream() ll_raw_data_block()的序列

ga_co_raw_data_stream() ga_co_raw_data_block()的序列

raw_stream_length 16比特，原始音频数据流的长度，单位为字节

audio_codec_id 4比特，
- ‘1’：无损音频编码数据
- ‘2’：通用全码率音频编码数据
- ‘3’：保留
- ‘4’：保留

anc_data_index 1比特，是否有辅助数据块的标识

resolution 当audio_codec_id为0时，表明输入信号的量化比特数索引，2比特
- ‘0’：8比特/采样点
- ‘1’：16比特/采样点
- ‘2’：24比特/采样点
- ‘3’：保留

coding_profile 3比特，目前定义了两种
- ‘0’：基本框架
- ‘1’：对象元数据编码框架
- ‘2’：HOA数据编码框架
- ‘3-7’：保留

channel_number_index 当audio_codec_id为0或4时，表明声道数索引，7比特，见表A.8。

channel_number 当audio_codec_id为1时，如果声道数小于16，4比特，其中0xf表示扩展，其他表示声道数；如果声道数不小于16，8比特

order 4比特，表示HOA信号阶数，目前定义了3阶HOA信号

sampling_frequency_index 输入信号采样频率索引，4比特，当audio_codec_id为0或4时，见表A.9

sampling_frequency 当audio_codec_id为0时，表明扩展用采样频率值(Hz)，24比特的无符号整数：
- 0x000000：0 Hz
- 0x000001：1 Hz

	… 0xFFFFFE：16777214 Hz 0xFFFFFF：保留
bitstream_type	当audio_codec_id为0时，表明位流类型的标志，1比特: ‘0’，匀速位流，可通过信道匀速传输 ‘1’，可变速位流，不适于匀速信道传输
bitrate_index	当audio_codec_id为0时，表明比特率的索引，4比特，见表A.10~表A.19
ll_raw_data_block()	无损音频编码原始位流数据
ga_co_raw_data_block()	通用全码率音频编码原始位流数据
anc_data_type	8比特，标识辅助数据类型，用户自定义
anc_data_block()	辅助数据块
ob_raw_data_block()	音频对象编码原始位流数据
aasf_sequence()	符合AVS_Audio_Storage_Format格式的序列，见表A.1
aasf_header()	AASF的字头，位于aasf_sequence的开始，见表A.2
aatf_sequence()	符合AVS_Audio_Transport_Format格式的序列，见表A.3
aatf_frame()	AATF帧，见表A.4
aatf_frame_header()	AATF的解码帧头，见表A.6
raw_frame_length	16比特，avs2码流当前帧的总长度，添加码流当前帧的总长度标识，得到码流基本信息
frame_error_check()	CRC校验生成的数据。AATF帧中的所有位根据期出现顺序进入CRC校验算法中进行校验，见表A.5 CRC-16的生成多项式为： $G_{16}(x) = x^{16} + x^{12} + x^5 + 1$
aatf_error_check()	CRC校验生成的数据。校验AATF帧的前一半数据位，并根据其出现的顺序进入CRC-16算法，见表A.7
syncword	同步字，比特串‘0111 1111 1110’
soundBedType	2比特，表示声床类型 ‘0’：没有声床，只有对象音频 ‘1’：声床为单声道音频或双声道立体声音频或多声道音频中的一种
object_channel_number	7比特，表示全部对象音频的声道数量
bitrate_index_per_channel	4比特，表示所有对象音频平均每个声道比特率的索引，复用表A.12
crc_check	CRC校验

表 A.8　channel_number 配置表（audio_codec_id 为 0 或 2）

channel_number_index	声道配置	channel_number
0x0	单声道	1
0x1	双声道立体声	2
0x2	5.1	6

表 A.8　channel_number 配置表（audio_codec_id 为 0 或 2）（续）

channel_number_index	声道配置	channel_number
0x3	7.1	8
0x4	10.2	12
0x5	22.2	24
0x6	4.0/FOA	4
0x7	5.1.2	8
0x8	5.1.4	10
0x9	7.1.2	10
0xa	7.1.4	12
0xb	3 阶 HOA	16
0xc	2 阶 HOA	9
0xd-0xf	保留	

扬声器的空间位置信息详见GB/T 33475.3-2018规范性附录。

表 A.9　采样率映射表（audio_codec_id 为 0 或 2）

sampling_frequency_index	采样频率(Hz)
0x0	192000
0x1	96000
0x2	48000
0x3	44100
0x4	32000
0x5	24000
0x6	22050
0x7	16000
0x8	8000
0x9~0xf	保留

采样率映射表（audio_codec_id 为 1）详见GB/T 33475.3规范性附录。

表 A.10　单声道编码比特率索引表

bitrate_index	比特率 (kb/s)
0x0	16
0x1	32
0x2	44
0x3	56
0x4	64
0x5	72
0x6	80

表 A.10　单声道编码比特率索引表（续）

bitrate_index	比特率 (kb/s)
0x7	96
0x8	128
0x9	144
0xa	164
0xb	192
0xc~0xf	保留

表 A.11　双声道立体声编码比特率索引表

bitrate_index	比特率 (kb/s)
0x0	24
0x1	32
0x2	48
0x3	64
0x4	80
0x5	96
0x6	128
0x7	144
0x8	192
0x9	256
0xa	320
0xb~0xf	保留

表 A.12 5.1 立体声编码比特率索引表

bitrate_index	比特率 (kb/s)
0x0	192
0x1	256
0x2	320
0x3	384
0x4	448
0x5	512
0x6	640
0x7	720
0x8	144
0x9	96
0xa	128
0xb	160
0xc~0xf	保留

表 A.13 7.1 立体声编码比特率索引表

bitrate_index	比特率 (kb/s)
0x0	192
0x1	480
0x2	256
0x3	384
0x4	576
0x5	640
0x6	128
0x7	160
0x8~0xf	保留

表 A.14 4.0/FOA 立体声编码比特率索引表

bitrate_index	比特率 (kb/s)
0x0	48
0x1	96
0x2	128
0x3	192
0x4	256
0x5~0xf	保留

表 A.15 5.1.2 立体声编码比特率索引表

bitrate_index	5.1.2 总比特率 (kb/s)	5.1 比特率（kb/s）	0.0.2 比特率（kb/s）
0x0	152	128	24
0x1	320	256	64
0x2	480	384	96
0x3	576	448	128
0x4~0xf	保留		

表 A.16 5.1.4 立体声编码比特率索引表

bitrate_index	5.1.4 总比特率 (kb/s)	5.1 比特率（kb/s）	0.0.4 比特率（kb/s）
0x0	176	128	48
0x1	384	256	128
0x2	576	384	192
0x3	704	448	256
0x4	256	192	64
0x5	448	320	128
0x6~0xf	保留		

表 A.17 7.1.2 立体声编码比特率索引表

bitrate_index	7.1.2 总比特率（kb/s）	7.1 比特率（kb/s）	0.0.2 比特率（kb/s）
0x0	216	192	24
0x1	480	416	64
0x2	576	480	96
0x3	384	320	64
0x4	768	640	128
0x5~0xf	保留		

表 A.18 7.1.4 立体声编码比特率索引表

bitrate_index	7.1.4 总比特率（kb/s）	7.1 比特率（kb/s）	0.0.4 比特率（kb/s）
0x0	240	192	48
0x1	608	480	128
0x2	384	288	96
0x3	512	384	128
0x4	832	576	256
0x5~0xf	保留		

表 A.19 2 阶 HOA（9 声道）立体声编码比特率索引表

bitrate_index	2 阶 HOA 立体声比特率（kb/s）
0x0	192
0x1	256
0x2	320
0x3	384
0x4	480
0x5	512
0x6	640
0x7~0xf	保留

表 A.20 3 阶 HOA（16 声道）立体声编码比特率索引表

bitrate_index	比特率（kb/s）
0x0	256
0x1	320
0x2	384
0x3	512
0x4	640
0x5	896
0x6~0xf	保留

附 录 B
（规范性）
音频编码表

附录B给出通用全码率音频编解码所用到的码书，所用码书信息汇总如表B.1所示，附录表B.2至表B.24给出了三维声音频编解码所用到的码书。

表 B.1 码书信息汇总

表 B.1 格索引	所属模块	码书意义	码书名称
表 B.2	高精度 LSF 矢量量化	第一级第一子矢量码书	lsf_stage1_CB1_hbr
表 B.3		第一级第二子矢量码书	lsf_stage1_CB2_hbr
表 B.4		第二级第一子矢量码书	lsf_stage2_CB1_hbr
表 B.5		第二级第二子矢量码书	lsf_stage2_CB2_hbr
表 B.6		第二级第三子矢量码书	lsf_stage2_CB3_hbr
表 B.7		第二级第四子矢量码书	lsf_stage2_CB4_hbr
表 B.8		第二级第五子矢量码书	lsf_stage2_CB5_hbr
表 B.9	低精度 LSF 矢量量化	第一级第一子矢量码书	lsf_stage1_CB1_lbr
表 B.10		第一级第二子矢量码书	lsf_stage1_CB2_lbr
表 B.11		第二级第一子矢量码书	lsf_stage2_CB1_lbr
表 B.12		第二级第二子矢量码书	lsf_stage2_CB2_lbr
表 B.13		第二级第三子矢量码书	lsf_stage2_CB3_lbr
表 B.14	TNS 反射系数 量化编码	标量量化码书	tnsCoeff4
表 B.15		量化索引的哈夫曼码书第 1 维	tnsCodingTable0
表 B.16		量化索引的哈夫曼码书第 2 维	tnsCodingTable1
表 B.17		量化索引的哈夫曼码书第 3 维	tnsCodingTable2
表 B.18		量化索引的哈夫曼码书第 4 维	tnsCodingTable3
表 B.19		量化索引的哈夫曼码书第 5 维	tnsCodingTable4
表 B.20		量化索引的哈夫曼码书第 6 维	tnsCodingTable5
表 B.21		量化索引的哈夫曼码书第 7 维	tnsCodingTable6
表 B.22		量化索引的哈夫曼码书第 8 维	tnsCodingTable7
表 B.23	变换域系数 区间编码	基础部分区间编码 CDF 表	
表 B.24		上下文部分区间编码 CDF 表	
表 B.25	HOA 空间编码	虚拟扬声器预设值表	
表 B.26		sin_table_N 预设值表	

表 B.2 高精度 LSF 矢量量化码书 第一级 第一子矢量码书 lsf_stage1_CB1_hbr

索引	码字
1	12.532774, -294.914795, -839.115295, -1283.263306, -1366.740234, -1291.976929, -889.037109, -662.501465, -394.010132,
2	7.659530, 64.449364, -429.962616, -159.504883, -127.081932, -528.241577, -898.911499, -1261.207764, -1585.741333,
3	-265.316223, -1177.764160, -1719.669189, -2321.858154, -2539.730713,

	-1376.201050, -393.688843, -135.207047, 153.807602,
4	-429.040771, 1138.646240, 1062.909912, 1183.278198, 1069.893311, 1066.192871, 987.967041, 938.215393, 848.846802,
5	-259.962219, -841.635864, -792.817505, -1015.578674, -1039.584106, -1190.869629, -1251.823975, -1344.401611, -1400.721069,
6	-255.383240, -340.604065, -225.726089, -194.386597, -82.405243, -87.643135, 83.903320, 127.325462, 214.289505,
7	-292.835663, -1187.095581, -1540.663330, -946.716309, -604.317749, -340.563690, -148.200073, -110.725548, -88.781868,
8	-66.158363, 288.254822, 52.301933, -176.605835, -372.656982, -638.140747, -765.024902, -1038.674561, -1158.282227,
9	-294.390991, -419.236633, 164.241470, 72.962151, 184.964706, -5.999948, 18.262583, -294.669708, -360.836609,
10	-354.790070, -980.296875, -664.455078, 154.531082, 347.748291, -81.605064, -166.168503, -575.064392, -619.221313,
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136	-69.882439, 99.225761, -316.386963, -783.445007, -774.641357, -866.159729, -460.005524, -366.746399, -196.000290,
137	-161.529800, -873.052002, -820.817627, -1312.994629, -1011.838318, -781.103821, -1038.130737, 533.575745, 471.384552,
138	-374.898529, -888.264526, -167.955841, -273.180542, -202.054932, -368.927612, -237.626297, -390.566956, -269.131531,
139	194.377274, 436.584747, 307.389587, 374.059601, 419.120728, 301.247375, 322.779480, 77.648521, 34.339844,
140	-77.034248, 685.388672, 415.089294, 122.450302, -161.383041, -452.515381, -613.104004, -873.833557, -951.395569,
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157	-47.745808, 137.209152, 168.656677, 88.941284, -78.959335, -387.421143, -421.709259, -261.284119, -19.217987,
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163	-15.817514, -411.485168, -394.904633, -753.658813, -597.352112, -668.474182, 116.694031, -271.499939, -593.399780,
164	68.322708, -326.461426, -433.361847, -998.881042, -920.705383, -390.451447, -750.696716, -1122.629150, -548.098206,
165	-308.922272, -1033.517578, -1245.763550, -1659.946777, -963.066772, -433.620239, -130.026184, -19.373592, 55.147762,
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169	708.548950, 192.753342, -206.201889, -693.366821, -838.465393, -1190.832153, -358.575958, -655.519409, -667.919006,
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171	-457.514343, 523.834534, 812.696045, 919.779358, 959.375000, 926.008667, 893.313049, 813.890991, 772.358887,
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194	-479.236481, -1292.459961, 486.444305, 617.295349, 807.077637, 742.250183, 786.319092, 690.602112, 686.478699,
195	-384.315399, -1041.603760, -388.681671, -720.672424, -491.007507, -261.076233, 70.605843, 193.263412, 359.707428,
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199	684.434998, 2677.031738, 2640.076416, 2477.602783, 2097.601562, 1757.809448, 1344.368896, 984.018860, 607.138794,
200	-275.864197, 29.051449, -274.191254, -358.941620, 46.813194, 657.108032, 913.113220, 1191.818359, 1285.592896,
201	617.544373, 809.540405, 751.557190, 656.415466, 539.906250, 344.674286, 311.402069, 104.217766, 43.276100,
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214	-169.272018, 30.012857, -109.015106, 465.255615, 453.288849, 40.586933, -249.114258, -631.611816, -837.331116,
215	-362.530945, -801.328735, 282.536194, 243.578491, 390.871216, 297.866333, 479.047913, 369.696472, 405.338074,
216	-238.607315, -852.011536, -964.665527, -1365.129395, -1391.019897, -1305.390503, -1077.980591, -937.738281, -683.551453,
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225	23.488888, -412.369110, -441.759216, -691.951904, -884.265442, -1368.422485, -1694.430542, -1727.004883, -1126.412109,
226	-34.125507, -201.101593, -432.403564, -877.453430, -1181.488647, -619.693298, -423.591156, -702.601868, -1005.619995,
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236	220.352310, 646.220276, 485.153656, 378.431824, 239.117081, 30.119192, -48.385849, -281.666260, -321.418243,
237	-37.013084, -12.237608, -445.684906, -694.351868, -519.398560, -689.213684, -619.480469, -789.566101, -831.354065,
238	-311.697540, -1214.498779, -1629.167725, -1667.692383, -252.691345, -41.316105, 138.973297, 128.725128, 171.948929,
239	-177.504532, -999.752441, -1437.215332, -2003.558228, -2320.895508, -2459.510742, -2212.731934, -1705.895630, -941.731689,
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243	-288.440033, -241.610382, -246.760681, -401.584534, -492.142914, -692.678162, -740.253235, -969.517273, -1111.669189,
244	-357.615021, -505.923218, 1234.285034, 1028.074219, 764.083801, 298.424377, 180.949036, -154.882401, -236.654190,
245	-159.627060, 1235.245239, 1178.883301, 1088.014160, 860.808533, 636.503967, 566.731140, 383.741333, 251.244156,
246	-54.214455, -417.550842, -859.441040, -1392.187866, -1611.388672, -927.907532, -386.700897, -194.817215, 14.651560,
247	-742.290100, -15.748692, 1266.636108, 1328.531128, 1668.744019, 1669.059204, 1832.402100, 1788.834961, 1862.470825,
248	-343.283539, -1302.701172, -1851.272339, -1961.326782, -130.270493, 248.502701, 551.546631, 607.094482, 766.398682,
249	107.124557, -148.659027, -554.413086, -982.619141, -1348.362915, -1730.620483, -2168.555664, -2596.479980, -2861.052490,
250	-418.114899, -961.129211, -17.794352, 661.979614, 851.078003, 437.627960, 205.163864, -273.702789, -388.516815,
251	275.978882, 184.001373, -100.555817, -225.438446, 74.304443, 22.188887, 179.736740, 0.251966, 10.995980,
252	1615.943481, 1123.951782, 539.817871, 175.317184, -110.204140, -465.569305, -681.310852, -827.931396, -798.271057,
253	580.269958, 370.878906, 110.667450, 134.644119, 306.276093, 418.459473, 557.146606, 516.662964, 507.707855,
254	36.891468, -515.519226, -762.948547, -1508.485718, -1802.767700, -1083.640381, -1172.074219, -1403.558838, -1596.932861,
255	383.148956, -26.410944, -467.441589, -667.710754, -780.453552, -992.135803, -1154.880615, -1385.698730, -1454.032837,
256	153.504349, -389.179504, -746.059998, -1376.398071, -2047.961426, -2373.300781, -1687.155884, -1366.466553, -1077.949463f

表 B.3 高精度 LSF 矢量量化码书 第一级 第二子矢量码书 lsf_stage1_CB2_hbr

索引	码字
1	-2.419283, 160.314499, -65.667160, 145.171967, -234.788620, 58.263897, -857.876892,
2	-1078.523315, -1171.671143, -1471.139771, -1721.603516, -2394.023438, -3054.640137, -371.735413,
3	-1384.490234, -722.422668, -1254.738892, -1515.970703, -1980.408691, -1571.614868, -2312.044922,
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158	-1557.501587, -1493.935425, -1315.934204, -1132.046143, -782.128296, -679.114502, -560.047363,
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160	-1616.942993, -617.771545, -350.499329, -60.721684, 76.723930, 237.614853, 156.796127,
161	-876.453308, 166.194077, -586.573547, -950.025879, -162.685486, -11.021299, -74.673676,
162	-933.958252, -792.638428, -681.551208, -596.130432, -585.906128, -594.729431, -936.187195,
163	-1208.862915, -1227.308350, -1181.368286, -1337.841309, -948.802124, -172.173843, 113.793404,
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165	2227.242676, 2299.043213, 1983.756958, 1611.156250, 1230.987183, 910.737427, 687.558899,
166	-2634.895264, -1341.407104, -655.939148, -435.204132, -138.849350, 109.223824, 175.581787,
167	381.176819, 172.363068, -181.324799, -255.549347, 88.474831, 314.105194, 349.051849,
168	-942.328003, -727.934448, -1051.050659, -895.382385, -1331.618530, -949.222717, -1827.845581,
169	1050.846069, 960.810059, 899.902222, 918.711304, 741.007629, 642.515076, 427.510681,
170	-1923.227295, -2332.062744, -2334.375244, -2903.227539, -2950.154785, -3899.762695, -2456.197754,
171	-1321.074463, -1645.838745, -1858.400757, -2214.028320, -1537.176392, -342.966125, 61.078449,
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173	-1196.832886, -1046.309692, -974.942627, -507.224152, -811.209106, -686.430359, -1591.003418,
174	-1766.451294, -1068.532959, -1442.078491, -1631.367676, -1790.646729, -1115.237061, -1888.490234,
175	-2597.554443, -3010.818359, -3857.105469, -4409.147461, -5543.684570, -5077.316406, -969.496399,
176	686.251831, 616.379700, 427.633118, 373.425873, 278.641876, 251.032150, 277.012299,
177	-938.053894, -423.530273, -804.657959, -1640.446411, -1215.777222, -1003.299316, -1671.776978,
178	222.797958, 344.567383, 353.334686, 417.572205, 452.120239, 471.539337, 452.700836,
179	-193.654877, 486.405945, 1418.244995, 1514.918335, 1254.049561, 1046.550415, 773.944763,

180	-1542.704712, -1538.845825, -1861.758179, -1613.740601, -1869.317993, -1350.750854, -2065.242920,
181	-1929.660034, -1931.505859, -2094.259277, -2162.314209, -2643.336426, -3044.777344, -388.269257,
182	2023.152832, 2168.609131, 1901.014771, 1566.093262, 1199.623291, 905.672363, 677.364563,
183	-1454.306519, -1817.152954, -2259.534668, -1921.817383, -2116.793457, -1604.087891, -2239.123047,
184	-2059.189697, -1293.733521, -1435.723511, -1025.210571, -1308.423828, -1063.895020, -1869.822754,
185	1757.312622, 2066.028564, 1840.750732, 1509.043823, 1156.838501, 859.446899, 657.098877,
186	-1604.242920, -1782.429321, -2060.613525, -989.568481, -304.592560, 52.363155, 261.436890,
187	-790.060547, -677.193604, -854.483887, -1002.869568, -1361.044922, 187.528214, -758.687378,
188	-850.720215, -815.171509, -782.120972, -750.712524, -930.394592, -1100.443970, -1842.617432,
189	-1013.528564, -619.302734, -1039.494873, -1345.197998, -1822.371460, -1228.573486, -1966.074951,
190	-890.626709, -1002.113586, -1763.994995, 44.655560, -635.783936, -1296.306763, -1941.137939,
191	-2550.192383, -3048.042969, -3690.282471, -4373.286133, -5208.394531, -1917.806274, -581.258240,
192	-46.051090, -444.285278, -621.605347, 218.354416, 294.350952, 309.784790, 355.443756,
193	-832.117493, -659.459045, -481.507568, -341.173279, -48.068172, 158.933624, 259.165100,
194	-723.183533, -566.399109, -422.477692, -387.357666, -312.310120, -495.552063, -642.440918,
195	-3213.293945, -3731.129150, -3566.625977, -1970.124390, -969.271667, -349.031250, 88.375351,
196	-1493.730713, -1925.979980, -2232.583740, -1535.923706, -1746.921387, -1267.045776, -1990.320190,
197	-931.412964, -793.034607, -1133.670776, -1261.493530, -1737.755371, -699.421814, -1597.601440,
198	-802.901489, -780.312927, -1156.061279, -814.251770, -1303.202515, -1265.482178, -2118.627930,
199	1859.657349, 1899.714355, 1752.933350, 1489.179077, 1168.854858, 923.944519, 675.960144,
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201	-654.688660, -1015.827209, -1190.445923, -605.556641, -856.632019, -

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202	1119.471191, 858.251709, 249.507751, 471.759491, 265.540253, -206.793472, -294.015991,
203	-1211.920776, -1029.572876, -1262.090942, -1054.197144, -1343.196411, -919.689575, -1749.811035,
204	-610.228638, -286.711029, -544.461487, -354.503784, -793.421814, -698.029663, -1636.272949,
205	-1988.942139, -2270.791504, -2623.452881, -3106.659668, -3696.352295, -4359.229980, -1231.581909,
206	-769.379578, -1117.632202, -1622.923950, -1560.120117, -1645.681274, -1032.027710, -1828.624878,
207	-214.166290, 389.766052, 490.709106, 845.222534, 281.663879, -253.058563, -1178.845459,
208	-1189.373657, -1266.664551, -1796.728516, -1872.993408, -2566.956055, -2864.288330, -3873.072998,
209	-752.549072, -213.618332, -171.188766, 526.129272, 59.229225, -384.757385, -1381.908691,
210	589.618896, 958.856995, 1043.165405, 1143.152832, 1853.732544, 2285.578369, 1410.694824,
211	-1040.660400, -1191.703125, -654.014648, -941.981873, -1474.148315, -921.510010, -1640.542358,
212	-1563.276001, -1639.329346, -2228.906738, -2306.195312, -2921.983398, -2888.887939, -3908.613770,
213	-1378.559082, -1430.042114, -1700.228394, -53.977154, -540.871887, -542.380432, -1553.821655,
214	-1160.307495, -1163.990601, -1185.203003, -1398.706299, -1303.736572, -987.148376, -471.440216,
215	-1030.117188, -972.643860, -1276.948486, -738.906311, -1100.516724, -795.453491, -1693.452637,
216	-468.792480, -450.322815, -974.565002, -1008.784973, -1696.910156, -1940.522095, -2817.710938,
217	-838.831787, 274.059998, -663.343933, -1405.616699, -877.030273, -879.753784, -1595.256836,
218	137.608704, 69.000343, -47.363461, -233.584244, -445.194702, -970.103699, -1565.977539,
219	-1042.776245, -477.652252, -729.477844, -454.572510, -946.314819, -931.773499, -1823.560181,
220	42.125374, 35.638535, 740.415527, 843.886780, 668.383301, 543.146301, 472.985168,
221	392.935059, 653.371216, -448.405304, 375.040161, 295.584198, 471.666870, 103.572754,
222	-154.301132, -306.378052, -466.394440, -551.980957, -192.136795, 165.342453, 298.238892,
223	-2925.972656, -2523.248535, -1111.652954, -685.163635, -275.557953,

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224	-1574.326416, -1417.313110, -1626.486328, -1278.805542, -1589.582886, -1240.964600, -2012.671753,
225	594.715515, 1486.845581, 1531.019653, 1274.003052, 970.901367, 732.011169, 579.845337,
226	137.167023, 36.624592, -517.013245, -589.374573, -1265.440552, -1145.184204, -2051.384277,
227	-26.435886, -56.422054, -404.378052, -394.194000, -813.856628, -314.063995, -1064.395996,
228	-1260.744629, -1497.010498, -2024.455566, -2299.268555, -2770.762207, -2045.283081, -2527.341797,
229	-359.603333, -176.854752, -683.117859, -981.453491, -1492.026001, -1031.153564, -1905.748535,
230	-1651.876099, -1859.713501, -2263.955811, -2451.694580, -2612.706787, -1484.526978, -2041.182739,
231	-597.484070, -370.993713, -597.899780, 472.524628, -203.220230, -1188.975708, -2064.148193,
232	-626.137695, -534.148499, -583.699036, -581.131592, -782.097595, -1054.995117, -1791.960815,
233	-1330.559326, -1746.493286, -1845.468750, -2474.347168, -2675.653564, -3675.258301, -3224.888184,
234	-350.680878, -649.529663, -1278.257690, -1429.337891, -1821.152344, -1156.966309, -1977.541138,
235	-1108.990601, -980.478210, -1450.680420, -1764.365967, -2155.622559, -1117.615234, -1904.928223,
236	-731.516907, -960.150146, -368.916779, 237.534698, 298.949432, 354.164429, 369.252014,
237	726.680481, 970.058655, 1240.952026, 1122.956055, 901.566833, 712.591248, 579.026184,
238	-1509.388062, -1746.989380, -1382.398804, -1719.351562, -2064.650879, -1278.447510, -1975.246460,
239	414.816895, 535.429321, -51.128113, -234.962631, -1016.078186, -1202.653809, -2175.594971,
240	-759.597778, -960.860474, -1123.675293, -1550.068359, -1919.764771, -2633.365967, -1350.687866,
241	-1151.824707, -1196.646729, -1087.567993, -1698.596680, -1496.082275, -1052.537354, -1673.215332,
242	-1385.504883, -1422.370239, -1487.047119, -1680.568115, -1802.940796, -1530.545532, -793.454041,
243	1013.024414, 923.160645, 798.228455, 699.183228, 541.279236, 341.881500, 412.349915,
244	-2169.254883, -1868.476440, -1482.921021, -1427.902588, -1178.953979, -290.343079, 48.260975,

245	-2174.610840, -2151.178711, -2372.573730, -2247.478760, -2823.552979, -1877.511353, -206.024292,
246	1082.607422, 2064.338379, 2365.753174, 2626.614014, 2299.045410, 2062.203125, 1200.084229,
247	144.305130, -24.135992, -270.347900, -433.131073, -458.793701, -345.861237, 27.411316,
248	-1911.949707, -2278.694824, -2423.027588, -2859.584961, -3014.995117, -3781.610840, -3822.277100,
249	-836.404602, -933.741699, -1307.806152, -1098.735352, -1511.847290, -1059.338257, -1894.064087,
250	-640.583130, -440.947906, -751.173767, -560.251831, -1045.903076, -798.479858, -1751.981079,
251	-2256.432617, -1674.571045, -700.385254, 756.211304, 1299.046753, 1050.701660, 726.589233,
252	-722.514709, -774.690674, -832.236450, -947.848145, -522.118652, 7.550344, 214.319077,
253	-1925.266357, 238.258560, -597.768127, -720.570435, 15.188728, 186.199814, 8.823078,
254	-1493.605347, -1635.037720, -1872.133667, -1141.085938, -1540.600220, -1550.948486, -2279.032471,
255	-250.391434, -80.652458, -379.481018, -217.784698, -719.979736, -681.776978, -1644.389404,
256	-1256.465210, -1254.223389, -1621.097778, -1516.847778, -1851.374390, -1392.915283, -2135.959473f

表 B.4 高精度 LSF 矢量量化码书 第二级 第一子矢量码书 lsf_stage2_CB1_hbr

索引	码字
1	-713.785767, 168.407120, 153.748795,
2	36.340725, 90.616714, -32.429771,
3	52.624313, -38.090992, -364.945282,
4	154.185974, 109.762367, 355.092072,
5	-375.530365, -62.235508, -134.981415,
6	115.415070, -699.178345, 276.090454,
7	-363.505493, -245.460114, -404.869843,
8	-102.644508, 121.746376, -52.143639,
9	250.990021, -180.223267, -60.538208,
10	2.304316, 254.452957, -118.709351,
11	-64.000519, -172.352188, -549.504944,
12	145.008041, -198.819794, 74.863930,
13	-319.988373, 62.626167, -325.089386,
14	-288.144287, -715.401611, -396.285156,
15	-211.637512, -4.421244, -14.446482,

16	82.578644, 123.950401, -213.957626,
17	-164.570007, 844.651917, 255.872421,
18	-247.887390, 55.306465, 200.785889,
19	-215.868759, -609.106079, -63.238937,
20	392.302124, 42.328953, 249.753616,
21	-184.973984, -69.296509, 118.628799,
22	51.923347, -142.208099, 177.060547,
23	53.448772, -305.917572, -103.890076,
24	229.675934, 0.439482, 122.373756,
25	-277.801453, 166.968170, 733.307129,
26	170.546982, 339.845001, 31.960520,
27	64.136490, -25.794970, 65.980400,
28	-43.597557, -34.969471, -37.739056,
29	-212.885864, 507.455505, 437.958435,
30	-493.030060, -311.711365, 187.651596,
31	-354.960724, 144.233612, 368.872223,
32	81.155983, 198.582993, -361.475037,
33	-57.561897, -190.277390, -40.531013,
34	225.483200, 184.535919, 145.773300,
35	37.873772, -300.896942, 273.377380,
36	-161.762527, -104.531548, -353.909149,
37	437.577271, -248.396957, -118.537544,
38	95.924393, -536.217834, -123.140144,
39	-116.965042, 137.023346, -432.474640,
40	-401.308441, -316.035950, -124.605537,
41	265.316132, 7.975056, -193.403076,
42	-10.286757, -256.780396, -308.450928,
43	286.242706, 221.018967, -186.312241,
44	231.734329, -155.717773, 278.019806,
45	-344.505493, -185.656815, 515.490845,
46	-210.659317, -371.243408, 298.229218,
47	-55.369648, -502.107391, 166.864746,
48	-237.739120, 449.408295, 71.104065,
49	-197.362518, 292.102844, 232.818176,
50	-244.392792, 154.775345, 58.205173,
51	266.715729, 694.912415, 70.328987,
52	-204.886414, -186.953674, -33.269745,
53	119.856064, -148.999146, -212.473984,
54	-96.027031, -133.978561, 283.992157,
55	-277.930481, 14.714230, -619.926331,
56	108.560051, 381.440857, -174.843597,
57	-532.884521, 158.514374, -200.185989,
58	-14.112489, 326.978088, 130.464569,

59	-101.656219, 31.647610, -269.940765,
60	-144.576035, -422.618805, -323.873138,
61	65.474930, -420.618225, -505.687775,
62	209.829102, -387.511017, 94.998833,
63	-172.908279, -60.086086, -150.022415,
64	-46.326584, 260.807922, 452.773834,
65	279.548889, -141.048431, -322.010864,
66	393.468262, 8.009486, -42.706268,
67	-81.231201, 45.355511, 65.719444,
68	222.150711, -141.217514, -564.965637,
69	346.164856, 434.299622, -66.598831,
70	568.707031, -159.705505, 544.176575,
71	-211.341019, -216.253036, -211.727448,
72	224.405930, 357.485809, 257.797882,
73	553.497620, 31.112984, -678.450806,
74	82.964523, 135.422699, -656.731628,
75	175.658020, -128.771088, 503.778290,
76	14.064637, 492.906281, 239.662155,
77	472.926147, -403.081818, -391.692749,
78	-292.928436, -699.444397, 353.090057,
79	72.990135, -133.231140, -53.157795,
80	-52.832638, -117.261017, 69.052734,
81	426.745056, 201.403336, 31.993965,
82	223.471848, 449.586548, -409.097839,
83	-74.437065, 170.063431, 109.249542,
84	94.061584, -8.890752, -155.487183,
85	181.220139, -12.836661, -26.633982,
86	-257.568481, 404.635712, -478.268524,
87	-118.702698, -1.801430, 436.133667,
88	-328.992798, -148.799011, 49.605450,
89	685.787781, -5.360787, 84.299042,
90	-92.548859, -405.149048, -942.782654,
91	545.499023, 378.187408, 237.816772,
92	223.737640, 689.972900, 549.611572,
93	-402.027008, 256.815186, 47.899891,
94	198.374649, -338.206146, -228.664978,
95	-74.177917, -279.765411, 485.423126,
96	592.158936, 327.568512, -262.079163,
97	-97.092148, 110.176552, 270.185944,
98	-134.869324, 293.152802, -12.102485,
99	196.897675, 149.523315, -40.585079,
100	974.516663, 442.782013, 130.876434,
101	-119.678520, 183.199692, -210.154816,

102	520.430542, -462.481323, 137.886856,
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104	-65.387932, 380.154449, -306.889679,
105	312.868439, 105.024971, -392.744720,
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107	-286.622528, -143.909866, 256.411652,
108	361.120209, 194.673004, 488.534027,
109	608.696533, -6.981796, -274.527039,
110	45.004539, 218.194778, 28.713619,
111	-256.952240, -384.646057, 64.113510,
112	-488.355804, 532.116638, 224.472809,
113	-128.912506, -241.478180, 128.511200,
114	-272.429382, 330.666290, -179.248230,
115	33.182674, 226.608612, 254.291412,
116	-439.983124, 8.855278, 102.383743,
117	53.941254, 37.994209, 697.273926,
118	-128.799225, -350.602203, -105.367256,
119	-11.603866, -330.001129, 57.193336,
120	-109.075554, -486.121399, 795.247375,
121	-183.717377, 632.973999, -138.407562,
122	-6.666337, 486.127014, -17.339613,
123	389.025299, -181.146561, 137.332169,
124	-271.502441, 115.163071, -122.910507,
125	-39.242790, 21.079741, -150.635345,
126	257.078369, -403.075104, 437.620300,
127	-45.516216, -8.866961, 180.737320,
128	70.438759, 98.982910, 139.766769f

表 B.5 高精度 LSF 矢量量化码书 第二级 第二子矢量码书 lsf_stage2_CB2_hbr

索引	码字
1	20.507162, 117.254471, 308.534973,
2	167.627548, -284.581360, 35.337910,
3	-50.533733, 262.051270, -222.744385,
4	213.973526, -192.300507, 227.454147,
5	324.752869, 154.691422, 142.521759,
6	-302.892273, 22.365881, -268.279053,
7	384.219574, -46.759758, 295.384735,
8	-326.932983, -142.875214, 123.286591,
9	462.440582, 30.680933, -644.826782,
10	75.870522, 100.746597, -229.091095,

11	-184.132187, -518.547424, -105.319809,
12	-128.916153, -172.195633, 83.659973,
13	63.237682, -497.342957, 72.141266,
14	274.313446, 167.584351, -33.896770,
15	-596.630493, 8.026925, -321.141144,
16	50.223522, -16.749166, -83.381676,
17	44.889523, -767.325989, -139.284637,
18	224.780106, 352.491333, 75.805626,
19	-33.128654, 305.753296, -601.859070,
20	115.771713, -93.239197, 107.058525,
21	-148.837738, 183.316940, 413.980072,
22	-182.227646, -697.383789, 278.016632,
23	445.581207, 256.918182, -61.204651,
24	707.401611, 599.105469, 466.282776,
25	172.835205, -255.287506, -399.850555,
26	-182.281845, 185.917496, 198.393707,
27	-354.348358, 77.655319, 121.351845,
28	165.057236, -250.012955, -153.211365,
29	15.198963, -101.545570, 337.992859,
30	635.096924, -22.253139, -276.124939,
31	-174.264359, 306.408936, -30.304029,
32	63.197758, 65.521347, 148.829025,
33	-565.097168, -720.727173, 95.707863,
34	173.535858, 4.769509, 226.110519,
35	-302.163788, -364.092468, 40.338612,
36	322.009796, -130.186035, -257.399811,
37	-143.584061, 432.809937, 187.272064,
38	-8.131482, 172.260559, 72.100441,
39	-69.128052, -15.661174, -246.318619,
40	141.381821, 678.433350, 463.580078,
41	205.150635, 60.560955, -127.768204,
42	-396.496399, 355.075836, 271.316498,
43	-16.061943, 261.906860, 182.079605,
44	119.859367, -86.526634, -181.600311,
45	-278.325073, 273.584839, -346.330780,
46	-848.170715, -77.039818, 206.621765,
47	-20.108572, -224.001541, -248.247284,
48	-152.951675, 146.029510, 4.365578,
49	62.817871, 353.723999, 343.701416,
50	-436.317230, -275.409271, 341.552063,
51	147.565918, 230.680481, 166.706573,
52	-34.370865, -308.244354, -41.257004,
53	-241.203552, -430.650146, 813.072693,

54	368.040619, -410.771362, 232.966476,
55	51.651077, -146.025299, -22.975538,
56	-282.722992, -620.837402, -850.400146,
57	-165.943176, -55.919006, 572.439575,
58	-103.814415, -227.512253, -490.515442,
59	124.234863, -193.956253, -844.806152,
60	-505.521362, 82.886086, 466.838531,
61	148.491516, -239.119812, 546.069153,
62	63.785629, -80.139122, -321.356995,
63	564.061768, 129.677856, 165.186554,
64	158.311157, 128.742462, 70.707832,
65	316.238434, -27.633970, 86.694901,
66	-175.450073, -93.772957, -166.443024,
67	-142.252975, -157.993195, 255.044876,
68	-313.525330, 13.380783, -652.654724,
69	-241.896759, 28.034353, -57.149029,
70	-190.798920, 0.189457, 116.813072,
71	844.387390, 337.000793, -19.824232,
72	-564.077698, 500.165619, -415.747192,
73	213.419327, -91.672638, -57.745274,
74	-99.660248, 74.968384, -407.527557,
75	-29.572922, -96.862167, -131.641983,
76	-135.936050, -355.414703, 151.864426,
77	222.614548, -673.049561, 517.544067,
78	111.716286, 204.121689, -51.537071,
79	80.887352, 35.771717, 2.501737,
80	-370.751129, -221.242981, -170.055420,
81	-549.659729, -200.956406, 12.992573,
82	59.403713, -418.178558, -191.717911,
83	-52.472393, 56.039600, 70.462021,
84	-88.299973, -178.931824, -61.182095,
85	125.889633, 580.681763, -326.664459,
86	-592.087524, 160.197723, 37.150238,
87	362.081543, 337.822754, 311.010651,
88	186.879440, 331.649445, -169.341782,
89	-238.267609, 783.910889, 138.339188,
90	-5.536943, -490.727203, -455.820465,
91	349.078400, -449.050262, -113.857185,
92	524.526978, -149.489349, 603.087891,
93	470.803162, 318.161041, -352.185669,
94	-166.528366, -349.740906, 415.440033,
95	159.741531, 26.906466, 458.308716,
96	123.212921, -21.127138, -508.872711,

97	-239.674759, -150.437744, -346.729095,
98	300.417145, 81.030838, -299.241089,
99	-400.569550, -31.321560, -64.911179,
100	-329.600861, 264.643341, 72.342133,
101	-76.098831, 23.414692, 223.034027,
102	410.300262, 545.022339, 14.200037,
103	64.472435, -380.021576, 299.929443,
104	-276.012024, -14.363681, 307.793549,
105	458.341339, -364.150879, -473.549255,
106	-134.677811, -57.834167, -0.576738,
107	-138.862488, 111.922058, -166.296036,
108	-390.244507, 475.571930, -62.043774,
109	146.384476, 230.729202, -393.689453,
110	216.011246, 162.604935, 315.091980,
111	371.276337, -198.172241, -7.094508,
112	-412.132812, -448.155182, -344.452454,
113	21.202076, -217.792053, 148.690628,
114	-239.708435, -178.662338, -46.387856,
115	-372.993713, 190.326294, -134.271698,
116	78.791969, 546.357361, 89.262733,
117	108.147072, 201.503693, 691.316589,
118	-295.153564, 468.795502, 587.713989,
119	11.740393, 334.976410, -1.581412,
120	-170.412354, -303.384949, -200.288986,
121	3.908800, 121.635567, -68.972488,
122	183.778122, 8.971548, 47.254635,
123	-62.340725, 12.960299, -53.699871,
124	422.356262, 21.269390, -79.914871,
125	-10.798393, -58.968788, 82.892532,
126	-110.142456, 493.066437, -173.040512,
127	-762.578003, 593.424316, 203.118790,
128	648.862854, -213.159912, 89.717255f

表 B.6 高精度 LSF 矢量量化码书 第二级 第三子矢量码书 lsf_stage2_CB3_hbr

索引	码字
1	61.442013, 88.865410, -6.914186,
2	-189.400803, 183.880447, 453.544067,
3	119.694290, 122.304260, -185.256332,
4	185.325165, 257.642426, 21.324890,
5	176.223907, 376.925690, 276.048035,
6	44.387566, -336.891266, -287.661438,
7	364.234314, -399.658417, 453.150360,

8	309.771759, -396.966858, -246.510818,
9	-98.734177, -268.355042, 117.649399,
10	68.921753, 181.501190, 315.960663,
11	-16.736830, -112.308594, 57.227196,
12	-191.615204, -370.536560, -89.005638,
13	-635.830200, -111.513008, 426.530273,
14	133.312378, -378.453064, 44.851124,
15	-247.431152, 145.292679, 33.881779,
16	702.903503, 405.354767, -185.583740,
17	55.931442, -52.922546, 225.309769,
18	-329.518463, 23.220282, 207.375168,
19	-81.797279, 61.733788, 214.160568,
20	-333.189178, -366.966156, 253.709396,
21	300.709991, 191.407745, 190.362869,
22	-54.259617, 292.960663, -166.641479,
23	207.949539, -137.050339, 90.344116,
24	292.658539, 413.935455, -165.154205,
25	43.520733, -285.075592, 348.921387,
26	-173.507782, -407.853882, -702.097595,
27	576.308167, 110.584236, -7.069339,
28	583.669678, 2.836300, -559.254211,
29	331.974945, 23.614412, -271.937256,
30	275.383270, -28.569506, 282.474884,
31	311.056641, 79.100693, -21.822622,
32	-192.355347, -147.341660, -184.034576,
33	-439.608124, 448.283508, 603.143738,
34	-201.011368, 21.700256, -159.099167,
35	135.237228, 2.610675, 35.422089,
36	-19.653358, -37.952515, -95.742783,
37	-74.458069, 109.526535, -83.227531,
38	-335.823456, 744.129639, 38.045818,
39	466.931183, -218.274597, 4.676877,
40	-13.563426, 208.090698, 87.632927,
41	119.996140, 111.237968, 156.117310,
42	-259.981445, 466.053467, -437.298828,
43	-84.826576, 11.426362, 51.927937,
44	-158.319885, 331.992126, 210.548325,
45	494.739502, 174.590012, 389.298523,
46	-27.986452, -202.765732, -108.582108,
47	-81.897018, -700.229736, 150.311615,
48	-441.722595, -63.444637, -332.879852,
49	87.043427, 43.144299, 555.890503,
50	-174.406799, -471.973938, 753.418884,

51	154.363052, -138.182922, -528.208679,
52	-610.850464, 358.816376, 115.910812,
53	-172.365845, -105.489944, 361.526398,
54	-500.688629, -436.756714, -99.204269,
55	156.351166, 236.082245, -466.519012,
56	-179.466690, -272.355408, -352.192108,
57	383.152679, 591.679932, 542.802246,
58	164.616272, -115.712784, -131.835144,
59	-373.097534, 293.575073, -173.105423,
60	-251.338821, -126.143494, 19.707720,
61	-147.272232, 61.723743, -422.298248,
62	3.450175, 514.963806, 16.579840,
63	-531.877258, -14.696597, -27.526365,
64	12.894713, -64.106720, -285.631409f

表 B.7 高精度 LSF 矢量量化码书 第二级 第四子矢量码书 lsf_stage2_CB4_hbr

索引	码字
1	92.195709, -173.186340, -76.764999,
2	-42.733780, 402.076965, -167.067413,
3	216.264893, 102.677452, 168.312927,
4	-180.997543, 162.147827, -134.432327,
5	67.712898, 258.969391, 239.192825,
6	-170.611481, 256.868103, 173.602570,
7	-8.513791, -111.140099, 92.899986,
8	327.391144, 205.558334, -102.128365,
9	244.509750, -137.128418, -470.007751,
10	-305.208832, 85.310158, 56.496731,
11	180.332489, -404.626892, 35.443607,
12	-89.915100, -413.847076, 440.065216,
13	-49.306343, 63.195087, 62.291702,
14	-56.507740, -124.494896, -224.872910,
15	-117.042595, -206.133224, -17.508348,
16	-199.800507, -28.671963, -490.060699,
17	57.166000, 181.844971, 14.875186,
18	-11.494995, -12.210985, -83.709663,
19	83.800140, 98.593323, -225.477493,
20	130.287781, 5.693187, 39.476902,
21	128.140930, -135.807297, 296.940247,
22	-112.687485, -389.502289, -221.875732,
23	-157.652573, -37.295250, 11.366231,
24	-496.884033, -539.886902, -120.588898,
25	-78.960876, 34.301903, 287.433350,

26	269.951935, -62.663803, -131.213440,
27	-538.176331, 470.946381, 245.755112,
28	-265.331299, -83.310402, -141.434708,
29	436.499817, 440.873291, 263.916779,
30	-631.545959, -29.409035, -72.509338,
31	-294.762054, -158.774612, 187.861343,
32	453.967224, -94.971153, 122.421051f

表 B.8 高精度 LSF 矢量量化码书 第二级 第五子矢量码书 lsf_stage2_CB5_hbr

索引	码字
1	-446.630402, 640.495911, 268.249786, -67.830261,
2	34.200180, 144.016098, 43.309258, 28.019665,
3	122.397560, 413.036896, 108.406776, 21.556137,
4	-291.235809, -590.999878, -4.219362, -29.149132,
5	-182.353165, 247.858917, -82.613281, -248.262726,
6	11.704876, -19.809439, 175.695541, 109.505432,
7	-199.381882, -162.686661, 116.547264, 96.769501,
8	85.434540, -28.285826, 18.597948, -23.235142,
9	112.726555, -284.508789, -29.389679, 257.062927,
10	-253.303757, -54.471107, -98.781433, -31.290049,
11	-28.797440, -6.548668, -64.319229, 103.122360,
12	102.159714, -280.140747, 276.293243, -38.849163,
13	-184.768158, -482.613373, -769.700989, -47.989521,
14	-223.921066, 166.102005, 120.577484, 120.780533,
15	58.940697, 148.444000, 49.055420, 347.937683,
16	-194.453476, -55.881226, -203.431305, 440.613892,
17	271.730316, 37.378754, -396.253754, 157.584000,
18	-125.173019, 240.714401, -231.325714, 77.097366,
19	245.718994, 72.768524, 112.223206, 59.880192,
20	-58.394215, -204.128754, -21.877651, -69.457428,
21	198.198151, 152.518585, -76.095955, -92.793144,
22	5.645205, -2.743056, -126.321007, -129.334778,
23	140.627350, 39.890167, 114.086823, -290.992889,
24	129.491241, 165.633606, 406.660248, 150.717422,
25	-606.185791, -12.697894, 7.033066, -27.042786,
26	585.682068, 260.057220, 63.060730, -9.845518,
27	254.377533, -187.517456, -100.691185, -109.688454,
28	-81.884468, -167.102570, -333.533386, -11.585288,
29	216.725479, 93.283714, -303.676849, -367.260162,
30	-95.634460, -174.039597, -142.232117, -356.129242,
31	-83.721230, -3.592948, 37.293602, -44.416279,
32	-173.826035, -209.999924, 505.608887, 329.540344f

表 B.9　低精度 LSF 矢量量化码书 第一级 第一子矢量码书 lsf_stage1_CB1_lbr

索引	码字
1	-350.459351, -1110.657715, -1039.387939, -307.705811, -81.258949, -67.539551, 27.608225, -15.766386, 26.909994,
2	830.518982, 1316.991455, 969.974976, 701.664673, 395.667511, 140.679199, -86.249687, -326.514038, -441.620605,
3	875.874268, 300.750061, -135.191727, -749.033386, -624.504944, -977.145691, -270.945770, -528.141113, -484.400909,
4	-37.185486, -438.739746, -198.407791, -716.461426, 25.968819, -322.178650, -642.945679, -1081.934448, -619.731140,
5	8.619967, -325.081543, -537.529907, -906.260193, -1086.351807, -1269.749512, -990.259827, -1082.904907, -659.676147,
6	1975.103882, 1380.655762, 714.073425, 323.243988, 40.096863, -340.828369, -585.161987, -748.583984, -674.141174,
7	-149.657196, -842.284973, -991.205566, -1085.922729, -1127.279663, -1483.629272, -1023.704834, -461.994324, -253.976318,
8	-18.673189, 189.549789, -168.876450, -405.123322, -453.465790, -77.701363, 268.827789, 600.122742, 675.741089,
9	-481.714874, -1312.720947, 497.238983, 617.127869, 809.172363, 738.139771, 787.788086, 698.119446, 695.123840,
10	165.517990, 463.347443, 161.873764, -94.733566, -408.583618, -801.933167, -1183.599121, -1549.846436, -1829.587524,
11	-54.419785, -532.895569, -852.639648, -1328.288696, -1952.080444, -2071.530518, -92.382095, -203.139877, -186.850891,
12	183.861481, -367.273651, -851.810547, -411.512238, -523.118713, -562.440063, -624.123779, -710.631714, -784.563538,
13	-177.176773, -521.651245, -243.776535, -638.196167, -178.797272, 619.959656, 324.879456, -91.975945, -505.510773,
14	-257.685272, -815.271667, -835.617249, -1264.782471, -1022.726257, 1117.330078, 928.825928, 663.468262, 264.610596,
15	25.521532, 100.323082, -382.839996, -812.957520, -1234.972046, -1564.814453, -1898.064453, -1977.380615, -2026.754517,
16	-176.444000, -438.630615, -730.473633, -1083.432129, -1262.495728, -1234.185547, -1185.764893, -1210.682739, -1209.831421,
17	-360.419434, -785.268372, -865.262695, -1157.854126, 766.852356, 969.479614, 737.747498, 532.021301, 313.538544,
18	73.917870, -175.426498, -555.667419, -1068.706665, -1075.443237, -587.874329, -348.189636, -173.672394, -40.342525,
19	-171.413345, 57.096062, -278.747833, -399.241699, -545.361328, -765.097778, -964.719727, -1209.839111, -1428.539917,
20	-357.214722, -896.660034, -37.925079, -239.189606, -322.952301, -631.056213, -714.007874, -913.038513, -878.441833,

21	1577.066040, 1529.908569, 1551.067139, 1455.275879, 1443.303467, 1338.591675, 1316.248779, 1216.262451, 1138.473267,
22	-409.347382, -896.647339, 645.859741, 732.300842, 705.857483, 302.651703, 108.818642, -286.890961, -332.548187,
23	-245.251160, -851.509521, -998.825500, -1403.856812, -688.652405, -72.345734, -200.590012, -436.256897, -716.309570,
24	-330.863983, -905.250244, -375.980499, -700.450745, -352.954773, -106.922882, -215.295853, -600.505005, -879.973511,
25	-414.539246, -976.347595, 90.056046, 24.310310, 12.638400, -256.423431, -215.814499, -414.811096, -375.642853,
26	-407.677155, 67.193260, -239.487579, -109.491417, 505.456665, 979.732239, 1202.223755, 1395.712646, 1486.746216,
27	-103.741013, 419.907928, 320.453217, 215.451691, 83.301155, -252.383514, -505.506042, -914.186646, -1144.382202,
28	22.720533, -186.878723, -341.957092, -498.801239, -536.332214, -952.614136, -1357.851318, -1808.392944, -2053.646729,
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164	-201.716019, -376.240814, -457.417786, -95.987808, 325.228302, 398.688049, 527.887512, 476.375580, 496.663727,
165	-243.958618, -349.740448, -196.670685, -205.858994, -178.919907, -210.137161, -34.842102, 96.661407, 234.190201,
166	-22.390350, 489.585999, 985.910645, 861.128479, 541.654785, 74.230301, -314.271606, -788.963013, -999.877136,
167	222.074677, -287.362183, 74.757889, -117.507614, 15.699092, -264.202545, -159.531601, -392.734039, -338.009735,
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200	92.801064, 1164.293945, 802.599792, 479.609894, 40.354275, -409.047546, -837.928162, -1215.925171, -1403.282349,
201	-103.158302, 900.035217, 838.126953, 700.942932, 490.099823, 215.066879, 54.649097, -221.317123, -332.887360,
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203	-208.605103, -930.010925, -1317.236084, -1524.382568, -1237.802368, -1231.182373, -1223.147705, -1303.267090, -1338.722656,
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209	11.646732, 964.122498, 523.617188, 150.000824, -173.893707, -157.686981, -103.815186, 156.810150, 247.870422,
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213	-329.422394, -1097.037354, -1218.800781, -1606.691040, -640.537842, -167.328995, 50.598976, 132.925644, 204.857117,
214	-76.864571, 1566.287720, 1979.153564, 1816.987061, 1480.883545, 1051.511841, 680.155212, 283.731506, 49.960445,
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218	-65.633423, 1715.546143, 1273.253662, 891.733337, 491.938904, 317.231781, 236.129700, 258.489990, 122.087456,
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225	-199.768204, -522.689270, -259.972870, -581.607056, -790.009460, -1049.283936, -1102.648071, -1337.240479, -1395.463989,
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237	-238.826248, 200.013123, 110.359848, 71.252274, -9.610732, -190.478989, -175.310699, -294.996704, -249.046890,

238	156.508057, -156.490112, -465.772675, -913.607361, -1022.254211, -1363.447388, -615.717407, -1028.598267, -1266.942139,
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242	-132.807831, -638.202820, -917.321838, -1318.292114, -1810.082275, -1220.721802, 685.909424, 556.612610, 370.619812,
243	-197.379715, -1072.747314, -1440.673584, -1876.071411, -2089.344238, -1721.490356, -494.098083, -140.939713, 217.494400,
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246	68.185127, -25.366402, -289.149689, -775.257812, -47.512859, -551.142700, -992.717712, -1406.638184, -1423.804077,
247	1074.732666, 523.538391, 143.826492, -187.822311, -245.405121, -337.596924, -392.422150, -526.609680, -543.828674,
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254	-294.975677, -1109.926758, -1316.428345, -987.775269, -629.906128, -331.063782, -88.151436, -42.998192, -9.167728,
255	-720.846436, 1115.457275, 1445.276978, 1626.742798, 1758.635132, 1845.389893, 1893.553589, 1901.911011, 1885.918091,
256	-10.630882, 173.645126, -194.461044, -520.689392, 145.682388, -76.744125, -411.265472, -869.935303, -1199.078491f

表 B.10 低精度 LSF 矢量量化码书 第一级 第二子矢量码书 lsf_stage1_CB2_lbr

索引	码字
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3	-619.806885, -685.579651, -746.767395, -691.805176, -616.305969, -647.728027, -512.941956,
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17	-1555.807617, -501.324615, -1023.675842, -1040.626343, -1486.283691, -1266.904053, -2026.519897,
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20	-1528.967285, -1655.654541, -1899.280884, -1819.910645, -2133.318115, -1590.653442, -2254.575684,
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181	-1208.621948, -1512.455566, -1852.088623, -1282.296753, -1691.754395, -1564.541748, -2293.062256,
182	-130.666595, 106.064713, -89.260017, 103.645401, -379.526367, -480.569031, -1442.557129,
183	-846.357117, -764.076843, -1203.165894, -1197.817749, -1811.429077, -1983.140259, -2796.902344,
184	-46.024593, -110.736679, -447.505859, -469.773193, -874.538391, -402.937805, -1133.668335,
185	-1509.996582, -1677.197876, -2105.592041, -2329.006592, -2809.195801, -3156.773926, -3939.870605,
186	-1452.266235, -1189.537476, -1349.120117, -1023.163513, -1286.727051, -908.575500, -1733.368286,
187	53.716125, 98.533348, 124.961006, 58.117867, 82.433022, -320.471771, -455.971619,
188	-1663.746948, -1640.456543, -1816.988037, -1481.121338, -1737.681274, -1288.965454, -2014.165039,
189	-1192.195312, -1001.089722, -831.286682, -678.389160, -372.874237, -121.623199, 6.853171,
190	-593.864868, 172.604919, -302.387390, -386.411194, -1001.882935, -940.392395, -1903.361816,
191	-2012.852295, -1209.255737, -1386.427612, -1058.992920, -1368.542480, -1097.503174, -1899.640991,
192	-1302.134644, -1512.447388, -1917.826904, -2187.393311, -2412.989014, -1257.125000, -1899.332275,
193	-662.509155, -142.376114, -597.944763, -952.603516, -1486.605835, -941.209778, -1875.773926,
194	-766.835876, -813.700745, -965.409729, -1245.255371, -1896.465210, -555.912415, 139.788239,
195	-53.709496, -24.457977, -27.835449, -9.611705, 202.381714, 296.835175, 376.950104,
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197	-813.587952, -693.967896, -843.175720, -1081.308472, -

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198	105.552757, 71.800415, -42.032394, -72.381523, -146.560120, -183.135468, 85.448723,
199	265.414490, 642.176758, -456.374176, 320.947174, 278.549408, 459.789032, 103.696960,
200	220.106293, 364.429077, 130.036377, 291.826294, -106.766251, 113.313423, -802.879395,
201	-3134.160400, -3552.298096, -3854.004883, -4320.645508, -1937.848022, -665.023315, -176.597946,
202	-1004.107605, -1031.160889, -1016.486206, -1210.363159, -849.197205, -107.791985, 161.588196,
203	-693.122864, 325.670166, -643.304443, -1307.331299, -789.680725, -839.081665, -1511.067627,
204	-391.568237, -99.078201, -259.886230, -22.610729, -472.509125, -513.719727, -1472.088257,
205	-1575.965454, -1609.202637, -1605.129883, -1001.017700, -1327.703369, -1221.082031, -2007.426270,
206	-354.735535, -381.940735, -894.146545, -998.646545, -1582.024902, -1441.162598, -2270.900391,
207	-750.359741, -745.182007, -1095.111572, -693.184387, -1186.341431, -954.111694, -1859.068237,
208	250.793350, 308.514526, 257.658905, 259.137177, 223.083923, 209.800003, 187.700897,
209	-398.730713, -282.424469, -167.861862, -148.836700, -112.436821, -333.931335, -371.274994,
210	1144.176147, 854.793945, 247.951218, 476.229004, 262.055573, -210.412064, -311.474915,
211	549.641846, 657.539246, 324.278534, 175.408035, 147.500793, -372.890747, -527.594421,
212	-1552.106812, -1189.027100, -1516.479858, -1235.234619, -1642.160400, -1497.831909, -2275.606689,
213	-1900.223633, -1642.089966, -1345.290283, -844.898010, -877.631287, -742.815796, -1521.429077,
214	-1037.835571, -656.155457, -1014.410461, -1315.275879, -1811.045044, -1302.612793, -2036.575439,
215	-1133.035889, -952.475220, -746.429382, -676.345276, -574.932373, -664.157715, -847.545410,
216	-277.608704, -261.225098, -345.695862, -430.000031, -623.311157, -1011.414001, -1672.150635,
217	-624.576355, -378.763763, -600.394714, 450.444885, -208.235550, -1186.607300, -2060.245605,
218	-1379.375122, -1278.502930, -1671.380737, -1521.290283, -2184.201172, 1036.537231, 14.498406,

219	830.555298, 273.704865, -430.866608, -879.656616, -1596.880859, -1735.605835, -2732.404785,
220	-862.293884, -338.837738, -256.978302, 453.634369, 21.184637, -388.895355, -1367.653931,
221	-1692.275391, -837.354309, -996.297546, -650.886047, -921.391785, -735.284485, -1599.094971,
222	-1439.049561, -403.948120, -264.716797, 34.880165, 133.721527, 270.342712, 130.799301,
223	-1024.433105, -954.402954, -1288.265259, -1510.096436, -1241.741699, -1407.657593, -2138.514893,
224	-451.752625, -810.942505, -1316.806030, -927.019775, -1375.180420, -1263.507812, -2100.465088,
225	-1834.794678, -2015.035034, -2055.714844, -1205.373779, -1243.619385, -921.998596, -1739.512573,
226	-653.094360, 321.666351, -575.164124, -1054.779297, -423.627563, -749.007141, -649.139587,
227	-1019.843872, -932.372925, -1270.553223, -954.567322, -1360.970947, -982.806152, -1841.252563,
228	656.237000, 825.421204, 1135.276611, 1071.027466, 868.291321, 698.187012, 569.556580,
229	-164.890488, 1052.856323, 1300.618042, 1116.814819, 866.946289, 658.868591, 540.566589,
230	406.070679, 248.316833, 124.479065, -133.411728, -337.961334, -940.607117, -1446.928711,
231	-2312.506348, -2472.395020, -2646.736816, -2790.495605, -3112.582520, -3451.777344, -701.623169,
232	-1843.943604, 176.875397, -623.110596, -896.002991, -45.831070, 140.156006, -0.054655,
233	-932.922363, -900.730530, -913.869141, -806.471497, -986.032654, -1149.484009, -1910.793213,
234	-133.844696, -514.168762, 390.051361, 641.783997, 484.533081, 417.025787, 398.798676,
235	-459.463898, -717.394775, -1327.284668, -1522.364502, -1866.756714, -1091.245850, -1919.993530,
236	-1220.196655, -560.840759, -629.177979, -229.373505, -581.638794, -572.932739, -1513.422974,
237	2318.115723, 2330.241455, 2003.659424, 1627.261719, 1242.322510, 922.694458, 694.189758,
238	-2558.335205, -3061.049561, -3702.576660, -4377.168945, -5217.957520, -1919.715210, -578.802551,
239	-1606.604858, -1942.337036, -2280.985107, -1590.558960, -1840.323120, -1495.487305, -2178.358887,
240	47.630093, 198.778152, -192.687698, -91.508957, -656.806152, -685.909973, -1680.821411,

241	-1399.591064, -1436.676147, -1885.677856, -1912.264404, -2472.140137, -2558.057861, -3365.300781,
242	-1179.167236, -329.757782, -726.824158, -1418.054688, -688.230408, -842.688477, -1137.900513,
243	-1112.851807, -863.788086, -1080.140869, -825.756531, -1136.570923, -786.616638, -1648.041382,
244	-662.255981, -671.808655, -1132.820679, -1111.957642, -1657.906616, -1473.291992, -2316.884277,
245	-58.572517, -21.614277, -155.525177, -194.482086, -169.745590, -534.487610, -758.021912,
246	-2220.477051, -1790.342407, -1814.036011, -1498.163818, -1578.185303, -1200.352905, -1899.312378,
247	-996.253418, -764.938782, -1122.369385, -1230.562012, -1659.632324, -761.955811, -1652.573120,
248	897.895508, 1630.975220, 1602.244385, 1327.910034, 1011.544312, 757.971924, 595.457275,
249	-1431.946777, -1347.628540, -1499.096924, -1541.816772, -2171.504150, -898.291260, 66.963020,
250	-312.534912, -152.314102, -438.497650, -254.288010, -734.177368, -682.732117, -1636.434814,
251	-1506.427002, -1305.687256, -1081.984497, -917.416138, -629.043396, -482.883453, -376.623718,
252	-672.532898, -546.122559, -512.605530, -442.461212, -371.147522, -294.251678, -130.954529,
253	-616.184143, -447.972778, -481.961853, -102.225723, -291.078766, 145.353958, -757.344055,
254	383.866699, 442.064697, 416.969147, 467.443085, 480.903381, 487.482300, 455.388672,
255	-1118.679810, -1169.146851, -1470.901733, -1265.922729, -1537.622925, -955.582031, -1795.824219,
256	-2596.727295, -3005.560547, -3863.063232, -4400.398926, -5535.787598, -5088.401367, -931.938293f

表 B.11 低精度 LSF 矢量量化码书 第二级 第一子矢量码书 lsf_stage2_CB1_lbr

索引	码字
1	125.176781, 97.578979, -336.364807, 137.200378, 596.080078,
2	-65.084419, 60.324146, 216.620468, 217.536072, -1.865530,
3	-271.406830, -56.965103, -308.899261, -197.953033, -211.553497,
4	-53.075191, 110.288887, -125.435249, -134.959381, 106.253815,
5	-208.034668, -478.204865, -54.979763, -170.765671, 56.116074,
6	-351.061218, -100.707382, 4.522793, -203.290604, -63.801029,
7	-15.212132, -196.821518, -594.479004, -396.369141, 340.373474,

8	233.424438, -0.900044, -146.513824, 45.203060, 199.356506,
9	-175.750717, -504.816986, -123.821861, 272.267731, 17.651171,
10	56.609001, -164.182388, 282.474365, -167.583649, -611.753967,
11	-115.305000, -410.567474, -245.159256, 32.249302, 472.335541,
12	-395.985168, -152.604843, -179.300735, 98.311966, 40.804863,
13	-58.728832, -182.516876, -255.976562, -256.143646, 22.885551,
14	316.159882, 151.374481, -191.210144, 7.382407, -124.037529,
15	267.551727, -143.205856, -556.498352, 10.446942, -139.945602,
16	-59.872601, -218.755066, -135.179184, 17.986374, 126.528053,
17	-167.446899, 404.004425, 89.689842, 215.293472, 99.381721,
18	23.880964, 436.191742, -66.432892, 294.669983, -230.850113,
19	-97.411232, -77.451683, -39.728432, 151.893845, 400.719330,
20	-189.941666, -360.634338, 305.063385, -129.827194, -229.681717,
21	147.476151, -121.121750, 123.489090, 198.466431, 133.996948,
22	168.695541, -282.628235, 57.746059, -110.763184, 256.777191,
23	466.524017, 48.549519, 3.054227, -309.880829, 455.355286,
24	-96.707848, -226.300293, -348.300476, 437.114319, -237.053360,
25	-159.994415, 266.700043, 385.393860, -41.254078, 155.542038,
26	124.722549, 68.716454, 374.974396, -59.638531, -5.237550,
27	765.235229, 351.720734, 289.651245, 234.858963, 174.149719,
28	241.708282, -199.616089, 212.995590, -351.008759, -104.327087,
29	1.665737, -141.787033, -396.943237, 249.341492, 187.570786,
30	-58.401596, -344.893921, 223.540710, 343.499237, 307.385132,
31	-53.936222, 375.296906, -315.383698, 102.585754, 150.957932,
32	21.016300, 155.413589, -21.852629, 207.617325, 200.649414,
33	10.351093, 92.124763, -347.863464, -212.420975, -146.219879,
34	3.016294, 200.229645, 119.715279, -4.462936, 58.314323,
35	-63.068295, -357.047424, 646.101807, 171.314423, -429.449341,
36	177.134491, 163.830048, 123.773827, -95.167198, -304.159729,
37	46.081257, 204.553513, -387.171906, 633.753296, 87.968590,
38	-169.514145, 252.454620, -264.691772, -435.691376, 153.001617,
39	120.640579, 405.465973, -192.274933, -221.965805, -202.758636,
40	100.166435, -400.800293, -40.715820, -107.465210, -118.487724,
41	45.016270, 65.268402, 171.456894, 302.890778, -417.200684,
42	347.150360, -242.992111, -209.205505, -246.726746, 38.139465,
43	194.945053, 351.289307, -99.387756, -158.804657, 213.550888,
44	-129.357178, -340.776123, -39.346504, -359.011292, -283.851349,
45	31.403564, -107.484909, 242.595520, 21.619331, -228.102585,
46	-262.826965, -117.488831, -73.219154, -197.742828, 284.209808,
47	-60.193638, -38.268238, 159.151459, -35.138390, 194.001358,
48	-317.376831, -240.991592, 144.735809, 76.405945, 161.191895,
49	-194.797623, -231.669067, -88.555389, 1.277639, -171.221588,
50	-252.915497, 141.291977, -215.599533, 349.899689, 233.891418,

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52	-85.279602,	84.387878,	-18.888111,	-115.487076,	-158.464539,
53	245.224274,	-426.197693,	303.512543,	63.986469,	-74.643738,
54	-236.141190,	103.960800,	-59.016613,	284.933868,	-190.134613,
55	34.146214,	243.138809,	-90.727913,	53.836540,	-75.016983,
56	-270.712738,	-726.983887,	315.456696,	119.656967,	-48.197346,
57	-31.662683,	5.897125,	3.455140,	53.694481,	-2.451202,
58	729.026001,	175.908218,	-257.285645,	-153.161713,	41.570004,
59	-80.404160,	261.090393,	192.832947,	51.316048,	-202.484619,
60	-158.006607,	145.411636,	565.739990,	175.046204,	-235.165543,
61	310.425751,	-37.598225,	47.160507,	402.864685,	373.127075,
62	50.817093,	-32.576046,	-161.691788,	-209.549042,	349.112793,
63	-279.980255,	181.749924,	117.845192,	-292.787567,	156.011307,
64	237.036133,	177.224197,	174.540649,	30.305742,	297.236847,
65	358.010071,	-172.392334,	-15.699339,	31.589804,	-312.457031,
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67	-45.966713,	-147.063065,	34.420399,	-154.320145,	-20.449684,
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70	-93.373451,	-316.287323,	-203.803635,	731.280029,	355.487061,
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72	315.710754,	365.675140,	-113.759560,	257.418457,	151.386566,
73	-54.277527,	575.995667,	116.280495,	-313.935638,	326.100006,
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75	265.604034,	144.857193,	114.580612,	191.633926,	-72.416084,
76	45.641788,	312.367981,	157.248138,	-349.953979,	-87.191002,
77	-65.918320,	150.779114,	-131.731110,	-531.736023,	662.466064,
78	-159.697388,	-246.035385,	244.156631,	381.940033,	-146.819397,
79	230.185669,	-366.364471,	-172.252045,	174.231308,	92.061836,
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82	-61.141945,	508.815582,	467.931915,	527.722839,	420.139313,
83	-131.588577,	-167.306580,	485.843109,	63.184635,	89.237114,
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85	520.248596,	-109.993576,	51.674213,	101.569778,	76.834473,
86	24.268560,	-203.155319,	-323.396484,	-30.644506,	-457.271484,
87	-111.438065,	-399.305115,	-865.804260,	309.888092,	138.058884,
88	-82.622826,	-54.742317,	254.196701,	-139.716690,	566.830811,
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92	-40.049488,	-286.559692,	141.962418,	62.360870,	34.843357,
93	189.553772,	74.619942,	-83.881447,	-261.958984,	-27.939610,

94	403.209381,	68.722786,	-173.985245,	-335.583771,	-369.518097,
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102	-173.476822,	472.666779,	-5.357996,	-132.365311,	-48.892284,
103	245.283829,	-84.957413,	457.927094,	321.619659,	42.520683,
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106	-3.690514,	-179.861206,	-476.954803,	-632.629822,	-250.939194,
107	-66.380966,	170.722198,	-530.042786,	177.100327,	-181.131012,
108	-128.159744,	55.080872,	308.354065,	-254.569229,	-221.356033,
109	-201.901703,	242.691742,	-86.607887,	-396.883148,	-314.213501,
110	205.063766,	462.954620,	155.144760,	-16.457201,	-29.848045,
111	327.753082,	-196.080566,	433.168854,	-82.308937,	279.670837,
112	-25.943148,	122.535789,	106.418846,	524.088684,	64.240387,
113	126.005486,	57.947956,	-185.083878,	293.347504,	-32.417767,
114	204.149628,	-38.046509,	58.536194,	-31.194141,	-16.386127,
115	-86.873398,	-414.818848,	21.891113,	142.845123,	-476.217682,
116	117.195274,	-132.432159,	-209.501282,	-48.684799,	-105.391930,
117	-282.344055,	-42.621487,	202.447464,	49.988632,	-101.511032,
118	-149.238113,	-321.226227,	742.572449,	467.619019,	257.926819,
119	-55.879326,	65.658493,	287.207520,	217.585556,	307.118652,
120	243.938828,	-203.829315,	10.253199,	480.966309,	-107.561493,
121	-268.738800,	92.606926,	8.622302,	64.133263,	114.917183,
122	-90.888931,	497.001007,	161.134674,	-130.725739,	-558.346558,
123	-467.650482,	288.785370,	160.522598,	-0.405135,	-159.286697,
124	-399.703735,	89.198013,	259.508423,	295.884003,	167.580093,
125	-146.541641,	-195.395798,	298.586151,	-316.311310,	100.641792,
126	-148.101120,	743.981140,	366.386505,	121.370277,	-161.657700,
127	134.723831,	320.460175,	349.293152,	238.967743,	33.517555,
128	-35.735043,	-292.962158,	-26.472088,	-518.628357,	271.610901f

表 B.12　低精度 LSF 矢量量化码书 第二级 第二子矢量码书 lsf_stage2_CB2_lbr

索引	码字			
1	-243.409409,	-116.480858,	389.801025,	181.432846,
2	-696.340149,	-287.063507,	446.367493,	236.489014,
3	-393.174835,	117.744064,	-62.679790,	-412.519104,
4	-74.848740,	27.573660,	285.320068,	-59.181179,

5	116.752983, -1.356940, -109.929138, 113.496178,
6	-225.366104, -189.137146, -44.427967, -286.845917,
7	242.165924, 287.599548, -181.383621, -330.778229,
8	-179.347458, 66.509262, 109.463470, 87.632050,
9	-253.711777, 323.794830, 338.500244, -337.053680,
10	160.067596, -163.665115, 6.405066, -264.836487,
11	-60.688374, -185.087067, -191.619583, -197.485458,
12	21.429399, -370.080780, -42.411572, -108.452370,
13	-52.254684, -23.956074, -313.852173, -7.787478,
14	12.098438, 230.482193, -478.094971, -100.934822,
15	-37.458061, 288.877838, 10.201681, 475.521515,
16	2.881128, 343.488373, 450.687256, -47.208767,
17	-83.777214, 151.401154, 322.103760, 253.128464,
18	-316.890259, 28.818686, -616.391968, 192.355240,
19	511.084839, -133.957230, 361.529755, 198.506775,
20	72.080055, 199.831650, -108.111671, -84.174294,
21	-98.012787, -39.761772, -68.415688, 178.787384,
22	-265.631104, 164.766037, -440.029663, 823.557129,
23	-168.251541, 702.906860, 207.797424, -79.284523,
24	305.986115, 272.766815, 292.596832, -235.731766,
25	-788.239197, 239.276917, 113.054337, -212.844467,
26	258.902313, -333.383759, -243.586655, -307.619171,
27	-121.466507, 174.642380, -293.016357, 272.726562,
28	39.102711, -165.410400, -337.241791, 313.644287,
29	-10.405048, -185.301270, -512.177002, -270.207581,
30	101.790581, 11.252160, -62.398804, 392.750671,
31	-239.751587, -471.905090, -310.683197, -300.936493,
32	-155.268570, 119.035522, 79.837418, -192.250656,
33	131.482040, 86.621811, 93.051872, -150.859161,
34	200.261765, 223.326935, -433.248749, 433.448395,
35	-94.155045, -43.422302, 131.647949, 330.752167,
36	311.755371, 50.656456, 49.977379, -428.572540,
37	-312.415009, -121.180763, -232.275406, 138.695938,
38	209.342743, 687.162781, 184.681885, -401.803741,
39	114.690254, 171.625977, 181.704712, 260.692871,
40	-381.737579, -85.716354, 179.320496, -116.409515,
41	90.773277, -43.356819, 633.900757, 6.079812,
42	671.235840, 336.139923, -112.772232, -600.057617,
43	371.775330, -1.344244, 163.382965, -95.445984,
44	-193.736588, -71.884460, -77.847572, -49.722527,
45	-141.227814, -446.522247, 236.406113, 184.287979,
46	-268.798889, 352.709106, 39.056961, -68.754677,
47	-221.551651, -119.258545, -121.718758, 479.259888,

48	676.735718, 194.002365, -362.131866, 175.913193,
49	50.821251, -591.166016, 616.756592, -97.901886,
50	382.693909, -181.652420, -680.908813, 676.854553,
51	-80.215393, -282.486908, -509.045990, -791.799927,
52	53.088028, 499.772308, -195.334656, 77.658592,
53	17.863188, 292.266754, 71.577980, -618.104736,
54	120.337517, -7.530244, -264.265137, -287.812256,
55	-394.066956, 219.687286, 295.375671, 72.552650,
56	179.996841, -192.677536, -261.940826, -25.612436,
57	58.660305, 336.429840, 100.187775, -220.980881,
58	42.412331, 13.519630, 112.433083, 138.155304,
59	266.368958, 21.970327, -107.287674, -144.994812,
60	78.719635, -430.507874, 168.567307, -456.712982,
61	-411.224457, 74.529732, -57.504768, -21.765814,
62	196.090912, 137.380432, 57.631134, 50.901695,
63	-123.902313, -284.127167, 288.213501, -152.852875,
64	-302.251831, -356.747955, 204.819641, 551.967896,
65	-393.012970, -43.004662, 636.058228, -192.525909,
66	-127.849014, 434.849792, -159.721878, -301.210571,
67	21.238861, -452.225281, -153.344681, 734.341736,
68	10.870827, 185.948196, -6.938921, 175.038879,
69	-432.968109, -610.992554, -137.377045, 243.536591,
70	180.154404, 423.220062, 163.796448, 72.456429,
71	-452.403168, 175.101013, 299.354309, 512.337463,
72	38.909637, -7.877390, 262.278534, 613.609680,
73	-47.382046, -109.140800, 42.966789, -158.798386,
74	-425.121552, -512.733276, 249.457809, -226.062881,
75	182.071060, -206.442108, -688.257446, 108.594162,
76	2.062111, 224.044220, 155.120468, 19.599276,
77	38.487358, -31.999537, -109.859627, -119.361366,
78	162.551880, 67.492264, 290.018524, 45.786263,
79	436.423676, -43.198994, -77.049904, 569.098450,
80	363.950043, 281.895386, -25.208874, -89.876564,
81	-248.373856, -321.788391, -56.249428, -39.337593,
82	425.436371, -16.661833, -59.625412, 116.543587,
83	-82.381096, -163.117569, 114.577087, 70.018883,
84	253.342102, -523.466125, 201.246658, 378.887482,
85	-131.377869, 66.285393, -167.358292, -217.760086,
86	-566.463745, -226.344803, -157.164017, -86.413437,
87	390.181671, -371.196930, 13.734019, -36.191559,
88	446.689575, -241.156555, -321.963715, 233.878906,
89	77.666321, -131.525879, 320.331818, 256.978943,
90	367.632355, 216.511093, 243.643234, 123.523415,

91	-657.771362, 41.172512, -83.689575, 283.212250,
92	-460.604584, 638.931152, 35.756577, -559.100403,
93	-226.586746, -80.584587, 233.980896, -493.453033,
94	417.722504, -1.672927, -464.180389, -184.742569,
95	167.272629, -281.216431, 276.785431, -22.157265,
96	-284.334778, -108.795586, -299.789734, -209.318359,
97	-132.045181, 395.118500, 158.724670, 211.790054,
98	301.987091, -0.899439, -280.349152, -661.502075,
99	578.751221, 626.476074, 518.695251, 378.556610,
100	257.378601, -25.404896, 135.438293, 242.261215,
101	132.840515, -251.884521, -2.454656, 241.139893,
102	22.451145, 63.981472, -25.862547, -355.621521,
103	-132.091568, -329.954651, -77.058594, 239.968750,
104	-34.870598, -171.217773, -174.181763, -465.647217,
105	449.525177, -237.710693, 438.640564, -306.627014,
106	-20.192402, -701.768494, 79.301132, -45.662354,
107	-29.979303, -361.198029, 703.003723, 443.174042,
108	591.450317, -28.069363, -93.527534, -223.932785,
109	-472.069946, -989.679260, 528.279358, 340.102905,
110	114.742538, -549.570740, -281.955597, 145.624893,
111	-292.186951, 138.453705, 13.866644, 271.594849,
112	307.743439, 269.438049, -34.875519, 267.321228,
113	-33.110497, -172.138855, -109.525803, 26.296240,
114	246.703857, 123.510437, -305.353668, 83.845627,
115	-102.935699, 587.943848, 636.555054, 524.072510,
116	-145.242615, -315.349030, -352.720276, 21.209959,
117	142.747467, -102.298622, 50.486584, -9.182832,
118	234.382019, 261.100342, 365.964935, 399.349396,
119	684.732361, 396.310455, 181.284805, -108.301056,
120	-241.690918, -467.369324, -675.536865, 491.443207,
121	-100.938423, 147.491653, -313.448547, -511.904236,
122	-698.902588, 653.364136, 431.230652, -23.328299,
123	-15.995284, 31.354193, 3.822088, -5.892229,
124	-432.100098, 260.371490, -357.567444, -122.324028,
125	-354.313080, -164.696030, 75.725403, 181.991409,
126	-447.009247, 496.912720, -161.698349, 245.110306,
127	77.673477, -7.057706, 335.725311, -319.795929,
128	-162.106491, 166.707016, -136.834305, 26.008549f

表 B.13 低精度 LSF 矢量量化码书 第二级 第三子矢量码书 lsf_stage2_CB3_lbr

索引	码字
1	-120.858948, -66.756027, 54.656181, 64.874451, 124.259438,

	20.630352, 458.284790,
2	54.381855, 279.556610, -216.506119, -67.174606, 1.014068, 17.655251, 6.228757,
3	-28.685160, 154.050797, -48.445076, -277.829315, 285.749939, 195.247452, 132.268265,
4	-141.355896, -64.183372, -85.978325, 75.814301, 73.956757, 249.112961, 100.836151,
5	-395.490082, 105.968681, -137.138885, -185.565430, -4.196878, 9.040785, 9.331719,
6	297.102386, -264.661957, -128.039383, -27.582905, -86.045662, -90.526764, -60.119183,
7	174.266235, -103.852974, -37.978733, 31.690355, 302.096497, 135.048508, 114.836746,
8	-101.046234, -23.895374, -147.228592, 31.045322, -344.268677, 149.099213, -37.257492,
9	-61.336628, 37.914291, 10.385083, 105.648895, 6.490855, 109.133385, -364.720398,
10	-57.522472, -73.206619, -200.797119, -141.121109, -115.150620, 650.165649, 423.394958,
11	-73.722351, -140.067551, 140.425919, -391.595581, -5.604278, -10.986897, -15.726768,
12	-108.406639, -6.762465, -37.700020, -6.168937, -11.448340, 0.249742, 0.123609,
13	152.156693, 28.136551, -168.495224, 65.982376, -84.628181, -83.325134, -141.856110,
14	486.470673, 77.363564, -187.013657, 136.576614, 96.876122, 25.852430, 7.105801,
15	-983.513672, 399.680298, 283.328339, 145.344055, 54.366695, -53.572399, 39.212997,
16	-220.661285, -47.986832, 179.123917, 401.111053, 340.343872, 159.414078, 69.568336,
17	-105.138153, 51.941540, 56.188911, -144.363174, -119.869408, 141.778366, 128.125656,
18	-263.076965, 254.405991, 333.602570, -42.307457, -451.265350, -73.605690, 22.996130,
19	-29.157436, 69.872826, 346.867462, -87.169640, 26.287106, -3.849262, 4.497209,
20	-24.435114, -195.265182, -99.388878, 206.267960, 83.080887, -0.377817, -45.230667,
21	-187.647476, 181.213882, -273.944153, 255.762146, -67.340736, 23.068657, 10.287804,
22	-172.619736, -140.707123, -190.551239, -6.177309, -41.383221, -111.614410, -169.822540,
23	27.315220, -127.491776, -76.529587, -380.704071, 712.483704,

	168.066162, -282.497314,
24	144.456070, 74.449486, 73.299232, -89.281288, -230.136108, -50.344418, -61.720192,
25	71.039864, 16.484489, -81.132729, -146.860245, -239.453995, -276.474915, -495.753235,
26	-6.601482, -6.596558, -135.847580, -200.303955, -149.754517, -46.271084, -42.693810,
27	114.541161, 96.925179, -62.422073, 267.284790, 92.719643, 138.007202, 0.382021,
28	39.763325, -115.202148, -418.437439, -42.130184, 56.940830, 87.226730, 38.288715,
29	21.468893, -166.728149, -67.645279, -66.803993, -17.396999, 36.986813, 13.436744,
30	4.862719, -45.827774, -68.863770, -164.614624, -305.732239, -554.339478, 19.752028,
31	6.885021, -95.595200, -104.018166, -184.963974, 31.702078, -84.178284, 256.128448,
32	-192.003845, -394.069550, -488.481445, -438.397797, -190.934586, -44.327446, -26.086609,
33	-125.266785, 137.131226, 39.229233, -10.948144, -105.625397, -123.229942, -139.748444,
34	184.016785, 264.055878, 123.471939, -34.399540, -232.265396, 397.860321, 90.333214,
35	80.903946, -43.319683, 180.592911, -59.142773, 138.443069, -390.676544, 205.455032,
36	-132.122040, -139.576950, 106.337486, -21.377464, 174.604553, 16.855715, 61.933849,
37	88.327904, -498.666840, 137.356384, 33.944885, 67.351425, 20.773945, 24.755754,
38	-345.485718, -27.660803, 67.980339, 83.968163, 23.501289, -11.475863, -47.268600,
39	178.483002, -24.934628, -96.635849, -13.439441, -88.224274, 176.098663, 124.763161,
40	-26.483379, 21.979994, -20.658539, 330.616333, -43.313259, -384.421143, 48.723835,
41	62.266487, -44.714783, -115.789307, -188.385208, 183.125153, -185.326904, -155.693787,
42	53.820332, 81.532997, 98.294876, 40.696548, 98.454292, 119.502266, 147.300720,
43	254.267975, 70.164246, 47.383190, -142.257462, 37.144730, -19.954918, 38.457348,
44	-82.691055, -20.630274, 185.650543, 180.139053, -90.897530, 109.889763, 58.255798,

45	244.058670, -122.199280, 189.862457, 132.944275, 46.770733, 22.384722, -2.599370,
46	-236.754898, -243.830826, -54.952366, -73.321976, -94.426300, -12.912512, 69.587036,
47	91.892441, -262.573792, 314.933350, -58.419174, -324.563995, 88.949524, 50.423519,
48	417.443909, 69.775948, -251.358078, -512.123352, 4.932464, -0.540782, 29.553900,
49	-150.129364, -145.058929, 114.207970, 211.513779, 194.664597, -268.673645, -373.467438,
50	66.813667, 16.556433, 26.886477, 15.414439, 15.461973, -7.944495, -0.863844,
51	302.242676, 324.145844, 329.172577, 244.085281, 176.245163, 87.874321, 56.691006,
52	-36.683731, -139.869324, 80.175735, -27.114138, -77.579376, -157.658203, -124.447487,
53	108.132103, 97.285461, 7.401071, -2.834207, -210.823380, -171.585175, 446.059509,
54	-244.690735, -307.984222, 598.741272, 230.457870, -28.186348, -101.380302, -8.740450,
55	-70.319702, 127.248039, -167.226410, 85.655022, 303.577606, -59.247124, -66.811310,
56	-215.468704, 348.959717, 98.189171, 90.742363, 79.830116, 84.431984, 36.955971,
57	-36.783245, 69.040504, 133.008469, 157.655502, 128.536774, -34.705322, -65.879082,
58	-73.992271, 343.438080, 48.778431, -304.844391, 57.568405, -77.251152, -63.522530,
59	200.285736, 120.431190, 115.817978, 93.692749, 40.653152, -164.645035, -240.228683,
60	110.406593, 221.153152, 92.144363, 56.062359, -36.240662, 27.389029, -19.072336,
61	-588.968384, -505.493042, -121.743179, 46.453411, 157.052521, 44.954498, 34.388012,
62	526.978088, 425.036041, 189.527222, -62.570236, -241.602249, -253.744858, -42.391441,
63	239.768356, 44.924934, -128.932877, -433.974670, -694.861633, 37.230545, 13.897585,
64	32.482452, -241.068497, -579.445068, 523.904236, 267.373016, 4.412733, -53.777256f

表 B.14 TNS 反射系数标量量化码书 tnsCoeff4

索引	码字
1	-0.9957341763F
2	-0.9618256432F
3	-0.8951632914F
4	-0.7980172227F
5	-0.6736956436F
6	-0.5264321629F
7	-0.3612416661F
8	-0.1837495178F
9	0.0000000000F
10	0.2079116908F
11	0.4067366431F
12	0.5877852523F
13	0.7431448255F
14	0.8660254038F
15	0.9510565163F
16	0.9945218954F

表 B.15　TNS 反射系数量化索引的哈夫曼码书 第 1 维 tnsCodingTable0

索引	码字	比特数
1	4053	12
2	1012	10
3	507	9
4	127	7
5	30	5
6	0	3
7	1	3
8	2	3
9	2	2
10	3	3
11	6	3
12	14	4
13	62	6
14	252	8
15	2027	11
16	8105	13

表 B.16　TNS 反射系数量化索引的哈夫曼码书 第 2 维 tnsCodingTable1

索引	码字	比特数
1	15360	15

2	7681	14
3	3841	13
4	961	11
5	241	9
6	61	7
7	14	5
8	2	3
9	2	2
10	3	2
11	0	2
12	6	4
13	31	6
14	121	8
15	481	10
16	1921	12

表 B.17　TNS 反射系数量化索引的哈夫曼码书 第 3 维 tnsCodingTable2

索引	码字	比特数
1	27136	15
2	27137	15
3	3393	12
4	425	9
5	107	7
6	52	6
7	12	4
8	7	3
9	0	1
10	2	2
11	27	5
12	213	8
13	849	10
14	1697	11
15	6785	13
16	27138	15

表 B.18　TNS 反射系数量化索引的哈夫曼码书 第 4 维 tnsCodingTable3

索引	码字	比特数
1	8708	14
2	8709	14
3	8710	14
4	1089	11

5	273	9
6	137	8
7	35	6
8	5	3
9	0	1
10	3	2
11	9	4
12	16	5
13	69	7
14	545	10
15	8711	14
16	4352	13

表 B.19　TNS 反射系数量化索引的哈夫曼码书 第 5 维 tnsCodingTable4

索引	码字	比特数
1	4100	14
2	4101	14
3	4102	14
4	257	10
5	65	8
6	17	6
7	5	4
8	0	2
9	1	1
10	3	3
11	9	5
12	33	7
13	129	9
14	513	11
15	4103	14
16	2048	13

表 B.20　TNS 反射系数量化索引的哈夫曼码书 第 6 维 tnsCodingTable5

索引	码字	比特数
1	8272	14
2	8273	14
3	2069	12
4	516	10
5	128	8
6	65	7
7	17	5

8	5	3
9	0	1
10	3	2
11	9	4
12	33	6
13	259	9
14	1035	11
15	8274	14
16	8275	14

表 B.21　TNS 反射系数量化索引的哈夫曼码书 第 7 维 tnsCodingTable6

索引	码字	比特数
1	13312	14
2	13313	14
3	3329	12
4	833	10
5	209	8
6	53	6
7	12	4

表 B.21　TNS 反射系数量化索引的哈夫曼码书 第 7 维 tnsCodingTable6（续）

索引	码字	比特数
8	2	2
9	0	1
10	7	3
11	27	5
12	105	7
13	417	9
14	1665	11
15	13314	14
16	13315	14

表 B.22　TNS 反射系数量化索引的哈夫曼码书 第 8 维 tnsCodingTable7

索引	码字	比特数
1	10490	14
2	2625	12
3	657	10
4	165	8
5	83	7
6	21	5

7	4	3
8	3	2
9	10497	14
10	0	1
11	11	4
12	40	6
13	329	9
14	1313	11
15	10498	14
16	10499	14

表 B.23　基础部分区间编码 CDF 表

索引	概率表
1	0, 1, 65534, 65535, 65536
2	0, 2, 65533, 65535, 65536
3	0, 12, 65523, 65535, 65536
4	0, 55, 65480, 65535, 65536
5	0, 179, 65356, 65535, 65536
6	0, 459, 65076, 65535, 65536
7	0, 977, 64558, 65535, 65536
8	0, 1794, 63741, 65535, 65536
9	0, 2930, 62605, 65535, 65536
10	0, 4363, 61172, 65535, 65536
11	0, 2, 6036, 59499, 65533, 65535, 65536
12	0, 14, 7875, 57659, 65521, 65535, 65536
13	0, 60, 9803, 55732, 65475, 65535, 65536
14	0, 193, 11751, 53783, 65342, 65535, 65536
15	0, 486, 13662, 51872, 65047, 65533, 65536
16	0, 11, 1026, 15497, 50038, 64509, 65524, 65535, 65536
17	0, 49, 1865, 17225, 48310, 63670, 65486, 65535, 65536
18	0, 162, 3022, 18829, 46701, 62508, 65368, 65530, 65536
19	0, 413, 4460, 20292, 45210, 61042, 65089, 65502, 65536
20	0, 67, 923, 6162, 21653, 43879, 59370, 64608, 65464, 65531, 65536
21	0, 201, 1702, 7997, 22859, 42645, 57507, 63802, 65303, 65504, 65536
22	0, 61, 530, 2824, 9939, 23967, 41557, 55585, 62700, 64994, 65464, 65525, 65536,
23	0, 180, 1078, 4213, 11864, 24931, 40550, 53617, 61268, 64402, 65300, 65480, 65536
24	0, 88, 502, 1967, 5882, 13783, 25824, 39680, 51721, 59622, 63537, 65002, 65416, 65504, 65536
25	0, 55, 286, 1064, 3165, 7714, 15614, 26614, 38897, 49897, 57797, 62346, 64447, 65225, 65456, 65511, 65536
26	0, 156, 637, 1884, 4605, 9595, 17291, 27272, 38156, 48136, 55832, 60822, 63543, 64790, 65271, 65427, 65536

27	0, 124, 469, 1304, 3067, 6316, 11545, 18890, 27895, 37534, 46540, 53885, 59114, 62363, 64126, 64961, 65306, 65430, 65536
28	0, 114, 396, 1024, 2278, 4531, 8170, 13454, 20350, 28441, 36974, 45065, 51961, 57245, 60884, 63137, 64391, 65019, 65301, 65415, 65536
29	0, 116, 373, 896, 1874, 3556, 6217, 10091, 15279, 21671, 28915, 36468, 43712, 50104, 55292, 59166, 61827, 63509, 64487, 65010, 65267, 65383, 65536
30	0, 60, 188, 443, 917, 1743, 3091, 5153, 8106, 12068, 17049, 22914, 29382, 36065, 42533, 48398, 53379, 57341, 60294, 62356, 63704, 64530, 65004, 65259, 65387, 65447, 65536
31	0, 78, 227, 495, 953, 1698, 2849, 4538, 6893, 10013, 13940, 18637, 23975, 29739, 35652, 41416, 46754, 51451, 55378, 58498, 60853, 62542, 63693, 64438, 64896, 65164, 65313, 65391, 65536
32	0, 58, 162, 340, 633, 1097, 1804, 2838, 4291, 6253, 8798, 11970, 15767, 20136, 24964, 30091, 35322, 40449, 45277, 49646, 53443, 56614, 59159, 61121, 62574, 63608, 64315, 64779, 65072, 65250, 65354, 65412, 65536
33	0, 50, 134, 271, 486, 814, 1299, 1995, 2962, 4263, 5961, 8109, 10742, 13870, 17471, 21490, 25836, 30391, 35018, 39573, 43919, 47938, 51539, 54667, 57300, 59448, 61146, 62448, 63415, 64111, 64596, 64924, 65139, 65276, 65360, 65410, 65536
34	0, 49, 126, 245, 423, 683, 1054, 1570, 2271, 3201, 4403, 5920, 7789, 10034, 12667, 15680, 19044, 22709, 26606, 30648, 34740, 38783, 42680, 46345, 49709, 52722, 55355, 57600, 59469, 60986, 62188, 63118, 63819, 64335, 64706, 64966, 65144, 65263, 65340, 65389, 65536
35	0, 53, 131, 245, 407, 634, 945, 1364, 1917, 2634, 3545, 4680, 6068, 7734, 9694, 11957, 14521, 17370, 20475, 23795, 27278, 30863, 34483, 38068, 41551, 44871, 47976, 50825, 53389, 55652, 57612, 59278, 60666, 61801, 62712, 63429, 63982, 64401, 64712, 64939, 65101, 65215, 65293, 65346, 65536
36	0, 43, 104, 189, 306, 466, 680, 962, 1329, 1799, 2392, 3129, 4031, 5119, 6412, 7925, 9669, 11650, 13867, 16311, 18965, 21804, 24796, 27902, 31079, 34280, 37457, 40563, 43555, 46394, 49048, 51492, 53709, 55690, 57434, 58947, 60240, 61328, 62230, 62967, 63560, 64030, 64397, 64679, 64893, 65053, 65171, 65256, 65317, 65360, 65536
37	0, 39, 93, 166, 263, 390, 556, 770, 1042, 1383, 1807, 2327, 2958, 3715, 4613, 5664, 6881, 8274, 9849, 11610, 13555, 15679, 17971, 20416, 22993, 25678, 28443, 31257, 34088, 36902, 39667, 42352, 44929, 47374, 49666, 51790, 53735, 55496, 57071, 58464, 59681, 60732, 61630, 62387, 63018, 63538, 63962, 64303, 64575, 64789, 64955, 65083, 65180, 65253, 65307, 65346, 65536
38	0, 31, 71, 124, 193, 282, 395, 538, 717, 939, 1211, 1543, 1943, 2422, 2989, 3655, 4429, 5322, 6341, 7495, 8789, 10227, 11810, 13537, 15404, 17403, 19525, 21757, 24083, 26485, 28942, 31433, 33936, 36427, 38884, 41286, 43612, 45844, 47966, 49965, 51832, 53559, 55142, 56580, 57874, 59028, 60047, 60940, 61714, 62380, 62947, 63426, 63826, 64158, 64430, 64652, 64831, 64974, 65087, 65176, 65245, 65298, 65338, 65369, 65536
39	0, 27, 62, 107, 163, 234, 322, 431, 564, 726, 922, 1158, 1439, 1771, 2162, 2618, 3146, 3753, 4446, 5232, 6116, 7104, 8201, 9409, 10730, 12165, 13712, 15368, 17128, 18985, 20931, 22955, 25045, 27188, 29370, 31575, 33788, 35993, 38175, 40318, 42408, 44432, 46378, 48235, 49995, 51651, 53198, 54633, 55954, 57162, 58259, 59247, 60131, 60917, 61610, 62217, 62745, 63201, 63592, 63924, 64205, 64441, 64637, 64799, 64932, 65041, 65129, 65200, 65256, 65301, 65336, 65363, 65536
40	0, 28, 62, 104, 156, 219, 296, 389, 500, 632, 789, 974, 1192, 1446, 1740, 2080, 2470, 2914, 3418, 3987, 4625, 5337, 6127, 6998, 7953, 8995, 10125, 11344, 12651, 14045, 15524, 17084, 18720,

	20426, 22195, 24020, 25891, 27800, 29736, 31688, 33645, 35597, 37533, 39442, 41313, 43138, 44907, 46613, 48249, 49809, 51288, 52682, 53989, 55208, 56338, 57380, 58335, 59206, 59996, 60708, 61346, 61915, 62419, 62863, 63253, 63593, 63887, 64141, 64359, 64544, 64701, 64833, 64944, 65037, 65114, 65177, 65229, 65271, 65305, 65333, 65536
41	0, 25, 55, 91, 135, 187, 249, 322, 408, 509, 627, 764, 923, 1107, 1318, 1559, 1833, 2144, 2494, 2888, 3328, 3818, 4361, 4960, 5619, 6339, 7124, 7975, 8894, 9882, 10939, 12065, 13260, 14522, 15850, 17240, 18689, 20193, 21748, 23347, 24986, 26657, 28354, 30070, 31797, 33528, 35255, 36971, 38668, 40339, 41978, 43577, 45132, 46636, 48085, 49475, 50803, 52065, 53260, 54386, 55443, 56431, 57350, 58201, 58986, 59706, 60365, 60964, 61507, 61997, 62437, 62831, 63181, 63492, 63766, 64007, 64218, 64402, 64561, 64698, 64816, 64917, 65003, 65076, 65138, 65190, 65234, 65270, 65300, 65325, 65536
42	0, 21, 46, 76, 111, 152, 200, 256, 320, 395, 481, 580, 693, 822, 969, 1135, 1323, 1534, 1771, 2036, 2331, 2658, 3020, 3419, 3858, 4339, 4864, 5434, 6052, 6720, 7439, 8210, 9034, 9912, 10845, 11832, 12873, 13967, 15113, 16309, 17553, 18842, 20174, 21545, 22952, 24391, 25857, 27346, 28853, 30373, 31901, 33431, 34959, 36479, 37986, 39475, 40941, 42380, 43787, 45158, 46490, 47779, 49023, 50219, 51365, 52459, 53500, 54487, 55420, 56298, 57122, 57893, 58612, 59280, 59898, 60468, 60993, 61474, 61913, 62312, 62674, 63001, 63296, 63561, 63798, 64009, 64197, 64363, 64510, 64639, 64752, 64851, 64937, 65012, 65076, 65132, 65180, 65221, 65256, 65286, 65311, 65332, 65536
43	0, 20, 44, 71, 102, 138, 180, 228, 282, 344, 414, 494, 584, 685, 799, 926, 1068, 1227, 1403, 1599, 1815, 2053, 2315, 2603, 2918, 3261, 3635, 4040, 4479, 4952, 5462, 6009, 6595, 7221, 7887, 8595, 9345, 10137, 10971, 11848, 12767, 13727, 14728, 15769, 16848, 17964, 19115, 20299, 21513, 22755, 24022, 25311, 26620, 27945, 29282, 30628, 31979, 33332, 34683, 36029, 37366, 38691, 40000, 41289, 42556, 43798, 45012, 46196, 47347, 48463, 49542, 50583, 51584, 52544, 53463, 54340, 55174, 55966, 56716, 57424, 58090, 58716, 59302, 59849, 60359, 60832, 61271, 61676, 62050, 62393, 62708, 62996, 63258, 63496, 63712, 63908, 64084, 64243, 64385, 64512, 64626, 64727, 64817, 64896, 64966, 65028, 65082, 65130, 65172, 65208, 65239, 65266, 65290, 65310, 65536
44	0, 16, 35, 56, 80, 108, 139, 174, 214, 259, 309, 365, 428, 498, 577, 664, 761, 868, 986, 1116, 1260, 1418, 1591, 1780, 1986, 2210, 2453, 2717, 3002, 3310, 3642, 3999, 4381, 4790, 5227, 5693, 6189, 6715, 7273, 7862, 8484, 9139, 9827, 10548, 11302, 12089, 12909, 13761, 14645, 15560, 16505, 17480, 18483, 19512, 20566, 21644, 22743, 23862, 24999, 26151, 27317, 28494, 29679, 30871, 32066, 33263, 34458, 35650, 36835, 38012, 39178, 40330, 41467, 42586, 43685, 44763, 45817, 46846, 47849, 48824, 49769, 50684, 51568, 52420, 53240, 54027, 54781, 55502, 56190, 56845, 57467, 58056, 58614, 59140, 59636, 60102, 60539, 60948, 61330, 61687, 62019, 62327, 62612, 62876, 63119, 63343, 63549, 63738, 63911, 64069, 64213, 64343, 64461, 64568, 64665, 64752, 64831, 64901, 64964, 65020, 65070, 65115, 65155, 65190, 65221, 65249, 65273, 65294, 65313, 65329, 65536
45	0, 15, 32, 51, 72, 96, 123, 153, 186, 223, 264, 309, 359, 414, 475, 542, 616, 697, 786, 883, 989, 1105, 1231, 1368, 1516, 1676, 1849, 2036, 2238, 2455, 2688, 2938, 3205, 3490, 3795, 4119, 4464, 4830, 5218, 5629, 6063, 6521, 7003, 7509, 8040, 8597, 9180, 9788, 10422, 11082, 11768, 12480, 13217, 13980, 14767, 15579, 16414, 17272, 18152, 19053, 19974, 20915, 21873, 22848, 23838, 24842, 25859, 26886, 27923, 28967, 30017, 31072, 32129, 33187, 34244, 35299, 36349, 37393, 38430, 39458, 40475, 41479, 42469, 43444, 44402, 45343, 46264, 47165, 48045, 48903, 49738, 50550,

	51337, 52100, 52837, 53549, 54235, 54895, 55529, 56137, 56720, 57277, 57808, 58314, 58796, 59254, 59688, 60099, 60487, 60853, 61198, 61522, 61827, 62112, 62379, 62629, 62862, 63079, 63281, 63468, 63641, 63801, 63949, 64086, 64212, 64328, 64434, 64531, 64620, 64701, 64775, 64842, 64903, 64958, 65008, 65053, 65094, 65131, 65164, 65194, 65221, 65245, 65266, 65285, 65302, 65317, 65536
46	0, 14, 30, 47, 66, 87, 110, 136, 164, 195, 229, 266, 307, 351, 399, 452, 510, 573, 641, 715, 795, 881, 974, 1075, 1184, 1301, 1427, 1562, 1707, 1862, 2028, 2205, 2394, 2595, 2809, 3036, 3277, 3533, 3804, 4090, 4392, 4711, 5047, 5400, 5771, 6160, 6568, 6995, 7441, 7907, 8393, 8899, 9425, 9971, 10537, 11124, 11731, 12358, 13005, 13672, 14358, 15063, 15787, 16529, 17289, 18066, 18860, 19670, 20495, 21335, 22188, 23054, 23932, 24820, 25718, 26625, 27539, 28460, 29386, 30316, 31249, 32184, 33120, 34055, 34988, 35918, 36844, 37765, 38679, 39586, 40484, 41372, 42250, 43116, 43969, 44809, 45634, 46444, 47238, 48015, 48775, 49517, 50241, 50946, 51632, 52299, 52946, 53573, 54180, 54767, 55333, 55879, 56405, 56911, 57397, 57863, 58309, 58736, 59144, 59533, 59904, 60257, 60593, 60912, 61214, 61500, 61771, 62027, 62268, 62495, 62709, 62910, 63099, 63276, 63442, 63597, 63742, 63877, 64003, 64120, 64229, 64330, 64423, 64509, 64589, 64663, 64731, 64794, 64852, 64905, 64953, 64997, 65038, 65075, 65109, 65140, 65168, 65194, 65217, 65238, 65257, 65274, 65290, 65304, 65536
47	0, 12, 25, 39, 55, 72, 91, 111, 133, 157, 183, 212, 243, 277, 313, 352, 395, 441, 491, 544, 601, 663, 729, 800, 876, 958, 1045, 1138, 1238, 1344, 1457, 1578, 1706, 1842, 1987, 2141, 2304, 2476, 2658, 2850, 3053, 3267, 3492, 3729, 3978, 4239, 4513, 4800, 5100, 5414, 5742, 6084, 6441, 6812, 7198, 7600, 8017, 8449, 8897, 9361, 9841, 10337, 10848, 11375, 11918, 12477, 13051, 13641, 14246, 14866, 15501, 16150, 16813, 17490, 18181, 18884, 19600, 20328, 21067, 21817, 22577, 23347, 24126, 24913, 25707, 26508, 27315, 28128, 28945, 29766, 30590, 31416, 32243, 33070, 33897, 34723, 35547, 36368, 37185, 37998, 38805, 39606, 40400, 41187, 41966, 42736, 43496, 44246, 44985, 45713, 46429, 47132, 47823, 48500, 49163, 49812, 50447, 51067, 51672, 52262, 52836, 53395, 53938, 54465, 54976, 55471, 55951, 56415, 56863, 57295, 57712, 58114, 58500, 58871, 59228, 59570, 59898, 60212, 60512, 60799, 61073, 61334, 61583, 61820, 62045, 62259, 62462, 62654, 62836, 63008, 63171, 63325, 63470, 63606, 63734, 63855, 63968, 64074, 64174, 64267, 64354, 64436, 64512, 64583, 64649, 64711, 64768, 64821, 64871, 64917, 64960, 64999, 65035, 65069, 65100, 65129, 65155, 65179, 65201, 65221, 65240, 65257, 65273, 65287, 65300, 65312, 65536
48	0, 11, 23, 35, 49, 64, 80, 97, 115, 135, 156, 179, 204, 231, 260, 291, 324, 359, 397, 437, 480, 526, 575, 628, 684, 744, 808, 876, 948, 1024, 1105, 1191, 1282, 1378, 1480, 1587, 1700, 1820, 1946, 2079, 2219, 2366, 2521, 2683, 2854, 3033, 3220, 3416, 3621, 3835, 4059, 4293, 4537, 4791, 5055, 5330, 5616, 5913, 6221, 6541, 6872, 7215, 7570, 7937, 8316, 8707, 9110, 9526, 9954, 10394, 10847, 11312, 11790, 12280, 12782, 13296, 13822, 14360, 14910, 15471, 16044, 16628, 17223, 17828, 18444, 19069, 19704, 20348, 21001, 21663, 22333, 23010, 23695, 24386, 25084, 25787, 26496, 27209, 27927, 28648, 29372, 30099, 30828, 31558, 32289, 33020, 33751, 34481, 35210, 35937, 36661, 37382, 38100, 38813, 39522, 40225, 40923, 41614, 42299, 42976, 43646, 44308, 44961, 45605, 46240, 46865, 47481, 48086, 48681, 49265, 49838, 50399, 50949, 51487, 52013, 52527, 53029, 53519, 53997, 54462, 54915, 55355, 55783, 56199, 56602, 56993, 57372, 57739, 58094, 58437, 58768, 59088, 59396, 59693, 59979, 60254, 60518, 60772, 61016, 61250, 61474, 61688, 61893, 62089, 62276, 62455, 62626, 62788, 62943, 63090, 63230, 63363, 63489, 63609, 63722, 63829, 63931, 64027, 64118, 64204, 64285, 64361, 64433, 64501, 64565, 64625, 64681, 64734,

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表 B.24　上下文部分区间编码 CDF 表

索引	概率表
1	0, 1, 65534, 65535, 65536
2	0, 1, 65534, 65535, 65536
3	0, 1, 65534, 65535, 65536
4	0, 1, 65534, 65535, 65536
5	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 16, 30, 69, 169, 405, 909, 1885, 3581, 6203, 9806, 14349, 20045, 27710, 39581, 63884, 65352, 65478, 65513, 65523, 65526,

	65527, 65528, 65529, 65530, 65531, 65532, 65533, 65534, 65535, 65536
6	0, 1, 65534, 65535, 65536
7	0, 1, 65534, 65535, 65536
8	0, 1, 65534, 65535, 65536
9	0, 1, 65534, 65535, 65536
10	0, 1, 65534, 65535, 65536
11	0, 1, 65534, 65535, 65536
12	0, 1, 65534, 65535, 65536
13	0, 1, 2, 3, 4, 16, 227, 4637, 62245, 65417, 65525, 65531, 65532, 65533, 65534, 65535, 65536
14	0, 1, 65534, 65535, 65536
15	0, 1, 65534, 65535, 65536
16	0, 1, 65534, 65535, 65536

表 B.25 虚拟扬声器预设值表

索引	索引值
0	{2, 768}
1	{2, 791}
2	{146, 791}
3	{293, 791}
4	{439, 791}
5	{585, 791}
6	{731, 791}
7	{878, 791}
8	{2, 815}
9	{79, 815}
10	{158, 815}
11	{236, 815}
12	{315, 815}
13	{394, 815}
14	{473, 815}
15	{551, 815}
16	{630, 815}
17	{709, 815}
18	{788, 815}
19	{866, 815}
20	{945, 815}
21	{2, 838}
22	{54, 838}
23	{108, 838}
24	{162, 838}
25	{216, 838}

26	{269, 838}
27	{323, 838}
28	{377, 838}
29	{431, 838}
30	{485, 838}
31	{539, 838}
32	{593, 838}
33	{647, 838}
34	{701, 838}
35	{755, 838}
36	{808, 838}
37	{862, 838}
38	{916, 838}
39	{970, 838}
40	{2, 861}
41	{41, 861}
42	{82, 861}
43	{123, 861}
44	{164, 861}
45	{205, 861}
46	{246, 861}
47	{287, 861}
48	{328, 861}
49	{369, 861}
50	{410, 861}
51	{451, 861}
52	{492, 861}
53	{532, 861}
54	{573, 861}
55	{614, 861}
56	{655, 861}
57	{696, 861}
58	{737, 861}
59	{778, 861}
60	{819, 861}
61	{860, 861}
62	{901, 861}
63	{942, 861}
64	{983, 861}
65	{2, 884}
66	{34, 884}
67	{68, 884}
68	{102, 884}

69	{137, 884}
70	{171, 884}
71	{205, 884}
72	{239, 884}
73	{273, 884}
74	{307, 884}
75	{341, 884}
76	{375, 884}
77	{410, 884}
78	{444, 884}
79	{478, 884}
80	{512, 884}
81	{546, 884}
82	{580, 884}
83	{614, 884}
84	{649, 884}
85	{683, 884}
86	{717, 884}
87	{751, 884}
88	{785, 884}
89	{819, 884}
90	{853, 884}
91	{887, 884}
92	{922, 884}
93	{956, 884}
94	{990, 884}
95	{2, 908}
96	{29, 908}
97	{59, 908}
98	{88, 908}
99	{117, 908}
100	{146, 908}
101	{176, 908}
102	{205, 908}
103	{234, 908}
104	{263, 908}
105	{293, 908}
106	{322, 908}
107	{351, 908}
108	{380, 908}
109	{410, 908}
110	{439, 908}
111	{468, 908}

112	{497, 908}
113	{527, 908}
114	{556, 908}
115	{585, 908}
116	{614, 908}
117	{644, 908}
118	{673, 908}
119	{702, 908}
120	{731, 908}
121	{761, 908}
122	{790, 908}
123	{819, 908}
124	{848, 908}
125	{878, 908}
126	{907, 908}
127	{936, 908}
128	{965, 908}
129	{995, 908}
130	{2, 931}
131	{27, 931}
132	{54, 931}
133	{81, 931}
134	{108, 931}
135	{135, 931}
136	{162, 931}
137	{189, 931}
138	{216, 931}
139	{243, 931}
140	{269, 931}
141	{296, 931}
142	{323, 931}
143	{350, 931}
144	{377, 931}
145	{404, 931}
146	{431, 931}
147	{458, 931}
148	{485, 931}
149	{512, 931}
150	{539, 931}
151	{566, 931}
152	{593, 931}
153	{620, 931}
154	{647, 931}

155	{674, 931}
156	{701, 931}
157	{728, 931}
158	{755, 931}
159	{781, 931}
160	{808, 931}
161	{835, 931}
162	{862, 931}
163	{889, 931}
164	{916, 931}
165	{943, 931}
166	{970, 931}
167	{997, 931}
168	{2, 954}
169	{25, 954}
170	{50, 954}
171	{75, 954}
172	{100, 954}
173	{125, 954}
174	{150, 954}
175	{175, 954}
176	{200, 954}
177	{225, 954}
178	{250, 954}
179	{275, 954}
180	{300, 954}
181	{325, 954}
182	{350, 954}
183	{375, 954}
184	{400, 954}
185	{425, 954}
186	{450, 954}
187	{475, 954}
188	{500, 954}
189	{524, 954}
190	{549, 954}
191	{574, 954}
192	{599, 954}
193	{624, 954}
194	{649, 954}
195	{674, 954}
196	{699, 954}
197	{724, 954}

198	{749, 954}
199	{774, 954}
200	{799, 954}
201	{824, 954}
202	{849, 954}
203	{874, 954}
204	{899, 954}
205	{924, 954}
206	{949, 954}
207	{974, 954}
208	{999, 954}
209	{2, 977}
210	{23, 977}
211	{47, 977}
212	{70, 977}
213	{93, 977}
214	{116, 977}
215	{140, 977}
216	{163, 977}
217	{186, 977}
218	{209, 977}
219	{233, 977}
220	{256, 977}
221	{279, 977}
222	{303, 977}
223	{326, 977}
224	{349, 977}
225	{372, 977}
226	{396, 977}
227	{419, 977}
228	{442, 977}
229	{465, 977}
230	{489, 977}
231	{512, 977}
232	{535, 977}
233	{559, 977}
234	{582, 977}
235	{605, 977}
236	{628, 977}
237	{652, 977}
238	{675, 977}
239	{698, 977}
240	{721, 977}

241	{745, 977}
242	{768, 977}
243	{791, 977}
244	{815, 977}
245	{838, 977}
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1113	{701, 93}
1114	{714, 93}
1115	{728, 93}
1116	{741, 93}
1117	{755, 93}
1118	{768, 93}
1119	{781, 93}
1120	{795, 93}
1121	{808, 93}
1122	{822, 93}
1123	{835, 93}
1124	{849, 93}
1125	{862, 93}
1126	{876, 93}
1127	{889, 93}
1128	{903, 93}
1129	{916, 93}
1130	{930, 93}
1131	{943, 93}
1132	{957, 93}
1133	{970, 93}
1134	{984, 93}
1135	{997, 93}
1136	{1011, 93}
1137	{2, 105}
1138	{14, 105}
1139	{28, 105}
1140	{42, 105}
1141	{56, 105}
1142	{70, 105}
1143	{84, 105}

1144	{98, 105}
1145	{112, 105}
1146	{126, 105}
1147	{140, 105}
1148	{154, 105}
1149	{168, 105}
1150	{182, 105}
1151	{196, 105}
1152	{210, 105}
1153	{224, 105}
1154	{238, 105}
1155	{252, 105}
1156	{267, 105}
1157	{281, 105}
1158	{295, 105}
1159	{309, 105}
1160	{323, 105}
1161	{337, 105}
1162	{351, 105}
1163	{365, 105}
1164	{379, 105}
1165	{393, 105}
1166	{407, 105}
1167	{421, 105}
1168	{435, 105}
1169	{449, 105}
1170	{463, 105}
1171	{477, 105}
1172	{491, 105}
1173	{505, 105}
1174	{519, 105}
1175	{533, 105}
1176	{547, 105}
1177	{561, 105}
1178	{575, 105}
1179	{589, 105}
1180	{603, 105}
1181	{617, 105}
1182	{631, 105}
1183	{645, 105}
1184	{659, 105}
1185	{673, 105}
1186	{687, 105}

1187	{701, 105}
1188	{715, 105}
1189	{729, 105}
1190	{743, 105}
1191	{757, 105}
1192	{772, 105}
1193	{786, 105}
1194	{800, 105}
1195	{814, 105}
1196	{828, 105}
1197	{842, 105}
1198	{856, 105}
1199	{870, 105}
1200	{884, 105}
1201	{898, 105}
1202	{912, 105}
1203	{926, 105}
1204	{940, 105}
1205	{954, 105}
1206	{968, 105}
1207	{982, 105}
1208	{996, 105}
1209	{1010, 105}
1210	{2, 116}
1211	{15, 116}
1212	{30, 116}
1213	{45, 116}
1214	{59, 116}
1215	{74, 116}
1216	{89, 116}
1217	{104, 116}
1218	{119, 116}
1219	{134, 116}
1220	{148, 116}
1221	{163, 116}
1222	{178, 116}
1223	{193, 116}
1224	{208, 116}
1225	{223, 116}
1226	{237, 116}
1227	{252, 116}
1228	{267, 116}
1229	{282, 116}

1230	{297, 116}
1231	{312, 116}
1232	{326, 116}
1233	{341, 116}
1234	{356, 116}
1235	{371, 116}
1236	{386, 116}
1237	{401, 116}
1238	{416, 116}
1239	{430, 116}
1240	{445, 116}
1241	{460, 116}
1242	{475, 116}
1243	{490, 116}
1244	{505, 116}
1245	{519, 116}
1246	{534, 116}
1247	{549, 116}
1248	{564, 116}
1249	{579, 116}
1250	{594, 116}
1251	{608, 116}
1252	{623, 116}
1253	{638, 116}
1254	{653, 116}
1255	{668, 116}
1256	{683, 116}
1257	{698, 116}
1258	{712, 116}
1259	{727, 116}
1260	{742, 116}
1261	{757, 116}
1262	{772, 116}
1263	{787, 116}
1264	{801, 116}
1265	{816, 116}
1266	{831, 116}
1267	{846, 116}
1268	{861, 116}
1269	{876, 116}
1270	{890, 116}
1271	{905, 116}
1272	{920, 116}

1273	{935, 116}
1274	{950, 116}
1275	{965, 116}
1276	{979, 116}
1277	{994, 116}
1278	{1009, 116}
1279	{2, 128}
1280	{16, 128}
1281	{32, 128}
1282	{48, 128}
1283	{64, 128}
1284	{80, 128}
1285	{96, 128}
1286	{112, 128}
1287	{128, 128}
1288	{144, 128}
1289	{160, 128}
1290	{176, 128}
1291	{192, 128}
1292	{208, 128}
1293	{224, 128}
1294	{240, 128}
1295	{256, 128}
1296	{272, 128}
1297	{288, 128}
1298	{304, 128}
1299	{320, 128}
1300	{336, 128}
1301	{352, 128}
1302	{368, 128}
1303	{384, 128}
1304	{400, 128}
1305	{416, 128}
1306	{432, 128}
1307	{448, 128}
1308	{464, 128}
1309	{480, 128}
1310	{496, 128}
1311	{512, 128}
1312	{528, 128}
1313	{544, 128}
1314	{560, 128}
1315	{576, 128}

1316	{592, 128}
1317	{608, 128}
1318	{624, 128}
1319	{640, 128}
1320	{656, 128}
1321	{672, 128}
1322	{688, 128}
1323	{704, 128}
1324	{720, 128}
1325	{736, 128}
1326	{752, 128}
1327	{768, 128}
1328	{784, 128}
1329	{800, 128}
1330	{816, 128}
1331	{832, 128}
1332	{848, 128}
1333	{864, 128}
1334	{880, 128}
1335	{896, 128}
1336	{912, 128}
1337	{928, 128}
1338	{944, 128}
1339	{960, 128}
1340	{976, 128}
1341	{992, 128}
1342	{1008, 128}

表 B.26 sin_table_N 预设值表

索引	索引值
0	0.000000
1	0.006136
2	0.012272
3	0.018407
4	0.024541
5	0.030675
6	0.036807
7	0.042938
8	0.049068
9	0.055195
10	0.061321
11	0.067444

12	0.073565
13	0.079682
14	0.085797
15	0.091909
16	0.098017
17	0.104122
18	0.110222
19	0.116319
20	0.122411
21	0.128498
22	0.134581
23	0.140658
24	0.146730
25	0.152797
26	0.158858
27	0.164913
28	0.170962
29	0.177004
30	0.183040
31	0.189069
32	0.195090,
33	0.201105
34	0.207111
35	0.213110
36	0.219101
37	0.225084
38	0.231058
39	0.237024
40	0.242980
41	0.248928
42	0.254866
43	0.260794
44	0.266713
45	0.272621
46	0.278520
47	0.284408
48	0.290285
49	0.296151
50	0.302006
51	0.307850
52	0.313682
53	0.319502
54	0.325310

55	0.331106
56	0.336890
57	0.342661
58	0.348419
59	0.354164
60	0.359895
61	0.365613
62	0.371317
63	0.377007
64	0.382683,
65	0.388345
66	0.393992
67	0.399624
68	0.405241
69	0.410843
70	0.416430
71	0.422000
72	0.427555
73	0.433094
74	0.438616
75	0.444122
76	0.449611
77	0.455084
78	0.460539
79	0.465977
80	0.471397
81	0.476799
82	0.482184
83	0.487550
84	0.492898
85	0.498228
86	0.503538
87	0.508830
88	0.514103
89	0.519356
90	0.524590
91	0.529804
92	0.534998
93	0.540171
94	0.545325
95	0.550458
96	0.555570,
97	0.560662

98	0.565732
99	0.570781
100	0.575808
101	0.580814
102	0.585798
103	0.590760
104	0.595699
105	0.600616
106	0.605511
107	0.610383
108	0.615232
109	0.620057
110	0.624860
111	0.629638
112	0.634393
113	0.639124
114	0.643832
115	0.648514
116	0.653173
117	0.657807
118	0.662416
119	0.667000
120	0.671559
121	0.676093
122	0.680601
123	0.685084
124	0.689541
125	0.693971
126	0.698376
127	0.702755
128	0.707107,
129	0.711432
130	0.715731
131	0.720003
132	0.724247
133	0.728464
134	0.732654
135	0.736817
136	0.740951
137	0.745058
138	0.749136
139	0.753187
140	0.757209

141	0.761202
142	0.765167
143	0.769103
144	0.773010
145	0.776888
146	0.780737
147	0.784557
148	0.788346
149	0.792107
150	0.795837
151	0.799537
152	0.803208
153	0.806848
154	0.810457
155	0.814036
156	0.817585
157	0.821102
158	0.824589
159	0.828045
160	0.831470,
161	0.834863
162	0.838225
163	0.841555
164	0.844854
165	0.848120
166	0.851355
167	0.854558
168	0.857729
169	0.860867
170	0.863973
171	0.867046
172	0.870087
173	0.873095
174	0.876070
175	0.879012
176	0.881921
177	0.884797
178	0.887640
179	0.890449
180	0.893224
181	0.895966
182	0.898674
183	0.901349

184	0.903989
185	0.906596
186	0.909168
187	0.911706
188	0.914210
189	0.916679
190	0.919114
191	0.921514
192	0.923880,
193	0.926210
194	0.928506
195	0.930767
196	0.932993
197	0.935184
198	0.937339
199	0.939459
200	0.941544
201	0.943593
202	0.945607
203	0.947586
204	0.949528
205	0.951435
206	0.953306
207	0.955141
208	0.956940
209	0.958703
210	0.960431
211	0.962121
212	0.963776
213	0.965394
214	0.966976
215	0.968522
216	0.970031
217	0.971504
218	0.972940
219	0.974339
220	0.975702
221	0.977028
222	0.978317
223	0.979570
224	0.980785,
225	0.981964
226	0.983105

227	0.984210
228	0.985278
229	0.986308
230	0.987301
231	0.988258
232	0.989177
233	0.990058
234	0.990903
235	0.991710
236	0.992480
237	0.993212
238	0.993907
239	0.994565
240	0.995185
241	0.995767
242	0.996313
243	0.996820
244	0.997290
245	0.997723
246	0.998118
247	0.998476
248	0.998795
249	0.999078
250	0.999322
251	0.999529
252	0.999699
253	0.999831
254	0.999925
255	0.999981
256	1.0

附 录 C
（规范性）
三维声音频基本流在传输流中的复用定义

C.1 三维声音频基本流在 GB/T 17975.1-2010 或 MPEG-2 TS 传输流中的复用定义

C.1.1 介绍

该章节主要介绍三维声音频在MPEG-2 TS中的定义。由于三维声音频封装在MPEG2-TS中使用的还是PES包，所以封装方式与其他Audio在MPEG2-TS中一致。为了区别三维声音频与其他音频，以下条款用来指定三维声音频在MPEG2-TS中的不同之处。

C.1.2 三维声音频在MPEG-2 TS中的限制

C.1.2.1 音频基础流（elementary stream）

音频基础流打包参考附录A.1.3，即封装成aatf_sequence（）。

C.1.2.2 PES封包

1）stream_id 定义为 0xBD(private_stream_1)。

2）elementary stream 在 PES payload 里应该是字节对齐的，即三维声音频的首字节必须位于 PES payload 的首字节中。

3）一个 PES 包可以包含一帧或多帧三维声音频

C.1.2.3 stream_type

在 PMT 中 stream_type 应该设置成 0xD5

C.1.2.4 Registration descriptor

在 registration_descriptor()中，推荐 format_identifier 为 0x61, 0x76, 0x33, 0x61(‘av3a’)

C.1.2.5 AVS3-Audio 描述子

AVS3_Audio_descriptor()位于 PMT 中的 ES_info_length 字段后面。其语法见表 1.1

C.1.3 STD音频缓冲器大小

请参考 ISO/IEC 13818-1 对 Audio 的 BSn 的规定。

表 D.1 三维声音频标准实现方式

语 法	位 数	助 记 符
AVS3_audio_descriptor()		
{		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf

表 D.1 三维声音频标准实现方式（续）

语 法	位 数	助 记 符
audio_codec_id	4	Uimsbf (codec-ID 区分不同实现方式)
coding_profile	3	uimsbf
reserved	1	‘0’
sampling_frequency_index	4	uimsbf
if(audio_codec_id==1) {		
if (sampling_frequency_index==0xf) {		
sampling_frequency	24	uimsbf
}		
}		
num_channels	8	uimsbf
reserved	4	‘0’
for (i=0; i<N; i++) {		
addition_info[i]	8	bslbf
}		
}		

descriptor_tag:0xB5 (AVS2 AUDIO: 0x40)

descriptor_length：最小长度为 3 字节

audio_codec_id：参考附录 A.2

coding_profile:参考附录 A.2

sampling_frequency_index：参考表 A.9

sampling_frequency:参考附录 A.2

num_channels：当 audio_codec_id 为 1 时，如果声道数小于 16，4 比特，其中 0xf 表示扩展，其他表示声道数；如果声道数不小于 16，8 比特，见表 67

addition_info:可选字段，附加信息

C.2 三维声音频基本流在 ISO base media file format(ISOBMFF)中的定义

C.2.1 介绍

该章节主要介绍三维声音频在 ISOBMFF 中的定义。ISOBMFF 的格式，比较常见的例子就是在 MP4/MOV/3GPP

C.2.2 三维声track定义

根据 ISOBMFF 规定，AVS3-P3 音频定义为 Audio Tracks，因此必须遵循以下规定：

1）在 Handler Reference Box(‘hdlr’)中，handler_type 应该为’ soun’

2）Media Information Header Box(‘minf’) 必须包含一个 Sound Media Header Box(‘smhd’)

3）Sample Description Box(‘stsd’)必须包含一个继承至 AudioSampleEntry 的 box，即 CA3SampleEntry(定义在 2.4)

C.2.3 三维声sample定义

AVS3-P3 音频在 ISOBMFF 打包参考附录 A.1.3，即封装成 aatf_sequence（），并且只有一帧

C.2.4 CA3SampleEntry

表 D.2

语法	位数
CA3SampleEntry()	
{	
BoxHeader.Size; .	32
BoxHeader.Type;	32
Reserved;	6*8
DataReferenceIndex;	16
Reserved;	2*32
ChannelCount;	16
SampleSize;	16
Reserved;	32
SamplingFrequency;	16
Reserved;	16
CA3SpecificBox();	
}	

CA3SampleEntry()是 AudioSampleEntry()衍生而来，其中 AudioSampleEntry()定义在 ISO/IEC 14496-12。

BoxHeader.Type: ’av3a’

CA3SampleEntry()的字段除了 CA3SpecificBox()，都与遵循 ISO/IEC 14496-12。

C.2.5 CA3SpecificBox

表 D.3

语法	位数
CA3SpecificBox ()	
{	
BoxHeader.Size;	32
BoxHeader.Type;	32
AVS3AudioSpecificConfig()	
}	

BoxHeader.Size: CA3SpecificBox()的长度

BoxHeader.Type: ’dca3’

C.2.6 AVS3AudioSpecificConfig

表 D.4

语法	位数
AVS3AudioSpecificConfig()	
{	
audio_codec_id;	4
coding_profile;	3
sampling_frequency_index;	4
if(audio_codec_id==1 （codec_id 区分不同 codec 实现方式）) {	
if (sampling_frequency_index==0xf) {	
sampling_frequency;	24
num_channels;	8
resolution;	2
if(audio_codec_id==0 || audio_codec_id==2){	
bitrate_index;	4
if(audio_codec_id < 3){	
if (coding_profile == 1)	
3DVersion;	4
}	
}	

audio_codec_id：参考附录 A.2

coding_profile:参考附录 A.2

sampling_frequency_index：参考表 A.9

sampling_frequency:参考附录 A.2

num_channels：当 audio_codec_id 为 1 时，如果声道数小于 16，4 比特，其中 0xf 表示扩展，其他表示声道数；如果声道数不小于 16，8 比特，见表 67

resolution: 参考附录 A.2

bitrate_index: 参考附录 A.2

3DVersion: 对象元数据编码版本号，当前版本为 1.0

C.2.7 MIME codecs 参数

MIME codecs 参数必须遵循 IETF RFC 6381 规范。

AVS3-P3 音频 codecs 参数定义如下:

codecs = ‘av3a. audio_codec_id. coding_profile’

其中,audio_codec_id，coding_profile 见附录 A.2 中定义。

示例：当 AVS3 音频 audio_codec_id 为 0,coding_profile 为 1， 则对应 codecs 为‘av3a.0.1’。

C.3 三维声音频基本流在 HLS中的定义

C.3.1 介绍

该章节主要介绍三维声音频在 HLS 中的定义

C.3.2 CODEC

三维声音频的 CODEC 请参考 2.7
例子：
#EXT-X-STREAM-INF:BANDWIDTH=3464568,CODECS="avc1.640028, av3a.0.1"
example.m3u8

C.3.3 CHANNELS

参考附录 A.2 的 num_channels

C.3.4 三维声Sample的定义

支持两种文件格式存放：MPEG2-TS 与 fragmented MP4(fMP4)。

C.3.5 MPEG2-TS

MPEG2-TS 打包方式请参考第一章中对 AVS3-P3 的规定。

C.3.6 fragmented MP4

fMP4 打包方式请参考第二章中对 AVS3-P3 的规定。

C.4 三维声音频基本流在 DASH中的定义

C.4.1 介绍

该章节主要介绍三维声音频在 DASH 中的定义。

C.4.2 Media presentation description (MPD)

C.4.2.1 介绍

DASH 的 MPD 必须遵循 ISO/IEC 23009-1 规范。

C.4.2.2 mimeType

mimeType 为"audio/mp4"

C.4.2.3 @codecs

@codecs 请参考 D.7

C.4.2.4 AudioChannelConfiguration

@schemeIdUri 设置成 urn:mpeg:dash:23003:3:audio_channel_configuration:2011

value 参考附录 A.2 的 num_channels

C.5 三维声音频基本流在 CMAF中的定义

C.5.1 介绍

该章节主要介绍三维声音频在 CMAF 中的定义。

C.5.2 CMAF Sample

CMAF 的打包方式遵循的是 ISOBMFF，所以 AVS3-P3 在 CMAF 的打包也要遵循 ISOBMFF，即第二章中的定义。

C.5.3 Media presentation description (MPD)

与 4.2 的规定一致。

C.5.4 Random access point 和stream access point

每个三维声 Sample 都是 Random access point and stream access point。

C.5.5 三维声CMAF media profiles

Compatibility brand 为"av3a"。

C.6 三维声音频基本流在 RTMP中的定义

C.6.1 介绍

该章节主要介绍三维声音频在 RTMP 中的定义。RTMP 使用的文件格式是 FLV,即定义在"Adobe Flash Video File Format Specification Version 10.1"中。需要对该标准进行扩展来支持 AVS3-P3 音频

C.6.2 AudioTagHeader

表 D.5

AudioTagHeader		
Field	Type	Comment
SoundFormat	UB[4]	9=Extended Format
SoundRate	UB[2]	For AVS3 Audio, Always 3
SoundSize	UB[1]	For AVS3 Audio, Always 1
SoundType	UB[1]	For AVS3 Audio, Always 1

表 D.5（续）

AudioTagHeader		
SourdFormatEx	If SoundFormat=9 UB[16]	如果 SoundFormat=9，增加 SoundFormatEx 字段。 17 = AVS3 Audio 其余为保留值
AudioPacketType	IF SoundFormat==9 且 SoundFormatEx==17 UI8	The following values are defined(SoundFormat==9 且 SoundFormatEx==17): 0: AVS3 Audio sequence header information 1: AVS3 Audio RAW

AVS3-P3 的 SoundFormat 为 9，即原来的 reserved 扩展为 Extended Format，在 AudioTagBody 前增加 SourdFormatEx，值为 17，用来指定三维声 Audio

C.6.3 AudioTagBody

表 D.6

AudioTagBody		
Field	Type	Comment
SoundData	IF SoundFormat==9 且 SoundFormatEx==17 AVS3AUDIODATA	新增 AVS3AUDIODATA 数据结构 0: AVS3 Audio sequence header information 1: AVS3 Audio RAW

如果 AudioTagHeader 中 SoundFormat 为 9 且 SoundFormatEx 为 17，AudioTagBody 包含 AVS3AUDIODATA

C.6.4 AVS3AUDIODATA

表 D.7

AVS3AUDIODADA		
Field	Type	Comment
Data	IF AudioPacketType==0 AVS3AudioSpecificConfig() IF AudioPacketType==1 aatf_sequence()	AVS3AudioSpecificConfig()参考 2.6 aatf_sequence()参考 A.1.3