Doc. A/112
18 April 2006

ATSC Recommended Practice: E-VSB Implementation Guidelines

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The Advanced Television Systems Committee, Inc., is an international, non-profit organization developing voluntary standards for digital television. The ATSC member organizations represent the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries. Specifically, ATSC is working to coordinate television standards among different communications media focusing on digital television, interactive systems, and broadband multimedia communications. ATSC is also developing digital television implementation strategies and presenting educational seminars on the ATSC standards.

ATSC was formed in 1982 by the member organizations of the Joint Committee on InterSociety Coordination (JCIC): the Electronic Industries Association (EIA), the Institute of Electrical and Electronic Engineers (IEEE), the National Association of Broadcasters (NAB), the National Cable and Telecommunications Association (NCTA), and the Society of Motion Picture and Television Engineers (SMPTE). Currently, there are approximately 140 members representing the broadcast, broadcast equipment, motion picture, consumer electronics, computer, cable, satellite, and semiconductor industries.

ATSC Digital TV Standards include digital high definition television (HDTV), standard definition television (SDTV), data broadcasting, multichannel surround-sound audio, and satellite direct-to-home broadcasting.

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1. DOCUMENT PURPOSE AND SCOPE

The purpose of this document is to explicate the ATSC standards related to E-VSB (Enhanced VSB), and provide guidelines to parameter selection and implementation scenarios where useful.

Sections of this document may assume some familiarity with features of ATSC 8-VSB transmission and the ATSC transport and source coding standards that were developed prior to E-VSB. These topics can be found in ATSC documents, especially documents A/53D (ATSC Digital Television Standard) [2] and A/54A (Guide to the Use of the ATSC Digital Television Standard) [3].

The reader is cautioned not to rely on this document for compliance to the ATSC E-VSB Standard(s), but to always refer to the appropriate ATSC Standard(s). This document may omit some requirements, or on the other hand may suggest restrictions to parameters that are appropriate to certain applications but not generally required. While every attempt has been made to conform this document to the standards, in case of conflict, the standards of course prevail.

2. INFORMATIVE REFERENCES

[1] ATSC A/52B: "Digital Audio Compression (AC-3, E-AC-3) Standard," Advanced Television Systems Committee, Washington, D.C., 14 June 2005.

[2] ATSC A/53E: "ATSC Digital Television Standard," Advanced Television Systems Committee, Washington, D.C., 27 December 2005.

[3] ATSC Recommended Practice A/54A: "Guide to the Use of the Digital Television Standard," Advanced Television Systems Committee, Washington, D.C., 4 December 2003.

[4] ATSC A/65B: "Program and System Information Protocol for Terrestrial Broadcast and Cable," Advanced Television Systems Committee, Washington, D.C., 18 March 2003.

[5] ATSC A/110A: "Synchronization Standard for Distributed Transmission," Advanced Television Systems Committee, Washington, D.C., 19 July 2005.

[6] IEC 60958-1 (1999-12) Digital audio interface - Part 1: General.

[7] IEC 61937-1 (2003-5) Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 1: General.

[8] IEC 61937-3 (2003-5) Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958 - Part 3: Non-linear PCM bitstreams according to the AC-3 format.

[9] ISO/IEC IS 13818-1:2000 (E), International Standard, Information technology – Generic coding of moving pictures and associated audio information: Systems.

3. DEFINITIONS

The following definitions are included here for reference but the precise meaning of each may vary slightly from standard to standard.

3.1 Treatment of Syntactic Elements

This document contains symbolic references to syntactic elements used in the audio, video, and transport coding subsystems. These references are typographically distinguished by the use of a different font (e.g., restricted), may contain the underscore character (e.g., sequence_end_code) and may consist of character strings that are not English words (e.g., dynrng).

3.2 Terms Employed

Throughout this document, the following definitions apply:

STL – Studio-to-transmitter link, a system used to convey program-related signals or data from a studio or other origination point to the transmitter site, typically using either radio (microwave) or coax/fiber landline systems.

TS – Abbreviation for Transport Stream. Defined by ISO/IEC 13818-1 [9].

Other terms may be defined in the text of this document, in which case the scope of the definition is limited to the section in which it appears, to avoid possible conflicts with other sections and/or with defined terms in other ATSC documents.

4. SYSTEM OVERVIEW

4.1 What Is E-VSB?

The basis of E-VSB is a method to add increased error protection to a portion of the ATSC 8-VSB transmission. Figure 4.1 shows a simple block diagram of the processing in the E-VSB system. Some of the transmitted 8-VSB symbols (a selectable number of data segments in each 8-VSB data frame) are dedicated to carrying the desired enhanced data and associated E-VSB forward-error-correction bits. Data to be transmitted via the enhanced process is first subject to the addition of forward error correction. It is then formatted into standard MPEG transport packets. The packets of enhanced data are then interspersed with packets intended for normal 8-VSB transmission, according to a pre-determined algorithm. All the packets are then processed by the normal 8-VSB forward error correction, so that no errors are produced in legacy 8-VSB receivers due to the E-VSB process.

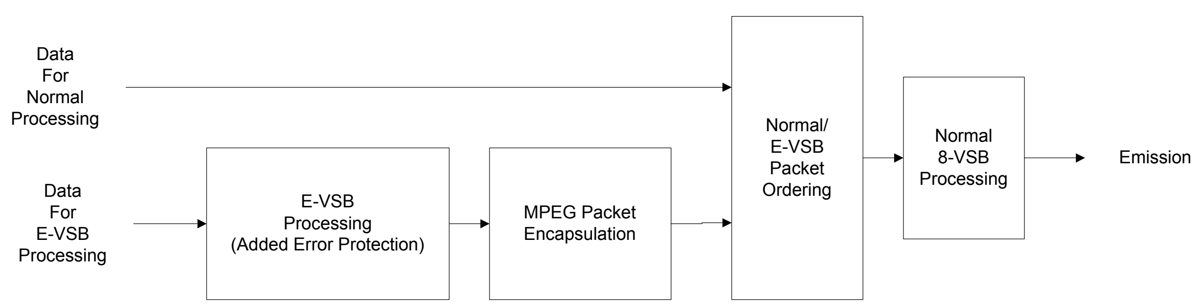

Figure 4.1 E-VSB modulation system overview.

The full development of an E-VSB system application from end-to-end, including especially multiplexing of various program elements, must take into account the different processing and delay of the E-VSB data and 8-VSB data, including the introduction of emission timing changes when the two types of data segments are placed in separate positions in the data frame according to the pre-determined algorithm. This may require adjustment of time stamps, special operation of source coders and multiplexers, and/or other adjustments in particular cases. Additional considerations depend on the application, especially on whether close synchronization of material ("essence") carried in the normal and enhanced data paths is required. Figure 4.2 shows an overview and expanded views of particular areas of the studio that require special consideration.

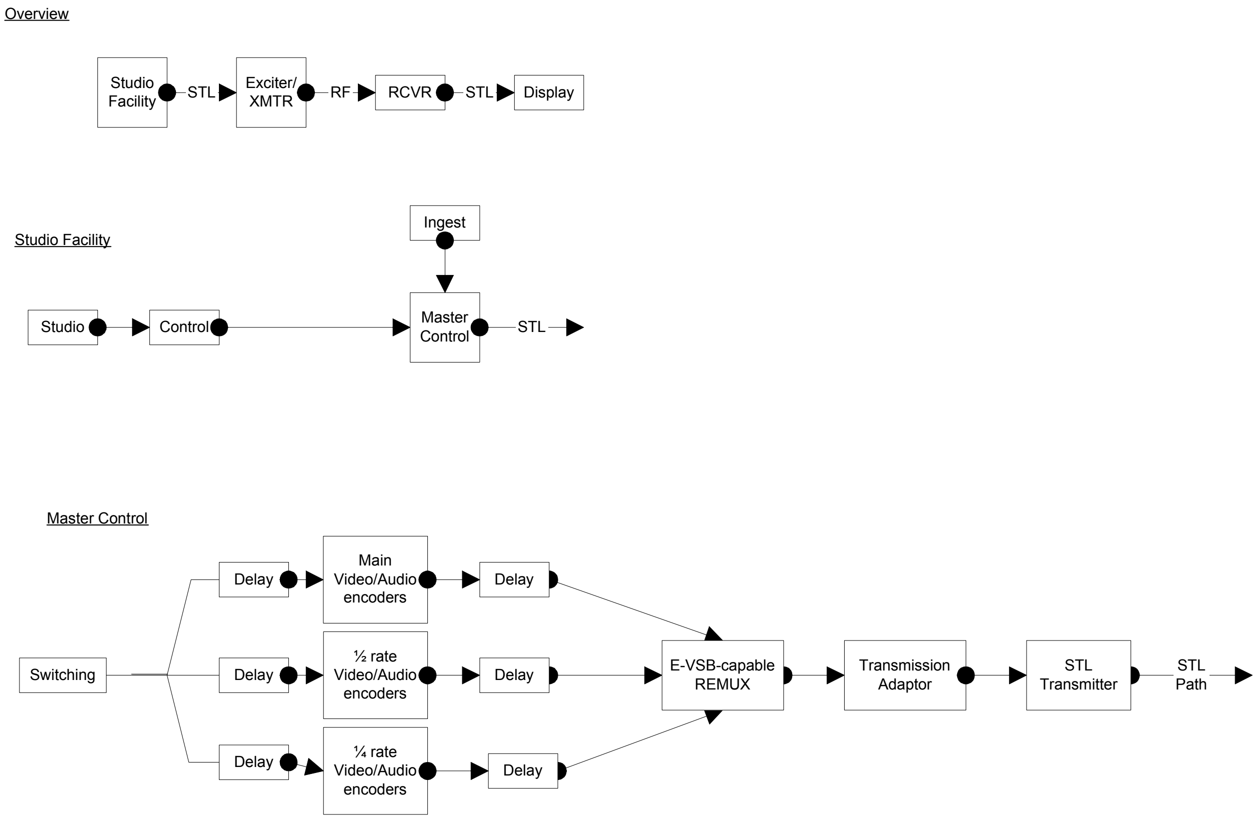

Figure 4.2 End-to-end system and details of studio/master control showing possible locations for delay compensation of source encoder latency and modulation latency.

4.2 New Technical Features Compared to 8-VSB

4.2.1 Enhanced Stream

A portion of the VSB transmitted symbol stream is dedicated to the enhanced symbols. The remaining portion not transmitted by the enhanced method is referred to as the "main" or "normal" stream. The data at the transport layer therefore consists of packets intended for enhanced transmission and packets intended for normal transmission.

4.2.2 New Transport Features

New transport layer tables are defined for carriage in the enhanced stream. They are designed to allow proper cross-referencing and synchronization of the content of the main and enhanced streams.

4.2.3 Advanced Video Codecs

The details of use of advanced video codecs in the enhanced stream were not finalized at the time of this writing. H.264 and VC-1 codecs were under consideration. While it is possible to carry enhanced video codecs as private data, the intention is to provide a standardized way to carry an advanced video codec or codecs in MPEG transport packets.

4.2.4 Advanced Audio Codec

E-VSB includes the addition of an advanced audio codec, Enhanced AC-3 (E-AC-3). Annex E of ATSC A/52B defines the bit stream syntax used by Enhanced AC-3 bit streams and decoders. Enhanced AC-3 bit streams are similar in nature to AC-3 bit streams, but are not backwards compatible (i.e., they are not decodable by AC-3 decoders). However, all Enhanced AC-3 decoders will also decode all AC-3 bit streams.

A feature inherent in Enhanced AC-3 is that the coding structure is built upon the basic AC-3 coding structure (with additional enhancements) and therefore can support true fallback audio for E-VSB systems. In ATSC systems that support fallback audio via E-VSB, receivers can replace individual AC-3 frames from the main VSB transport stream with an equivalent Enhanced AC-3 frame from the E-VSB transport stream. This allows Enchanced AC-3 decoders to perform seamless fallback audio on a frame-by-frame basis. In addition, it is feasible to perform a modest-complexity conversion (transcode) to the AC-3 bit stream syntax, thus enabling backwards compatibility with external decoders that have IEC 60958 [6] digital inputs.

In all applications Enhanced AC-3 includes several new features that are primarily focused on achieving greater coding efficiency (lower data rates) than AC-3 while maintaining audio quality. These features include:

- **Expanded Data Rate Flexibility**: allows the number of blocks per sync frame and the number of compressed data bits per frame in Enhanced AC-3 to be adjusted to achieve significantly more data rate flexibility than AC-3. This allows finer adjustments to data rate than AC-3.
- **Spectral Extension**: attempts to recreate a signal's high frequency amplitude spectrum from side data transmitted in the bit stream.
- **Transient Pre-Noise Processing**: offers improved audio quality by better handling of transient audio signals.
- **Adaptive Hybrid Transform Processing**: improves coding efficiency and thus quality by increasing the length of the transform.
- **Enhanced Coupling**: improves on traditional coupling techniques by allowing the technique to be used at lower frequencies than conventional coupling, thus increasing coder efficiency.

Enhanced AC-3 supports other new features that may be used in ATSC applications that do not require the fallback audio feature, or in non-ATSC applications. These features include:

- **Channel and Program Extensions**: enables a single bit stream to carry program streams of more than 5.1 channels or multiple program streams.
- **Sample Rate Processing**: applies to content that has an original sample rate higher than 48kHz (e.g., 88.2 kHz or 96 kHz).
- **Mixing Control Processing**: allows for metadata for applications that involve the mixing of two program streams.

4.2.5 Use of Legacy Video and Audio Codecs in the Enhanced Stream

Use of legacy video and audio codecs in the enhanced stream is allowed, but consideration should be given to the bit rate required and the impact on the remaining main stream available bit rate. Use of advanced codecs in the enhanced stream is preferable to maintain the highest possible main stream rate.

5. SYSTEM COMPONENTS

5.1 E-VSB Transmission

E-VSB requires an exciter (modulator) capable of distinguishing the main and enhanced data and encoding them into the properly processed main or enhanced symbols. In order to maintain use of a single studio-transmitter link (STL), a "transmission adapter" may be used at the studio side of the STL, which sends messages to the exciter to control its demultiplexing of main and enhanced data contained in a single STL transport stream.

5.1.1 E-VSB Exciter and Transmission Adapter

Figure 5.1 shows for review the block diagram of an 8-VSB transmitter.

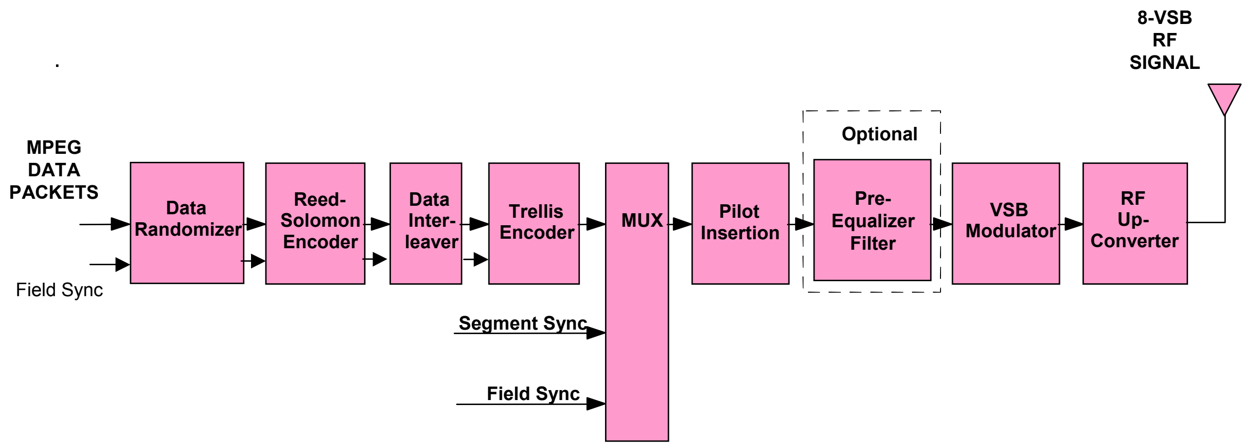

Figure 5.1 8-VSB transmitter.

Figure 5.2 shows the block diagram of an E-VSB transmitter, including the 8-VSB processing (in the top row of blocks). The E-VSB exciter includes a number of pre-processing blocks for the E-VSB data, and also has some modifications to the trellis coding part of the 8-VSB part of the hardware that is required to synchronize the concatenated trellis codes.

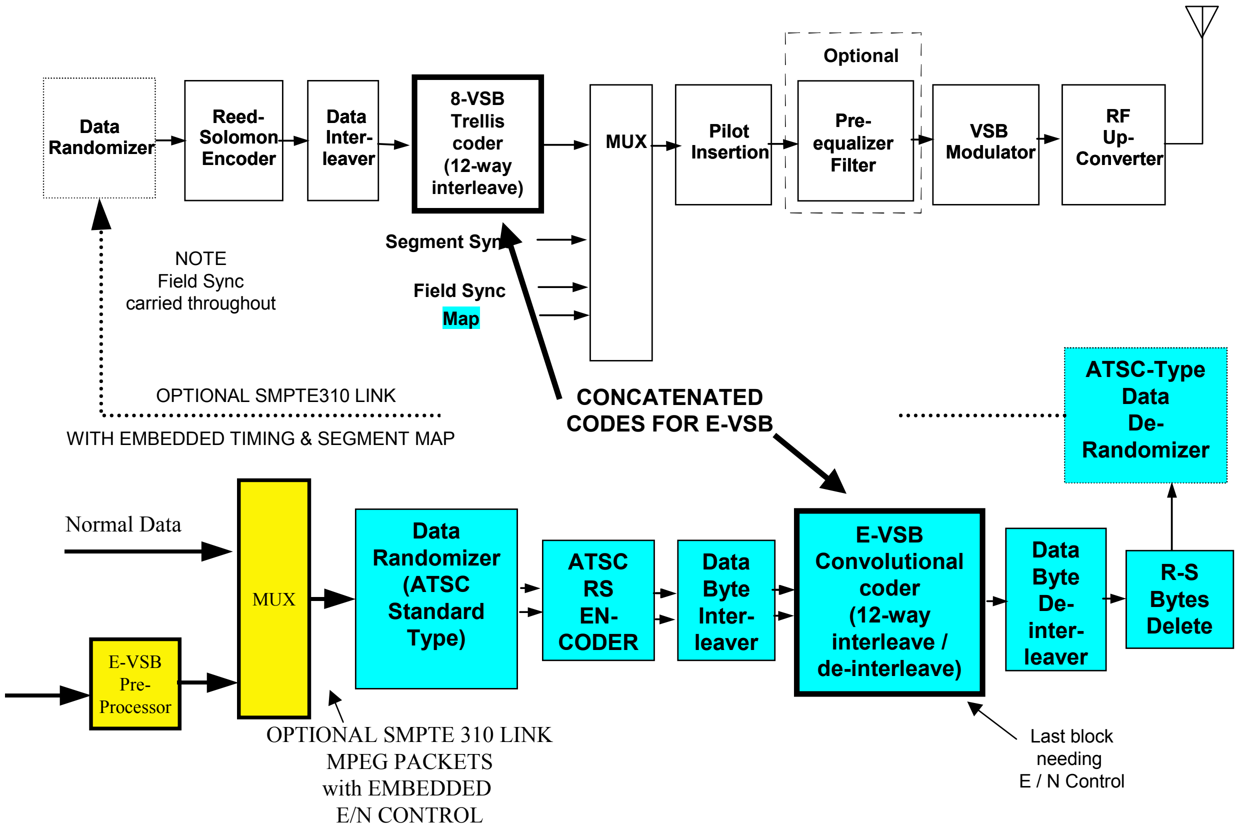

Figure 5.2 VSB transmitter with E-VSB capability.

The special processing of the E-VSB data includes an added Reed-Solomon code (which adds overhead by a factor of 184/164), encapsulation of the data into standard MPEG packets and expansion of the trellis code (by a factor of either 2 or 4 for the two code rate choices). The E-VSB preprocessor block inserts the additional R-S code and also expands the data with place-holder bytes. It encapsulates the result into MPEG packets. These packets are then muxed with packets intended for 8-VSB coding.

The E-VSB convolutional coder replaces the place-holders with the new trellis coding. It is preceded and followed by blocks (randomizer, R-S, byte interleaver, and their reverse processes) that do and then undo the 8-VSB process in order to make the transmitted symbols compatible with legacy receivers (as will be explained below).

Figure 5.3 is an expanded block diagram of a complete exciter, showing the location and detail of parts that are discussed separately below.

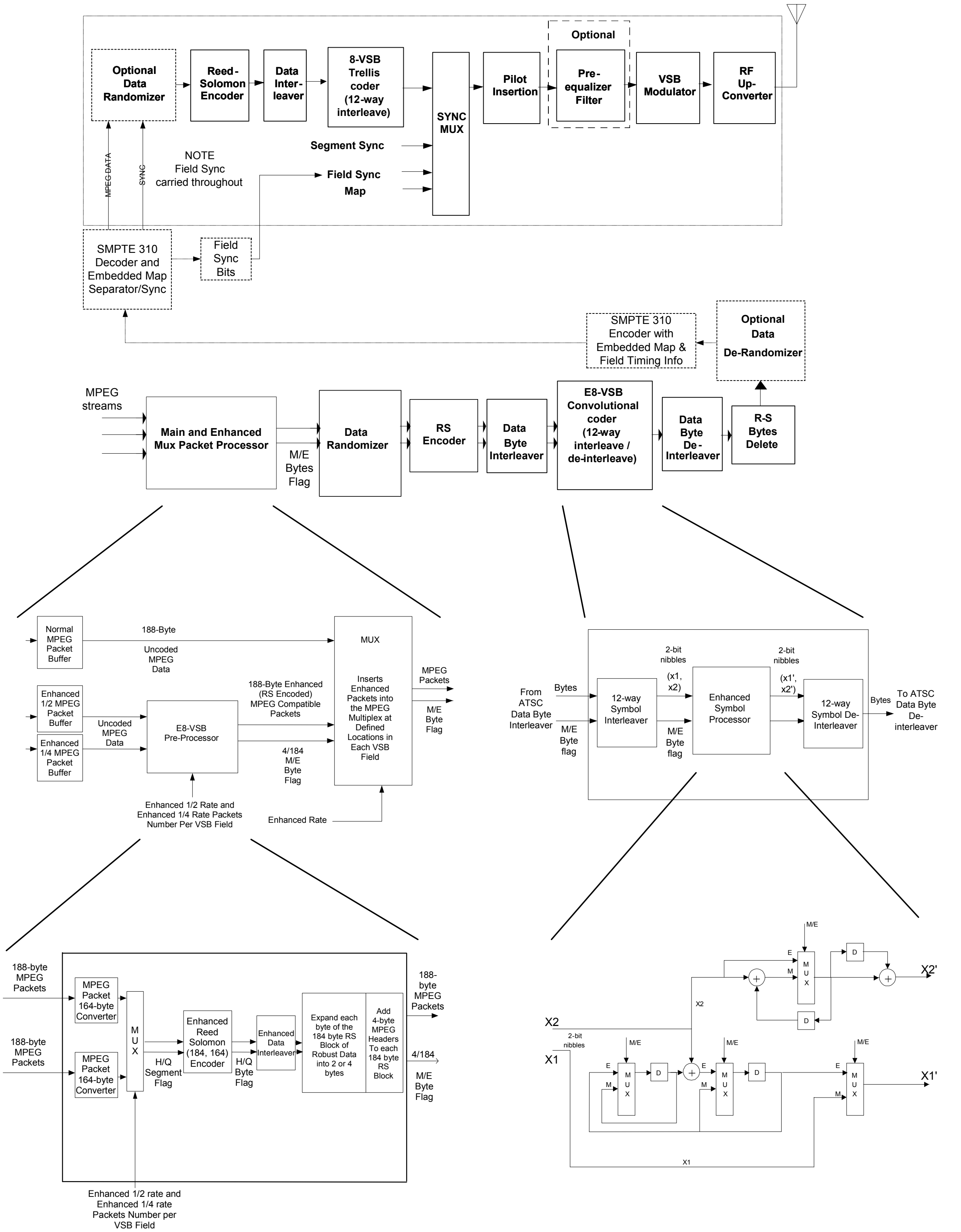

Figure 5.3 Exciter expanded block diagram.

Figures 5.4 and 5.5 show details of the E-VSB preprocessor.

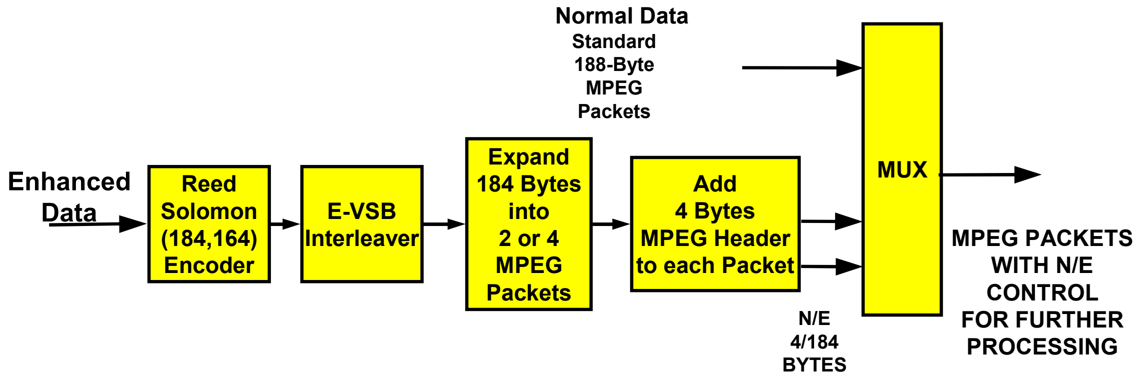

Figure 5.4 Simplified E-VSB preprocessor and MUX detail.

Refer to Figure 5.4. The E-VSB data (which is supplied as 188-byte MPEG-2 TS packets) is first broken into 164-byte chunks. These do not require special headers or other added data, as they will be re-assembled in order after decoding. Note that the MPEG packet sync bytes are carried as part of this data (unlike the 8-VSB exciter processing, in which the 0x47 sync byte is replaced by a VSB segment sync). The data then passes through an E-VSB interleaver. The data is next expanded by 2 (or 4) times, and placed as the payload into 2 (or 4) MPEG packets, with standard MPEG headers including 0x47 sync bytes. These MPEG packets can be multiplexed with MPEG packets intended for normal 8-VSB transmission. At this point, the E-VSB data is segregated from the 8-VSB data on a packet-by-packet basis, and can be identified by PID and/or by a parallel ID stream inside the equipment.

The effects of bit stuffing can be seen in Figures 5.4 and 5.2. When placeholder bits are inserted to expand 184 bytes into 2 or 4 MPEG packets (see A/53D, Annex D Section 5.4.2.1.1 [2]), the resulting packets are RS encoded, then E-VSB trellis encoded. However, this sequence of processing produces an invalid 8-VSB RS code for legacy receivers due to the insertion of newly-generated symbols in the E-VSB trellis coder. Therefore, the RS code is regenerated after the trellis-coding step, as shown in Figure 5.2. Any value of stuffing bits (ones or zeros) may be used to expand the E-VSB data, and the final RS generator will produce a valid RS code, although the resulting symbol streams will be different for different stuffing-bit values. Therefore, if transmitters are to be synchronized in multiple-transmitter networks, they must all use the same stuffing-bit values. For this reason it is recommended to use all zeros for stuffing bits.

Figure 5.5 shows further detail of the pre-processing. The pre-process is complicated by the presence of both 1/2 rate and 1/4 rate data in some allowable mixes. A single E-VSB interleaver operates on both the 1/2 rate and 1/4 rate data, so that after the preprocessor and before the mux (which places the E-VSB packets among the 8-VSB packets), 1/2 rate data is not segregated from 1/4 rate data on a packet by packet basis. This fact becomes important in considering transient conditions when the mix rate is changing.

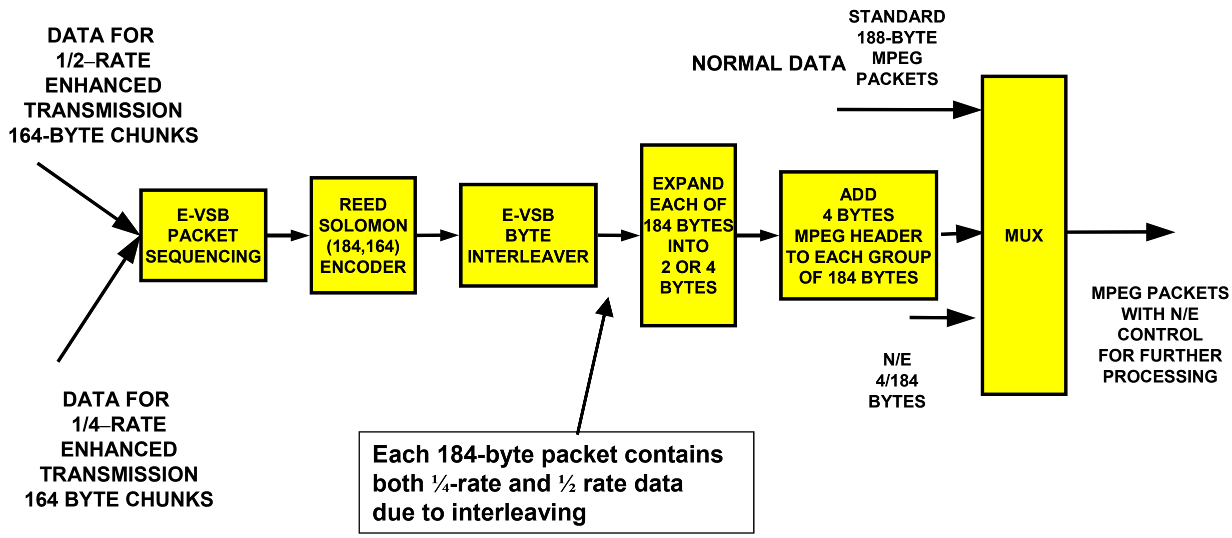

Figure 5.5 Details of E-VSB interleaving sequence.

There are two types of E-VSB/8-VSB mix transitions to consider. In the first type, there is no change in the main (8-VSB) data rate. In this case, the only change is in the data payloads of the 1/2-rate and 1/4-rate streams. This can be done without loss of data since the packet boundaries are determined before the E-VSB interleaver. In the second type of transition, the main (8-VSB) data rate is changed. This results in a different number of 8-VSB and E-VSB segments being packed into a data frame. Since these segment boundaries are determined after the E-VSB interleaver, some data will be lost, because it extends into segments that were E-VSB segments in the old mix but are 8-VSB segments in the new mix. E-VSB data loss can be avoided by suspending the E-VSB input for a period of 46 184-byte packets, allowing all valid data to exit the E-VSB interleaver before the mix is changed. Note that main stream (8-VSB) data is never lost due to the E-VSB interleaving process, since main stream data is always inserted by the mux at normal packet boundaries.

In addition to other functions, the preprocessor inserts corrections to PCRs that are necessary due to the delay introduced into the E-VSB data by the E-VSB interleaver and the packet placement process. The points at which corrections can be made are shown in Figure 5.6. (A more detailed discussion of delay is given in Section 5.1.3.1 below.)

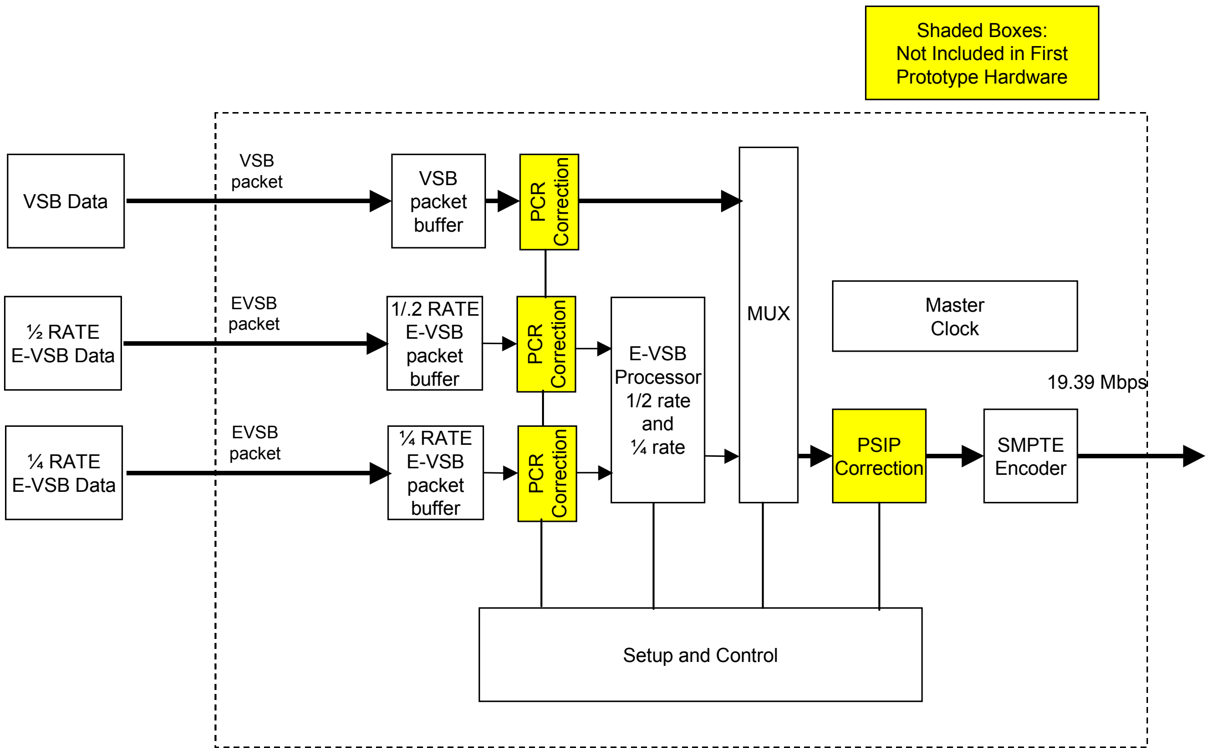

Figure 5.6 Preprocessor/Mux PCR correction points.

5.1.1.1 Transmission Adapter

In order to make control of the E-VSB mix of rates available, and use existing studio-to-transmitter link (STL) arrangements, a transmission adapter may be used at the studio side of the STL, with an exciter at the transmitter site that is controlled by the adapter. The techniques used are the same as for synchronized VSB transmitters (see A/110A [5]), with the addition of control of the E-VSB trellis states and the data frame sync bits that signal the E-VSB main, 1/2-rate and 1/4 rate data mix. A transmission adapter is essentially a master exciter, which pre-determines all of the Reed-Solomon and trellis coder states. It also pre-determines the exciter data frame sync timing and the placement of main, 1/2-rate and 1/4-rate packets in the frame. The three types of data packets can then be carried on one STL without special formatting for identification of packet type. The exciter control information is multiplexed as transmission adapter packets in the STL stream so that the exciter at the transmitter site is slaved to the adapter operation. Once the initial conditions have been established, adapter packets need not be sent continually (unless the mix is changed). For operation with a given E-VSB mix, adapter packets may be sent intermittently at a rate intended to restore the transmitter to a known condition in a timely manner in case of data errors on the STL. If the transmitter output is monitored, detection of incorrect operation may be used to trigger transmission of adapter packets to restore the correct state.

E-VSB Map Data uses 64 of the 92 bits that are reserved in 8-VSB transmission. These 64 bits are used to Kerdock code 12 Map bits for use in the E-VSB receiver. The 64 bit Kerdock code alternates polarity in successive data fields, and has the same polarity as the alternating middle PN63 sequence of the data field sync. (See Figure 5.7.)

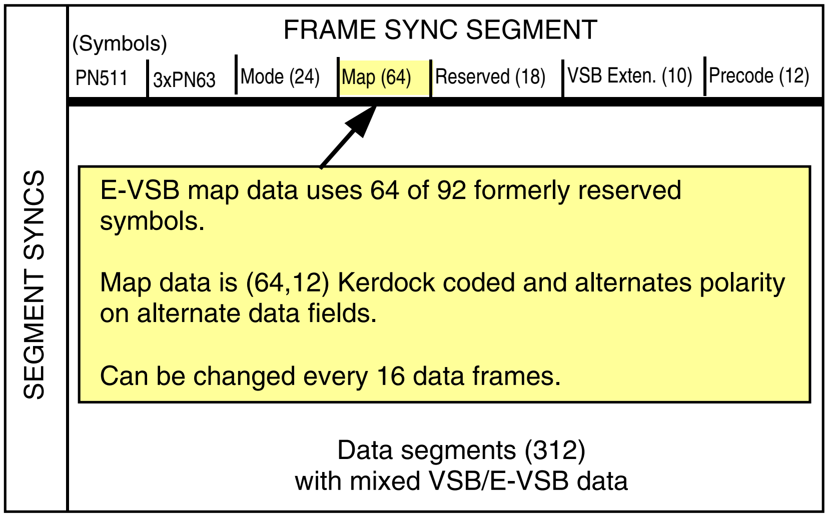

Figure 5.7 EVSB data frame as emitted.

For enhanced transmission the last 10 symbols before the 12 precode symbols are defined as enhancement signaling symbols. When enhanced transmission is used, these symbols are defined for signaling the type of enhancement present according to A/53D Annex D [2]. The 82 symbols shown as “map” or “reserved” in Figure 5.7 may be redefined according to the particular type of enhancement that is signaled.

When enhanced transmission is used, the 10 enhancement signaling symbols alternate polarity on successive data fields. In legacy (non-enhanced) 8-VSB transmissions, these symbols do not alternate polarity, and their values are undefined, although it is suggested to fill the reserved symbol areas with a continuation of the PN63 sequence

5.1.1.2 Interpretation of 12 Map Bits

The map bits signify the following:

- One bit: signals the enhanced segment packing arrangement, either bursted (also called one-of-four or bunched), or uniform. Two bits in each field (total of four bits) indicate a countdown (number of data fields) until the change from the current map data to new map data. The Odd field (positive PN63) contains the high-order 2 bits, and the Even field (negative PN63) contains the low-order 2 bits.
- The remaining nine bits comprise a “MAP Number” that is used to address a series of look-up tables to select a particular mix of normal, 1/2 rate and 1/4 rate data from 512 choices. (See Section 5.5.3, “E-VSB Map Interpretation.”) Each mix in combination with the choice of packing mode has a specific placement of E-VSB 1/2 rate and 1/4 rate data segments in the data frame. Note that because of the normal 8-VSB data interleaving, the bytes with various coding rates are spread across data segment boundaries and data field boundaries in the emitted signal, although the number of bytes/symbols for each data rate corresponds to an integer number of data segments per field. (This is similar to normal 8-VSB transmission, where the interleaving spreads data from multiple MPEG packets across multiple VSB data segments.) Because of the E-VSB byte interleaving, the segment mapping between 8-VSB and E-VSB exists in the receiver only after the 8-VSB deinterleaver. Similarly, the mapping of 1/2 rate and 1/4 rate coded segments exists in the receiver only after the E-VSB deinterleaver.

- In the odd field (positive PN63), the map currently in use is signaled. In the Even field (negative PN63), the next map to be used is signaled.

5.1.2 E-VSB Error Coding

E-VSB uses an initial Reed-Solomon coding of the enhanced data, as shown in Figure 5.5. It also uses additional trellis coding. ATSC standard A/53D should be consulted for the precise details. The equivalent coders for the main and enhanced data are shown in Figures 5.24*a–c*, below.

5.1.3 E-VSB Interleaving

The E-VSB interleaver follows the same principles as the main 8-VSB interleaver, but is slightly smaller, with parameters M = 4, B = 46, and N = M x B = 184 (See Figure 5.8). The interleaver parameters are chosen such that the interleaver commutator makes an integer number of revolutions per data frame for any mix of E-VSB and main stream data.

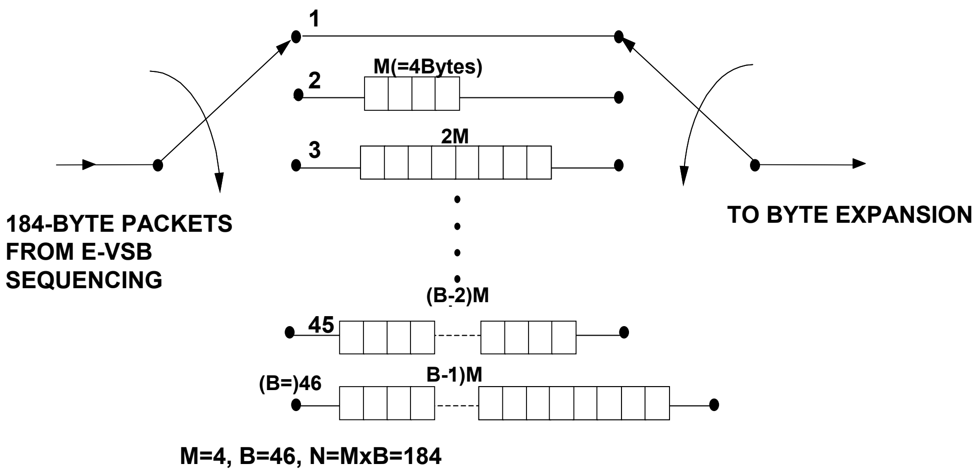

Figure 5.8 E-VSB interleaver.

5.1.3.1 E-VSB Processing and Interleaving Stream Delays

The E-VSB reference receiver does not contain buffers to compensate all the delays introduced in the E-VSB processing before transmission. Therefore, before transmission, each stream (main, 1/2-rate and 1/4-rate) should be delayed by a number of bytes to allow for synchronization of the streams in the receiver for fallback modes. The actual values needed are dependent on the particular mix of the enhanced and main rates defined in A/53D Annex D [2]. A complete enumeration of the required delays for different mixes of main, 1/2-rate and 1/4-rate is given in Appendix B.

Figure 5.9 represents the path of any one particular stream mode (1/2 rate, 1/4 rate, or main). Some example mixes and the required delays are shown in Table 5.1

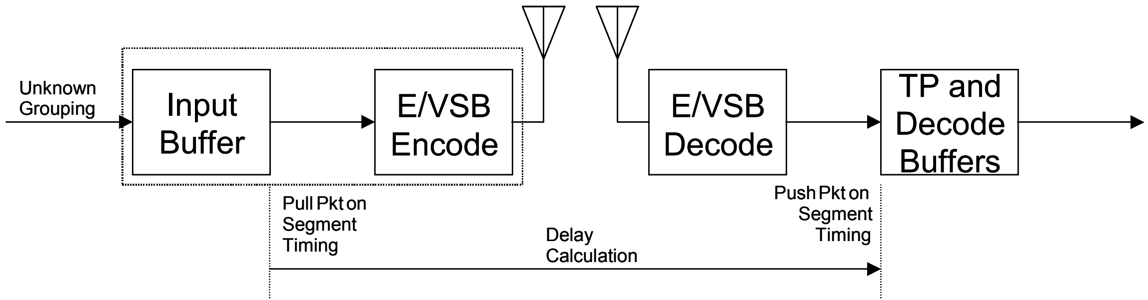

Figure 5.9 Alignment delay calculation points.

Table 5.1*a* Example Data Rates

Decimal Map Number (9 Bit Value)	1/2 Rate, # Steps	Segments Per Data Frame for 1/2 Rate	1/2 Rate Payload, Mbps	1/4 Rate, # Steps	Segments Per Data Frame for 1/4 Rate	1/4Rate Payload, Mbps	Total E-VSB Segments Per Frame	Normal Stream Payload Bitrate, Mbps	Segments Per Data Frame for Main
80	0	0	0.000000	10	40	0.542212	40	16.90642020	272
131	11	40	1.084423	0	0	0.000000	40	16.90642020	272
160	8	24	0.650654	4	16	0.216885	40	16.90642020	272
57	1	2	0.054221	7	28	0.379548	30	17.52797976	282

Table 5.1*b* Alignment Delays (Segments) for Example Data Rates

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
80	1529	1500	-	-	0	0
131	839	746	0	0	-	-
160	1200	1123	209	144	0	0
57	2275	2411	0	0	401	500

The table entries (B and U) represent compensation of the delay from the encoder pull interface in Figure 5.9 to the receiver push interface. Conceptually, to initialize this synchronization, the next full transport packet would enter the input buffer starting at time TA. TA is based on a segment clock and is coincident for all three stream buffers. At time TA + Table Entry, the pull interface for a particular stream is enabled so that the next packet request will be honored. There is no need for resynchronization until the MAP number (that is, the mix of 1/2 rate, 1/4 rate, and main data) is changed. (The MAP number is defined in ATSC A/53D Annex D [2]0.)

The entries in Table 5.1*a* show detailed data rates and number of segments per data frame for some example mixes of main, 1/2-rate, and 1/4-rate data. Further explanation of the column headings is given in Annex A, which contains the complete tables. The entries in Table 5.1*b* represent compensation of the relative delays between the three streams (main, 1/2 rate, and 1/4 rate) introduced in the E-VSB transmission processing (see A/53D Annex D [2]0). The delay of each stream that is introduced by the transmission system is measured from the encoder pull interface to the receiver push interface shown in Figure 5.9. Each row of Table 5.1*a* or 5.1*b* corresponds to a particular mix of main, 1/2 rate and 1/4 rate data. For each example mix, Table 5.1*b* contains the compensating delays for the two data streams with the two shortest transmission-processing delays. The entries are the delays (measured in number of data *segment*[1] times of the complete emitted signal) that must be inserted (via the input buffer of Figure 5.9) into two of the streams to align them with the stream having the longest transmission system delay. Note that since each of the three streams contains packets at less than the emitted segment rate, the size of the delay in packets depends on the ratio of packet rate for the particular stream (main, 1/2 rate, or 1/4 rate) to total segment rate.

In Table 5.1*b*, Columns labeled B contain the compensating delays for Option 1 E-VSB packing (see A/53D Annex D [2]); i.e., *bursted packing*. Columns labeled U are for Option 2 E-VSB packing (see A/53D Annex D [2]); i.e., *uniform packing*.

5.1.3.2 E-VSB Interleaver Startup Condition

The Enhanced Data Interleaver startup condition needs to be studied carefully because the Enhanced Data Interleaver has a parallel interleaver that carries the stream of H/Q flag bits associated with the data bytes. The H/Q flag is used by the immediately following block to expand each data byte by either two times (H) or four times (Q), and, therefore, alters the length of the data stream.

When the transmitter system powers up, the H/Q flag contents may be random. As a result, the data byte expansion based on these random H/Q flag bits will produce unexpected and generally incorrect enhanced data lengths at the output of the expansion block. This will subsequently cause random underflow and/or overflow at the input to the following Main and Enhanced multiplexer packet processor, and cause the valid enhanced data to be multiplexed at an incorrect position of a VSB data field.

Note that the parallel interleaving of data and flags may be implemented in other ways, for example, as a single interleaver with 9-bit words including the flag bit. The problem of random start-up conditions generally will also be present in alternative implementations.

In the following paragraphs, a detailed discussion on the E-VSB Interleaver startup condition and possible means to avoid this problem are provided.

The Enhanced Data Interleaver includes a storage component (memory or shift register) for storing and interleaving the incoming enhanced RS encoded data bytes. Each enhanced data byte carries with it an H/Q flag indicating which MPEG data streams (i.e., enhanced 1/2 rate MPEG data stream or enhanced 1/4 rate MPEG data stream) this data byte belongs to (see Figure 5.10). Assuming the Enhanced Data Interleaver storage component powers up in a random state, before the first valid enhanced RS encoded data byte is received by the Enhanced Data Interleaver, the Enhanced Data Interleaver storage component will contain only random data, referred to as the initial random data hereafter.

These initial random data values stored in the Enhanced Data Interleaver during system startup belong to neither the valid enhanced 1/2 rate MPEG data stream nor the valid enhanced 1/4 rate MPEG data stream. Therefore, the H/Q flags associated with these initial random data are truly undefined and random.

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1 See A/53D Annex D [2]. For main data, one data segment corresponds to one MPEG transport packet.

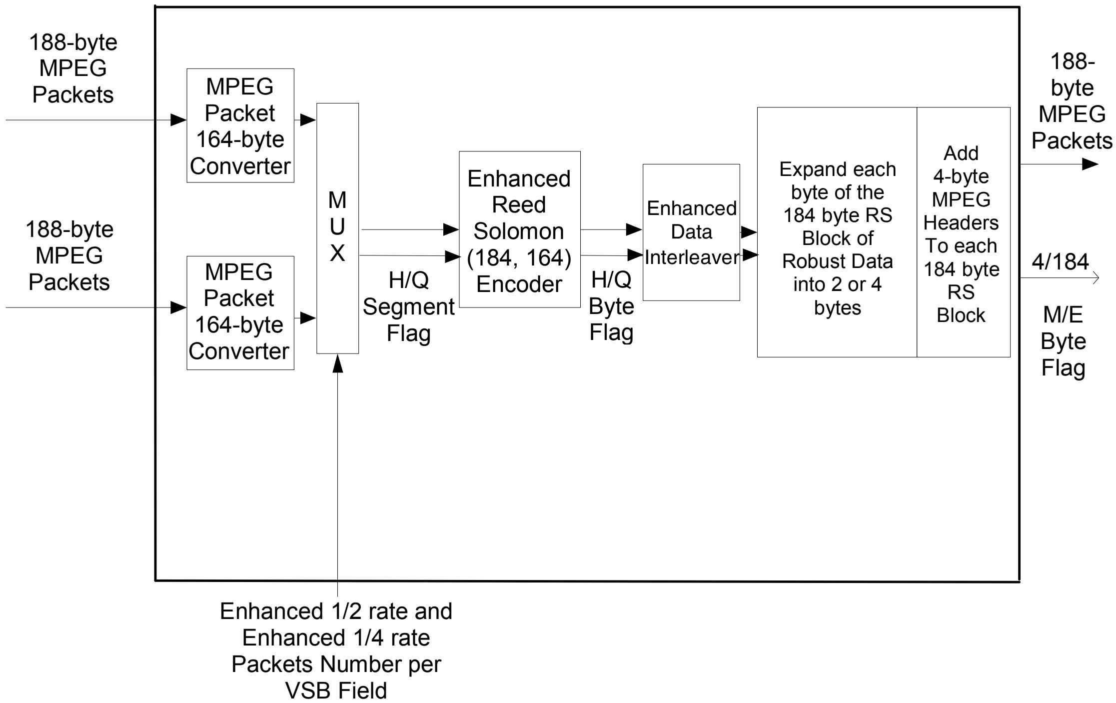
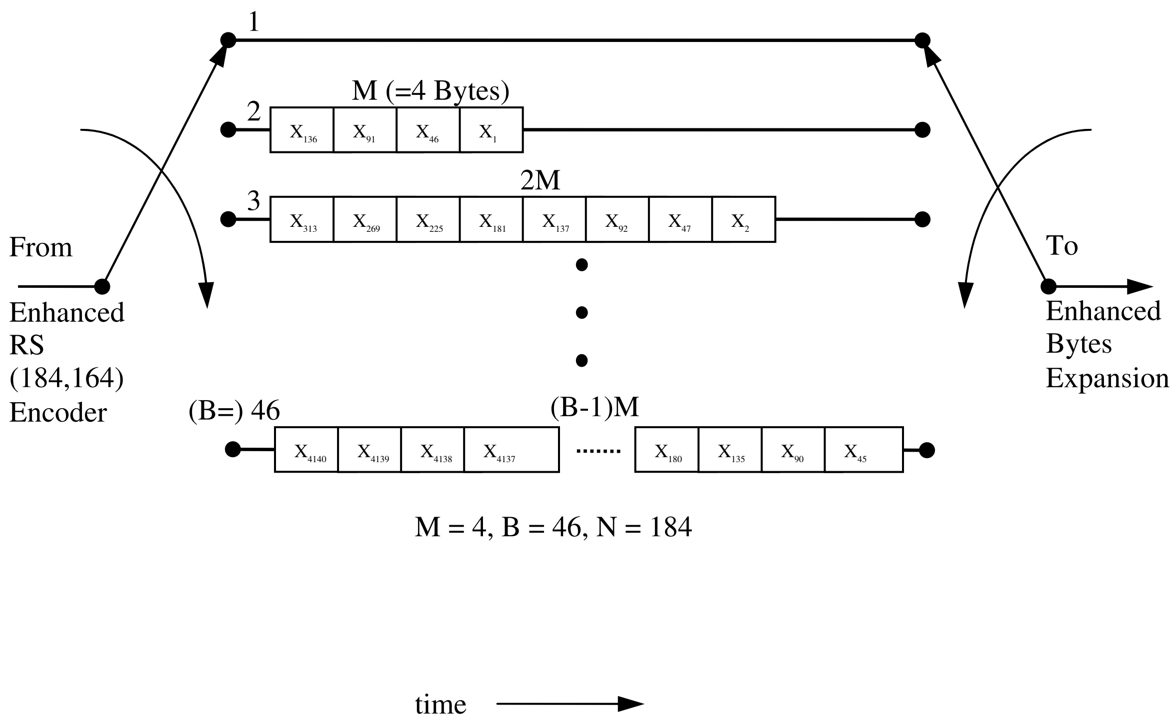


Figure 5.10 E-8-VSB pre-processor.

Because of the enhanced interleaving process, when the valid enhanced RS encoded data begins to be received by the Enhanced Data Interleaver, the valid data and their associated H/Q flags will be mixed with the initial random data and their associated random H/Q flags at the output of the Enhanced Data Interleaver. That is, many of the initial data bytes and their associated H/Q flags following the first valid enhanced data byte at the Enhanced Data Interleaver output will be random and belong to neither the valid enhanced 1/2 rate MPEG data stream nor the valid enhanced 1/4 rate MPEG data stream.

Figure 5.11 illustrates the Enhanced Data Interleaver startup condition where X_i represents an initial random data byte stored in the storage component of the Enhanced Data Interleaver when the transmitter system powers up, 1 <= i <= 4140. An example illustrating the mix of the valid enhanced data and the initial random data at the Enhanced Data Interleaver output given one 184-byte enhanced 1/2 rate packet followed by one 184-byte enhanced 1/4 rate packet at the Enhanced Data Interleaver input is also provided at the bottom of Figure 5.11, where D_j represent the valid enhanced input data, j >= 1, H or Q represents a valid H/Q flag and Y_i denotes the undefined random H/Q flag associated with an initial random data byte X_i. It is worthwhile to mention that at the Enhanced Data Interleaver output, the first valid enhanced RS encoded data byte D1 is followed by the initial random data X_i. Therefore, the random H/Q flag Y_i associated with X_i will be processed as regular H/Q flag in the following blocks.




```
Input Byte: D1 D2 D3 D4 … D184 D185 D186 D187 D188 … D368 …
Input Flag: H H H H … H Q Q Q Q … Q …

Output Byte: D1 X1 X2 … X45 D47 X46 … X90 D93 X91 … X135 D139 X136 … X180 D185 D2 X181 …
Output Flag: H Y1 Y2 … Y45 H Y46 … Y90 H Y91 … Y135 H Y136 … Y180 Q H Y181 …
```

Figure 5.11 Enhanced data interleaver startup condition (byte shift register illustration).

The H/Q flag is used in the block immediately following the enhanced data interleaver block, (Enhanced Bytes Expansion, see Figure 5.10), as a basis to expand each incoming byte into two bytes or four bytes. Without explicitly defining how the Enhanced Byte Expansion handles the initial random data, the Enhanced Bytes Expansion will start expanding every incoming data byte (including both the valid enhanced data and the initial random data) based on its associated H/Q flag when the first valid enhanced data byte arrives. As a result, the byte expansion based on the subsequent random H/Q flags will cause the number of data bytes following the first valid enhanced data byte at the Enhanced Bytes Expansion block output to be non-deterministic. Consequently, the number of data bytes following the first valid enhanced data byte at the E8-VSB Pre-processor output (Figure 5.10) will be non-deterministic.

This randomness in the number of data bytes at the output of E8-VSB Pre-processor is not acceptable because a pre-determined number of enhanced data packets are required to be multiplexed with a pre-determined number of Main data packets to be a single MPEG compatible data stream at the Main and Enhanced Mux Packet Processor (see Figure 5.12).

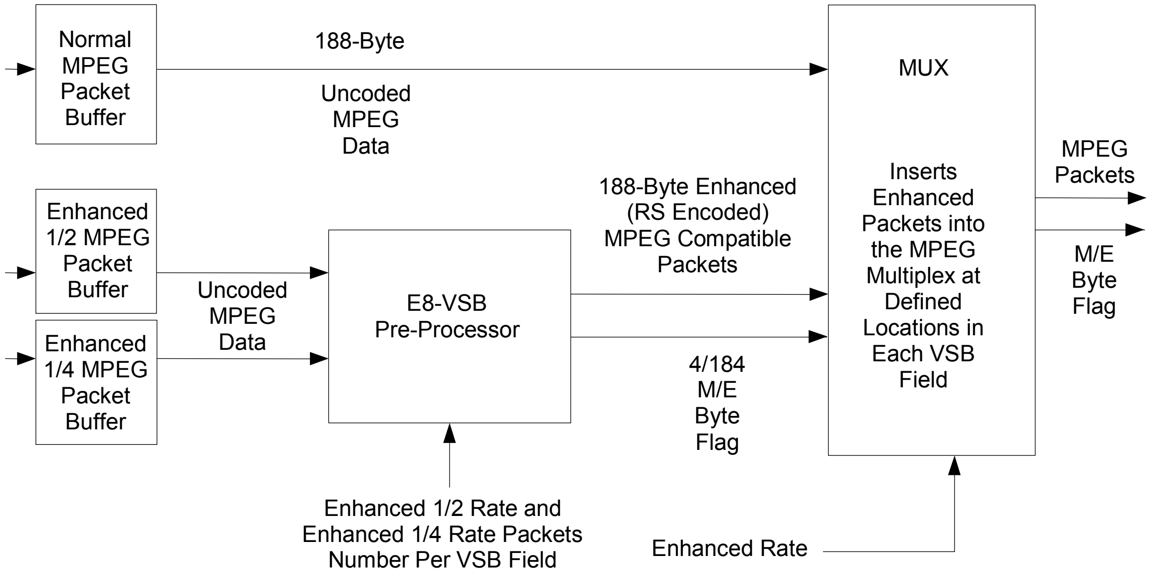


Figure 5.12 Main and Enhanced mux packet processor.

For example, in the case that the 12-bit map data equals to 0x8DC, 172 segments worth of VSB symbols in a VSB field will be used by the Main data, 40 segments will be used by the enhanced 1/2 rate data and 100 segments will be used by the enhanced 1/4 rate data. This is equivalent to multiplex 172 188-Byte packets of Main data with 140 188-byte packets of the enhanced data at the Main and Enhanced Mux Packet Processor. An incorrect number of the enhanced data bytes at the Main and Enhanced Mux Packet Processor input will cause the subsequent valid enhanced data to be packetized at the incorrect position of a VSB field.

In above example, for every 20 164-byte packets of enhanced 1/2 rate data and 25 164-byte packets of enhanced 1/4 rate data at the MPEG Packet 164-byte Converter output (see Figure 5.10), exactly 140 188-byte packets of the enhanced data need to be generated at the Main and Enhanced Mux Packet Processor input. If however, more or less than 140 188-byte packets worth of the enhanced data are generated at the Main and Enhanced Mux Packet Processor input because of the random byte expansion described previously, all the subsequent valid enhanced data bytes will be packetized at an offset from the correct position.

This incorrect packetization on the enhanced data will propagate to all the subsequent VSB fields until a controlled reset or a map change occurs that allow the Main and Enhanced Mux Packet Processor to receive the correct number of the enhanced data packets from the beginning.

To avoid the problem created by the random H/Q flags corresponding to the initial random data in the Enhanced Data Interleaver when the transmitter system powers up, it is recommended that the Enhanced Bytes Expansion block drops all initial input data and H/Q flags until both of the following two criteria are satisfied:

1) The Enhanced Data Interleaver storage component is full of the valid enhanced RS encoded data.
2) The first byte of the enhanced payload carried by a VSB field is received by the Enhanced Bytes Expansion block.

Note that in criterion 2, the first byte of the enhanced payload carried by a VSB field should be readily identifiable by the Enhanced 1/2 Rate and 1/4 Rate Packet Multiplexer (see Figure 5.10). Note also that in order to satisfy both criterion 1 and criterion 2, depending on the 12-bit map data specified, much of the initial enhanced data will be dropped together with the initial random data by the Enhanced Bytes Expansion block. It is therefore recommended that the relevant numbers of null MPEG packets are prepended to the valid enhanced 1/2 rate and valid enhanced 1/4 rate MPEG data streams entering into the E8-VSB Pre-Processor upon system power-up.

5.1.4 Segment Packing and Jitter

The time-multiplexing ("packing") of the main and enhanced data packets (and also the multiplexing of the 1/2 rate and 1/4 rate packets) necessarily changes the emission times of packets compared to what they would be in a stream containing only one type of packet. This has two effects on the packets from an MPEG2 systems point of view:

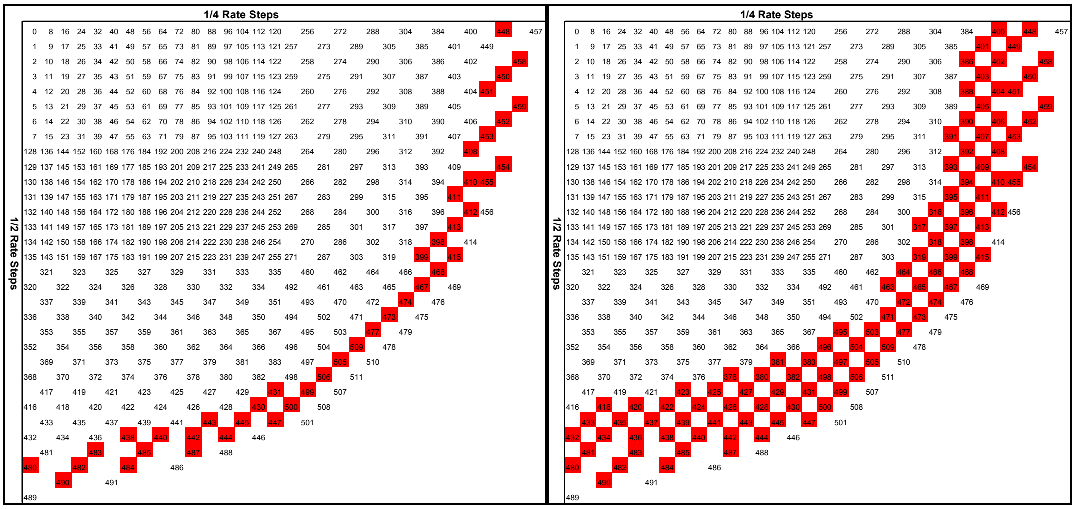
- First, since PCRs are stamped before this re-multiplexing, they will become incorrect and must be corrected.
- Second, if the source encoder and MPEG2 service multiplexer are unaware of this process, there will be additional buffer excursions caused by the advancement or delay of packets and their contents.

In practical situations, the large video buffers in MPEG2 can accommodate these added excursions easily. Buffers in the audio path are much smaller, however, and some applications using particular mix ratios may require special attention. Therefore, the following sections discuss these issues with particular attention to audio. Note that these considerations apply mainly to the main data path, since legacy receiver/decoders cannot receive content transmitted in 1/2-rate or 1/4-rate, and, on the other hand, enhanced receiver/decoders should have additional buffer space in anticipation of this effect.

5.1.4.1 Main Stream Audio Jitter

Figure 5.13 shows all the mixes available for E-VSB. The chart axes are 1/4 rate E-VSB along the top and 1/2 rate E-VSB along the left side. Each available mix has its MAP number entered in the chart. Locations where a mix is not available are left blank.

Mixes that have transport packet delays which result in there being more than 552 bytes less than expected may cause an underflow condition in the AC-3 audio buffer Bn, when the audio is coded at 448 kbps. These occur at the higher E-VSB mix ratios (lower main stream data rates), shown by the dark shaded squares in Figure 5.13. The left half of the figure reflects the burst mapping mode and the right half reflects the uniform mapping mode.



Bursted Packing Mode Uniform Packing Mode

Figure 5.13 Packing modes, data mixes, and jitter.

It is apparent that the high jitter occurs with the lower Main stream rates (toward the bottom and right). The lowest Main stream rates are too low to support 448 kbps.

The packet jitter experienced by any particular PID stream in a TP stream is proportional to the percentage of the stream utilized by that PID. A PID using half the available packets will experience half the peak jitter for the stream.

5.1.4.1.1 Main Stream Audio Jitter Remedies

There are multiple methods to construct the transport stream in order to not violate the MPEG-2 T-STD. Depending on the method used the potential impact of displaced packets varies.

5.1.4.1.1.1 Audio Bit Rate Limitation

Since the main audio jitter equals the total main stream jitter times the proportion of the main stream used for audio, this leads to a simple method to manage the audio packet jitter within the legacy hardware's limits. Reducing the audio coding rate will reduce the jitter. The frame buffer used for audio coding at 192 kbps is 768 bytes, as compared with the frame buffer at 448 kbps of 1792 bytes. The audio buffer fullness for the elementary stream as it goes into the multiplexer can be caused to be higher than the nominal mid point by three packets (552 payload bytes) so that delay in some packets due to TS-E packets does not cause underflow. This delay point is reached when the Transport Stream rate is under 3 Mbps in the burst packing mode and is under 6 Mbps for the uniform packing mode.

5.1.4.1.1.2 Buffer Fullness Method

One approach to mitigate the impact of packet displacement could be to model the BSn buffer as smaller in a custom encoder/multiplex system design. The remaining buffer size may constrain the choice of audio coding bit rate for some mix ratios.

5.1.4.1.1.3 Audio Frame Bursting

Typical MPEG-2 transport stream multiplexers meter out audio transport packets at a regular rate with a duty cycle set by the ratio of the audio packet rate to the overall packet rate. By altering the audio packet scheduling, the transport stream can be made to be completely tolerant of the variation in E-VSB delay (which is in addition to a fixed delay component) without any impact on the audio buffer (or audio bit rate). Given the maximum variation in delay of X msec imposed by E-VSB , this method requires delivery of all transport packets containing a particular audio access unit (audio frame) at least X msec prior to the presentation time for that audio access unit. The AC-3 access units occur every 32 msec. This method requires audio packets to be sent more frequently for (32-X) msec, and then to not be sent during the X msec just prior to the presentation time for the audio frame. The average packet rate is the same, the packets have just been moved around in time. The audio buffer just fills a bit faster while the packets are being sent, and then sits at a constant fullness during the X msec when E-VSB imposes a delay. The value of X depends on the particular E-VSB map number being used. This method can break down in the extreme cases where the audio bit rate is a large fraction of the total bit rate available. This is because in those extreme cases there may no longer be enough flexibility to schedule enough audio packets during the 32-X msec time window due to the fact that some other packets may also have to be delivered during that time period.

5.1.4.1.2 Video Packet Displacement Considerations

One alternative that may facilitate meeting this requirement would be to follow the constraints for the level encoded in the video elementary stream, with the following exception to ISO/IEC 13818-1 Section 2.4.2.6, "Definition of overflow and underflow" [9]:

Let Fn(t) be the instantaneous fullness of T-STD buffer BSn.

$$Fn(t) = 0 \text{ instantaneously before } t = t(0)$$

Overflow does not occur if

$$Fn(t) \leq BSn - (TBD/2)$$

for all t and n.

Underflow does not occur if

$$0 \leq Fn(t) - (TBD/2)$$

for all t and n.

5.1.4.2 PCR Correction

E-VSB exciter/modulator designers should be aware that PCR correction will be required for each of the three packet streams, for main, 1/2 rate, and 1/4 rate. Historically, modulators have avoided doing any such correction; however, with the potentially wide variations in the packet emission times required by many map selections, PCR correction is necessary. Please refer to A/53D Annex C, Section 9.4 [2].

5.1.5 E-VSB Signal Links

The E-VSB signal may be composed of up to three packet streams, for main, 1/2-rate, and 1/4-rate coded transmission. In practice these streams are combined by the service multiplexer into one transport stream for delivery to the modulator/exciter for transmission as shown in Figure 5.12. This is important for many reasons, only one of which is consistency of exciter equipment, whether that equipment is co-located with studio operations or separated and connected to the studio via a studio-to-transmitter (STL) link.

5.1.5.1 STL Types

A studio-to-transmitter link (STL) is usually accomplished via a microwave channel or fiber optic link. The two most common microwave types are those designed to carry combined NTSC and ATSC signals across the link and those that are designed to carry only the ATSC or other digital signal. Fiber optic links are usually specialized equipment modules for ATSC that are designed to work between particular fiber optic receiver/transmitter equipment.

5.1.5.2 Signal Format

The DVB-ASI signal standard format has become widely used for moving transport streams between equipment within a television facility or plant. However, most ATSC compliant modulators/exciters employ the SMPTE-310M standard on their inputs. Working with the DVB-ASI standard has advantages that have resulted in widespread uptake for studio transport equipment. The interface rate is fixed at 270 Mbps regardless of payload within the stream and the 270 Mbps data rate makes interfacing with 27 MHz oscillators used in MPEG encoders straightforward. This signal may be routed through most serial digital (270 Mbps) capable routing switchers, which assists in ease of facility design. Furthermore, DVB-ASI's clock rate tolerance is ±100 ppm as opposed to SMPTE-310M's tolerance of ± 2.8 ppm, which makes it cost effective to implement as well.

Using DVB-ASI throughout the plant is a good practice as long as the output from the STL link is in the SMPTE-310M format for exciter compatibility, as shown in Figure 5.14. Avoiding unnecessary conversions between the two signal formats is advisable so as not to introduce unwanted jitter. A good practice is to keep the signal in DVB-ASI as far in the chain possible for studio gear compatibility and convert to SMPTE-310M as far down the chain as possible, with only one conversion point. An ideal situation is implied in Figure 5.14, where the STL input equipment accepts the DVB-ASI format and its companion receiver emits the SMPTE-310M format. The goal is to ensure that the exciter receives a fully SMPTE-310M compliant (i.e., frequency, slew rate, jitter, etc.) signal. This is important since the ATSC A/53D standard requires that the exciter's symbol clock be locked to the transport clock. The transport clock is derived from the received SMPTE-310M signal.

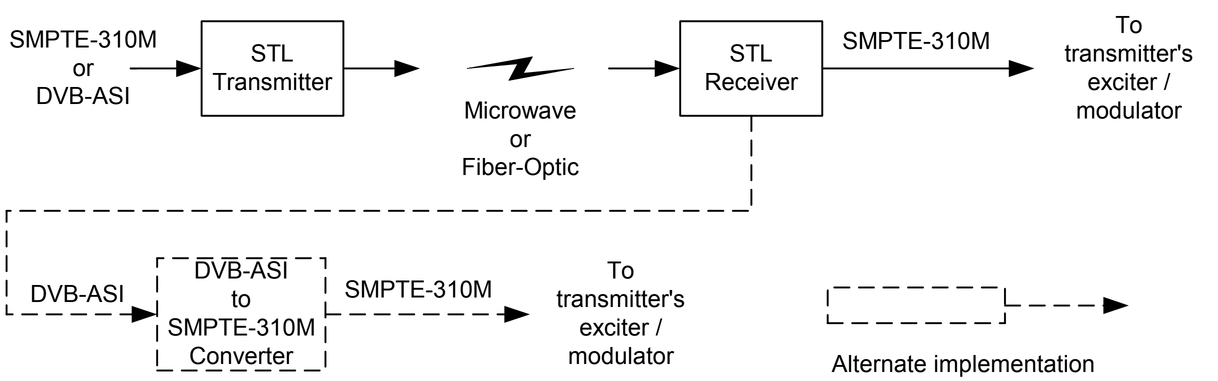


Figure 5.14 Transport stream formats to transmitter.

If the above conventions are followed, the DTV signal at the transport stream level to be sent to the transmitter will be electrically identical to what is sent with legacy 8-VSB. Therefore no STL chain modifications will be necessary.

5.2 Transport

In addition to the effects of E-VSB physical layer delays on the transport layer (discussed above) transport for E-VSB involves several additional concepts over and above pure 8-VSB:

- PSIP for the content of the Enhanced stream.
- PSIP additions to describe the mutual relationship (if any) of material in the Enhanced stream and the Main stream, and to allow close synchronization where required.
- Specifications to make streams derived from the E-VSB transmission MPEG2 compliant (such streams include the transport stream received by a legacy receiver and in an

enhanced receiver, the individual Main and Enhanced streams as well as a synthesized combined stream containing both decoded Main and Enhanced content.

Note: The first two listed items may be accomplished by additions to the PSIP specifications, which were under development and in Candidate Standard status at the time of this writing, including enhanced versions of most common PSIP tables. The third item may be accomplished by specification of a reference receiver, also in Candidate Standard status at the time of this writing. The reader is referred to ATSC Standard A/65B (Program and System Information Protocol for Terrestrial Broadcast and Cable) [4] for further details of the related specifications. This document will concentrate on expanded discussion of some particular issues for which more detail may be helpful.

5.2.1 Audio Elementary Stream Multiplexing

Audio elementary streams must be formatted into PES packets according to ISO/IEC 13818-1 [9] prior to multiplexing into the ATSC transport stream. ATSC A/53D Annex C, Section 5.5, contains additional requirements for PES packetization for ATSC transport streams, however it does not specify the method of formatting audio access units (AAUs) within PES packets. In particular, the number of AAUs per PES is not specified, nor is the alignment of AAUs within PES packets. Several considerations apply when multiplexing ATSC audio elementary streams.

5.2.1.1 Audio Access Unit (AAU)

As indicated in A/52B, an AC-3 or E-AC-3 audio access unit is defined as a sync frame. In the case of AC-3 the sync frame always represents 1536 audio samples (6 blocks of 256 audio samples). In the case of E-AC-3 the sync frame may represent from 256 to 1536 audio samples depending on the number of audio blocks per sync frame (1 to 6). Therefore, for ATSC applications (48 kHz sampling rate) the number of AAUs per second will be as shown in Table 5.2.

Table 5.2 Audio Access Unit Rates

Bit-Stream Type	Blocks/Frame	AAUs/Second
E-AC-3	1	187.5
E-AC-3	2	93.75
E-AC-3	3	62.5
AC-3 or E-AC-3	6	31.25

5.2.1.2 Alignment Mode

The data_alignment_indicator field in the PES header is not strictly defined when packetizing AC-3 and E-AC-3 (which are identified as “private_stream_1” however the field may be interpreted as an audio type in the context of ISO/IEC 13818-1. Similarly the data stream alignment descriptor specified in ISO/IEC 13818-1 is not defined for AC-3 and E-AC-3, but if present, it may be interpreted as an audio type. Whether or not the descriptor is present the only defined audio stream alignment value is type ‘1’ (sync word). In the case of AC-3 and E-AC-3 “sync word” may be interpreted as the syncword field defined in A/52B (0x0B77).

Using this interpretation, when the data_alignment_indicator is set to ‘1’ it indicates the first byte of the PES packet payload is an AC-3 or E-AC-3 syncword. When the data_alignment_indicator is set to ‘0’ it is not defined whether the first byte of the PES packet payload is a syncword. When AC-3 or E-AC-3 frames are packetized such that a sync word occurs at the start of each PES packet, and the data_alignment_indicator is always set to ‘1’ the audio can be described as being packetized in the “aligned” mode. If the data_alignment_indicator is always set to ‘0’ and sync words are allowed to occur randomly within PES packets, the audio can be described as being packetized in the “non-aligned” mode. In the aligned mode, each PES packet will contain an integer number of AAUs and PES packet sizes are restricted based on the audio frame sizes. In the non-aligned mode, PES packet sizes are not restricted by audio frame sizes.

PES packet sizes are also practically limited to the maximum size allowed by the PES_packet_length field (65536 PES payload bytes), and the ISO/IEC 13818-1 requirement that time stamps (PTS) be encoded in the multiplexed PES streams at least every 700 msec (meaning a PES header must occur at least every 700 msec). Therefore the audio PES packet size can contain no more than 700 msec of audio (approximately 21 AC-3 audio frames). While the overhead of the PES packet header is relatively minor, a small advantage in PES packetization efficiency is gained by making larger PES packets. The disadvantage of larger PES packet sizes is longer receiver acquisition time to lock to audio streams, as PES headers (including PTS values) are required to synchronize the audio stream.

While it is not required for each audio PES packet header to contain a coded PTS value it is suggested that they do to improve signal acquisition and recovery in the event of errors. DTS values are implied to be equal to PTS values in the case of ATSC audio streams and are not explicitly coded.

5.2.1.3 Transport Stream Efficiency

Any PES stream multiplexed in an MPEG-2 transport stream incurs overhead from the transport stream multiplexing process. This includes at least 4 transport stream header bytes per 184 payload bytes plus overhead due to receiver buffer management and other multiplexing requirements. While these are outside the control of the audio encoding or PES packetization process, PES packet sizes can also incur additional transport stream overhead.

PES packet headers must always start at the beginning of a transport packet. If the PES packet size does not map to an integer number of transport packets, the last transport packet must contain null stuffing bytes which will incur additional data rate overhead. The additional overhead of multiplexing AC-3 and E-AC-3 audio streams is therefore a function of the audio frame size (bit rate), alignment mode, and number of audio frames per PES packet.

As an example, consider PES packetization of AC-3 or 6 block/frame E-AC-3 encoded at 384 kbps (1536 bytes/frame) using the aligned mode. Estimates of transport stream efficiency for this example are shown in Table 5.3. The size of each PES packet (Bytes/PES) will be a multiple of 1536 bytes, as determined by the number of audio access units per PES packet (AAU/PES), plus the size of the PES header, which is assumed to be 14 bytes in this example. TP/PES shows the minimum number of transport packets needed for each PES packet. Based on this number, Null Bytes/PES indicates the number of unused bytes in the last transport packet, including adaptation field and stuffing bytes. Based on an access unit rate of 31.25 AAUs/sec, Null Bitrate indicates the overhead due to the PES packet size in terms of data rate. Total Transport Bitrate indicates the overall data rate required within the transport stream including both PES and transport packetization overhead. This does not factor in additional adaptation fields required for audio transport packets (except for the last packet per PES), or other multiplexing overhead requirements, so it can be considered a minimum bit rate requirement. Efficiency is calculated as the elementary stream bit rate (384 kbps) as a percentage of the required transport stream bit rate. The maximum efficiency in any case is approximately 97.9 percent (184/188). Tables 5.4 and 5.5 show similar examples for 192 kbps and 64 kbps audio streams.

Table 5.3 Transport Stream Efficiency for 384 kbps Audio (aligned mode)

AAU/PES	Bytes/PES	TP/PES	Null Bytes/PES	Null Bitrate	Total Transport Bitrate	Efficiency
1	1550	9	106	26.5 kbps	423.0 kbps	90.8%
2	3086	17	42	5.3 kbps	399.5 kbps	96.1%
3	4622	26	162	13.5 kbps	407.3 kbps	94.3%
4	6158	34	98	6.1 kbps	399.5 kbps	96.1%
5	7694	42	34	1.7 kbps	394.8 kbps	97.3%
6	9230	51	154	6.4 kbps	399.5 kbps	96.1%
7	10766	59	90	3.2 kbps	396.1 kbps	96.9%
8	12302	67	26	0.8 kbps	393.6 kbps	97.6%
9	13838	76	146	4.1 kbps	396.9 kbps	96.8%
10	15374	84	82	2.1 kbps	394.8 kbps	97.3%

For the non-aligned mode PES packet sizes can be restricted to multiples of 184 bytes, to match an integer number of transport packets, largely eliminating extra PES packetization overhead. There still may be additional overhead due to transport packetization requirements and receiver buffer management, however.

The above examples imply constant bit rate audio encoding (fixed audio frame sizes). Variable bit rate coding may result in more or less multiplexing overhead.

5.2.1.4 E-AC-3 Considerations

Enhanced AC-3 has the advantage of finer data rate granularity as compared to AC-3. Whereas AC-3 frames are restricted in size, E-AC-3 frames can be any size from 1 to 2048 16-bit words. Therefore, the encoded E-AC-3 frame size can be matched to a specific PES packetization format for maximum efficiency. For example, in the first case shown in Table 5.3 (1 AAU/PES) the E-AC-3 frame size may be increased to 1642 bytes (821 words) to utilize the otherwise wasted null bits. In this case a 410.5 kbps E-AC-3 stream may be transmitted with no additional penalty in terms of transport bit rate. Alternatively, the frame size may be reduced to 1458 bytes, corresponding to a 364.5 kbps E-AC-3 stream, reducing the audio bit rate by 19.5 kbps but saving 47 kbps in overall transport stream bit rate.

When E-AC-3 streams are used in the fallback mode, where the E-AC-3 streams are linked with AC-3 streams, A/53D requires the E-AC-3 audio access units (frames) to “match” the AC-3 frames in the sense that they encode an equivalent set of audio samples and that the presentation times of the corresponding frames be the same. This does *not* require the AC-3 and E-AC-3 streams to be PES packetized in the same manner. Each PES stream may be optimized for efficiency in cases where the AC-3 and E-AC-3 frame sizes/bit rates differ.

Table 5.4 Transport Stream Efficiency for 192 kbps Audio (aligned mode)

AAU/PES	Bytes/PES	TP/PES	Null Bytes/PES	Null Bitrate	Total Transport Bitrate	Efficiency
1	782	5	138	34.5 kbps	235.0 kbps	81.7%
2	1550	9	106	13.3 kbps	211.5 kbps	90.8%
3	2318	13	74	6.2 kbps	203.7 kbps	94.3%
4	3086	17	42	2.6 kbps	199.8 kbps	96.1%
5	3854	21	10	0.5 kbps	197.4 kbps	97.3%
6	4622	26	162	6.8 kbps	203.7 kbps	94.3%
7	5390	30	130	4.6 kbps	201.4 kbps	95.3%
8	6158	34	98	3.1 kbps	199.8 kbps	96.1%
9	6926	38	66	1.8 kbps	198.4 kbps	96.8%
10	7694	42	34	0.9 kbps	197.4 kbps	97.3%

Table 5.4 Transport Stream Efficiency for 64 kbps Audio (aligned mode)

AAU/PES	Bytes/PES	TP/PES	Null Bytes/PES	Null Bitrate	Total Transport Bitrate	Efficiency
1	270	2	98	24.5 kbps	94.0 kbps	68.1%
2	526	3	26	3.3 kbps	70.5 kbps	90.8%
3	782	5	138	11.5 kbps	78.3 kbps	81.7%
4	1038	6	66	4.1 kbps	70.5 kbps	90.8%
5	1294	8	178	8.9 kbps	75.2 kbps	85.1%
6	1550	9	106	4.4 kbps	70.5 kbps	90.8%
7	1806	10	34	1.2 kbps	67.1 kbps	95.3%
8	2062	12	146	4.6 kbps	70.5 kbps	90.8%
9	2318	13	74	2.1 kbps	67.9 kbps	94.3%
10	2574	14	2	0.1 kbps	65.8 kbps	97.3%

5.2.2 Exciter Delay Compensation

The amount of delay compensation required in each packet stream (main, 1/2 rate, and 1/4 rate) for each E-VSB mix is detailed in Annex B. Smooth change of mix rate depends on coordinating the change in delays with the change in mix. When the length of a compensating delay is changed, the initial conditions of the delay FIFO contents should be managed. Decreasing the FIFO length necessarily deletes some content, while increasing it will result in a gap in data provided to the exciter, which should be filled with null packets. When coordinated with the mix rate bit map change, this break in the streams will coincide with the interleaver buffer flushing of the receiver, rather than producing a separate additional break.

5.3 Advanced Video Coding

Use of advanced codecs in the enhanced stream maintains the highest possible main stream rate. The details of their use were not finalized at the time of this writing. Note: Use of legacy video and audio codecs in the enhanced stream is allowed, but consideration should be given to the bit rate required and the impact on the remaining main stream available bit rate.

5.4 Advanced Audio Coding – Enhanced-AC-3

5.4.1 Overview

Enhanced AC-3 has been designed to meet four major requirements of a next-generation broadcast audio codec: compatibility with legacy equipment, improved spectrum efficiency, cost effectiveness, and interoperability with other future media formats. E-AC-3 offers new coding tools that fundamentally improve audio performance and new features that allow operation over a wider range of bit-rates and numbers of channels as compared to AC-3. E-AC-3 bit streams can also be converted into AC-3 bit streams for playback compatibility on consumer's existing A/V decoders.

Since E-AC-3 builds upon the basic AC-3 algorithm specified in the main body of ATSC A/52B, all decoders for the Enhanced version will also decode all legacy AC-3 bit streams. In addition, although the new enhanced audio format is not directly compatible with current AC-3 decoders, it is feasible to perform a modest complexity conversion into a compliant AC-3 bit stream syntax, thus enabling backwards compatibility to legacy decoders that have IEC 60958 [6] bit stream inputs.

Enhanced AC-3 can be operated in one of two modes: 1) fallback audio or other audio services related to a primary video service, and 2) new audio services completely unrelated to existing primary video services.

5.4.2 Fallback Audio

5.4.2.1 Transmission

Enhanced AC-3 is ideal for fallback (backup) audio. Because the Enhanced AC-3 builds on the basic AC-3 coding structure, the same encoder and decoder can handle both main and fallback audio. At the broadcast site, for each AC-3 frame (corresponding to 1536 PCM input samples) the audio encoder produces two encoded output packets. Both packets are generated from identical input audio samples. The first packet (main) contains a main AC-3 frame (e.g., 1536 bytes in the case of a 5.1 channel program encoded at 384 kbps). The second packet (fallback) contains an Enhanced AC-3 frame (e.g., 384 bytes for a 2 channel matrix-encoded downmix of the 5.1 channel program encoded at 96 kbps). The main audio packet is muxed into the MPEG-2 transport stream for transmission via 8-VSB (TS-M). The fallback packet is muxed into the MPEG-2 transport stream intended for transmission via the E-VSB mode (TS-E). The PTS values in the MPEG-2 PES packets will be identical for the corresponding main and fallback audio packets, as shown in Figure 5.15.

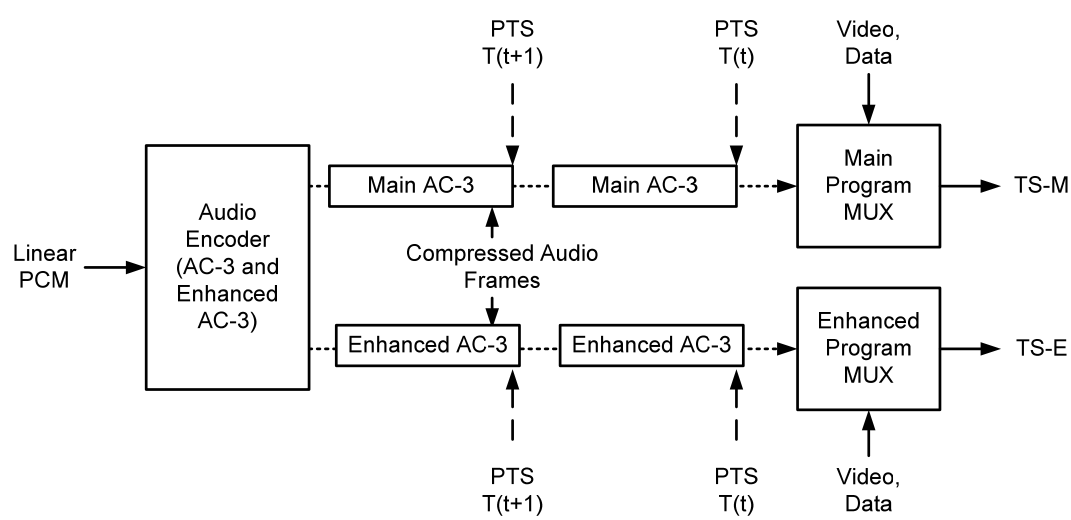


Figure 5.15 Audio Encoding for Fallback.

5.4.2.2 Reception

At the receiver the audio decoder will, in good reception conditions, be delivered the stream of main audio frame packets (each containing one AC-3 frame of encoded audio). In the event one of the main AC-3 audio packets contains errors, the corresponding E-AC-3 fallback packet is delivered to the audio decoder. The Enhanced AC-3 decoder seamlessly decodes either type of packet and produces a seamless audio output. In order to provide seamless audio when the audio decoding is taking place in an external home theater A/V decoder, the backup E-AC-3 audio packet is transcoded into a bit stream that is fully compliant with the main AC-3 syntax. Figure 5.16 shows a block diagram of the receiver audio decode path.

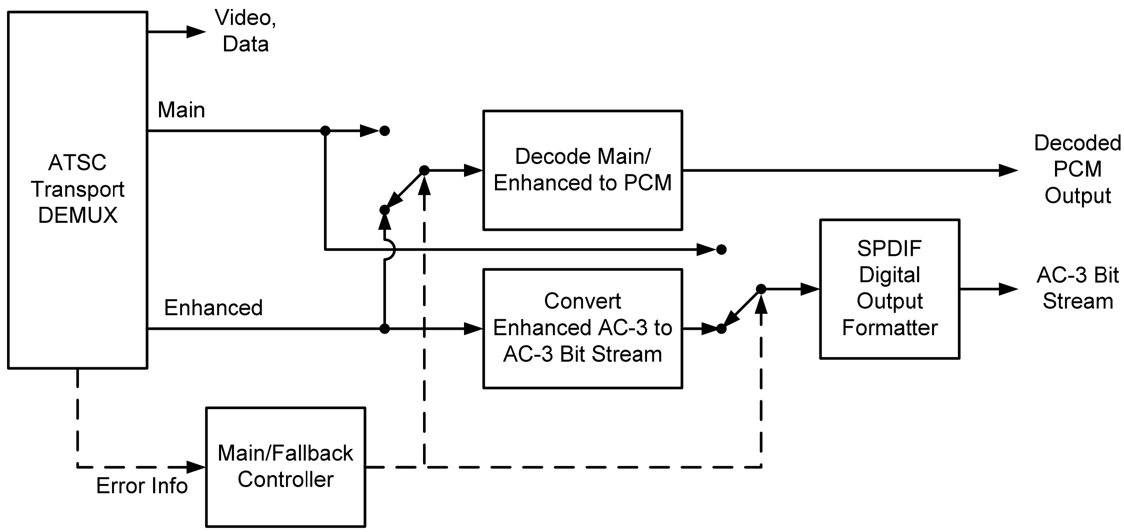


Figure 5.16 Audio decoding for fallback.

5.4.2.3 Additional Audio Services

Other audio services related to primary video that are carried by the E-VSB modulation may also be encoded with the Enhanced AC-3 system.

5.4.3 New Devices and Services

The greater coding efficiency of Enhanced AC-3 makes it feasible to deliver new audio services that are not related to the primary video services. Devices receiving these new services may be the same devices that receive standard ATSC broadcast signals, or they may be unique devices intended only for advanced services. Some of these new receivers may include the same two audio outputs (analog and IEC 61937 [7] bitstream) as today's products. Alternatively, lower complexity options may be applied to mobile or non-real time devices. Regardless of the complexity, all enhanced decoders will be able to decode both AC-3 and Enhanced AC-3 bit streams.

5.4.4 Technical Description

The Enhanced AC-3 technology is an extension of the AC-3 audio standard described in the main body of the ATSC A/52B document [1]. Enhanced AC-3 offers typical operating points that provide better overall audio quality at lower bit rates when compared to AC-3.

5.4.4.1 Enhancements for Lower Data Rates

Enhancements for lower data rates are achieved through additional algorithms and functionality in both the encoder and decoder. Some of the improvements are simply better algorithm trade-offs for lower data rates, and do not increase complexity. Others use small increases in complexity to improve the performance.

The main algorithm enhancement for lower data rates is the inclusion of a high-frequency regeneration (HFR) technique, though additional, relatively simple algorithms such as Huffman coding may be used to provide additional coding gain. High-frequency regeneration works by synthesizing the audio spectrum above a specified frequency through non-linear distortions, spectral folding or spectral translation. Because all spectral coefficients above the specified frequency are synthesized during decoding, the encoder does not need to transmit any spectral coefficients above the specified frequency. Instead, the encoder must only transmit information that enables the decoder to restore the original spectral envelope of the waveform.

The HFR technique can be used in place of the channel coupling algorithm to improve lower data rate performance. There are two main reasons why the HFR algorithm is better suited to low data rates than the coupling algorithm. First, the HFR algorithm can operate on mono signals, whereas the coupling algorithm cannot. Second, while both algorithms require the encoder to transmit information to restore the spectral envelope of the original waveform, the coupling algorithm also requires the encoder to transmit a composite channel of spectral coefficients for frequencies above the coupling frequency. For these reasons, the HFR technique can provide better overall audio quality than coupling at very low bit rates for all channel configurations.

5.4.4.2 Compatibility with Existing Infrastructure

An important aspect of the current ATSC system allows the compressed AC-3 frames to be transmitted over a standardized interface, currently IEC 60958, to external devices like home A/V receivers that enable reproduction of the full multi-channel audio experience. A benefit of Enhanced AC-3 is that it enables conversion of Enhanced AC-3 streams to AC-3 streams without the need for an AC-3 encoder in the ATSC receiver. This maintains compatibility with the existing infrastructure while minimizing complexity in the ATSC receiver.

Conversion to the standard format is performed by partially decoding the E-AC-3 bit stream, modifying the data that is not common in the two formats, and repacking the data into an AC-3 bit stream. The enhanced encoder supplies additional side-chain information that the conversion device uses to eliminate the need for rate control, a major source of complexity. Figure 5.17 shows the audio decoding and conversion stages for E-AC-3 with PCM and AC-3 bit stream output.

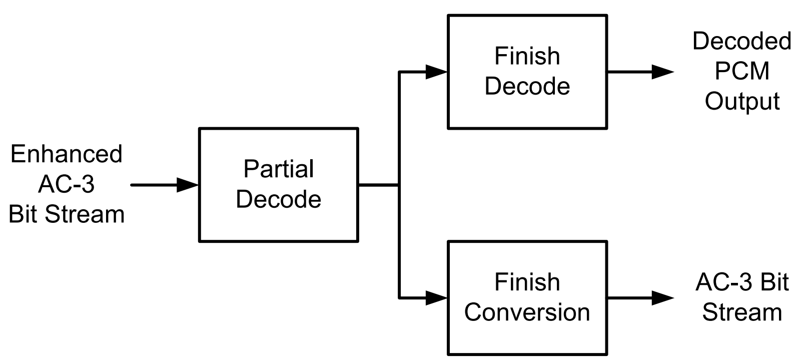


Figure 5.17 E-AC-3 decoding and conversion.

5.4.4.3 Seamless Transition Between Main and Robust Channels

Another benefit of using an extension of the core AC-3 technology for the enhanced channel is that both the Enhanced AC-3 technology and AC-3 can operate at identical sampling rates with the same time basis. This enables switching between main and enhanced channels on any frame boundary with no gaps in the decoded audio, provided that corresponding frames of the main and enhanced channels were encoded from identical PCM input samples. Additionally, using the conversion technique described above, the digital audio connection (IEC 60958 [6], Toslink) can maintain an uninterrupted AC-3 output even when the ATSC receiver transitions between main and fallback channels. This ensures that there will be no gaps in the audio decoded by an external device as well..

5.4.4.4 Flexibility for New Devices and Services

For applications that do not require compatibility with legacy AC-3 decoders, additional flexibility is built into the Enhanced AC-3 system that can be used to further reduce the data rate. For example, the Enhanced AC-3 system can be run at sample rates lower than 48 kHz to yield increased bandwidth efficiency.

5.4.4.5 Compatibility of Enhanced AC-3 on Transport Stream and Video Codec

As with AC-3 bit streams, Enhanced AC-3 bit streams are transport stream and video codec agnostic.

5.4.5 Enhanced AC-3 Features

5.4.5.1 Expanded Data Rate Flexibility

Enhanced AC-3 sync frames may contain 1, 2, 3, or 6 blocks, representing 256, 512, 768, or 1536 audio samples respectively. Each Enhanced AC-3 sync frame may contain up to 32768 bits of compressed data. The number of blocks per sync frame and the number of compressed data bits per frame can be adjusted to achieve significantly more data rate flexibility than AC-3, including the following possibilities:

- Greater maximum theoretical data rate
- Finer data rate granularity

5.4.5.1.1 Greater Maximum Data Rate

The maximum data rate allowed by Enhanced AC-3 is achieved when every sync frame contains 32768 compressed data bits. Table 5.5 shows the maximum data rates for various sample rates and numbers of blocks per sync frame.

Table 5.5 Maximum Data Rates

	1 Block / Frame	2 Blocks / Frame	3 Blocks / Frame	6 Blocks / Frame
48 kHz	6.144 Mbps	3.072 Mbps	2.048 Mbps	1.024 Mbps
44.1 kHz	5.644 Mbps	2.822 Mbps	1.881 Mbps	0.940 Mbps
32 kHz	4.096 Mbps	2.048 Mbps	1.365 Mbps	0.682 Mbps

5.4.5.1.2 Finer Data Rate Granularity

The number of compressed data bits per sync frame, which is proportional to the data rate, can be adjusted in steps as small as 16 bits. Table 5.6 shows the corresponding minimum data rate adjustment step size for various sample rates and numbers of blocks per sync frame. Note that some entries have been truncated. For comparison, the smallest step size between AC-3 data rates is 8 kbps.

Table 5.6 Minimum Data Rate Adjustment Step Size

	1 Block / Frame	2 Blocks / Frame	3 Blocks / Frame	6 Blocks / Frame
48 kHz	3.000 kbps	1.500 kbps	1.000 kbps	0.500 kbps
44.1 kHz	2.756 kbps	1.378 kbps	0.918 kbps	0.459 kbps
32 kHz	2.000 kbps	1.000 kbps	0.666 kbps	0.333 kbps

5.4.5.2 Spectral Extension

Enhanced AC-3 decoders support a new coding technique called spectral extension. Like channel coupling, spectral extension codes the highest frequency content of the signal more efficiently Spectral extension recreates a signal's high frequency spectrum from side data transmitted in the bit stream that characterizes the original signal, as well as from actual signal content from the lower frequency portion of the signal. Because spectral extension does not require transmission of the high frequency composite channel frequency coefficients, spectral extension can offer greater data reduction than channel coupling. Additionally, spectral extension can be used to provide data reduction for mono signals, while channel coupling requires at least two channels in order to operate.

Because it may be desirable, in some circumstances, to use channel coupling for a mid-range portion of the frequency spectrum and spectral extension for the higher-range portion of the frequency spectrum, spectral extension is fully compatible with channel coupling. Both tools can be enabled at the same time, for different portions of the frequency spectrum.

5.4.5.3 Transient Pre-Noise Processing

This is an optional decoder tool that improves audible performance by the substitution of audio segments just before transients to reduce the duration of pre-noise distortions. This technique is called time scaling synthesis, where synthesized PCM audio segments are used to eliminate the transient pre-noise, thereby improving the perceived quality of low-bit rate audio coded transient material. To enable the decoder to efficiently perform transient pre-noise processing with no impact on decoding latency, transient location detection and time scaling synthesis analysis is performed by the encoder and the information transmitted to the decoder. The encoder performs transient pre-noise processing for each full bandwidth audio channel and transmits helper information once per frame, only when necessary (i.e., when transients are present that will benefit from the technique).

5.4.5.4 Adaptive Hybrid Transform Processing

In 1995, the transform employed in AC-3, based on a modified discrete cosine transform (MDCT) of length 256 frequency samples, provided a reasonable tradeoff between audio coding gain and decoder implementation cost. With continuing advances in silicon manufacturing processes over the years, the integrated circuit complexity which constitutes a reasonable level has now increased. This increase in chip performance provides an opportunity to improve the coding gain of AC-3, and hence perceptual audio quality at a given bit-rate, by increasing the length of the transform. This is accomplished through use of the Adaptive Hybrid Transform (AHT).

The AHT is composed of two linear transforms connected in cascade. The first transform is identical to that employed in AC-3—a windowed Modified Discrete Cosine Transform (MDCT) of length 128 or 256 frequency samples. This feature provides compatibility with AC-3 without the need to return to the time domain when converting the E-AC-3 stream into an AC-3 stream for the S/PDIF output. For frames containing audio signals which are not time-varying in nature (stationary), a second transform can optionally be applied by the encoder, and inverted by the decoder. The second transform is composed of a non-windowed, non-overlapped Discrete Cosine Transform (DCT Type II). When the second transform is employed, the effective audio transform length increases from 256 to 1536 audio samples.

In order to best realize the additional coding gain made available by the AHT, the AC-3 scalar quantizers have been augmented with two new coding tools. When AHT is in use, both 6-dimensional vector quantization (VQ) and gain-adaptive quantization (GAQ) are employed. VQ is employed for the largest step sizes (coarsest quantization), and GAQ is employed for the smallest step sizes (finest quantization). The selection of quantizer step size is performed using the same parametric bit allocation method as AC-3, except the conventional bit allocation pointer table is replaced with a high-efficiency bit allocation table which employs finer-granularity than the conventional one, thus enabling more efficient allocation of bits.

The combination of the higher spectral resolution provided by the hybrid transform, the high efficiency bit allocation pointers, vector quantization, and gain adaptive quantization, lead to a coding efficiency increase of approximately 6 kbps per channel, and hence improved perceptual performance, for stationary signals.

5.4.5.5 Enhanced Coupling

Coupling, as implemented in AC-3, is a bit savings technique that allows high frequency sounds to be combined and conveyed by a single composite encoded channel (rather than multiple independent channels). Side information is conveyed to the decoder and is used to reconstruct the high frequency amplitude envelope of each individual channel on a subband by subband basis. Audio quality can suffer if the "coupling frequency" is brought down too low. Enhanced Coupling is a new tool that improves the imaging properties of coupled signals by adding phase compensation to the amplitude-based processing of conventional coupling. Prior to downmixing the coupled channels to a composite signal, the encoder derives both amplitude, and additionally interchannel phase information, on a subband basis for each channel. The phase information includes a decorrelation scale factor as a measure of the variation of the phase within a frame. This side chain information is transmitted to the decoder once per frame. The decoder uses the information to recover the multiple output channels from the composite signal using a combination of both amplitude scaling and phase rotation. The result is an improvement in sound imaging over conventional coupling. This improvement allows the technique to be used at lower frequencies than conventional coupling, thus improving coding efficiency. Additional benefits include greater resistance to undesired signal cancellations during creation of the composite channel, and preservation of phase information required by 2:N matrix systems, such as Dolby Pro Logic. In the case of a 2 channel fallback service, inclusion of this technique makes it practical to optionally apply additional processing (e.g., matrix decoding) to reconstruct a multichannel signal from the 2 channel fallback service, thus significantly improving the fallback experience for the consumer.

5.4.5.6 Channel and Program Extensions

The Enhanced AC-3 bit stream syntax allows for time-multiplexed substreams to be present in a single bit stream. By allowing time-multiplexed substreams, the Enhanced AC-3 bit stream syntax enables a single program with greater than 5.1 channels, multiple programs of up to 5.1 channels, or a mixture of programs with up to 5.1 channels and programs with greater than 5.1 channels, to be carried in a single bit stream. These extra channels do not affect a two or 5.1 channel decoder in ATSC broadcast applications.

5.4.5.7 Sample Rate Processing

Additional metadata is reserved for applications that involve source material sampled at 2x the nominal rate, such as 96 khz and 88.2 khz.

5.4.5.8 Mixing Control Processing

Additional metadata is reserved for applications that involve the mixing of two program streams. These applications require control of the mixing process and resultant dynamic range control metadata, such as dynrng, compr, and dialnorm. This change reserves data capacity to accomplish this.

5.5 E-VSB Receiver

5.5.1 E-VSB Receiver Front End Overview

Figure 5.18 shows the receiver block diagram of the E-VSB broadcast transmission system.

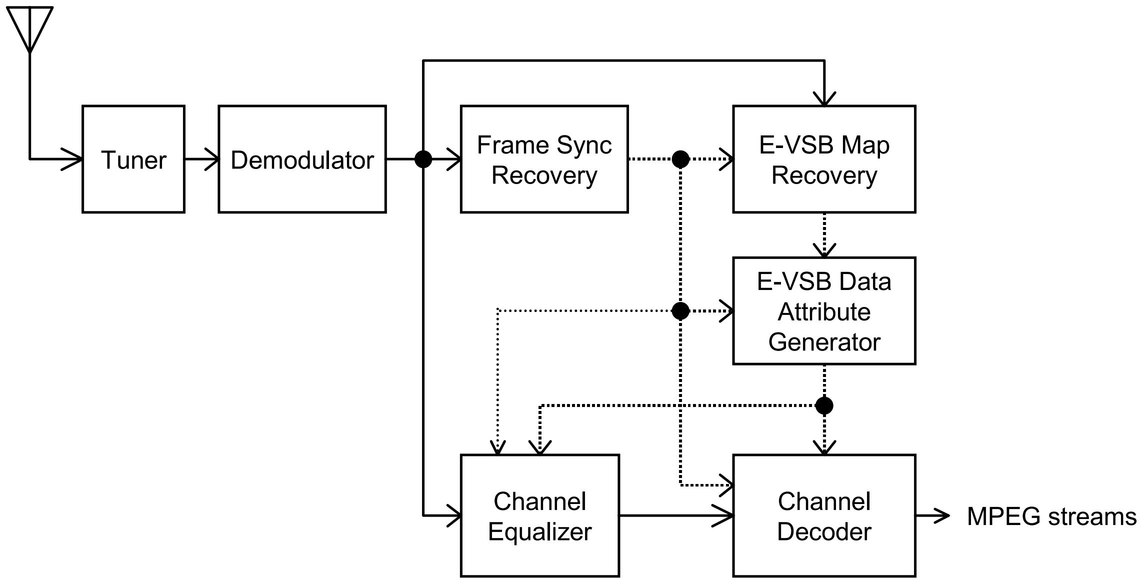


Figure 5.18 Block diagram of E-VSB receiver.

Receiver designs can differ somewhat from the block diagram of Figure 5.18. However, the above block diagram has all essential blocks for E-VSB signal processing. The following sections describe each functional block except the tuner.

5.5.1.1 Demodulator

The demodulator performs automatic gain control, carrier recovery, clock timing recovery, pilot removal and NTSC rejection, etc., on the received intermediate frequency (IF) signal. For a detailed discussion of VSB demodulation, please refer to ATSC document A/54A [3].

5.5.1.2 Frame Sync Recovery

The receiver performs synchronization of the VSB data frame using either the demodulator output or equalizer output. The frame synchronization process for an E-VSB receiver is the same as for an 8-VSB-only receiver. The frame sync recovery block provides a field sync signal and a segment sync signal to other blocks such as the channel equalizer, E-VSB MAP recovery block and E-VSB channel decoder. Note that it is necessary to distinguish between the two fields in a frame in order to receive the E-VSB map data correctly.

5.5.1.3 Channel Equalizer

The performance of the channel equalizer in an E-VSB receiver is enhanced by feedback from the Viterbi decoder that includes the more-reliable symbol decisions of the enhanced symbols. Equalizer modes such as blind equalization and parameters such as step size may be more reliably controlled by taking into account the differences in reliability measures generated by E-VSB symbols vs. normal 8-VSB symbols. A detailed discussion of the general equalization issue is beyond the scope of this document. Interested readers may consult the ATSC Technology Group Report T3-600, “DTV Signal Reception and Processing Considerations”.

To degenerate residual phase noise that is not completely compensated by the IF phase – locked loop (PLL) of the demodulator, a phase tracking loop may be included as part of the channel equalizer block in Figure 5.18. The phase tracker takes advantage of decision feedback to determine the phase offset and corrects a wider bandwidth of phase perturbations than the carrier PLL. For details of the phase tracker implemented in the Grand Alliance prototype ATSC 8VSB receiver, refer to document A/54A [3].

5.5.2 E-VSB MAP Recovery

The E-VSB Map data contains the information of how the main stream, enhanced 1/2-rate stream, and enhanced 1/4-rate stream are multiplexed in a data field. Five steps are needed to recover the E-VSB Map in current use. E-VSB Map recovery can be performed with the output of the demodulator as shown in Figure 5.18 or with the output of the equalizer. For best performance under strong ghost conditions, recovery from the equalizer output is preferred. A preliminary, partially converged equalization is sufficient to allow recognition of the map code by the recovery circuits even in the most difficult ghosting conditions.

1) **Frame synchronization**. The E-VSB Map data is carried within the (formerly) reserved area of the data field sync. The map data alternates polarity in successive data fields, and has the same polarity as the alternating middle PN63 sequence of the data field sync. Therefore the receiver should find the field sync segment and detect the polarity of the field as mentioned above.
2) **64-symbol extraction**. The map occupies the first 64 symbols following the VSB mode bits. These symbols formerly were part of 92 reserved symbols in the field sync segment. Note that legacy 8-VSB transmitters may put a fixed pattern of symbols in this area. The presence of a repeated non-alternating bit pattern can be used to recognize a legacy 8-VSB transmission with no enhanced data. It is also possible for E-VSB capable transmitters to signal the zero-enhanced-data case by sending map number = 0. When E-VSB map data is present, it is inverted according to the polarity of the middle PN63 sequence, and passed to the Kerdock decoder.
3) **Kerdock decoding**. The 64 symbols for E-VSB Map code word represent 12 map data bits, encoded by (64,12) Kerdock coding. The decoding can be performed by simple and repeated correlations. First of all, the 64 data bits in serial form are converted into parallel form and are stored in memory. Note that the total number of possible codewords is 4096. The stored received codeword is correlated with all 4096 possible codewords, and the word with the greatest correlation is chosen as correct. One possible way of generating the 4096 words for correlation is as follows: A 12-bit counter is used to generate all the possible 12-bit messages in sequence. Each 12-bit code from the counter is encoded to a 64-bit codeword by the (64,12) Kerdock coding specified in the transmission standard. Each 64-bit codeword is correlated with the 64 symbols that are stored in memory. The correlation process is repeated 4096 times and the 12-bit counter value that generates the maximum correlation is selected as the decoding result. A sequential decoding scheme like this can be used if accomplished in one frame time, because the decoded result is used not in the current data frame but in the next data frame. The value(s) of the correlation(s) can be used as a reliability index at the following Map Decision step.
4) **Map decision**. The last 2 bits of 12-bit decoded map data are for Map Change Countdown. Complete E-VSB Map data can be constructed with one VSB frame, which consists of 2 fields. The Map Change Countdown is comprised of 4 bits, two from each field. The Odd field (positive PN63) contains the high-order 2 bits and the Even field (negative PN63) contains the low-order 2 bits. The change of map can take place once

per 16 data frames and the time to use the new map is indicated by the Map Change Countdown. When the map change is needed, the counter is decremented in steps of 1 from 15 to 0. When the counter reaches 0, the map will be changed at the next frame. There are two states for map decision. One state is for no map change. In this state, the map from the odd field is the same as the map from the even field. That is, every 12-bit map message during this state is the same on even and odd fields, and this condition can be used for more reliable Kerdock decoding or for decision of the map in use. The other state is for a map change countdown period. The map currently in use is signaled in the odd field and the next map to be used is signaled in the even field. The next map is signaled repeatedly for 16 frames in advance (17 frames in advance including countdown state 0 and the 1-frame delay) so that the receiver can change maps reliably. A reliability index developed in step (4) may be used to verify the presence or absence of E-VSB data. If the reliability measure is low for several successive fields, the receiver may decide that the signal is 100 percent conventional 8-VSB only (map number 0). This can provide extra protection against false indication of the presence of enhanced data in extremely poor signal conditions.

5.5.3 E-VSB MAP Interpretation

After the map for the next frame is decided, the 10-bit map data is interpreted. See Figures 5.19 and 5.20. The first 9 bits of the 10-bit map data comprise a Map Number. The following 1 bit indicates Packing Mode. The Map Number is used to determine the transmitted mix ratio of main, 1/2-rate and 1/4-rate data from 512 choices. Step Numbers for enhanced packets are obtained through table lookup from Map Numbers (Table D5.3, Annex D of A/53D [2]). The numbers of the 1/2 rate or 1/4 rate segments per data field are obtained through a second table lookup based on their respective Step Numbers (Table D5.4*a* and Table D5.4*b*, Annex D of A/53D [2]). Finally, the Packing Mode indicates which of two multiplexing patterns is in use. The combination of the packing mode and the particular 9 bit map number determines both how 1/2 rate and 1/4 rate packets are multiplexed with each other, and how the combined 1/2 rate and 1/4 rate enhanced packet stream is multiplexed with the main mode packets. The interpretation for these 10 bits is described in detail in ATSC A/53D [2].

The Map Number is used to address a lookup table that indicates a “Step Number” for 1/2 rate EVSB data and another “Step Number” for 1/4 rate EVSB data. These Step Numbers are address entries for a second tier of two tables that indicate respectively the number of data segments per frame devoted to carrying 1/2 rate and 1/4 rate EVSB data.

The placement of the enhanced data in a data frame is then determined by one of two algorithms (according to the packing control bit). One algorithm is generally described as “bursted” (also “bunched”, “one of four”), the other as “uniform”.

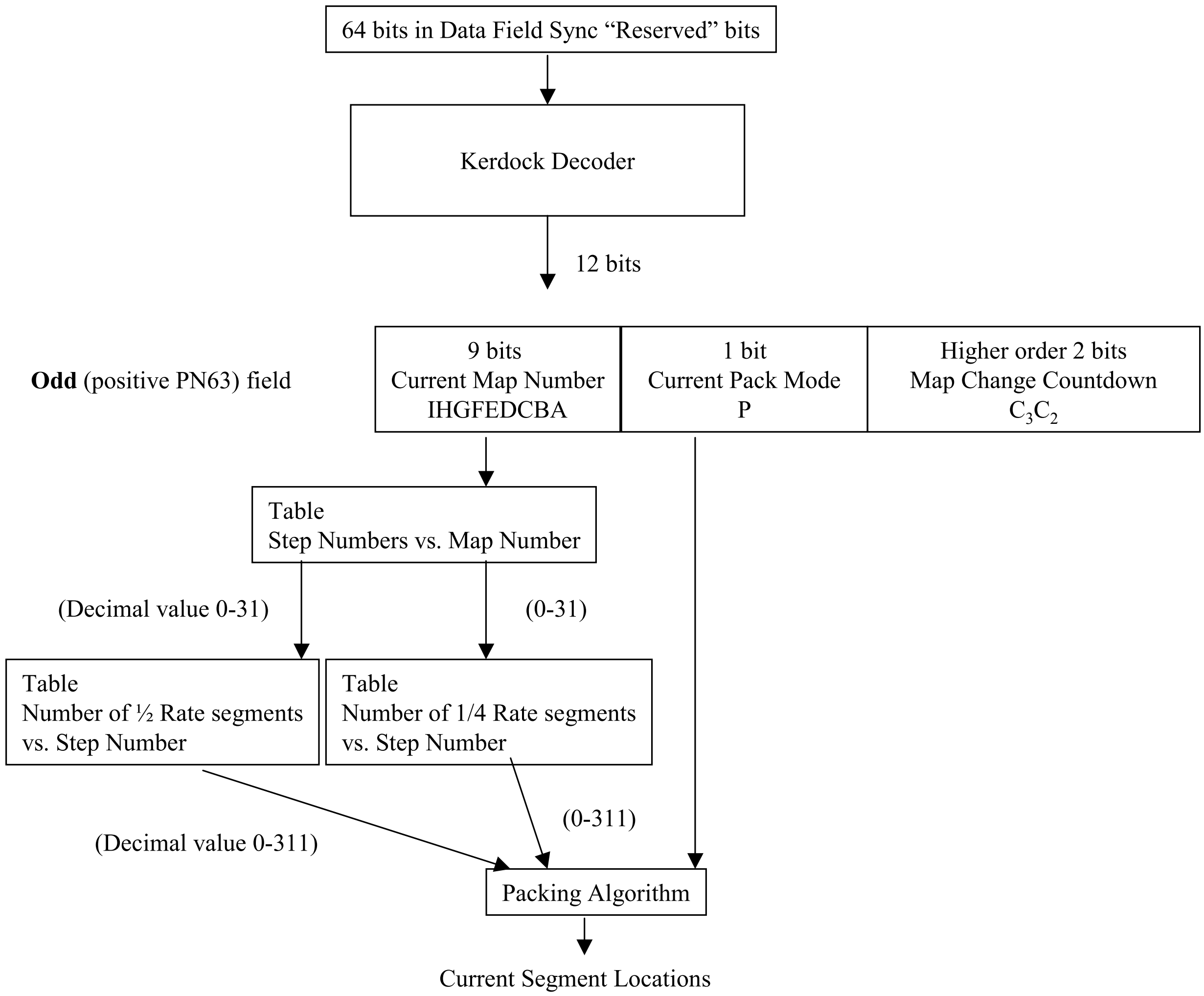


Figure 5.19 Decoding of current segment map.

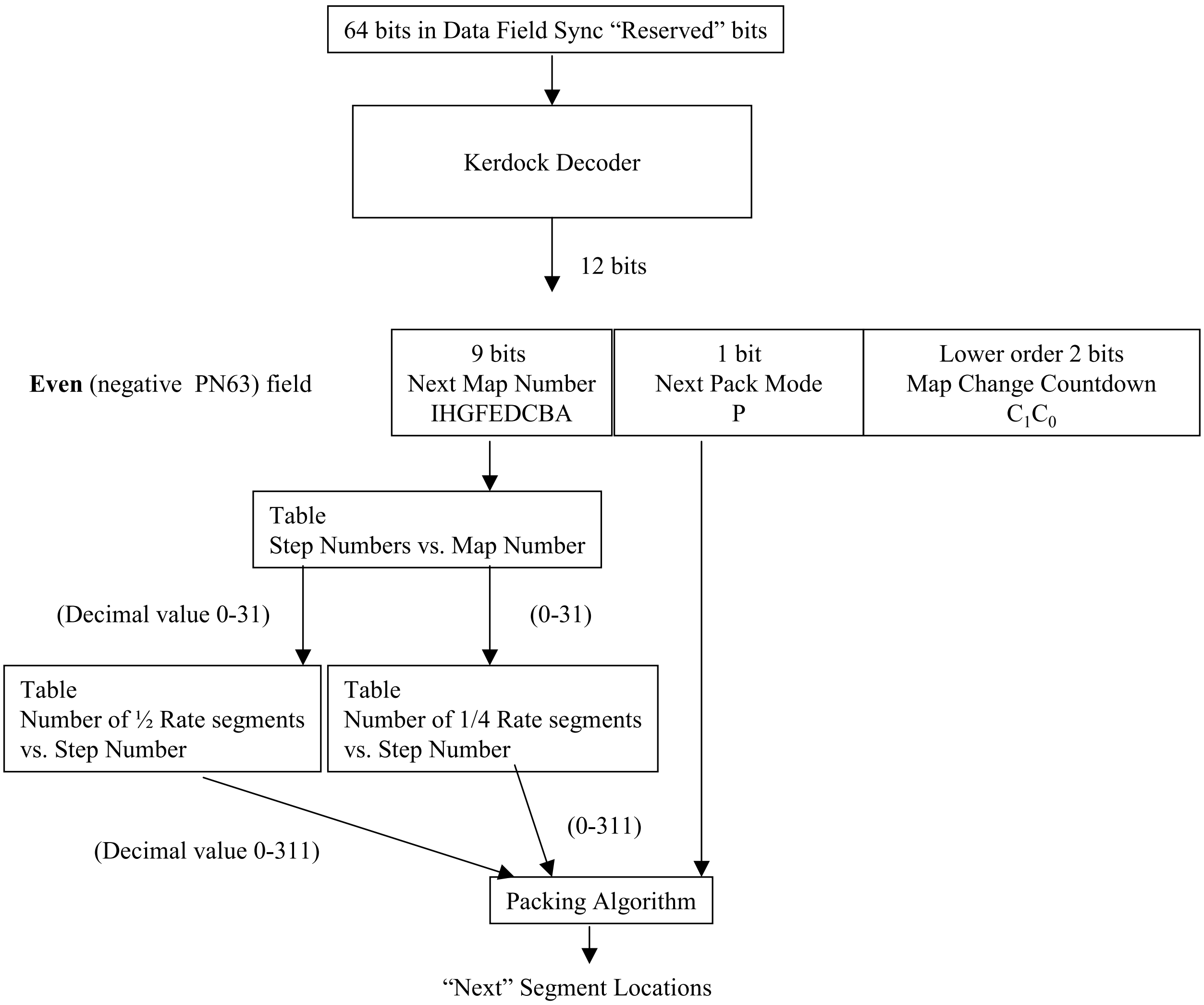


Figure 5.20 Decoding of next segment map.

5.5.4 E-VSB Data Attributes and the Attribute Flag Generator

For the correct decoding and de-multiplexing of the E-VSB signal, E-VSB data must be distinguished from normal (main) 8-VSB data. This identification is based upon the timing of the multiplex in the data field. In addition, some transmission processing of the E-VSB data varies from symbol to symbol based on past history and must be identified in order to decode the symbols correctly. Attributes of the VSB and E-VSB data are needed at the symbol and byte domains, and at two places in packet domains. In the following discussion, the reader should refer to Figure 5.22 (decoder diagram) for the points of application of the attributes. Attributes are implemented as 1-bit flag values in hardware.

5.5.4.1 Descriptions of E-VSB Data Attributes

Data Attributes used in decoding E-VSB include a Main/Enhanced (M/E) Packet Attribute, an Enhanced Byte half-rate/quarter-rate (H/Q) Attribute, an Enhanced Packet H/Q Attribute, and a group of four E-VSB Symbol Attributes: M/E, H/Q, Flip, and RBEQ. The latter two will be explained below.

The main/enhanced (M/E) Packet attribute is used at the RS decoder, the Data De-randomizer output, and the Main Packet Remover (refer to Figure 5.22 for the location). This packet attribute indicates to the RS decoder whether a received packet is a main packet or an enhanced packet. The RS decoder works normally for main packets, but simply deletes the RS bytes of enhanced packets. At the output of the Data De-randomizer, the M/E packet attribute is used to replace the received headers of enhanced packets (which may contain errors) with locally generated MPEG null headers, to insure that downstream hardware does not falsely recognize enhanced packets as main packets. This is useful both for a subsequent main-only decoder, or for hardware that combines the main and enhanced streams into a single MPEG transport stream. In the main packet remover, the M/E packet attribute is used to delete main packets from the stream so that the output contains only enhanced packets.

The Enhanced Byte H/Q attribute is used at the null bit remover. 1-byte data, which are input into the null bit remover, can be either a 1/2-rate byte or a 1/4-rate byte. The Enhanced Byte H/Q attribute indicates which bit-dropping pattern should be used by the null bit remover, in order to combine, respectively, two 1/2-rate input bytes or four 1/4-rate input bytes into one enhanced byte.

The Enhanced Packet H/Q attribute is used at the enhanced packet de-multiplexer to distinguish 1/2-rate enhanced packets from 1/4-rate enhanced packets and output two separate enhanced streams.

There are four E-VSB symbol attributes, all used at the Viterbi decoder. These are: the M/E Symbol Attribute (which indicates whether a symbol is a main symbol or an enhanced symbol), the H/Q Symbol Attribute (which indicates whether an enhanced symbol is a 1/2-rate symbol or a 1/4-rate symbol), the RBEQ attribute (which indicates whether the repeated bits of two 1/4-rate enhanced symbols remain equal or are altered after data randomizing), and the Flip attribute (which indicates that the symbol is from the recalculated RS parity). The usages of the symbol attributes are described in detail in the section below on the Viterbi decoder.

5.5.4.2 Implementation of the E-VSB Data Attribute Flag Generator

Figure 5.21 shows the block diagram of the E-VSB data attribute flag generator. This generator is synchronized with the data field sync signal and generates a M/E packet flag for every data segment, an enhanced packet H/Q flag for every enhanced packet, an enhanced byte H/Q flag for every enhanced byte, and four symbol attribute flags (M/E, H/Q, RBEQ, Flip) for every symbol.

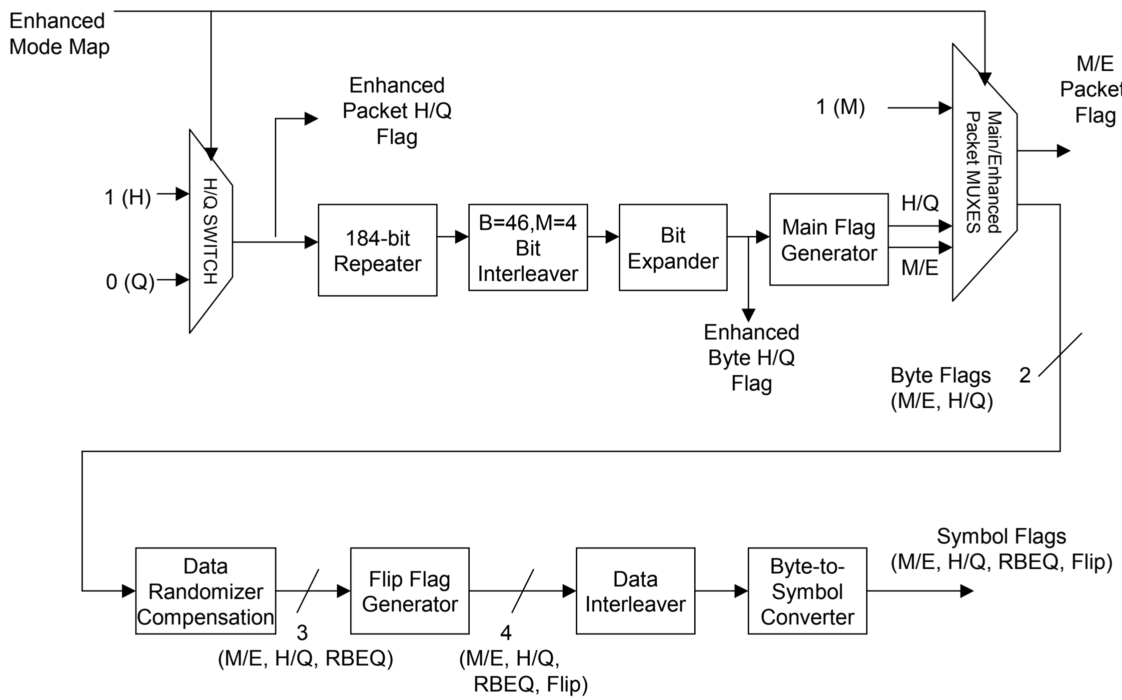


Figure 5.21 E-VSB data attribute flag generator.

The E-VSB data attribute flag generator in the receiver has a signal path similar to the E-VSB data-encoding path at the transmitter.

First of all, The Enhanced Packet H/Q Switch generates the enhanced packet H/Q flag using the enhanced mode map and field sync, by switching the H or Q value onto the flag line in synchronism with the type of packet being received. Recall that the enhanced mode map indicates the number of 1/2-rate enhanced data segments, the number of 1/4-rate enhanced data segments, and their positions in the data field. Therefore, the enhanced packet mux can generate the corresponding attribute flag bit for each data packet. This produces a serial stream of Enhanced Packet H/Q flag bits, each of which corresponds to a data packet.

The 184-bit Repeater corresponds to the enhanced RS encoder for flag generation. This repeater receives the 1-bit enhanced packet H/Q flag and outputs 184 repeated flags, which correspond to the 184 bytes in a 184-byte enhanced RS packet.

The Bit Interleaver corresponds to the enhanced data byte interleaver in the transmitter. It receives the output of the 184-bit repeater and performs bitwise convolutional interleaving of the flag bit stream with parameters (B = 46, M = 4), that is, in the same pattern as the enhanced data byte interleaving in the transmitter. Note that the internal memories of the bit interleaver should be initialized at the beginning of the first data field received after synchronization.

The Bit Expander corresponds to the data byte expander in the transmitter. It expands a flag bit (corresponding to a data byte) to 2 or 4 bits (corresponding to two or four data bytes) for 1/2-rate or 1/4-rate data respectively. When a 1/2-rate flag is input, the expander outputs two serial 1/2-rate flag bits. When a 1/4-rate flag is input, the expander outputs four serial 1/4-rate flag bits. The bit expander output is the serial stream of Enhanced Byte H/Q Attribute flag bits, each of which indicates the attribute for its corresponding data byte.

The Main Flag Generator generates a stream of 188 M/E flag bits for each enhanced packet, always indicating that the first four bytes (the compatible header bytes) are Main and that the following 184 bytes of the enhanced packet are Enhanced. It also passes through the Enhanced

Byte H/Q flag stream and prepends four "don't-care" place-holder bits per packet to make 188 serial H/Q bits per packet. The output of the Main Flag Generator block consists of two parallel streams, one indicating whether the corresponding data byte is Main or Enhanced, the other indicating whether the corresponding data byte is a 1/2-rate or 1/4-rate encoded byte.

The Main/Enhanced Packet MUX multiplexes the flags for main packets (which indicate Main for all bytes in the packet) and the flags for enhanced packets produced by the Main Flag Generator. This mux is synchronized with the field sync signal and generates packet-wise attributes as well as byte-wise attributes according to the multiplexing map signaled in the data field sync segment. It generates both the Main/Enhanced Packet Attribute flag bit stream, and the parallel byte-wise M/E and H/Q flag bit streams.

In the *transmitter*, the Data Randomizer performs an XOR operation on data bytes and randomizing bytes and produces randomized bytes (see A/53D Annex D [2]). In the *receiver*, the randomized data is subject to XOR with the same randomizing bytes, thus reversing the process. There is a corresponding Data Randomizer Compensation block in the receiver for attribute generation. This block receives 188 byte-wise attribute bits, discards the first byte attribute bit corresponding to the MPEG sync byte, and generates RBEQ flags for the remaining 187 byte-wise attribute bits. Therefore, there are three flags for the attributes of a byte after the Data Randomizer Compensation block, the M/E Byte flag, the H/Q Byte flag, and the RBEQ flag. The RBEQ flag has two bits per byte. RBEQ flags are meaningful only for 1/4-rate enhanced bytes. A byte is divided into four 2-bit symbols in the following Byte-to-Symbol Converter. In the case of 1/4-rate enhanced symbols, the second symbol in the byte carries the same information as the first symbol, and the fourth symbol carries the same information as the third symbol. Since two originally identical bits can have different polarities after randomizing, the receiver needs to identify the correct polarity when decoding. Figure 5.22 shows the generation of the RBEQ flags. RBEQ flag1 indicates whether q1 of the randomized byte is the same as q1' or not and RBEQ flag0 similarly indicates the relative polarity of q0 and q0'.

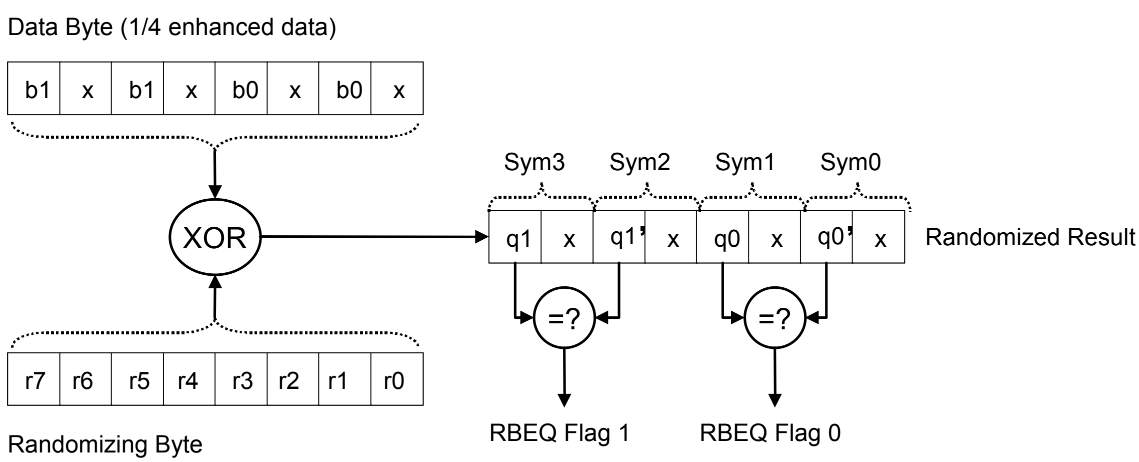


Figure 5.22 Randomization and RBEQ flags.

There is one more flag required at the byte level for decoding, to compensate for the main RS encoder of the transmitter. Since the RS encoder receives 187 data bytes, adds 20 bytes for RS parity, and constructs 207 data bytes, the Flip Flag Generator also receives 187 byte-wise attribute flags and constructs 207 byte-wise attribute flags. The Flip Flag completes the complement of four flags at the byte level. The first 187 Flip Flags are all zero. The remaining 20 Flip Flags are all zero for main packets and all ones for enhanced packets.

The Data Interleaver receives the four byte flags in parallel and performs convolutional interleaving with parameters (B = 52, M = 4). (Note that the RBEQ flag stream has two bits per data byte.) The Byte-to-Symbol Converter divides attributes for a byte into attributes for a symbol and performs 12-phase ("12-way") symbol interleaving. The outputs of the byte-to-symbol converter are E-VSB symbol flags, which consist of one M/E flag, one H/Q flag, one RBEQ flag, and one Flip Flag per symbol.

5.5.5 E-VSB Channel Decoder

Figure 5.23 shows the block diagram of an E-VSB system channel decoder. The decoder illustrated here does not include hardware for combining the main and enhanced streams into a single MPEG transport stream, which may not be needed in an integrated receiver/decoder, although the E-VSB signal is constructed to make this possible where a single MPEG transport stream output is desired.

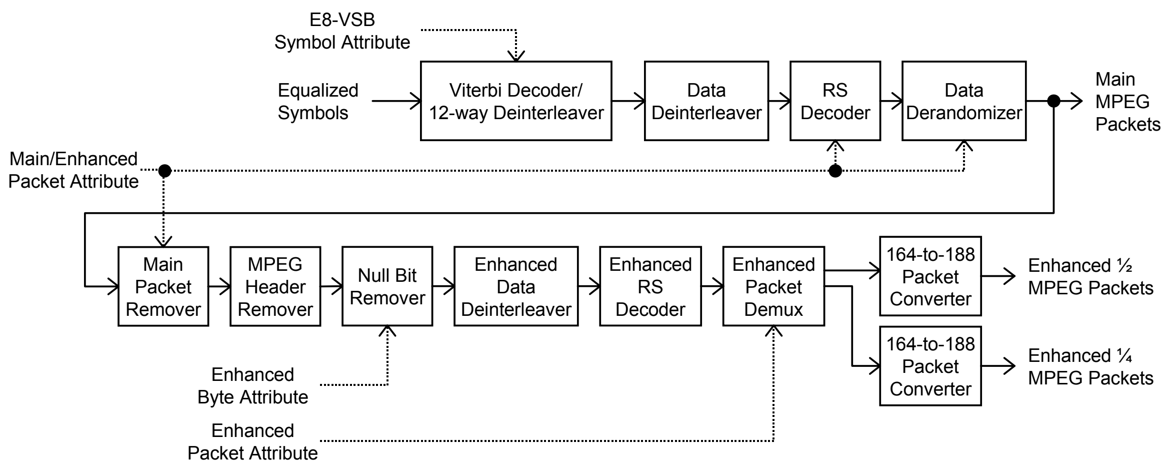


Figure 5.23 Block diagram of E-VSB channel decoder.

The channel decoder for the E-VSB signal receives symbols from the channel equalizer and E-VSB data attributes from E-VSB data attribute generator, performs decoding, and de-multiplexes main packets, enhanced 1/2-rate packets and enhanced 1/4-rate packets. Decoder design can differ somewhat from the block diagram of Figure 5.23. In some designs there may be two separate Viterbi decoders and their corresponding paths, one path for main packets and another for enhanced packets. Sections 5.5.5.1 through 5.5.5.11 describe each functional block based on the block diagram shown in Figure 5.23.

5.5.5.1 Viterbi Decoder/12-Way Symbol De-Interleaver

The Viterbi Decoder (or trellis decoder) block of the E-VSB channel decoder in Figure 5.23 performs Viterbi decoding on the equalized symbols according to the E-VSB data symbol attributes. It decodes both the main trellis code and the E-VSB convolutional code considering that they are effectively directly concatenated with each other. Figure 5.24*a* shows the trellis coder at the transmitter concatenated with the E-VSB symbol processor, and Figure 5.24*b* and Figure 5.24*c* represent the effective code of Figure 5.24*a* in case of a main symbol and an enhanced symbol, respectively. As shown in Figure 5.24*b*, the E-VSB symbol processor is bypassed in the case of a main symbol, and two bits of X2X1 are trellis encoded to output Z2Z1Z0. In the case of an enhanced symbol, the X2 bit bypasses the pre-coder and is convolutionally encoded to produce Z2Z1Z0 as shown in Figure 5.24*c*. The enhanced symbol has an effective code rate of 1/3.

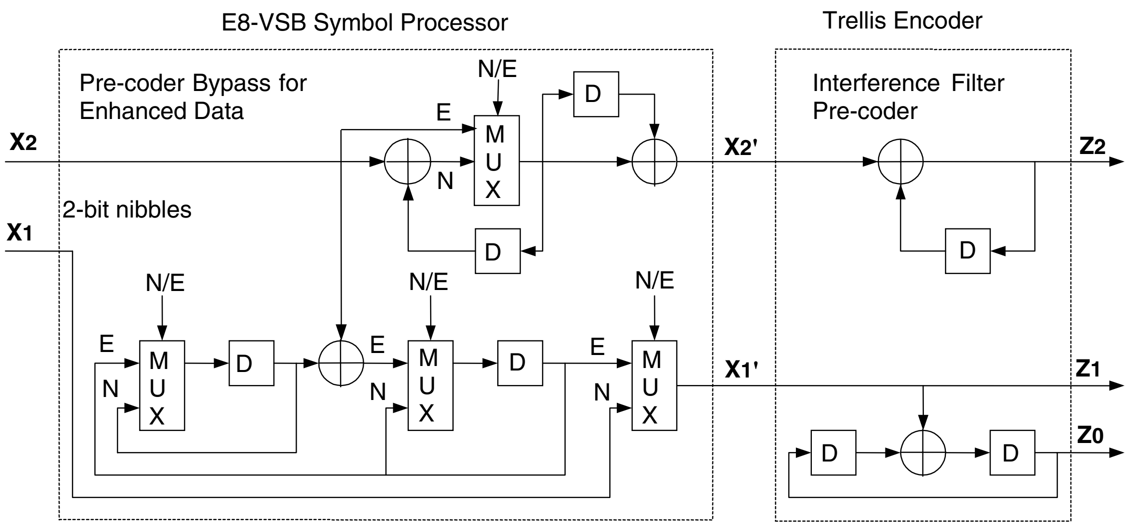


Figure 5.24*a* Concatenation of E-VSB symbol processor and trellis encoder.

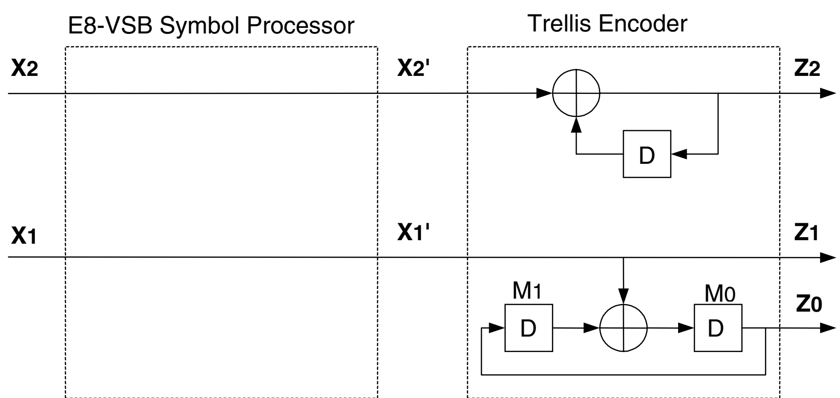


Figure 5.24*b* Effective code in case of main symbol.

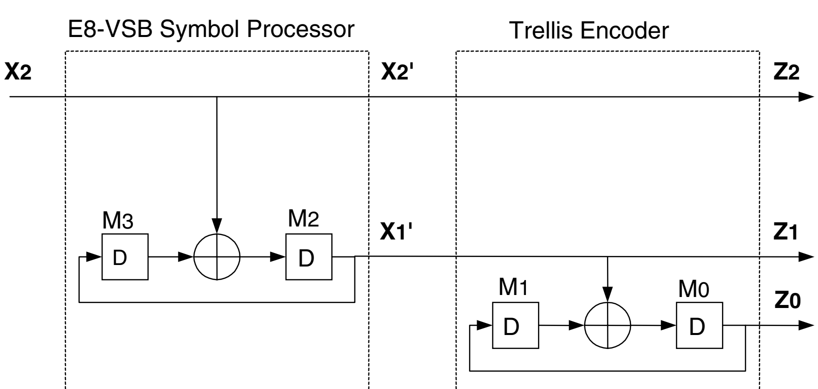


Figure 5.24*c* Effective code in case of enhanced symbol.

Figure 5.25 shows a trellis state transition diagram of enhanced and main symbols and the encoder memory states M3M2M1M0, which construct 16 trellis states. Since M3 and M2 are held during the main symbol interval, the state transition diagram of the main symbol repeats its pattern four times. The trellis transition of the main symbol includes parallel transitions by the X2 bit, but those transitions are not illustrated explicitly. The Viterbi decoder performs decoding of main and enhanced symbols by using the corresponding trellis state transition according to an M/E flag identifying the main or enhanced symbol.

For 1/4-rate enhanced FEC mode, the byte expander (or null bit inserter) of an E-VSB transmitter expands one input byte to four bytes by repeating each bit of the 1/4-rate byte and inserting null bits. However, the repeated bits of 1/4-rate byte may not be identical to each other after data randomizing and thus, the Viterbi decoder of the E-VSB receiver must know whether they are the same or different so that additional coding gain from the bit repetition is available. The E-VSB data attribute generator provides RBEQ symbol attribute flags, to indicate if the repeated bits have different polarity. The attribute generator also supplies a H/Q flag identifying 1/2-rate or 1/4-rate enhanced symbols.

For 1/4-rate enhanced symbol decoding, the Viterbi decoder performs decoding every two symbols. Figure 5.26*a* and Figure 5.26*b* explain decoding of 1/4-rate enhanced symbol when RBEQ = 1 and RBEQ = 0, respectively. If the H/Q flag indicates a 1/4-rate enhanced symbol, the Viterbi decoder collects two 1/4-rate enhanced symbols and performs decoding according to the RBEQ flag by only considering two paths out of four paths during two 1/4-rate enhanced symbol periods as shown in Figure 5.26*a* and Figure 5.26*b*. Figure 5.26*a* illustrates decoding when RBEQ = 1. An example is shown by the bold lines. For state M3M2M1M0 = 0000, there are four possible paths merging into the state during two symbol periods. But since the repeated bits of 1/4-rate enhanced data are equal after de-randomizing, the decoder can exclude the paths where consecutive X2 bits are different from each other. Similarly, when RBEQ = 0, the decoder can exclude the paths where consecutive X2 bits are the same, as shown in Figure 5.26*b*. By this operation, enhanced 1/4-rate mode has a coding gain over enhanced 1/2-rate mode. In Figure 5.26*a* and Figure 5.26*b*, the bold lines are the paths to be considered by the Viterbi decoder for decoding a 1/4-rate enhanced symbol.

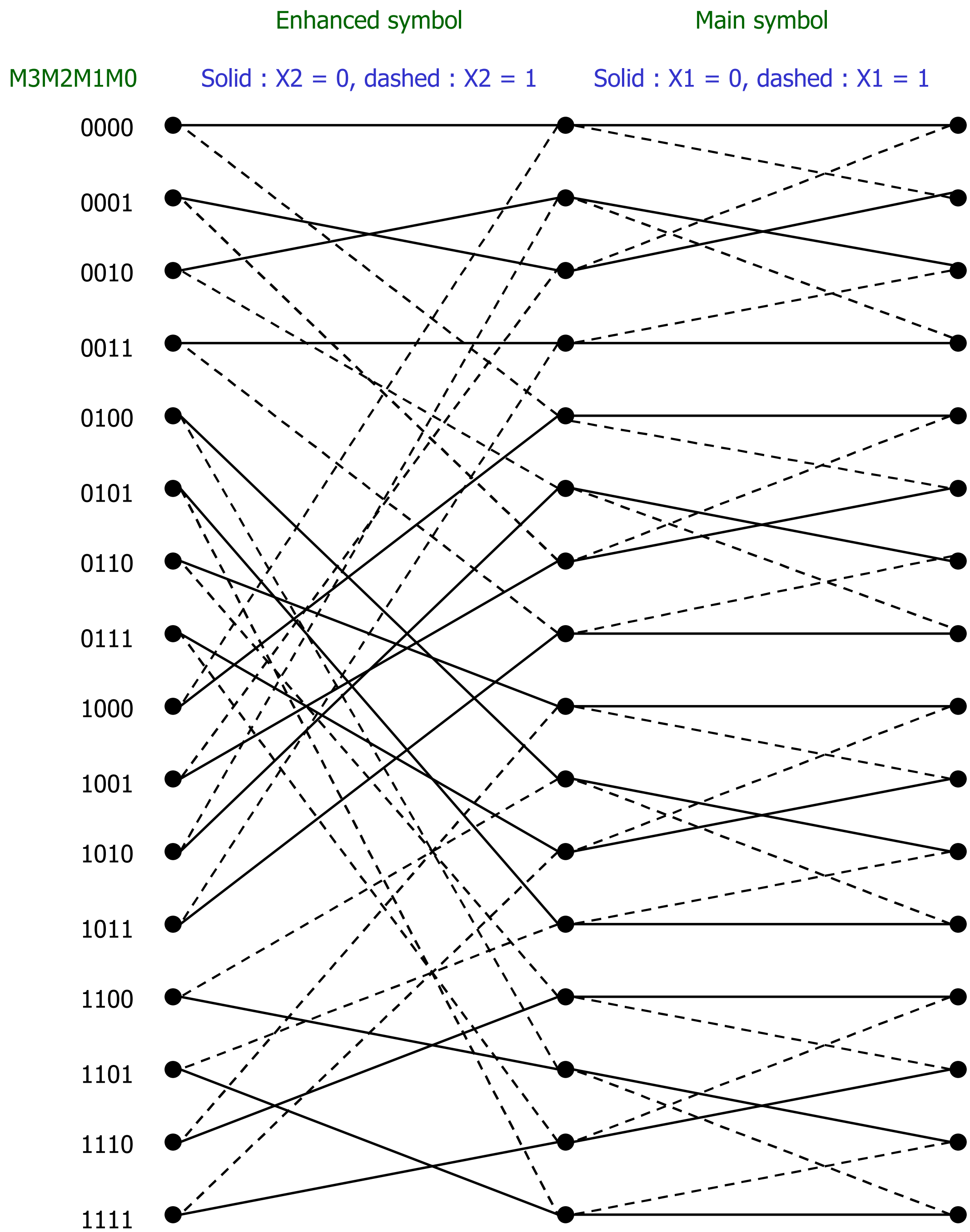


Figure 5.25 Trellis state transition diagram of main and enhanced symbol.

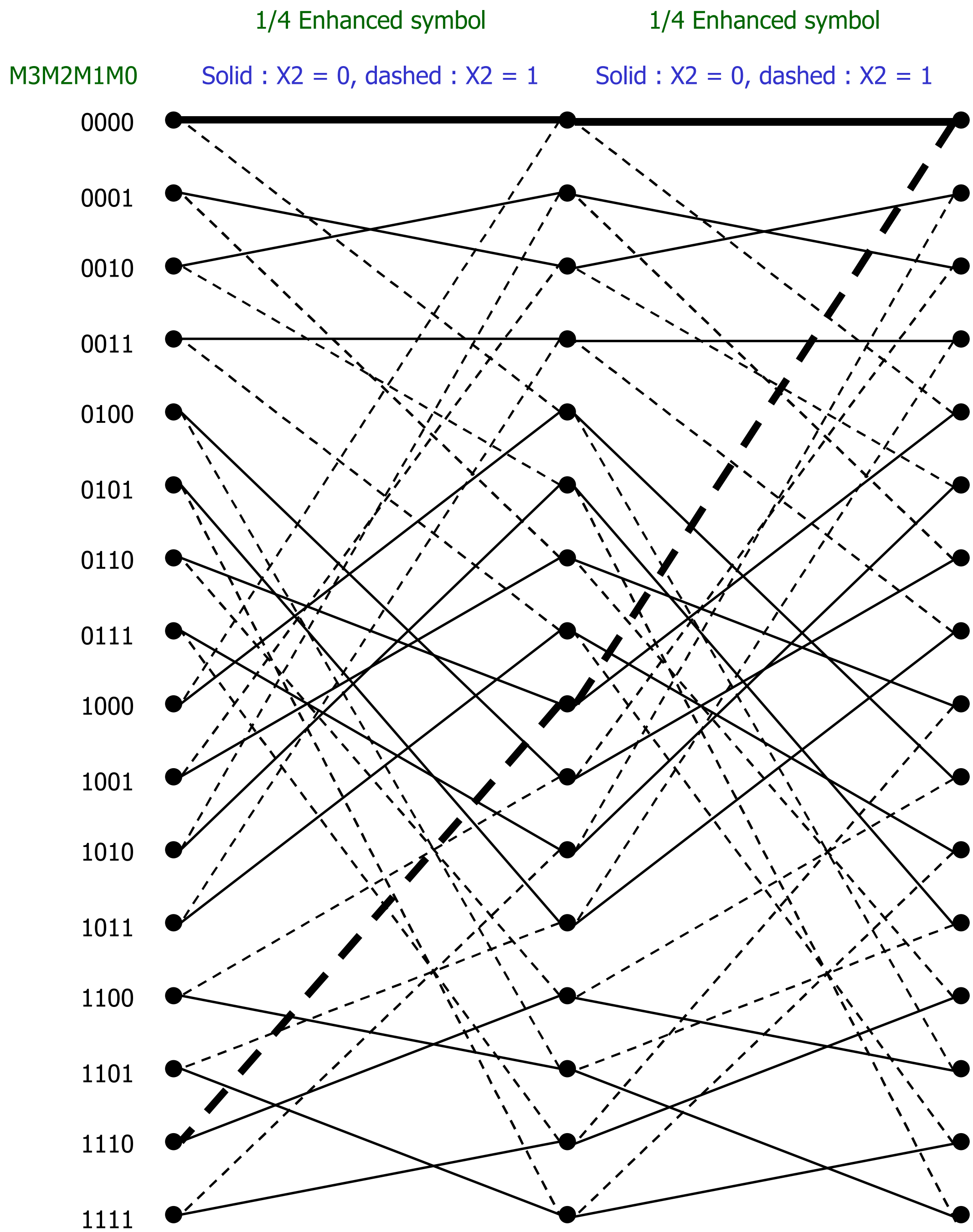


Figure 5.26*a* 1/4-rate enhanced symbol decoding when the repeated bits remain equal after data randomizing (RBEQ = 1).

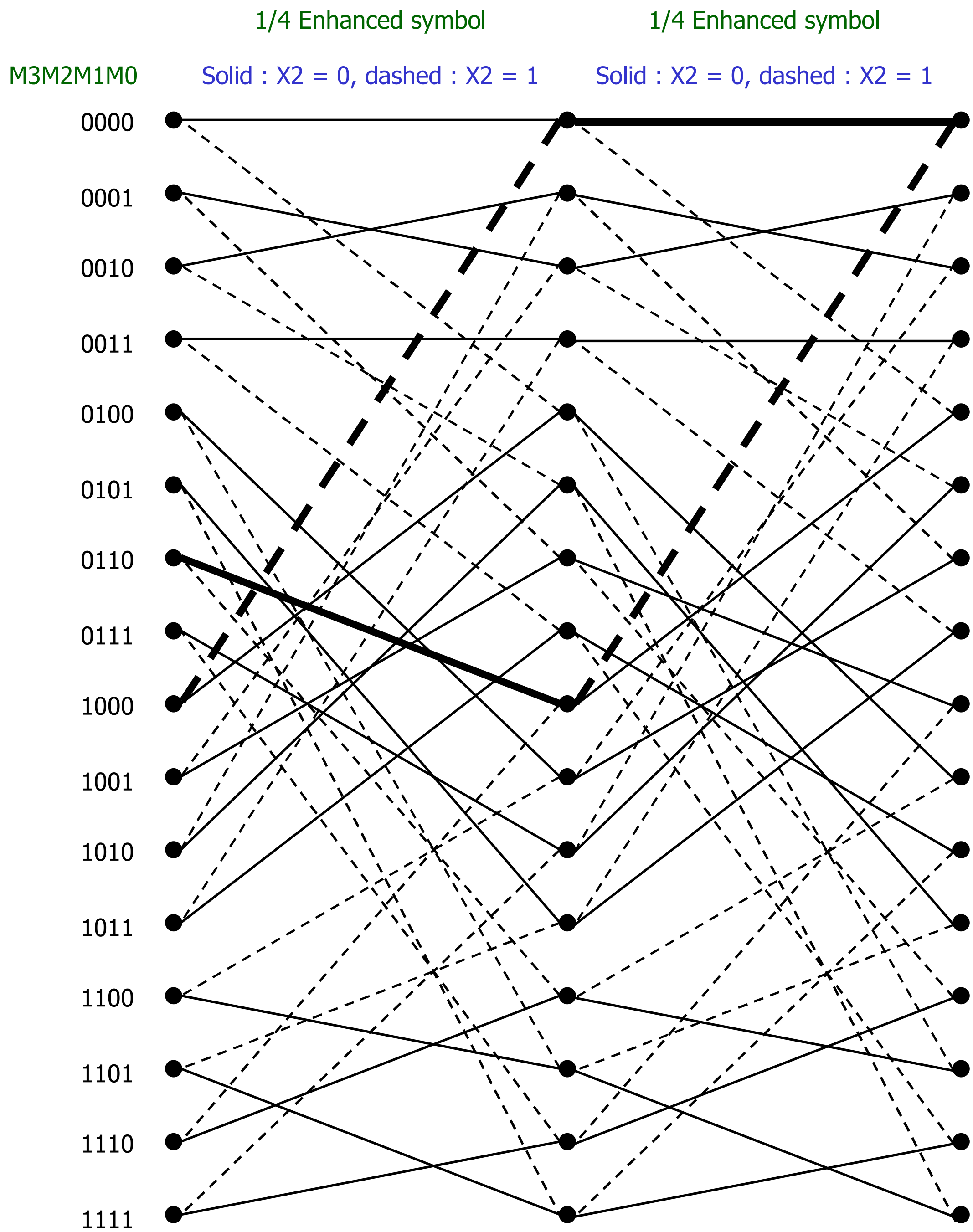


Figure 5.26*b* 1/4-rate enhanced symbol decoding when the repeated bits differ after data randomizing (RBEQ = 0).

The E-VSB symbol processor at the transmitter replaces the null bits inserted as placeholders with parity bits produced by the convolutional encoder. To ensure backward compatibility, the transmitter re-calculates the twenty (207,187) RS parity bytes of an enhanced data packet, which have been modified by the E-VSB symbol processor. This introduces a disparity between the X2' bit of the E-VSB symbol processor output and the upper input of the trellis encoder to be pre-coded, and can invert the Z2 bit of an enhanced symbol following the re-calculated RS parity. Therefore the receiver should estimate the polarity inversion of the Z2 bit. The Viterbi decoder of the E-VSB receiver resolves this ambiguity by implementing two decoders. One decoder decodes enhanced symbols assuming that the Z2 bit is not inverted (positive decoder), and the other one decodes enhanced symbols assuming that the Z2 bit is inverted (negative decoder). The timing information of the re-calculated RS parity symbol of enhanced packets is indicated by the Flip Flag provided by the E-VSB data attribute generator. Using this Flip Flag as a timing signal, the Viterbi decoder makes a decision on polarity inversion by comparing the minimum path metrics of the two decoders and choosing the minimum of the two. This decision can be made on a symbol-by-symbol basis or on a block-wise basis with blocks of arbitrary size.

The E-VSB Viterbi decoders for both main and enhanced symbols perform branch metric calculations, ACS (Accumulate/Compare/Select) and register-exchange (or trace-back) operations using the Viterbi algorithm, with the assistance of the attribute flags M/E, H/Q, RBEQ, and Flip. However, if a decoder traces back both main and enhanced symbols in a path history unit, then the effective decoding depth of the enhanced symbols may be short due to interruption by main symbols, and this induces some performance degradation, more so for low mix ratios of enhanced data. To minimize the performance loss in decoding the enhanced symbols due to main symbol interruption, it is desirable to trace back only enhanced symbols so that the effective decoding depth of enhanced symbols is fixed. Since only enhanced survivor symbols are stored in this case, they cannot be retrieved in the correct order, since no main symbols or placeholders are stored in the memory. The main symbols at the input to the enhanced symbol Viterbi decoder will not appear at the output. Thus, the order of the enhanced symbols at the output must be restored and they then must be interspersed correctly with main symbols before 12-way symbol de-interleaving and further processing. This can be accomplished in a re-ordering unit as described below.

The aforementioned Viterbi decoder, which traces back only enhanced symbols, performs branch metric calculations and ACS/register exchange operations for both main and enhanced symbols. However, it saves only the enhanced symbol survivors in the path history unit. Main symbol survivors are not saved in the path history unit. Since this separate decoder for only enhanced symbols outputs only enhanced symbol decisions, a separate Viterbi decoder or a separate path history unit for normal symbols (or normal symbols and enhanced symbols combined together) is needed to decode main symbols.

Figure 5.27 is a conceptual block diagram of the Viterbi decoder that decodes only enhanced symbols. The branch metric calculator receives an equalized E-VSB symbol and calculates 8 branch metrics of the input symbol corresponding to 8 levels. The positive decoder's ACS unit performs ACS operations according to the E-VSB symbol attributes and assuming that polarity inversion did not occur during an enhanced symbol period. The negative decoder's ACS unit operates assuming the contrary. The polarity inversion estimator compares the two decoders' minimum metrics and outputs a polarity signal by selecting the lesser of the two. The lesser of the two metrics is used to normalize both decoders' path metrics. Each decoder's path history unit keeps track of the path history of only enhanced symbols by saving only enhanced symbol survivors. Based on the estimated polarity, the Viterbi decoder selects either the positive or the negative decoder's path history output.

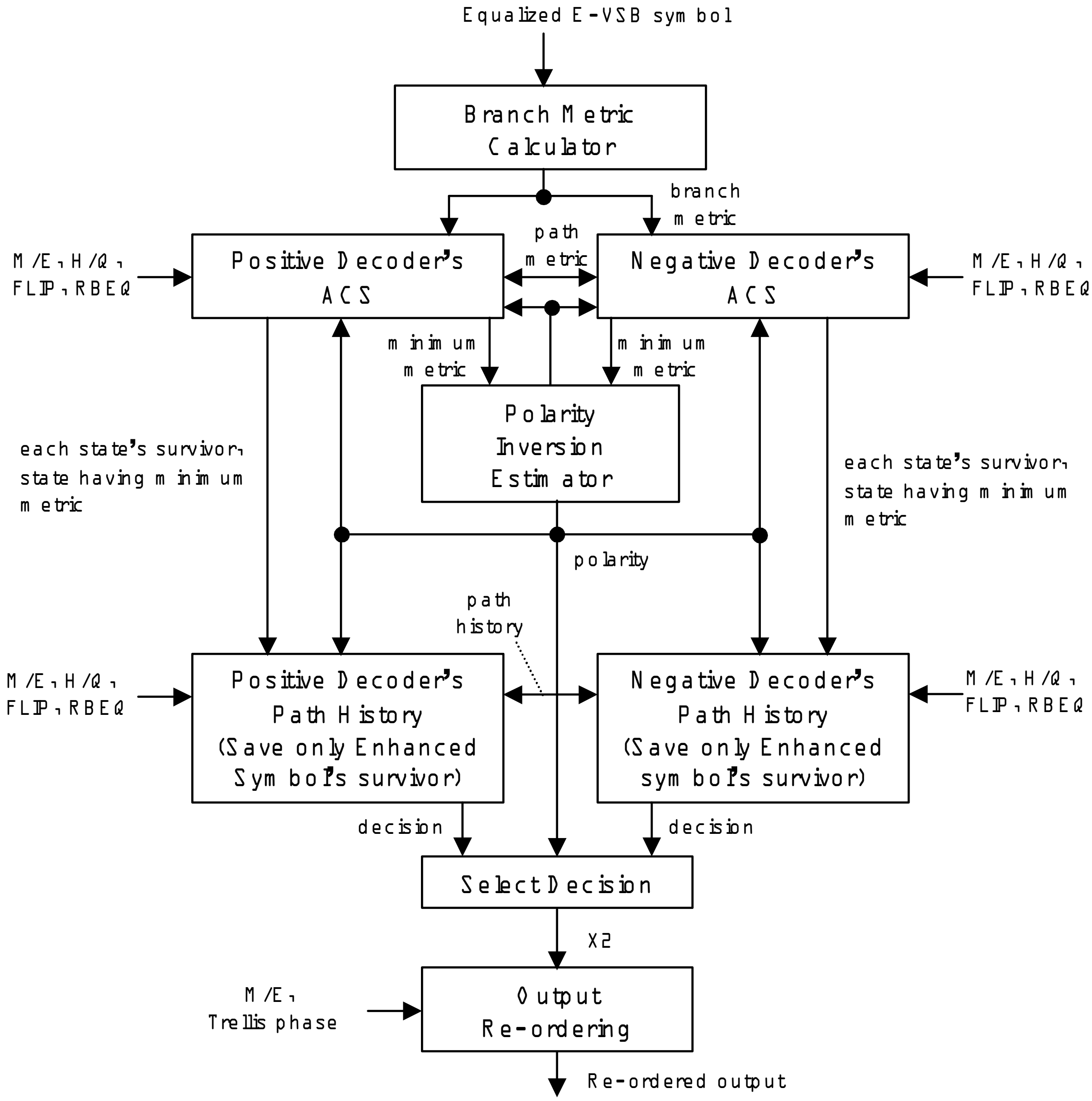


Figure 5.27 Architecture of E-VSB Viterbi decoder.

5.5.5.1.1 Dealing with main symbol interruption

To minimize a performance loss of enhanced symbols due to main symbol interruption, it is desirable to decode only enhanced symbols. However, if branch metric calculation, ACS operation and trace-back operation are performed only for enhanced symbols, there is an exponential increase in the number of paths vs. the number of interrupting main symbols. Therefore, the enhanced symbol decoder performs branch metric calculation and ACS operation for *both* main and enhanced symbols, but traces back only enhanced symbols.

Figure 5.28 is a simplified illustration of the interruption of state transitions of enhanced symbols due to main symbols. Main symbol interruptions actually occur in multiples of four symbols, but an interruption of only two symbols is shown for clarity. The bold lines show possible paths merging into the state ‘0000’ at the first enhanced symbol after main symbol interruption. As shown in the figure, there are 8 possible states at the last enhanced symbol before interruption connected to each state at the first enhanced symbol after interruption. Each additional interrupting main symbol expands the possible states by a factor of 2. For this reason, it is impractical to save all these possible paths for a final ACS operation on an enhanced symbol, and therefore ACS is performed on all symbols, both enhanced and main.

The path history unit does not have to save branch (or state) selection information during the main symbol intervals. However, during main symbol intervals, the path history unit must exchange path survivors among states according to the result of the ACS operation, even though it does not save new survivors.

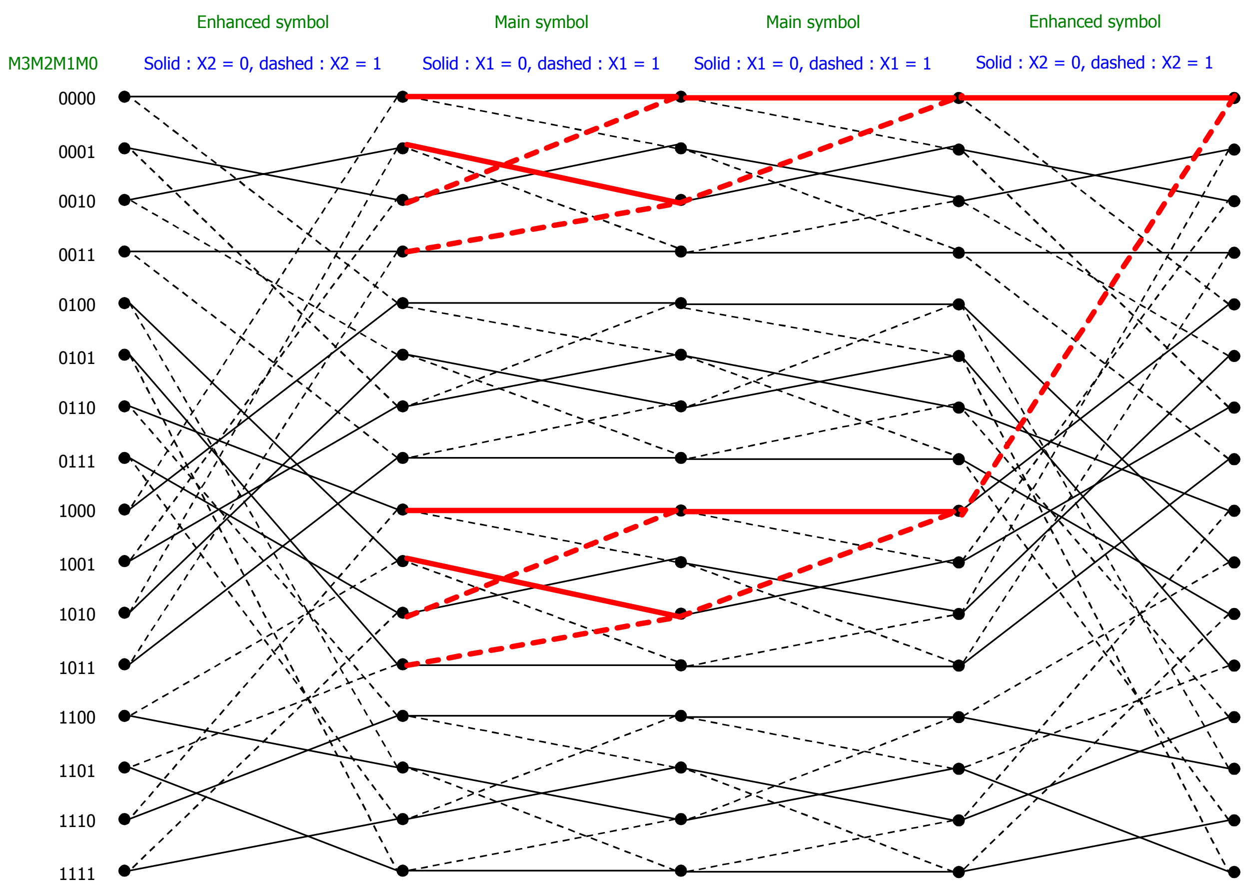


Figure 5.28 Main symbol interruption.

5.5.5.1.2 Output Reordering

The output re-ordering unit in Figure 5.27 re-orders the selected output and does 12-way symbol de-interleaving simultaneously. Figure 5.29 shows an example implementation of the re-ordering block. There are twelve FIFOs corresponding to the twelve trellis phases. The input mux steps continually through the 12 trellis phases in sequence, according to the input trellis phase signal. As an enhanced symbol decision arrives, it is flagged by the arrival of a M/E flag =1 (enhanced symbol), and it is written through the DEMUX to the FIFO indicated by the input-side trellis phase signal. If the M/E flag indicates a main symbol, no write to the FIFO occurs.

At the output, the trellis phase signal steps continually from FIFO to FIFO in order. MUX1 reads from one FIFO according to the output-side trellis phase signal only when M/E flag = 1 (enhanced symbol). If the M/E flag indicates main data, no read operation occurs. MUX2 selects the MUX1 output when the M/E flag = 1 and a dummy symbol or main symbol decision otherwise.

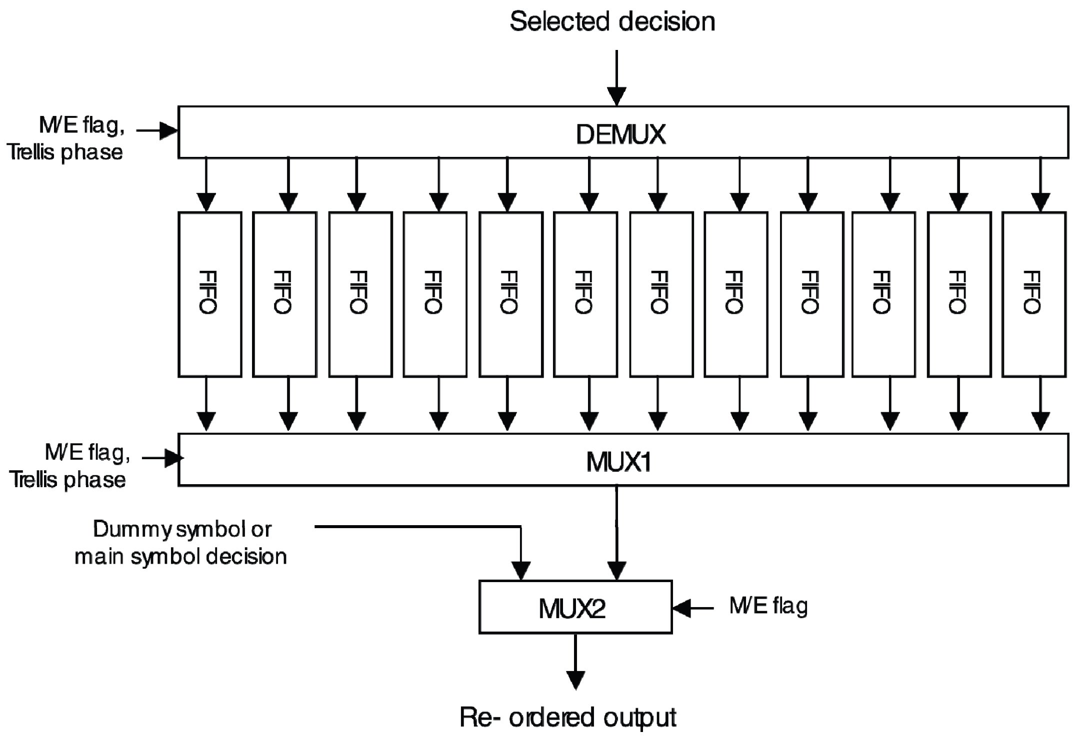


Figure 5.29 Output re-ordering of Viterbi decoder decoding only enhanced symbol.

Since the pre-coder is bypassed for enhanced symbols by E-VSB symbol processing at the transmitter, it is desirable not to use a comb filter to deal with co-channel interference in the E-VSB receiver. Notch filtering techniques or other methods to reject NTSC interference can be employed.

For enhanced equalization using more reliable symbol decision feedback from the Viterbi decoder, it is required that the Viterbi decoder saves Z2Z1Z0 as each state's survivor and traces back both main and enhanced symbols in the path history unit.

5.5.5.2 Data De-Interleaver

The convolutional de-interleaver (which works on main data as well as enhanced data) performs the exact inverse function of the transmitter convolutional interleaver. Its 1/6 data field depth, and inter-segment "dispersion" properties allow noise bursts lasting as long as about 193 microseconds to be corrected by subsequent Reed-Solomon error-correction circuitry of the type that locates byte errors as well as correcting them. Even strong NTSC co-channel signals passing through the NTSC rejection filter, and creating short bursts in response to NTSC vertical edges, are reliably suppressed by this de-interleaving and RS error-correction process. The de-interleaver uses Data Field Sync for synchronizing to the first data byte of the data field. The functional concept of the convolutional de-interleaver is shown in Figure 5.30.

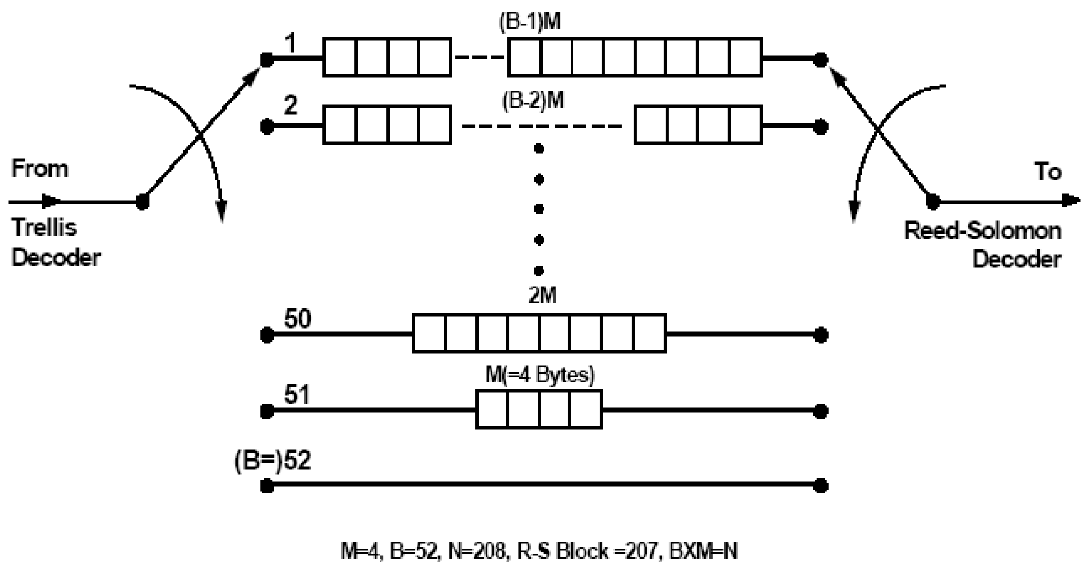


Figure 5.30 Conceptual diagram of convolutional de-interleaver.

In actual practice the convolutional de-interleaver is usually constructed in dual-port random access memory (RAM).

5.5.5.3 Reed-Solomon Decoder

The convolutional de-interleaved byte data (main and enhanced) is sent to the (main) (207, 187) RS decoder. However, in the E-VSB receiver, the main RS decoder decodes only main data packets. The main packets have the same white noise and burst error protection as in normal 8-VSB. Enhanced packets are identified by the M/E packet attribute flag. Since the 20 parity bytes of the (207,187) RS are not protected by the enhanced FEC mode, the main RS decoder simply deletes the 20 parity bytes from enhanced packets and passes the 187 data bytes to the enhanced decoding circuitry.

5.5.5.4 Data De-Randomizer

The data is randomized at the transmitter (both main and enhanced packets) by XOR with a Pseudo Random Sequence (PRS). The de-randomizer in the receiver accepts the error-corrected data bytes from the RS decoder, and applies the same PRS randomizing code to the data, thus reversing the process. The PRS code can be generated the same way as in the transmitter, using the same PRS generator feedback and output taps. Since the PRS is locked to the reliably recovered Data Field Sync (and not to some code word embedded within the potentially noisy data), it is exactly synchronized with the data, and performs reliably. The de-randomized data are all output as main MPEG packets and also are sent to the main packet remover. In addition, at the output of the de-randomizer, the 4-byte headers of the enhanced packets are replaced with locally generated MPEG null packet headers to prevent confusion in downstream equipment due to possible errors in the enhanced packet headers. The M/E Packet flag controls this replacement.

5.5.5.5 Main Packet Remover

The main packet remover discards main packets and passes enhanced packets to the MPEG header remover, using the M/E packet flag.

5.5.5.6 MPEG Header Remover

Four bytes of MPEG header including the 0x47 sync byte are removed at this block. (The MPEG header bytes are added in front of the 184-byte enhanced packet at the transmitter E-VSB pre-processor to ensure backward-compatibility.)

5.5.5.7 Null Bit Remover

The null bits and repeated bits of the de-interleaved enhanced data bytes are removed, based on the byte attribute flags. This block performs the exact inverse of the byte expander of the E8-VSB pre-processor in the transmitter.

5.5.5.8 Enhanced Data De-Interleaver

The enhanced data de-interleaver performs the inverse operation of the enhanced data interleaver of the transmitter with parameters B = 46, M = 4, and N (= B x M) = 184. Its operation and conceptual diagram are similar to that of the main data de-interleaver shown in Figure 5.30. The enhanced data interleaver and de-interleaver provide additional protection against burst noise or errors produced by channel impairments. The synchronization of the enhanced data de-interleaver is the same as that of the main data de-interleaver. The commutating switches should be at their topmost positions (connected to the longest delay path) at the beginning of the first received data field. The total number of paths (rows of delay elements) = B = 46.

5.5.5.9 Enhanced Reed-Solomon Decoder

The enhanced RS decoder decodes the (184,164) RS code, providing 10 bytes per packet error correction capability. The primitive field generator polynomial and the parity generator polynomial are the same as those of the (207,187) main RS decoder.

5.5.5.10 Enhanced Packet De-Multiplexer

The RS decoded packets are de-multiplexed to separate 1/2-rate enhanced packets and 1/4-rate enhanced packets under control of the H/Q packet flag provided by the E-VSB data attribute flag generator.

5.5.5.11 164-to-188 Packet Converter

The 164-to-188 packet converter performs synchronization using the MPEG sync bytes carried in the enhanced data payload and combines the portions of 188-byte packets contained in the 164-byte enhanced packets into complete 188-byte MPEG transport packets. If required, this block can do buffering to minimize MPEG timing jitter.

5.5.6 Fallback Behavior and Seamless Switching

The E-VSB transport enhancements provide close synchronization of the main and enhanced essence, so that fallback from main to enhanced streams can be accomplished with no loss of content. The purposed behavior is that the video or audio quality may be reduced in the fallback mode, but no transient noise or muting will occur.

5.5.6.1 Video

The basic method of obtaining fallback is by operating a main video decoder and a fallback decoder in parallel, with switching between the outputs when required. Future transmission enhancements and/or receiver designs may provide means to use a single decoder.

5.5.6.2 Audio

A primary application for Enhanced AC-3 in the E-VSB transport is to provide a fallback service in the event that reception of the main audio service fails. Section 5.4.2.2 gives an overview of fallback operation in receivers. This section describes additional receiver considerations for handling fallback audio.

The goal of fallback audio is to conceal errors in the main audio stream by transitioning to/from the fallback audio stream as transparently as possible. In general this means audio "pops" or mutes on the outputs of audio decoders should not occur. Depending on transmitted audio streams the transition may be noticeable, as may occur when the main audio signal is 5.1 channels and the fallback audio stream is stereo, but objectionable audio switching artifacts, such as abrupt changes in loudness, should be minimized. This behavior should be consistent whether the audio is decoded within the ATSC receiver or in an external device, including existing A/V receivers with AC-3 decoding only. In order to provide the consumer with as consistent an experience as possible, the fallback mode audio should be as compatible with the same variety of consumer product configurations as the main audio.

5.5.6.2.1 Internal Decoder Operation

Fallback audio is designed to work with single audio decoder, whether internal or external. For ATSC receivers that support fallback audio, the internal audio decoder will be able to support both AC-3 and E-AC-3 decoding. The fallback audio transmission assures that there is a one-to-one correspondence between AC-3 frames in the main channel and E-AC-3 frames in the enhanced channel. If an AC-3 frame from the main channel is found to have an error, the E-AC-3 frame with the same Presentation Time Stamp in the enhanced channel can be decoded instead. Either the transport demultiplexing process can monitor the AC-3 frames from the main channel for errors and insert E-AC-3 frames when necessary, so that the audio decoder receives a single audio stream, or both streams can be sent to the audio decoding process which will perform the error detection. Preferred behavior is for the audio decoder to be able to switch between AC-3 and E-AC-3 frames on a frame-by-frame basis, however in practice it may be preferable to switch less often, or remain with the fallback audio, if numerous errors in the main channel occur.

The ATSC receiver may include built-in speakers however external audio playback systems may be supported through analog or digital interfaces. The internal decoder should ensure that the audio playback during fallback switching is consistent however the audio is reproduced.

5.5.6.2.2 External Decoder Operation

ATSC receivers with fallback audio capability and support for external decoding via a digital output should produce consistent fallback operation whether the decoding is done internally or externally. Current A/V receivers rely on the IEC 60958 [6] (S/PDIF) digital interface with IEC 61937 [7] formatted data for input of coded audio streams, and this support is expected to continue for some time. Future A/V receivers and other decoding devices may support advanced digital interfaces, but for compatibility with existing products an IEC 60958 [6] interface is recommended.

5.5.6.2.2.1 Fallback Operation with IEC 60958 (S/PDIF) Interface

Existing A/V receivers support AC-3 decoding only, and rely on a single AC-3 input bitstream (they cannot accept dual input streams). In addition E-AC-3 is not supported as an IEC 61937 [8] data type. Therefore the ATSC receiver must provide a means to get both the main and fallback audio to the A/V receiver via the IEC 60958 interface. To support this function E-AC-3 has been designed to be easily transcoded to AC-3. ATSC receivers with fallback audio capability should include this transcoding feature to support external decoding.

Figure 5.31 shows one recommended fallback audio implementation when using the IEC 60958 [6] interface and an external decoder. Using this method the E-AC-3 fallback audio stream will be continuously converted to an AC-3 stream. For each AC-3 frame in the main audio channel there will be an equivalent "converted" AC-3 frame from the fallback audio channel. Under normal conditions the sequence of AC-3 frames from the main channel will be formatted according to IEC 61937 [8] for transmission over the IEC 60958 interface. If an error is found in an AC-3 frame from the main audio channel, the equivalent AC-3 from the fallback channel can be inserted instead. In this way the ATSC receiver will provide a single continuous AC-3 stream to the external decoder. Similar the internal decoding case, the fallback control should allow the replacement of main AC-3 frames with converted AC-3 frames from the fallback channel on a frame-by-frame basis, even though it may be preferred to switch less often.

Additional considerations apply to the IEC 60958 interface in order to provide seamless fallback operation. Some A/V receivers may be particularly sensitive to changes in frame spacing between IEC 61937 formatted AC-3 frames on the IEC 90958 interface. To avoid audio gaps, mutes, or other objectionable switching artifacts it is important that the IEC 61937 formatting process maintain the standard spacing between AC-3 frames (the AC-3 repetition rate as defined in IEC 61937), and it is recommended that the E-AC-3 conversion process produce AC-3 frames with a frame size (bit rate) that matches the size of the main channel audio frames. Care must be taken to ensure that the main AC-3 stream remains in synchronization with the converted fallback AC-3 stream, as indicated by the latency compensation function. The final IEC 61937 formatted output stream must also remain in proper synchronization with the video signal.

Taking into account these considerations an alternative fallback audio implementation is shown in Figure 5.32. In this implementation, the fallback control decision occurs prior to the transcode function, similar to the case when performing internal decoding. The advantage of this implementation is that the latency compensation can be simplified and the conversion process can ensure a consistent output bitstream for the IEC 60958 interface. When presented with uncorrupted AC-3 frames from the main channel, the conversion process is not required to process the AC-3 frames; however, it may be desired to alter them for consistent decoding behavior. For example, it may be desired to fix the output bit rate of the conversion process at 640 kbps so that bit rate changes will not affect the external decoder.

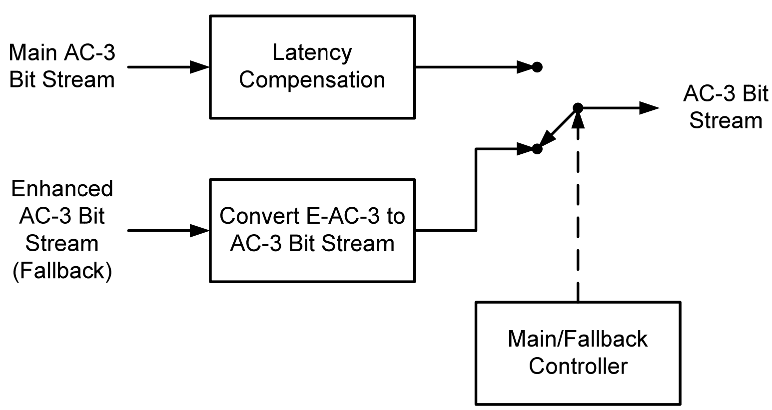


Figure 5.31 Main and fallback mode ATSC receiver with enhanced AC-3.

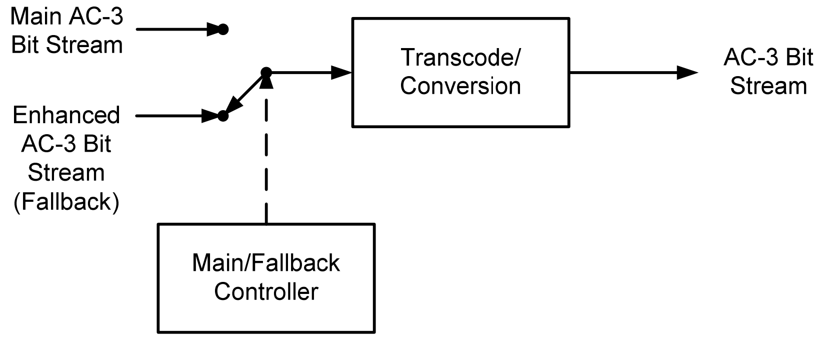


Figure 5.32 Main and fallback mode ATSC receiver with enhanced AC-3 - Alternative implementation.

5.5.6.2.2.2 Fallback Operation with Other Digital Interfaces

Newer ATSC receivers may include other digital interfaces such as USB, HDMI, IEEE1394, and other networking interfaces. External audio decoders that have these interfaces may be capable of supporting E-AC-3 decoding and/or multiple input bitstreams. In these cases it may be possible to bypass the internal E-AC-3/AC-3 conversion or the fallback process. However this implies that the external decoder is capable of performing the fallback audio functions, which may not be possible in all cases. Therefore the fallback functionality shown in Figure 5.31 or Figure 5.32 should remain an option.

5.5.6.2.2.3 External Compatibility Using PCM or Analog Outputs

It might seem that a less complex solution for maintaining compatibility with external devices in a fallback audio system would be to decode the Enhanced AC-3 audio to PCM and pass PCM over IEC 60958 [6] to the A/V receiver rather than perform the transcoding process. However, this solution has drawbacks that make it undesirable. First, the fallback audio (decoded E-AC-3) would be limited to 2 channels as IEC 60958 can carry a maximum of only two channels of PCM audio (total of 1.5 Mbps). Second, muting between main and fallback audio may be introduced as some A/V receivers generally mute for a short time when switching between audio and data formats. Third, there would be no way to manage the loudness of the fallback mode vs. main mode audio. The consumer may experience a noticeable change in levels when the fallback audio replaces the main audio.

It might also seem possible to connect an ATSC receiver to an A/V receiver using both the digital connection for the main audio and the analog audio outputs for the fallback audio. However, this solution is impractical as many AV receivers are not designed to automatically switch to analog inputs when the digital connection becomes deactivated.

Both these methods should be avoided in ATSC receiver designs.

5.5.6.2.3 Other Audio Fallback Considerations

The primary goal of the fallback audio is to maintain a consistent decoded audio signal to the end user avoiding objectionable audio artifacts when switching between the main and fallback audio streams. While avoiding audio “pops” and mutes when switching is part of this, other objectionable switching artifacts can occur and should be avoided.

Other than pops and mutes, changes in program loudness are likely the most objectionable switching artifact. When decoding internally, ATSC receivers should maintain a consistent output program level between main and fallback audio. A burden is placed on broadcasters to ensure that signal levels, dialog level (dialnorm) settings, and other important signal parameters are consistent between the main and fallback audio signals. Given consistent bitstream settings, receivers should ensure the settings are followed and that the average program level is maintained when switching between main and fallback audio. When using external audio decoders, the E-AC-3/AC-3 conversion process should ensure that the converted AC-3 stream for the fallback audio maintains signal levels and parameter settings consistent with the main audio.

Differences in audio coding modes (number of audio channels) between main and fallback audio may also cause objectionable artifacts. A common example would be when the main audio is 5.1 channels and the fallback audio is 2 channels (stereo). For mono or stereo playback the switching may be transparent or less noticeable, however when 5.1 channel surround playback is in use the mode switch may be obvious. Some current A/V receivers may not handle mode switches without muting so a bitstream change from 5.1 to 2 channels may be more objectionable than simply changing the number of channels. Therefore it is recommended that external decoders (or external playback systems) be provided with a consistent number of channels whenever possible. Note that changes in channel modes may affect program loudness levels as well.

Even when avoiding objectionable artifacts, the switch between main and fallback audio may be noticeable, and may become objectionable if the switch occurs often. Receiver designers may include methods to minimize the switching. For example, inserting a single frame of fallback audio occasionally may be acceptable, however if a large number of errors are occurring in the main audio channel it may be preferable to switch fully to the fallback audio stream until the main channel error rate is reduced. Some receivers may operate in locations or environments where the main channel signal is consistently marginal and errors occur on a regular basis. Therefore it is recommended for receivers to include a manual fallback mode where the user may manually select the fallback audio via the user interface.

Errors in the fallback audio signal are also possible. Current methods for minimizing or concealing audio errors in receivers should continue to be employed even when fallback operation is supported.

Annex A:
E-VSB Bit Rate Tables

1. E-VSB TABULAR DATA

The E-VSB bit rate tables sorted by map number and individual stream rates are given in Table A1 (see the following pages).

2. CALCULATION OF PAYLOAD BIT RATES FOR A GIVEN E-VSB MIX

2.1 8-VSB Nominal Average Bit Rate (no E-VSB data)

The basic VSB payload rate is calculated as the number of MPEG2 transport packets transmitted per second. The VSB transmission system substitutes data segment sync in the emitted signal for the 0x47 MPEG sync byte, so this byte is effectively transmitted as part of the payload rate, although in a different coding. Each data segment carries 187 MPEG bytes plus the recoded sync byte, or equivalently one full MPEG packet of 188 MPEG bytes.

The nominal average payload rate is then calculated as 188 bytes/ data segment, adjusted by a factor of (312/313) to account for the presence of data field sync segments, where the data segment rate is

$$f_{seg} = f_{symb} / 832$$

and

$$f_{symb} = 4.5\text{x}10^6 / 286 \text{ x } 684$$

So that the net payload for transmitting MPEG packets is

$$\text{Data rate (bps)} = 8 \text{ x } 188 \text{ x } 4.5\text{x}10^6 / 286 \text{ x } 684 /832 \text{ x } 312 / 313$$

The exact rate can be stated as an integer plus a fraction (whereas the decimal equivalent continues forever).

Factoring the numerator and denominator and canceling common factors gives a denominator of 11 x 13 x 313 = 44759. This gives an exact nominal average payload data rate of 19392658 + (20578 / 44759) bits per second.

2.2 Nominal Average Bit Rate with E-VSB Data

Note that the ratio 312/313 is the ratio of data segments per data field to total segments per data field. This ratio is modified in the case of E-VSB, so that the Main rate for a given mixture is calculated using a factor of ((Main segments per field) / 313).

For the 1/2 -rate data, the factors applied are:

- ((No. of 1/2-rate segments per field) / 313) instead of (main segments per field / 313)
- An additional factor of (164/188) to account for added RS encoding plus the inclusion of the MPEG header and sync bytes as part of the payload
- An additional factor of (1/2) to account for the added trellis coding

For the 1/4-rate data, the rate is calculated in the same way as the 1/2-rate data, except that the final factor of (1/2) is changed to (1/4).

2.3 Summary Results

- Main exact nominal maximum average payload rate =
  19392658 + (20578 / 44759) bits per second

- 1/2-rate exact nominal maximum average payload rate = 8458499 + (43259 / 44759) bits per second
- 1/4-rate exact nominal maximum average payload rate = 4229249 + (44009 / 44759) bits per second

Since the above already contain the factor 313 in the denominator, and are calculated for using all 312 data segments in a field, the average payload of each type of data for a mix other than maximum can be obtained by multiplying the summary maximum value given above by the number of segments of that data type used per field and dividing by 312.

3. E-VSB BIT RATE TABLES

Table A1 Sorted by MAP Table Number

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
0	0	0	0.000000	0	0	0.000000	0	19.39265846	312
1	1	2	0.054221	0	0	0.000000	2	19.26834655	310
2	2	4	0.108442	0	0	0.000000	4	19.14403463	308
3	3	6	0.162663	0	0	0.000000	6	19.01972272	306
4	4	8	0.216885	0	0	0.000000	8	18.89541081	304
5	5	12	0.325327	0	0	0.000000	12	18.64678698	300
6	6	16	0.433769	0	0	0.000000	16	18.39816315	296
7	7	20	0.542212	0	0	0.000000	20	18.14953933	292
8	0	0	0.000000	1	4	0.054221	4	19.14403463	308
9	1	2	0.054221	1	4	0.054221	6	19.01972272	306
10	2	4	0.108442	1	4	0.054221	8	18.89541081	304
11	3	6	0.162663	1	4	0.054221	10	18.77109889	302
12	4	8	0.216885	1	4	0.054221	12	18.64678698	300
13	5	12	0.325327	1	4	0.054221	16	18.39816315	296
14	6	16	0.433769	1	4	0.054221	20	18.14953933	292
15	7	20	0.542212	1	4	0.054221	24	17.90091550	288
16	0	0	0.000000	2	8	0.108442	8	18.89541081	304
17	1	2	0.054221	2	8	0.108442	10	18.77109889	302
18	2	4	0.108442	2	8	0.108442	12	18.64678698	300
19	3	6	0.162663	2	8	0.108442	14	18.52247507	298
20	4	8	0.216885	2	8	0.108442	16	18.39816315	296
21	5	12	0.325327	2	8	0.108442	20	18.14953933	292
22	6	16	0.433769	2	8	0.108442	24	17.90091550	288
23	7	20	0.542212	2	8	0.108442	28	17.65229167	284
24	0	0	0.000000	3	12	0.162663	12	18.64678698	300
25	1	2	0.054221	3	12	0.162663	14	18.52247507	298
26	2	4	0.108442	3	12	0.162663	16	18.39816315	296
27	3	6	0.162663	3	12	0.162663	18	18.27385124	294
28	4	8	0.216885	3	12	0.162663	20	18.14953933	292
29	5	12	0.325327	3	12	0.162663	24	17.90091550	288
30	6	16	0.433769	3	12	0.162663	28	17.65229167	284
31	7	20	0.542212	3	12	0.162663	32	17.40366785	280
32	0	0	0.000000	4	16	0.216885	16	18.39816315	296

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
33	1	2	0.054221	4	16	0.216885	18	18.27385124	294
34	2	4	0.108442	4	16	0.216885	20	18.14953933	292
35	3	6	0.162663	4	16	0.216885	22	18.02522741	290
36	4	8	0.216885	4	16	0.216885	24	17.90091550	288
37	5	12	0.325327	4	16	0.216885	28	17.65229167	284
38	6	16	0.433769	4	16	0.216885	32	17.40366785	280
39	7	20	0.542212	4	16	0.216885	36	17.15504402	276
40	0	0	0.000000	5	20	0.271106	20	18.14953933	292
41	1	2	0.054221	5	20	0.271106	22	18.02522741	290
42	2	4	0.108442	5	20	0.271106	24	17.90091550	288
43	3	6	0.162663	5	20	0.271106	26	17.77660359	286
44	4	8	0.216885	5	20	0.271106	28	17.65229167	284
45	5	12	0.325327	5	20	0.271106	32	17.40366785	280
46	6	16	0.433769	5	20	0.271106	36	17.15504402	276
47	7	20	0.542212	5	20	0.271106	40	16.90642020	272
48	0	0	0.000000	6	24	0.325327	24	17.90091550	288
49	1	2	0.054221	6	24	0.325327	26	17.77660359	286
50	2	4	0.108442	6	24	0.325327	28	17.65229167	284
51	3	6	0.162663	6	24	0.325327	30	17.52797976	282
52	4	8	0.216885	6	24	0.325327	32	17.40366785	280
53	5	12	0.325327	6	24	0.325327	36	17.15504402	276
54	6	16	0.433769	6	24	0.325327	40	16.90642020	272
55	7	20	0.542212	6	24	0.325327	44	16.65779637	268
56	0	0	0.000000	7	28	0.379548	28	17.65229167	284
57	1	2	0.054221	7	28	0.379548	30	17.52797976	282
58	2	4	0.108442	7	28	0.379548	32	17.40366785	280
59	3	6	0.162663	7	28	0.379548	34	17.27935594	278
60	4	8	0.216885	7	28	0.379548	36	17.15504402	276
61	5	12	0.325327	7	28	0.379548	40	16.90642020	272
62	6	16	0.433769	7	28	0.379548	44	16.65779637	268
63	7	20	0.542212	7	28	0.379548	48	16.40917254	264
64	0	0	0.000000	8	32	0.433769	32	17.40366785	280
65	1	2	0.054221	8	32	0.433769	34	17.27935594	278
66	2	4	0.108442	8	32	0.433769	36	17.15504402	276
67	3	6	0.162663	8	32	0.433769	38	17.03073211	274
68	4	8	0.216885	8	32	0.433769	40	16.90642020	272
69	5	12	0.325327	8	32	0.433769	44	16.65779637	268
70	6	16	0.433769	8	32	0.433769	48	16.40917254	264
71	7	20	0.542212	8	32	0.433769	52	16.16054872	260
72	0	0	0.000000	9	36	0.487990	36	17.15504402	276
73	1	2	0.054221	9	36	0.487990	38	17.03073211	274
74	2	4	0.108442	9	36	0.487990	40	16.90642020	272
75	3	6	0.162663	9	36	0.487990	42	16.78210828	270
76	4	8	0.216885	9	36	0.487990	44	16.65779637	268
77	5	12	0.325327	9	36	0.487990	48	16.40917254	264
78	6	16	0.433769	9	36	0.487990	52	16.16054872	260

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
79	7	20	0.542212	9	36	0.487990	56	15.91192489	256
80	0	0	0.000000	10	40	0.542212	40	16.90642020	272
81	1	2	0.054221	10	40	0.542212	42	16.78210828	270
82	2	4	0.108442	10	40	0.542212	44	16.65779637	268
83	3	6	0.162663	10	40	0.542212	46	16.53348446	266
84	4	8	0.216885	10	40	0.542212	48	16.40917254	264
85	5	12	0.325327	10	40	0.542212	52	16.16054872	260
86	6	16	0.433769	10	40	0.542212	56	15.91192489	256
87	7	20	0.542212	10	40	0.542212	60	15.66330106	252
88	0	0	0.000000	11	44	0.596433	44	16.65779637	268
89	1	2	0.054221	11	44	0.596433	46	16.53348446	266
90	2	4	0.108442	11	44	0.596433	48	16.40917254	264
91	3	6	0.162663	11	44	0.596433	50	16.28486063	262
92	4	8	0.216885	11	44	0.596433	52	16.16054872	260
93	5	12	0.325327	11	44	0.596433	56	15.91192489	256
94	6	16	0.433769	11	44	0.596433	60	15.66330106	252
95	7	20	0.542212	11	44	0.596433	64	15.41467724	248
96	0	0	0.000000	12	52	0.704875	52	16.16054872	260
97	1	2	0.054221	12	52	0.704875	54	16.03623680	258
98	2	4	0.108442	12	52	0.704875	56	15.91192489	256
99	3	6	0.162663	12	52	0.704875	58	15.78761298	254
100	4	8	0.216885	12	52	0.704875	60	15.66330106	252
101	5	12	0.325327	12	52	0.704875	64	15.41467724	248
102	6	16	0.433769	12	52	0.704875	68	15.16605341	244
103	7	20	0.542212	12	52	0.704875	72	14.91742958	240
104	0	0	0.000000	13	60	0.813317	60	15.66330106	252
105	1	2	0.054221	13	60	0.813317	62	15.53898915	250
106	2	4	0.108442	13	60	0.813317	64	15.41467724	248
107	3	6	0.162663	13	60	0.813317	66	15.29036532	246
108	4	8	0.216885	13	60	0.813317	68	15.16605341	244
109	5	12	0.325327	13	60	0.813317	72	14.91742958	240
110	6	16	0.433769	13	60	0.813317	76	14.66880576	236
111	7	20	0.542212	13	60	0.813317	80	14.42018193	232
112	0	0	0.000000	14	68	0.921760	68	15.16605341	244
113	1	2	0.054221	14	68	0.921760	70	15.04174150	242
114	2	4	0.108442	14	68	0.921760	72	14.91742958	240
115	3	6	0.162663	14	68	0.921760	74	14.79311767	238
116	4	8	0.216885	14	68	0.921760	76	14.66880576	236
117	5	12	0.325327	14	68	0.921760	80	14.42018193	232
118	6	16	0.433769	14	68	0.921760	84	14.17155811	228
119	7	20	0.542212	14	68	0.921760	88	13.92293428	224
120	0	0	0.000000	15	76	1.030202	76	14.66880576	236
121	1	2	0.054221	15	76	1.030202	78	14.54449384	234
122	2	4	0.108442	15	76	1.030202	80	14.42018193	232
123	3	6	0.162663	15	76	1.030202	82	14.29587002	230
124	4	8	0.216885	15	76	1.030202	84	14.17155811	228

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
125	5	12	0.325327	15	76	1.030202	88	13.92293428	224
126	6	16	0.433769	15	76	1.030202	92	13.67431045	220
127	7	20	0.542212	15	76	1.030202	96	13.42568663	216
128	8	24	0.650654	0	0	0.000000	24	17.90091550	288
129	9	28	0.759096	0	0	0.000000	28	17.65229167	284
130	10	32	0.867538	0	0	0.000000	32	17.40366785	280
131	11	40	1.084423	0	0	0.000000	40	16.90642020	272
132	12	48	1.301308	0	0	0.000000	48	16.40917254	264
133	13	56	1.518192	0	0	0.000000	56	15.91192489	256
134	14	64	1.735077	0	0	0.000000	64	15.41467724	248
135	15	72	1.951962	0	0	0.000000	72	14.91742958	240
136	8	24	0.650654	1	4	0.054221	28	17.65229167	284
137	9	28	0.759096	1	4	0.054221	32	17.40366785	280
138	10	32	0.867538	1	4	0.054221	36	17.15504402	276
139	11	40	1.084423	1	4	0.054221	44	16.65779637	268
140	12	48	1.301308	1	4	0.054221	52	16.16054872	260
141	13	56	1.518192	1	4	0.054221	60	15.66330106	252
142	14	64	1.735077	1	4	0.054221	68	15.16605341	244
143	15	72	1.951962	1	4	0.054221	76	14.66880576	236
144	8	24	0.650654	2	8	0.108442	32	17.40366785	280
145	9	28	0.759096	2	8	0.108442	36	17.15504402	276
146	10	32	0.867538	2	8	0.108442	40	16.90642020	272
147	11	40	1.084423	2	8	0.108442	48	16.40917254	264
148	12	48	1.301308	2	8	0.108442	56	15.91192489	256
149	13	56	1.518192	2	8	0.108442	64	15.41467724	248
150	14	64	1.735077	2	8	0.108442	72	14.91742958	240
151	15	72	1.951962	2	8	0.108442	80	14.42018193	232
152	8	24	0.650654	3	12	0.162663	36	17.15504402	276
153	9	28	0.759096	3	12	0.162663	40	16.90642020	272
154	10	32	0.867538	3	12	0.162663	44	16.65779637	268
155	11	40	1.084423	3	12	0.162663	52	16.16054872	260
156	12	48	1.301308	3	12	0.162663	60	15.66330106	252
157	13	56	1.518192	3	12	0.162663	68	15.16605341	244
158	14	64	1.735077	3	12	0.162663	76	14.66880576	236
159	15	72	1.951962	3	12	0.162663	84	14.17155811	228
160	8	24	0.650654	4	16	0.216885	40	16.90642020	272
161	9	28	0.759096	4	16	0.216885	44	16.65779637	268
162	10	32	0.867538	4	16	0.216885	48	16.40917254	264
163	11	40	1.084423	4	16	0.216885	56	15.91192489	256
164	12	48	1.301308	4	16	0.216885	64	15.41467724	248
165	13	56	1.518192	4	16	0.216885	72	14.91742958	240
166	14	64	1.735077	4	16	0.216885	80	14.42018193	232
167	15	72	1.951962	4	16	0.216885	88	13.92293428	224
168	8	24	0.650654	5	20	0.271106	44	16.65779637	268
169	9	28	0.759096	5	20	0.271106	48	16.40917254	264
170	10	32	0.867538	5	20	0.271106	52	16.16054872	260

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
171	11	40	1.084423	5	20	0.271106	60	15.66330106	252
172	12	48	1.301308	5	20	0.271106	68	15.16605341	244
173	13	56	1.518192	5	20	0.271106	76	14.66880576	236
174	14	64	1.735077	5	20	0.271106	84	14.17155811	228
175	15	72	1.951962	5	20	0.271106	92	13.67431045	220
176	8	24	0.650654	6	24	0.325327	48	16.40917254	264
177	9	28	0.759096	6	24	0.325327	52	16.16054872	260
178	10	32	0.867538	6	24	0.325327	56	15.91192489	256
179	11	40	1.084423	6	24	0.325327	64	15.41467724	248
180	12	48	1.301308	6	24	0.325327	72	14.91742958	240
181	13	56	1.518192	6	24	0.325327	80	14.42018193	232
182	14	64	1.735077	6	24	0.325327	88	13.92293428	224
183	15	72	1.951962	6	24	0.325327	96	13.42568663	216
184	8	24	0.650654	7	28	0.379548	52	16.16054872	260
185	9	28	0.759096	7	28	0.379548	56	15.91192489	256
186	10	32	0.867538	7	28	0.379548	60	15.66330106	252
187	11	40	1.084423	7	28	0.379548	68	15.16605341	244
188	12	48	1.301308	7	28	0.379548	76	14.66880576	236
189	13	56	1.518192	7	28	0.379548	84	14.17155811	228
190	14	64	1.735077	7	28	0.379548	92	13.67431045	220
191	15	72	1.951962	7	28	0.379548	100	13.17706280	212
192	8	24	0.650654	8	32	0.433769	56	15.91192489	256
193	9	28	0.759096	8	32	0.433769	60	15.66330106	252
194	10	32	0.867538	8	32	0.433769	64	15.41467724	248
195	11	40	1.084423	8	32	0.433769	72	14.91742958	240
196	12	48	1.301308	8	32	0.433769	80	14.42018193	232
197	13	56	1.518192	8	32	0.433769	88	13.92293428	224
198	14	64	1.735077	8	32	0.433769	96	13.42568663	216
199	15	72	1.951962	8	32	0.433769	104	12.92843897	208
200	8	24	0.650654	9	36	0.487990	60	15.66330106	252
201	9	28	0.759096	9	36	0.487990	64	15.41467724	248
202	10	32	0.867538	9	36	0.487990	68	15.16605341	244
203	11	40	1.084423	9	36	0.487990	76	14.66880576	236
204	12	48	1.301308	9	36	0.487990	84	14.17155811	228
205	13	56	1.518192	9	36	0.487990	92	13.67431045	220
206	14	64	1.735077	9	36	0.487990	100	13.17706280	212
207	15	72	1.951962	9	36	0.487990	108	12.67981515	204
208	8	24	0.650654	10	40	0.542212	64	15.41467724	248
209	9	28	0.759096	10	40	0.542212	68	15.16605341	244
210	10	32	0.867538	10	40	0.542212	72	14.91742958	240
211	11	40	1.084423	10	40	0.542212	80	14.42018193	232
212	12	48	1.301308	10	40	0.542212	88	13.92293428	224
213	13	56	1.518192	10	40	0.542212	96	13.42568663	216
214	14	64	1.735077	10	40	0.542212	104	12.92843897	208
215	15	72	1.951962	10	40	0.542212	112	12.43119132	200
216	8	24	0.650654	11	44	0.596433	68	15.16605341	244

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
217	9	28	0.759096	11	44	0.596433	72	14.91742958	240
218	10	32	0.867538	11	44	0.596433	76	14.66880576	236
219	11	40	1.084423	11	44	0.596433	84	14.17155811	228
220	12	48	1.301308	11	44	0.596433	92	13.67431045	220
221	13	56	1.518192	11	44	0.596433	100	13.17706280	212
222	14	64	1.735077	11	44	0.596433	108	12.67981515	204
223	15	72	1.951962	11	44	0.596433	116	12.18256749	196
224	8	24	0.650654	12	52	0.704875	76	14.66880576	236
225	9	28	0.759096	12	52	0.704875	80	14.42018193	232
226	10	32	0.867538	12	52	0.704875	84	14.17155811	228
227	11	40	1.084423	12	52	0.704875	92	13.67431045	220
228	12	48	1.301308	12	52	0.704875	100	13.17706280	212
229	13	56	1.518192	12	52	0.704875	108	12.67981515	204
230	14	64	1.735077	12	52	0.704875	116	12.18256749	196
231	15	72	1.951962	12	52	0.704875	124	11.68531984	188
232	8	24	0.650654	13	60	0.813317	84	14.17155811	228
233	9	28	0.759096	13	60	0.813317	88	13.92293428	224
234	10	32	0.867538	13	60	0.813317	92	13.67431045	220
235	11	40	1.084423	13	60	0.813317	100	13.17706280	212
236	12	48	1.301308	13	60	0.813317	108	12.67981515	204
237	13	56	1.518192	13	60	0.813317	116	12.18256749	196
238	14	64	1.735077	13	60	0.813317	124	11.68531984	188
239	15	72	1.951962	13	60	0.813317	132	11.18807219	180
240	8	24	0.650654	14	68	0.921760	92	13.67431045	220
241	9	28	0.759096	14	68	0.921760	96	13.42568663	216
242	10	32	0.867538	14	68	0.921760	100	13.17706280	212
243	11	40	1.084423	14	68	0.921760	108	12.67981515	204
244	12	48	1.301308	14	68	0.921760	116	12.18256749	196
245	13	56	1.518192	14	68	0.921760	124	11.68531984	188
246	14	64	1.735077	14	68	0.921760	132	11.18807219	180
247	15	72	1.951962	14	68	0.921760	140	10.69082454	172
248	8	24	0.650654	15	76	1.030202	100	13.17706280	212
249	9	28	0.759096	15	76	1.030202	104	12.92843897	208
250	10	32	0.867538	15	76	1.030202	108	12.67981515	204
251	11	40	1.084423	15	76	1.030202	116	12.18256749	196
252	12	48	1.301308	15	76	1.030202	124	11.68531984	188
253	13	56	1.518192	15	76	1.030202	132	11.18807219	180
254	14	64	1.735077	15	76	1.030202	140	10.69082454	172
255	15	72	1.951962	15	76	1.030202	148	10.19357688	164
256	0	0	0.000000	17	92	1.247087	92	13.67431045	220
257	1	2	0.054221	16	84	1.138644	86	14.04724619	226
258	2	4	0.108442	17	92	1.247087	96	13.42568663	216
259	3	6	0.162663	16	84	1.138644	90	13.79862237	222
260	4	8	0.216885	17	92	1.247087	100	13.17706280	212
261	5	12	0.325327	16	84	1.138644	96	13.42568663	216
262	6	16	0.433769	17	92	1.247087	108	12.67981515	204

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
263	7	20	0.542212	16	84	1.138644	104	12.92843897	208
264	8	24	0.650654	17	92	1.247087	116	12.18256749	196
265	9	28	0.759096	16	84	1.138644	112	12.43119132	200
266	10	32	0.867538	17	92	1.247087	124	11.68531984	188
267	11	40	1.084423	16	84	1.138644	124	11.68531984	188
268	12	48	1.301308	17	92	1.247087	140	10.69082454	172
269	13	56	1.518192	16	84	1.138644	140	10.69082454	172
270	14	64	1.735077	17	92	1.247087	156	9.69632923	156
271	15	72	1.951962	16	84	1.138644	156	9.69632923	156
272	0	0	0.000000	19	116	1.572413	116	12.18256749	196
273	1	2	0.054221	18	100	1.355529	102	13.05275089	210
274	2	4	0.108442	19	116	1.572413	120	11.93394367	192
275	3	6	0.162663	18	100	1.355529	106	12.80412706	206
276	4	8	0.216885	19	116	1.572413	124	11.68531984	188
277	5	12	0.325327	18	100	1.355529	112	12.43119132	200
278	6	16	0.433769	19	116	1.572413	132	11.18807219	180
279	7	20	0.542212	18	100	1.355529	120	11.93394367	192
280	8	24	0.650654	19	116	1.572413	140	10.69082454	172
281	9	28	0.759096	18	100	1.355529	128	11.43669601	184
282	10	32	0.867538	19	116	1.572413	148	10.19357688	164
283	11	40	1.084423	18	100	1.355529	140	10.69082454	172
284	12	48	1.301308	19	116	1.572413	164	9.19908158	148
285	13	56	1.518192	18	100	1.355529	156	9.69632923	156
286	14	64	1.735077	19	116	1.572413	180	8.20458627	132
287	15	72	1.951962	18	100	1.355529	172	8.70183392	140
288	0	0	0.000000	21	148	2.006183	148	10.19357688	164
289	1	2	0.054221	20	132	1.789298	134	11.06376028	178
290	2	4	0.108442	21	148	2.006183	152	9.94495306	160
291	3	6	0.162663	20	132	1.789298	138	10.81513645	174
292	4	8	0.216885	21	148	2.006183	156	9.69632923	156
293	5	12	0.325327	20	132	1.789298	144	10.44220071	168
294	6	16	0.433769	21	148	2.006183	164	9.19908158	148
295	7	20	0.542212	20	132	1.789298	152	9.94495306	160
296	8	24	0.650654	21	148	2.006183	172	8.70183392	140
297	9	28	0.759096	20	132	1.789298	160	9.44770540	152
298	10	32	0.867538	21	148	2.006183	180	8.20458627	132
299	11	40	1.084423	20	132	1.789298	172	8.70183392	140
300	12	48	1.301308	21	148	2.006183	196	7.21009097	116
301	13	56	1.518192	20	132	1.789298	188	7.70733862	124
302	14	64	1.735077	21	148	2.006183	212	6.21559566	100
303	15	72	1.951962	20	132	1.789298	204	6.71284331	108
304	0	0	0.000000	23	180	2.439952	180	8.20458627	132
305	1	2	0.054221	22	164	2.223067	166	9.07476966	146
306	2	4	0.108442	23	180	2.439952	184	7.95596245	128
307	3	6	0.162663	22	164	2.223067	170	8.82614584	142
308	4	8	0.216885	23	180	2.439952	188	7.70733862	124

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
309	5	12	0.325327	22	164	2.223067	176	8.45321010	136
310	6	16	0.433769	23	180	2.439952	196	7.21009097	116
311	7	20	0.542212	22	164	2.223067	184	7.95596245	128
312	8	24	0.650654	23	180	2.439952	204	6.71284331	108
313	9	28	0.759096	22	164	2.223067	192	7.45871479	120
314	10	32	0.867538	23	180	2.439952	212	6.21559566	100
315	11	40	1.084423	22	164	2.223067	204	6.71284331	108
316	12	48	1.301308	23	180	2.439952	228	5.22110035	84
317	13	56	1.518192	22	164	2.223067	220	5.71834801	92
318	14	64	1.735077	23	180	2.439952	244	4.22660505	68
319	15	72	1.951962	22	164	2.223067	236	4.72385270	76
320	17	88	2.385731	0	0	0.000000	88	13.92293428	224
321	16	80	2.168846	1	4	0.054221	84	14.17155811	228
322	17	88	2.385731	2	8	0.108442	96	13.42568663	216
323	16	80	2.168846	3	12	0.162663	92	13.67431045	220
324	17	88	2.385731	4	16	0.216885	104	12.92843897	208
325	16	80	2.168846	5	20	0.271106	100	13.17706280	212
326	17	88	2.385731	6	24	0.325327	112	12.43119132	200
327	16	80	2.168846	7	28	0.379548	108	12.67981515	204
328	17	88	2.385731	8	32	0.433769	120	11.93394367	192
329	16	80	2.168846	9	36	0.487990	116	12.18256749	196
330	17	88	2.385731	10	40	0.542212	128	11.43669601	184
331	16	80	2.168846	11	44	0.596433	124	11.68531984	188
332	17	88	2.385731	12	52	0.704875	140	10.69082454	172
333	16	80	2.168846	13	60	0.813317	140	10.69082454	172
334	17	88	2.385731	14	68	0.921760	156	9.69632923	156
335	16	80	2.168846	15	76	1.030202	156	9.69632923	156
336	19	112	3.036385	0	0	0.000000	112	12.43119132	200
337	18	96	2.602615	1	4	0.054221	100	13.17706280	212
338	19	112	3.036385	2	8	0.108442	120	11.93394367	192
339	18	96	2.602615	3	12	0.162663	108	12.67981515	204
340	19	112	3.036385	4	16	0.216885	128	11.43669601	184
341	18	96	2.602615	5	20	0.271106	116	12.18256749	196
342	19	112	3.036385	6	24	0.325327	136	10.93944836	176
343	18	96	2.602615	7	28	0.379548	124	11.68531984	188
344	19	112	3.036385	8	32	0.433769	144	10.44220071	168
345	18	96	2.602615	9	36	0.487990	132	11.18807219	180
346	19	112	3.036385	10	40	0.542212	152	9.94495306	160
347	18	96	2.602615	11	44	0.596433	140	10.69082454	172
348	19	112	3.036385	12	52	0.704875	164	9.19908158	148
349	18	96	2.602615	13	60	0.813317	156	9.69632923	156
350	19	112	3.036385	14	68	0.921760	180	8.20458627	132
351	18	96	2.602615	15	76	1.030202	172	8.70183392	140
352	21	144	3.903923	0	0	0.000000	144	10.44220071	168
353	20	128	3.470154	1	4	0.054221	132	11.18807219	180
354	21	144	3.903923	2	8	0.108442	152	9.94495306	160

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
355	20	128	3.470154	3	12	0.162663	140	10.69082454	172
356	21	144	3.903923	4	16	0.216885	160	9.44770540	152
357	20	128	3.470154	5	20	0.271106	148	10.19357688	164
358	21	144	3.903923	6	24	0.325327	168	8.95045775	144
359	20	128	3.470154	7	28	0.379548	156	9.69632923	156
360	21	144	3.903923	8	32	0.433769	176	8.45321010	136
361	20	128	3.470154	9	36	0.487990	164	9.19908158	148
362	21	144	3.903923	10	40	0.542212	184	7.95596245	128
363	20	128	3.470154	11	44	0.596433	172	8.70183392	140
364	21	144	3.903923	12	52	0.704875	196	7.21009097	116
365	20	128	3.470154	13	60	0.813317	188	7.70733862	124
366	21	144	3.903923	14	68	0.921760	212	6.21559566	100
367	20	128	3.470154	15	76	1.030202	204	6.71284331	108
368	23	176	4.771462	0	0	0.000000	176	8.45321010	136
369	22	160	4.337692	1	4	0.054221	164	9.19908158	148
370	23	176	4.771462	2	8	0.108442	184	7.95596245	128
371	22	160	4.337692	3	12	0.162663	172	8.70183392	140
372	23	176	4.771462	4	16	0.216885	192	7.45871479	120
373	22	160	4.337692	5	20	0.271106	180	8.20458627	132
374	23	176	4.771462	6	24	0.325327	200	6.96146714	112
375	22	160	4.337692	7	28	0.379548	188	7.70733862	124
376	23	176	4.771462	8	32	0.433769	208	6.46421949	104
377	22	160	4.337692	9	36	0.487990	196	7.21009097	116
378	23	176	4.771462	10	40	0.542212	216	5.96697183	96
379	22	160	4.337692	11	44	0.596433	204	6.71284331	108
380	23	176	4.771462	12	52	0.704875	228	5.22110035	84
381	22	160	4.337692	13	60	0.813317	220	5.71834801	92
382	23	176	4.771462	14	68	0.921760	244	4.22660505	68
383	22	160	4.337692	15	76	1.030202	236	4.72385270	76
384	0	0	0.000000	25	212	2.873721	212	6.21559566	100
385	1	2	0.054221	24	196	2.656837	198	7.08577905	114
386	2	4	0.108442	25	212	2.873721	216	5.96697183	96
387	3	6	0.162663	24	196	2.656837	202	6.83715523	110
388	4	8	0.216885	25	212	2.873721	220	5.71834801	92
389	5	12	0.325327	24	196	2.656837	208	6.46421949	104
390	6	16	0.433769	25	212	2.873721	228	5.22110035	84
391	7	20	0.542212	24	196	2.656837	216	5.96697183	96
392	8	24	0.650654	25	212	2.873721	236	4.72385270	76
393	9	28	0.759096	24	196	2.656837	224	5.46972418	88
394	10	32	0.867538	25	212	2.873721	244	4.22660505	68
395	11	40	1.084423	24	196	2.656837	236	4.72385270	76
396	12	48	1.301308	25	212	2.873721	260	3.23210974	52
397	13	56	1.518192	24	196	2.656837	252	3.72935740	60
398	14	64	1.735077	25	212	2.873721	276	2.23761444	36
399	15	72	1.951962	24	196	2.656837	268	2.73486209	44
400	0	0	0.000000	27	244	3.307490	244	4.22660505	68

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
401	1	2	0.054221	26	228	3.090606	230	5.09678844	82
402	2	4	0.108442	27	244	3.307490	248	3.97798122	64
403	3	6	0.162663	26	228	3.090606	234	4.84816461	78
404	4	8	0.216885	27	244	3.307490	252	3.72935740	60
405	5	12	0.325327	26	228	3.090606	240	4.47522888	72
406	6	16	0.433769	27	244	3.307490	260	3.23210974	52
407	7	20	0.542212	26	228	3.090606	248	3.97798122	64
408	8	24	0.650654	27	244	3.307490	268	2.73486209	44
409	9	28	0.759096	26	228	3.090606	256	3.48073357	56
410	10	32	0.867538	27	244	3.307490	276	2.23761444	36
411	11	40	1.084423	26	228	3.090606	268	2.73486209	44
412	12	48	1.301308	27	244	3.307490	292	1.24311913	20
413	13	56	1.518192	26	228	3.090606	284	1.74036678	28
414	14	64	1.735077	27	244	3.307490	308	0.24862383	4
415	15	72	1.951962	26	228	3.090606	300	0.74587148	12
416	25	208	5.639000	0	0	0.000000	208	6.46421949	104
417	24	192	5.205231	1	4	0.054221	196	7.21009097	116
418	25	208	5.639000	2	8	0.108442	216	5.96697183	96
419	24	192	5.205231	3	12	0.162663	204	6.71284331	108
420	25	208	5.639000	4	16	0.216885	224	5.46972418	88
421	24	192	5.205231	5	20	0.271106	212	6.21559566	100
422	25	208	5.639000	6	24	0.325327	232	4.97247653	80
423	24	192	5.205231	7	28	0.379548	220	5.71834801	92
424	25	208	5.639000	8	32	0.433769	240	4.47522888	72
425	24	192	5.205231	9	36	0.487990	228	5.22110035	84
426	25	208	5.639000	10	40	0.542212	248	3.97798122	64
427	24	192	5.205231	11	44	0.596433	236	4.72385270	76
428	25	208	5.639000	12	52	0.704875	260	3.23210974	52
429	24	192	5.205231	13	60	0.813317	252	3.72935740	60
430	25	208	5.639000	14	68	0.921760	276	2.23761444	36
431	24	192	5.205231	15	76	1.030202	268	2.73486209	44
432	27	240	6.506538	0	0	0.000000	240	4.47522888	72
433	26	224	6.072769	1	4	0.054221	228	5.22110035	84
434	27	240	6.506538	2	8	0.108442	248	3.97798122	64
435	26	224	6.072769	3	12	0.162663	236	4.72385270	76
436	27	240	6.506538	4	16	0.216885	256	3.48073357	56
437	26	224	6.072769	5	20	0.271106	244	4.22660505	68
438	27	240	6.506538	6	24	0.325327	264	2.98348592	48
439	26	224	6.072769	7	28	0.379548	252	3.72935740	60
440	27	240	6.506538	8	32	0.433769	272	2.48623826	40
441	26	224	6.072769	9	36	0.487990	260	3.23210974	52
442	27	240	6.506538	10	40	0.542212	280	1.98899061	32
443	26	224	6.072769	11	44	0.596433	268	2.73486209	44
444	27	240	6.506538	12	52	0.704875	292	1.24311913	20
445	26	224	6.072769	13	60	0.813317	284	1.74036678	28
446	27	240	6.506538	14	68	0.921760	308	0.24862383	4

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
447	26	224	6.072769	15	76	1.030202	300	0.74587148	12
448	0	0	0.000000	29	276	3.741260	276	2.23761444	36
449	1	2	0.054221	28	260	3.524375	262	3.10779783	50
450	3	6	0.162663	29	276	3.741260	282	1.86467870	30
451	4	8	0.216885	28	260	3.524375	268	2.73486209	44
452	6	16	0.433769	29	276	3.741260	292	1.24311913	20
453	7	20	0.542212	28	260	3.524375	280	1.98899061	32
454	9	28	0.759096	29	276	3.741260	304	0.49724765	8
455	10	32	0.867538	28	260	3.524375	292	1.24311913	20
456	12	48	1.301308	28	260	3.524375	308	0.24862383	4
457	0	0	0.000000	31	312	4.229250	312	0.00000000	0
458	2	4	0.108442	30	292	3.958144	296	0.99449531	16
459	5	12	0.325327	30	292	3.958144	304	0.49724765	8
460	16	80	2.168846	17	92	1.247087	172	8.70183392	140
461	17	88	2.385731	18	100	1.355529	188	7.70733862	124
462	16	80	2.168846	19	116	1.572413	196	7.21009097	116
463	17	88	2.385731	20	132	1.789298	220	5.71834801	92
464	16	80	2.168846	21	148	2.006183	228	5.22110035	84
465	17	88	2.385731	22	164	2.223067	252	3.72935740	60
466	16	80	2.168846	23	180	2.439952	260	3.23210974	52
467	17	88	2.385731	24	196	2.656837	284	1.74036678	28
468	16	80	2.168846	25	212	2.873721	292	1.24311913	20
469	16	80	2.168846	26	228	3.090606	308	0.24862383	4
470	18	96	2.602615	19	116	1.572413	212	6.21559566	100
471	19	112	3.036385	20	132	1.789298	244	4.22660505	68
472	18	96	2.602615	21	148	2.006183	244	4.22660505	68
473	19	112	3.036385	22	164	2.223067	276	2.23761444	36
474	18	96	2.602615	23	180	2.439952	276	2.23761444	36
475	19	112	3.036385	24	196	2.656837	308	0.24862383	4
476	18	96	2.602615	25	212	2.873721	308	0.24862383	4
477	20	128	3.470154	21	148	2.006183	276	2.23761444	36
478	21	144	3.903923	22	164	2.223067	308	0.24862383	4
479	20	128	3.470154	23	180	2.439952	308	0.24862383	4
480	29	272	7.374077	0	0	0.000000	272	2.48623826	40
481	28	256	6.940308	1	4	0.054221	260	3.23210974	52
482	29	272	7.374077	3	12	0.162663	284	1.74036678	28
483	28	256	6.940308	4	16	0.216885	272	2.48623826	40
484	29	272	7.374077	6	24	0.325327	296	0.99449531	16
485	28	256	6.940308	7	28	0.379548	284	1.74036678	28
486	29	272	7.374077	9	36	0.487990	308	0.24862383	4
487	28	256	6.940308	10	40	0.542212	296	0.99449531	16
488	28	256	6.940308	12	52	0.704875	308	0.24862383	4
489	31	312	8.458500	0	0	0.000000	312	0.00000000	0
490	30	288	7.807846	2	8	0.108442	296	0.99449531	16
491	30	288	7.807846	5	20	0.271106	308	0.24862383	4
492	17	88	2.385731	16	84	1.138644	172	8.70183392	140

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segments
493	18	96	2.602615	17	92	1.247087	188	7.70733862	124
494	19	112	3.036385	16	84	1.138644	196	7.21009097	116
495	20	128	3.470154	17	92	1.247087	220	5.71834801	92
496	21	144	3.903923	16	84	1.138644	228	5.22110035	84
497	22	160	4.337692	17	92	1.247087	252	3.72935740	60
498	23	176	4.771462	16	84	1.138644	260	3.23210974	52
499	24	192	5.205231	17	92	1.247087	284	1.74036678	28
500	25	208	5.639000	16	84	1.138644	292	1.24311913	20
501	26	224	6.072769	16	84	1.138644	308	0.24862383	4
502	19	112	3.036385	18	100	1.355529	212	6.21559566	100
503	20	128	3.470154	19	116	1.572413	244	4.22660505	68
504	21	144	3.903923	18	100	1.355529	244	4.22660505	68
505	22	160	4.337692	19	116	1.572413	276	2.23761444	36
506	23	176	4.771462	18	100	1.355529	276	2.23761444	36
507	24	192	5.205231	19	116	1.572413	308	0.24862383	4
508	25	208	5.639000	18	100	1.355529	308	0.24862383	4
509	21	144	3.903923	20	132	1.789298	276	2.23761444	36
510	22	160	4.337692	21	148	2.006183	308	0.24862383	4
511	23	176	4.771462	20	132	1.789298	308	0.24862383	4

Table A2 Sorted by Main Stream Bit Rate

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
0	0	0	0.000000	0	0	0.000000	0	19.39265846	312
1	1	2	0.054221	0	0	0.000000	2	19.26834655	310
8	0	0	0.000000	1	4	0.054221	4	19.14403463	308
2	2	4	0.108442	0	0	0.000000	4	19.14403463	308
9	1	2	0.054221	1	4	0.054221	6	19.01972272	306
3	3	6	0.162663	0	0	0.000000	6	19.01972272	306
16	0	0	0.000000	2	8	0.108442	8	18.89541081	304
10	2	4	0.108442	1	4	0.054221	8	18.89541081	304
4	4	8	0.216885	0	0	0.000000	8	18.89541081	304
17	1	2	0.054221	2	8	0.108442	10	18.77109889	302
11	3	6	0.162663	1	4	0.054221	10	18.77109889	302
24	0	0	0.000000	3	12	0.162663	12	18.64678698	300
18	2	4	0.108442	2	8	0.108442	12	18.64678698	300
12	4	8	0.216885	1	4	0.054221	12	18.64678698	300
5	5	12	0.325327	0	0	0.000000	12	18.64678698	300
25	1	2	0.054221	3	12	0.162663	14	18.52247507	298
19	3	6	0.162663	2	8	0.108442	14	18.52247507	298
32	0	0	0.000000	4	16	0.216885	16	18.39816315	296
26	2	4	0.108442	3	12	0.162663	16	18.39816315	296
20	4	8	0.216885	2	8	0.108442	16	18.39816315	296
13	5	12	0.325327	1	4	0.054221	16	18.39816315	296
6	6	16	0.433769	0	0	0.000000	16	18.39816315	296
33	1	2	0.054221	4	16	0.216885	18	18.27385124	294

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
27	3	6	0.162663	3	12	0.162663	18	18.27385124	294
40	0	0	0.000000	5	20	0.271106	20	18.14953933	292
34	2	4	0.108442	4	16	0.216885	20	18.14953933	292
28	4	8	0.216885	3	12	0.162663	20	18.14953933	292
21	5	12	0.325327	2	8	0.108442	20	18.14953933	292
14	6	16	0.433769	1	4	0.054221	20	18.14953933	292
7	7	20	0.542212	0	0	0.000000	20	18.14953933	292
41	1	2	0.054221	5	20	0.271106	22	18.02522741	290
35	3	6	0.162663	4	16	0.216885	22	18.02522741	290
128	8	24	0.650654	0	0	0.000000	24	17.90091550	288
48	0	0	0.000000	6	24	0.325327	24	17.90091550	288
42	2	4	0.108442	5	20	0.271106	24	17.90091550	288
36	4	8	0.216885	4	16	0.216885	24	17.90091550	288
29	5	12	0.325327	3	12	0.162663	24	17.90091550	288
22	6	16	0.433769	2	8	0.108442	24	17.90091550	288
15	7	20	0.542212	1	4	0.054221	24	17.90091550	288
49	1	2	0.054221	6	24	0.325327	26	17.77660359	286
43	3	6	0.162663	5	20	0.271106	26	17.77660359	286
136	8	24	0.650654	1	4	0.054221	28	17.65229167	284
129	9	28	0.759096	0	0	0.000000	28	17.65229167	284
56	0	0	0.000000	7	28	0.379548	28	17.65229167	284
50	2	4	0.108442	6	24	0.325327	28	17.65229167	284
44	4	8	0.216885	5	20	0.271106	28	17.65229167	284
37	5	12	0.325327	4	16	0.216885	28	17.65229167	284
30	6	16	0.433769	3	12	0.162663	28	17.65229167	284
23	7	20	0.542212	2	8	0.108442	28	17.65229167	284
57	1	2	0.054221	7	28	0.379548	30	17.52797976	282
51	3	6	0.162663	6	24	0.325327	30	17.52797976	282
144	8	24	0.650654	2	8	0.108442	32	17.40366785	280
137	9	28	0.759096	1	4	0.054221	32	17.40366785	280
130	10	32	0.867538	0	0	0.000000	32	17.40366785	280
64	0	0	0.000000	8	32	0.433769	32	17.40366785	280
58	2	4	0.108442	7	28	0.379548	32	17.40366785	280
52	4	8	0.216885	6	24	0.325327	32	17.40366785	280
45	5	12	0.325327	5	20	0.271106	32	17.40366785	280
38	6	16	0.433769	4	16	0.216885	32	17.40366785	280
31	7	20	0.542212	3	12	0.162663	32	17.40366785	280
65	1	2	0.054221	8	32	0.433769	34	17.27935594	278
59	3	6	0.162663	7	28	0.379548	34	17.27935594	278
152	8	24	0.650654	3	12	0.162663	36	17.15504402	276
145	9	28	0.759096	2	8	0.108442	36	17.15504402	276
138	10	32	0.867538	1	4	0.054221	36	17.15504402	276
72	0	0	0.000000	9	36	0.487990	36	17.15504402	276
66	2	4	0.108442	8	32	0.433769	36	17.15504402	276
60	4	8	0.216885	7	28	0.379548	36	17.15504402	276
53	5	12	0.325327	6	24	0.325327	36	17.15504402	276

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
46	6	16	0.433769	5	20	0.271106	36	17.15504402	276
39	7	20	0.542212	4	16	0.216885	36	17.15504402	276
73	1	2	0.054221	9	36	0.487990	38	17.03073211	274
67	3	6	0.162663	8	32	0.433769	38	17.03073211	274
160	8	24	0.650654	4	16	0.216885	40	16.90642020	272
153	9	28	0.759096	3	12	0.162663	40	16.90642020	272
146	10	32	0.867538	2	8	0.108442	40	16.90642020	272
131	11	40	1.084423	0	0	0.000000	40	16.90642020	272
80	0	0	0.000000	10	40	0.542212	40	16.90642020	272
74	2	4	0.108442	9	36	0.487990	40	16.90642020	272
68	4	8	0.216885	8	32	0.433769	40	16.90642020	272
61	5	12	0.325327	7	28	0.379548	40	16.90642020	272
54	6	16	0.433769	6	24	0.325327	40	16.90642020	272
47	7	20	0.542212	5	20	0.271106	40	16.90642020	272
81	1	2	0.054221	10	40	0.542212	42	16.78210828	270
75	3	6	0.162663	9	36	0.487990	42	16.78210828	270
168	8	24	0.650654	5	20	0.271106	44	16.65779637	268
161	9	28	0.759096	4	16	0.216885	44	16.65779637	268
154	10	32	0.867538	3	12	0.162663	44	16.65779637	268
139	11	40	1.084423	1	4	0.054221	44	16.65779637	268
88	0	0	0.000000	11	44	0.596433	44	16.65779637	268
82	2	4	0.108442	10	40	0.542212	44	16.65779637	268
76	4	8	0.216885	9	36	0.487990	44	16.65779637	268
69	5	12	0.325327	8	32	0.433769	44	16.65779637	268
62	6	16	0.433769	7	28	0.379548	44	16.65779637	268
55	7	20	0.542212	6	24	0.325327	44	16.65779637	268
89	1	2	0.054221	11	44	0.596433	46	16.53348446	266
83	3	6	0.162663	10	40	0.542212	46	16.53348446	266
176	8	24	0.650654	6	24	0.325327	48	16.40917254	264
169	9	28	0.759096	5	20	0.271106	48	16.40917254	264
162	10	32	0.867538	4	16	0.216885	48	16.40917254	264
147	11	40	1.084423	2	8	0.108442	48	16.40917254	264
132	12	48	1.301308	0	0	0.000000	48	16.40917254	264
90	2	4	0.108442	11	44	0.596433	48	16.40917254	264
84	4	8	0.216885	10	40	0.542212	48	16.40917254	264
77	5	12	0.325327	9	36	0.487990	48	16.40917254	264
70	6	16	0.433769	8	32	0.433769	48	16.40917254	264
63	7	20	0.542212	7	28	0.379548	48	16.40917254	264
91	3	6	0.162663	11	44	0.596433	50	16.28486063	262
184	8	24	0.650654	7	28	0.379548	52	16.16054872	260
177	9	28	0.759096	6	24	0.325327	52	16.16054872	260
170	10	32	0.867538	5	20	0.271106	52	16.16054872	260
155	11	40	1.084423	3	12	0.162663	52	16.16054872	260
140	12	48	1.301308	1	4	0.054221	52	16.16054872	260
96	0	0	0.000000	12	52	0.704875	52	16.16054872	260
92	4	8	0.216885	11	44	0.596433	52	16.16054872	260

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
85	5	12	0.325327	10	40	0.542212	52	16.16054872	260
78	6	16	0.433769	9	36	0.487990	52	16.16054872	260
71	7	20	0.542212	8	32	0.433769	52	16.16054872	260
97	1	2	0.054221	12	52	0.704875	54	16.03623680	258
192	8	24	0.650654	8	32	0.433769	56	15.91192489	256
185	9	28	0.759096	7	28	0.379548	56	15.91192489	256
178	10	32	0.867538	6	24	0.325327	56	15.91192489	256
163	11	40	1.084423	4	16	0.216885	56	15.91192489	256
148	12	48	1.301308	2	8	0.108442	56	15.91192489	256
133	13	56	1.518192	0	0	0.000000	56	15.91192489	256
98	2	4	0.108442	12	52	0.704875	56	15.91192489	256
93	5	12	0.325327	11	44	0.596433	56	15.91192489	256
86	6	16	0.433769	10	40	0.542212	56	15.91192489	256
79	7	20	0.542212	9	36	0.487990	56	15.91192489	256
99	3	6	0.162663	12	52	0.704875	58	15.78761298	254
200	8	24	0.650654	9	36	0.487990	60	15.66330106	252
193	9	28	0.759096	8	32	0.433769	60	15.66330106	252
186	10	32	0.867538	7	28	0.379548	60	15.66330106	252
171	11	40	1.084423	5	20	0.271106	60	15.66330106	252
156	12	48	1.301308	3	12	0.162663	60	15.66330106	252
141	13	56	1.518192	1	4	0.054221	60	15.66330106	252
104	0	0	0.000000	13	60	0.813317	60	15.66330106	252
100	4	8	0.216885	12	52	0.704875	60	15.66330106	252
94	6	16	0.433769	11	44	0.596433	60	15.66330106	252
87	7	20	0.542212	10	40	0.542212	60	15.66330106	252
105	1	2	0.054221	13	60	0.813317	62	15.53898915	250
208	8	24	0.650654	10	40	0.542212	64	15.41467724	248
201	9	28	0.759096	9	36	0.487990	64	15.41467724	248
194	10	32	0.867538	8	32	0.433769	64	15.41467724	248
179	11	40	1.084423	6	24	0.325327	64	15.41467724	248
164	12	48	1.301308	4	16	0.216885	64	15.41467724	248
149	13	56	1.518192	2	8	0.108442	64	15.41467724	248
134	14	64	1.735077	0	0	0.000000	64	15.41467724	248
106	2	4	0.108442	13	60	0.813317	64	15.41467724	248
101	5	12	0.325327	12	52	0.704875	64	15.41467724	248
95	7	20	0.542212	11	44	0.596433	64	15.41467724	248
107	3	6	0.162663	13	60	0.813317	66	15.29036532	246
216	8	24	0.650654	11	44	0.596433	68	15.16605341	244
209	9	28	0.759096	10	40	0.542212	68	15.16605341	244
202	10	32	0.867538	9	36	0.487990	68	15.16605341	244
187	11	40	1.084423	7	28	0.379548	68	15.16605341	244
172	12	48	1.301308	5	20	0.271106	68	15.16605341	244
157	13	56	1.518192	3	12	0.162663	68	15.16605341	244
142	14	64	1.735077	1	4	0.054221	68	15.16605341	244
112	0	0	0.000000	14	68	0.921760	68	15.16605341	244
108	4	8	0.216885	13	60	0.813317	68	15.16605341	244

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
102	6	16	0.433769	12	52	0.704875	68	15.16605341	244
113	1	2	0.054221	14	68	0.921760	70	15.04174150	242
217	9	28	0.759096	11	44	0.596433	72	14.91742958	240
210	10	32	0.867538	10	40	0.542212	72	14.91742958	240
195	11	40	1.084423	8	32	0.433769	72	14.91742958	240
180	12	48	1.301308	6	24	0.325327	72	14.91742958	240
165	13	56	1.518192	4	16	0.216885	72	14.91742958	240
150	14	64	1.735077	2	8	0.108442	72	14.91742958	240
135	15	72	1.951962	0	0	0.000000	72	14.91742958	240
114	2	4	0.108442	14	68	0.921760	72	14.91742958	240
109	5	12	0.325327	13	60	0.813317	72	14.91742958	240
103	7	20	0.542212	12	52	0.704875	72	14.91742958	240
115	3	6	0.162663	14	68	0.921760	74	14.79311767	238
224	8	24	0.650654	12	52	0.704875	76	14.66880576	236
218	10	32	0.867538	11	44	0.596433	76	14.66880576	236
203	11	40	1.084423	9	36	0.487990	76	14.66880576	236
188	12	48	1.301308	7	28	0.379548	76	14.66880576	236
173	13	56	1.518192	5	20	0.271106	76	14.66880576	236
158	14	64	1.735077	3	12	0.162663	76	14.66880576	236
143	15	72	1.951962	1	4	0.054221	76	14.66880576	236
120	0	0	0.000000	15	76	1.030202	76	14.66880576	236
116	4	8	0.216885	14	68	0.921760	76	14.66880576	236
110	6	16	0.433769	13	60	0.813317	76	14.66880576	236
121	1	2	0.054221	15	76	1.030202	78	14.54449384	234
225	9	28	0.759096	12	52	0.704875	80	14.42018193	232
211	11	40	1.084423	10	40	0.542212	80	14.42018193	232
196	12	48	1.301308	8	32	0.433769	80	14.42018193	232
181	13	56	1.518192	6	24	0.325327	80	14.42018193	232
166	14	64	1.735077	4	16	0.216885	80	14.42018193	232
151	15	72	1.951962	2	8	0.108442	80	14.42018193	232
122	2	4	0.108442	15	76	1.030202	80	14.42018193	232
117	5	12	0.325327	14	68	0.921760	80	14.42018193	232
111	7	20	0.542212	13	60	0.813317	80	14.42018193	232
123	3	6	0.162663	15	76	1.030202	82	14.29587002	230
321	16	80	2.168846	1	4	0.054221	84	14.17155811	228
232	8	24	0.650654	13	60	0.813317	84	14.17155811	228
226	10	32	0.867538	12	52	0.704875	84	14.17155811	228
219	11	40	1.084423	11	44	0.596433	84	14.17155811	228
204	12	48	1.301308	9	36	0.487990	84	14.17155811	228
189	13	56	1.518192	7	28	0.379548	84	14.17155811	228
174	14	64	1.735077	5	20	0.271106	84	14.17155811	228
159	15	72	1.951962	3	12	0.162663	84	14.17155811	228
124	4	8	0.216885	15	76	1.030202	84	14.17155811	228
118	6	16	0.433769	14	68	0.921760	84	14.17155811	228
257	1	2	0.054221	16	84	1.138644	86	14.04724619	226
320	17	88	2.385731	0	0	0.000000	88	13.92293428	224

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
233	9	28	0.759096	13	60	0.813317	88	13.92293428	224
212	12	48	1.301308	10	40	0.542212	88	13.92293428	224
197	13	56	1.518192	8	32	0.433769	88	13.92293428	224
182	14	64	1.735077	6	24	0.325327	88	13.92293428	224
167	15	72	1.951962	4	16	0.216885	88	13.92293428	224
125	5	12	0.325327	15	76	1.030202	88	13.92293428	224
119	7	20	0.542212	14	68	0.921760	88	13.92293428	224
259	3	6	0.162663	16	84	1.138644	90	13.79862237	222
323	16	80	2.168846	3	12	0.162663	92	13.67431045	220
256	0	0	0.000000	17	92	1.247087	92	13.67431045	220
240	8	24	0.650654	14	68	0.921760	92	13.67431045	220
234	10	32	0.867538	13	60	0.813317	92	13.67431045	220
227	11	40	1.084423	12	52	0.704875	92	13.67431045	220
220	12	48	1.301308	11	44	0.596433	92	13.67431045	220
205	13	56	1.518192	9	36	0.487990	92	13.67431045	220
190	14	64	1.735077	7	28	0.379548	92	13.67431045	220
175	15	72	1.951962	5	20	0.271106	92	13.67431045	220
126	6	16	0.433769	15	76	1.030202	92	13.67431045	220
322	17	88	2.385731	2	8	0.108442	96	13.42568663	216
261	5	12	0.325327	16	84	1.138644	96	13.42568663	216
258	2	4	0.108442	17	92	1.247087	96	13.42568663	216
241	9	28	0.759096	14	68	0.921760	96	13.42568663	216
213	13	56	1.518192	10	40	0.542212	96	13.42568663	216
198	14	64	1.735077	8	32	0.433769	96	13.42568663	216
183	15	72	1.951962	6	24	0.325327	96	13.42568663	216
127	7	20	0.542212	15	76	1.030202	96	13.42568663	216
337	18	96	2.602615	1	4	0.054221	100	13.17706280	212
325	16	80	2.168846	5	20	0.271106	100	13.17706280	212
260	4	8	0.216885	17	92	1.247087	100	13.17706280	212
248	8	24	0.650654	15	76	1.030202	100	13.17706280	212
242	10	32	0.867538	14	68	0.921760	100	13.17706280	212
235	11	40	1.084423	13	60	0.813317	100	13.17706280	212
228	12	48	1.301308	12	52	0.704875	100	13.17706280	212
221	13	56	1.518192	11	44	0.596433	100	13.17706280	212
206	14	64	1.735077	9	36	0.487990	100	13.17706280	212
191	15	72	1.951962	7	28	0.379548	100	13.17706280	212
273	1	2	0.054221	18	100	1.355529	102	13.05275089	210
324	17	88	2.385731	4	16	0.216885	104	12.92843897	208
263	7	20	0.542212	16	84	1.138644	104	12.92843897	208
249	9	28	0.759096	15	76	1.030202	104	12.92843897	208
214	14	64	1.735077	10	40	0.542212	104	12.92843897	208
199	15	72	1.951962	8	32	0.433769	104	12.92843897	208
275	3	6	0.162663	18	100	1.355529	106	12.80412706	206
339	18	96	2.602615	3	12	0.162663	108	12.67981515	204
327	16	80	2.168846	7	28	0.379548	108	12.67981515	204
262	6	16	0.433769	17	92	1.247087	108	12.67981515	204

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
250	10	32	0.867538	15	76	1.030202	108	12.67981515	204
243	11	40	1.084423	14	68	0.921760	108	12.67981515	204
236	12	48	1.301308	13	60	0.813317	108	12.67981515	204
229	13	56	1.518192	12	52	0.704875	108	12.67981515	204
222	14	64	1.735077	11	44	0.596433	108	12.67981515	204
207	15	72	1.951962	9	36	0.487990	108	12.67981515	204
336	19	112	3.036385	0	0	0.000000	112	12.43119132	200
326	17	88	2.385731	6	24	0.325327	112	12.43119132	200
277	5	12	0.325327	18	100	1.355529	112	12.43119132	200
265	9	28	0.759096	16	84	1.138644	112	12.43119132	200
215	15	72	1.951962	10	40	0.542212	112	12.43119132	200
341	18	96	2.602615	5	20	0.271106	116	12.18256749	196
329	16	80	2.168846	9	36	0.487990	116	12.18256749	196
272	0	0	0.000000	19	116	1.572413	116	12.18256749	196
264	8	24	0.650654	17	92	1.247087	116	12.18256749	196
251	11	40	1.084423	15	76	1.030202	116	12.18256749	196
244	12	48	1.301308	14	68	0.921760	116	12.18256749	196
237	13	56	1.518192	13	60	0.813317	116	12.18256749	196
230	14	64	1.735077	12	52	0.704875	116	12.18256749	196
223	15	72	1.951962	11	44	0.596433	116	12.18256749	196
338	19	112	3.036385	2	8	0.108442	120	11.93394367	192
328	17	88	2.385731	8	32	0.433769	120	11.93394367	192
279	7	20	0.542212	18	100	1.355529	120	11.93394367	192
274	2	4	0.108442	19	116	1.572413	120	11.93394367	192
343	18	96	2.602615	7	28	0.379548	124	11.68531984	188
331	16	80	2.168846	11	44	0.596433	124	11.68531984	188
276	4	8	0.216885	19	116	1.572413	124	11.68531984	188
267	11	40	1.084423	16	84	1.138644	124	11.68531984	188
266	10	32	0.867538	17	92	1.247087	124	11.68531984	188
252	12	48	1.301308	15	76	1.030202	124	11.68531984	188
245	13	56	1.518192	14	68	0.921760	124	11.68531984	188
238	14	64	1.735077	13	60	0.813317	124	11.68531984	188
231	15	72	1.951962	12	52	0.704875	124	11.68531984	188
340	19	112	3.036385	4	16	0.216885	128	11.43669601	184
330	17	88	2.385731	10	40	0.542212	128	11.43669601	184
281	9	28	0.759096	18	100	1.355529	128	11.43669601	184
353	20	128	3.470154	1	4	0.054221	132	11.18807219	180
345	18	96	2.602615	9	36	0.487990	132	11.18807219	180
278	6	16	0.433769	19	116	1.572413	132	11.18807219	180
253	13	56	1.518192	15	76	1.030202	132	11.18807219	180
246	14	64	1.735077	14	68	0.921760	132	11.18807219	180
239	15	72	1.951962	13	60	0.813317	132	11.18807219	180
289	1	2	0.054221	20	132	1.789298	134	11.06376028	178
342	19	112	3.036385	6	24	0.325327	136	10.93944836	176
291	3	6	0.162663	20	132	1.789298	138	10.81513645	174
355	20	128	3.470154	3	12	0.162663	140	10.69082454	172

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
347	18	96	2.602615	11	44	0.596433	140	10.69082454	172
333	16	80	2.168846	13	60	0.813317	140	10.69082454	172
332	17	88	2.385731	12	52	0.704875	140	10.69082454	172
283	11	40	1.084423	18	100	1.355529	140	10.69082454	172
280	8	24	0.650654	19	116	1.572413	140	10.69082454	172
269	13	56	1.518192	16	84	1.138644	140	10.69082454	172
268	12	48	1.301308	17	92	1.247087	140	10.69082454	172
254	14	64	1.735077	15	76	1.030202	140	10.69082454	172
247	15	72	1.951962	14	68	0.921760	140	10.69082454	172
352	21	144	3.903923	0	0	0.000000	144	10.44220071	168
344	19	112	3.036385	8	32	0.433769	144	10.44220071	168
293	5	12	0.325327	20	132	1.789298	144	10.44220071	168
357	20	128	3.470154	5	20	0.271106	148	10.19357688	164
288	0	0	0.000000	21	148	2.006183	148	10.19357688	164
282	10	32	0.867538	19	116	1.572413	148	10.19357688	164
255	15	72	1.951962	15	76	1.030202	148	10.19357688	164
354	21	144	3.903923	2	8	0.108442	152	9.94495306	160
346	19	112	3.036385	10	40	0.542212	152	9.94495306	160
295	7	20	0.542212	20	132	1.789298	152	9.94495306	160
290	2	4	0.108442	21	148	2.006183	152	9.94495306	160
359	20	128	3.470154	7	28	0.379548	156	9.69632923	156
349	18	96	2.602615	13	60	0.813317	156	9.69632923	156
335	16	80	2.168846	15	76	1.030202	156	9.69632923	156
334	17	88	2.385731	14	68	0.921760	156	9.69632923	156
292	4	8	0.216885	21	148	2.006183	156	9.69632923	156
285	13	56	1.518192	18	100	1.355529	156	9.69632923	156
271	15	72	1.951962	16	84	1.138644	156	9.69632923	156
270	14	64	1.735077	17	92	1.247087	156	9.69632923	156
356	21	144	3.903923	4	16	0.216885	160	9.44770540	152
297	9	28	0.759096	20	132	1.789298	160	9.44770540	152
369	22	160	4.337692	1	4	0.054221	164	9.19908158	148
361	20	128	3.470154	9	36	0.487990	164	9.19908158	148
348	19	112	3.036385	12	52	0.704875	164	9.19908158	148
294	6	16	0.433769	21	148	2.006183	164	9.19908158	148
284	12	48	1.301308	19	116	1.572413	164	9.19908158	148
305	1	2	0.054221	22	164	2.223067	166	9.07476966	146
358	21	144	3.903923	6	24	0.325327	168	8.95045775	144
307	3	6	0.162663	22	164	2.223067	170	8.82614584	142
492	17	88	2.385731	16	84	1.138644	172	8.70183392	140
460	16	80	2.168846	17	92	1.247087	172	8.70183392	140
371	22	160	4.337692	3	12	0.162663	172	8.70183392	140
363	20	128	3.470154	11	44	0.596433	172	8.70183392	140
351	18	96	2.602615	15	76	1.030202	172	8.70183392	140
299	11	40	1.084423	20	132	1.789298	172	8.70183392	140
296	8	24	0.650654	21	148	2.006183	172	8.70183392	140
287	15	72	1.951962	18	100	1.355529	172	8.70183392	140

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
368	23	176	4.771462	0	0	0.000000	176	8.45321010	136
360	21	144	3.903923	8	32	0.433769	176	8.45321010	136
309	5	12	0.325327	22	164	2.223067	176	8.45321010	136
373	22	160	4.337692	5	20	0.271106	180	8.20458627	132
350	19	112	3.036385	14	68	0.921760	180	8.20458627	132
304	0	0	0.000000	23	180	2.439952	180	8.20458627	132
298	10	32	0.867538	21	148	2.006183	180	8.20458627	132
286	14	64	1.735077	19	116	1.572413	180	8.20458627	132
370	23	176	4.771462	2	8	0.108442	184	7.95596245	128
362	21	144	3.903923	10	40	0.542212	184	7.95596245	128
311	7	20	0.542212	22	164	2.223067	184	7.95596245	128
306	2	4	0.108442	23	180	2.439952	184	7.95596245	128
493	18	96	2.602615	17	92	1.247087	188	7.70733862	124
461	17	88	2.385731	18	100	1.355529	188	7.70733862	124
375	22	160	4.337692	7	28	0.379548	188	7.70733862	124
365	20	128	3.470154	13	60	0.813317	188	7.70733862	124
308	4	8	0.216885	23	180	2.439952	188	7.70733862	124
301	13	56	1.518192	20	132	1.789298	188	7.70733862	124
372	23	176	4.771462	4	16	0.216885	192	7.45871479	120
313	9	28	0.759096	22	164	2.223067	192	7.45871479	120
494	19	112	3.036385	16	84	1.138644	196	7.21009097	116
462	16	80	2.168846	19	116	1.572413	196	7.21009097	116
417	24	192	5.205231	1	4	0.054221	196	7.21009097	116
377	22	160	4.337692	9	36	0.487990	196	7.21009097	116
364	21	144	3.903923	12	52	0.704875	196	7.21009097	116
310	6	16	0.433769	23	180	2.439952	196	7.21009097	116
300	12	48	1.301308	21	148	2.006183	196	7.21009097	116
385	1	2	0.054221	24	196	2.656837	198	7.08577905	114
374	23	176	4.771462	6	24	0.325327	200	6.96146714	112
387	3	6	0.162663	24	196	2.656837	202	6.83715523	110
419	24	192	5.205231	3	12	0.162663	204	6.71284331	108
379	22	160	4.337692	11	44	0.596433	204	6.71284331	108
367	20	128	3.470154	15	76	1.030202	204	6.71284331	108
315	11	40	1.084423	22	164	2.223067	204	6.71284331	108
312	8	24	0.650654	23	180	2.439952	204	6.71284331	108
303	15	72	1.951962	20	132	1.789298	204	6.71284331	108
416	25	208	5.639000	0	0	0.000000	208	6.46421949	104
389	5	12	0.325327	24	196	2.656837	208	6.46421949	104
376	23	176	4.771462	8	32	0.433769	208	6.46421949	104
502	19	112	3.036385	18	100	1.355529	212	6.21559566	100
470	18	96	2.602615	19	116	1.572413	212	6.21559566	100
421	24	192	5.205231	5	20	0.271106	212	6.21559566	100
384	0	0	0.000000	25	212	2.873721	212	6.21559566	100
366	21	144	3.903923	14	68	0.921760	212	6.21559566	100
314	10	32	0.867538	23	180	2.439952	212	6.21559566	100
302	14	64	1.735077	21	148	2.006183	212	6.21559566	100

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
418	25	208	5.639000	2	8	0.108442	216	5.96697183	96
391	7	20	0.542212	24	196	2.656837	216	5.96697183	96
386	2	4	0.108442	25	212	2.873721	216	5.96697183	96
378	23	176	4.771462	10	40	0.542212	216	5.96697183	96
495	20	128	3.470154	17	92	1.247087	220	5.71834801	92
463	17	88	2.385731	20	132	1.789298	220	5.71834801	92
423	24	192	5.205231	7	28	0.379548	220	5.71834801	92
388	4	8	0.216885	25	212	2.873721	220	5.71834801	92
381	22	160	4.337692	13	60	0.813317	220	5.71834801	92
317	13	56	1.518192	22	164	2.223067	220	5.71834801	92
420	25	208	5.639000	4	16	0.216885	224	5.46972418	88
393	9	28	0.759096	24	196	2.656837	224	5.46972418	88
496	21	144	3.903923	16	84	1.138644	228	5.22110035	84
464	16	80	2.168846	21	148	2.006183	228	5.22110035	84
433	26	224	6.072769	1	4	0.054221	228	5.22110035	84
425	24	192	5.205231	9	36	0.487990	228	5.22110035	84
390	6	16	0.433769	25	212	2.873721	228	5.22110035	84
380	23	176	4.771462	12	52	0.704875	228	5.22110035	84
316	12	48	1.301308	23	180	2.439952	228	5.22110035	84
401	1	2	0.054221	26	228	3.090606	230	5.09678844	82
422	25	208	5.639000	6	24	0.325327	232	4.97247653	80
403	3	6	0.162663	26	228	3.090606	234	4.84816461	78
435	26	224	6.072769	3	12	0.162663	236	4.72385270	76
427	24	192	5.205231	11	44	0.596433	236	4.72385270	76
395	11	40	1.084423	24	196	2.656837	236	4.72385270	76
392	8	24	0.650654	25	212	2.873721	236	4.72385270	76
383	22	160	4.337692	15	76	1.030202	236	4.72385270	76
319	15	72	1.951962	22	164	2.223067	236	4.72385270	76
432	27	240	6.506538	0	0	0.000000	240	4.47522888	72
424	25	208	5.639000	8	32	0.433769	240	4.47522888	72
405	5	12	0.325327	26	228	3.090606	240	4.47522888	72
504	21	144	3.903923	18	100	1.355529	244	4.22660505	68
503	20	128	3.470154	19	116	1.572413	244	4.22660505	68
472	18	96	2.602615	21	148	2.006183	244	4.22660505	68
471	19	112	3.036385	20	132	1.789298	244	4.22660505	68
437	26	224	6.072769	5	20	0.271106	244	4.22660505	68
400	0	0	0.000000	27	244	3.307490	244	4.22660505	68
394	10	32	0.867538	25	212	2.873721	244	4.22660505	68
382	23	176	4.771462	14	68	0.921760	244	4.22660505	68
318	14	64	1.735077	23	180	2.439952	244	4.22660505	68
434	27	240	6.506538	2	8	0.108442	248	3.97798122	64
426	25	208	5.639000	10	40	0.542212	248	3.97798122	64
407	7	20	0.542212	26	228	3.090606	248	3.97798122	64
402	2	4	0.108442	27	244	3.307490	248	3.97798122	64
497	22	160	4.337692	17	92	1.247087	252	3.72935740	60
465	17	88	2.385731	22	164	2.223067	252	3.72935740	60

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
439	26	224	6.072769	7	28	0.379548	252	3.72935740	60
429	24	192	5.205231	13	60	0.813317	252	3.72935740	60
404	4	8	0.216885	27	244	3.307490	252	3.72935740	60
397	13	56	1.518192	24	196	2.656837	252	3.72935740	60
436	27	240	6.506538	4	16	0.216885	256	3.48073357	56
409	9	28	0.759096	26	228	3.090606	256	3.48073357	56
498	23	176	4.771462	16	84	1.138644	260	3.23210974	52
481	28	256	6.940308	1	4	0.054221	260	3.23210974	52
466	16	80	2.168846	23	180	2.439952	260	3.23210974	52
441	26	224	6.072769	9	36	0.487990	260	3.23210974	52
428	25	208	5.639000	12	52	0.704875	260	3.23210974	52
406	6	16	0.433769	27	244	3.307490	260	3.23210974	52
396	12	48	1.301308	25	212	2.873721	260	3.23210974	52
449	1	2	0.054221	28	260	3.524375	262	3.10779783	50
438	27	240	6.506538	6	24	0.325327	264	2.98348592	48
451	4	8	0.216885	28	260	3.524375	268	2.73486209	44
443	26	224	6.072769	11	44	0.596433	268	2.73486209	44
431	24	192	5.205231	15	76	1.030202	268	2.73486209	44
411	11	40	1.084423	26	228	3.090606	268	2.73486209	44
408	8	24	0.650654	27	244	3.307490	268	2.73486209	44
399	15	72	1.951962	24	196	2.656837	268	2.73486209	44
483	28	256	6.940308	4	16	0.216885	272	2.48623826	40
480	29	272	7.374077	0	0	0.000000	272	2.48623826	40
440	27	240	6.506538	8	32	0.433769	272	2.48623826	40
509	21	144	3.903923	20	132	1.789298	276	2.23761444	36
506	23	176	4.771462	18	100	1.355529	276	2.23761444	36
505	22	160	4.337692	19	116	1.572413	276	2.23761444	36
477	20	128	3.470154	21	148	2.006183	276	2.23761444	36
474	18	96	2.602615	23	180	2.439952	276	2.23761444	36
473	19	112	3.036385	22	164	2.223067	276	2.23761444	36
448	0	0	0.000000	29	276	3.741260	276	2.23761444	36
430	25	208	5.639000	14	68	0.921760	276	2.23761444	36
410	10	32	0.867538	27	244	3.307490	276	2.23761444	36
398	14	64	1.735077	25	212	2.873721	276	2.23761444	36
453	7	20	0.542212	28	260	3.524375	280	1.98899061	32
442	27	240	6.506538	10	40	0.542212	280	1.98899061	32
450	3	6	0.162663	29	276	3.741260	282	1.86467870	30
499	24	192	5.205231	17	92	1.247087	284	1.74036678	28
485	28	256	6.940308	7	28	0.379548	284	1.74036678	28
482	29	272	7.374077	3	12	0.162663	284	1.74036678	28
467	17	88	2.385731	24	196	2.656837	284	1.74036678	28
445	26	224	6.072769	13	60	0.813317	284	1.74036678	28
413	13	56	1.518192	26	228	3.090606	284	1.74036678	28
500	25	208	5.639000	16	84	1.138644	292	1.24311913	20
468	16	80	2.168846	25	212	2.873721	292	1.24311913	20
455	10	32	0.867538	28	260	3.524375	292	1.24311913	20

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
452	6	16	0.433769	29	276	3.741260	292	1.24311913	20
444	27	240	6.506538	12	52	0.704875	292	1.24311913	20
412	12	48	1.301308	27	244	3.307490	292	1.24311913	20
490	30	288	7.807846	2	8	0.108442	296	0.99449531	16
487	28	256	6.940308	10	40	0.542212	296	0.99449531	16
484	29	272	7.374077	6	24	0.325327	296	0.99449531	16
458	2	4	0.108442	30	292	3.958144	296	0.99449531	16
447	26	224	6.072769	15	76	1.030202	300	0.74587148	12
415	15	72	1.951962	26	228	3.090606	300	0.74587148	12
459	5	12	0.325327	30	292	3.958144	304	0.49724765	8
454	9	28	0.759096	29	276	3.741260	304	0.49724765	8
511	23	176	4.771462	20	132	1.789298	308	0.24862383	4
510	22	160	4.337692	21	148	2.006183	308	0.24862383	4
508	25	208	5.639000	18	100	1.355529	308	0.24862383	4
507	24	192	5.205231	19	116	1.572413	308	0.24862383	4
501	26	224	6.072769	16	84	1.138644	308	0.24862383	4
491	30	288	7.807846	5	20	0.271106	308	0.24862383	4
488	28	256	6.940308	12	52	0.704875	308	0.24862383	4
486	29	272	7.374077	9	36	0.487990	308	0.24862383	4
479	20	128	3.470154	23	180	2.439952	308	0.24862383	4
478	21	144	3.903923	22	164	2.223067	308	0.24862383	4
476	18	96	2.602615	25	212	2.873721	308	0.24862383	4
475	19	112	3.036385	24	196	2.656837	308	0.24862383	4
469	16	80	2.168846	26	228	3.090606	308	0.24862383	4
456	12	48	1.301308	28	260	3.524375	308	0.24862383	4
446	27	240	6.506538	14	68	0.921760	308	0.24862383	4
414	14	64	1.735077	27	244	3.307490	308	0.24862383	4
489	31	312	8.458500	0	0	0.000000	312	0.00000000	0
457	0	0	0.000000	31	312	4.229250	312	0.00000000	0

Table A3 Sorted by 1/2 Bit Rate

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
489	31	312	8.458500	0	0	0.000000	312	0.00000000	0
490	30	288	7.807846	2	8	0.108442	296	0.99449531	16
491	30	288	7.807846	5	20	0.271106	308	0.24862383	4
480	29	272	7.374077	0	0	0.000000	272	2.48623826	40
482	29	272	7.374077	3	12	0.162663	284	1.74036678	28
484	29	272	7.374077	6	24	0.325327	296	0.99449531	16
486	29	272	7.374077	9	36	0.487990	308	0.24862383	4
481	28	256	6.940308	1	4	0.054221	260	3.23210974	52
483	28	256	6.940308	4	16	0.216885	272	2.48623826	40
485	28	256	6.940308	7	28	0.379548	284	1.74036678	28
487	28	256	6.940308	10	40	0.542212	296	0.99449531	16
488	28	256	6.940308	12	52	0.704875	308	0.24862383	4
432	27	240	6.506538	0	0	0.000000	240	4.47522888	72

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
434	27	240	6.506538	2	8	0.108442	248	3.97798122	64
436	27	240	6.506538	4	16	0.216885	256	3.48073357	56
438	27	240	6.506538	6	24	0.325327	264	2.98348592	48
440	27	240	6.506538	8	32	0.433769	272	2.48623826	40
442	27	240	6.506538	10	40	0.542212	280	1.98899061	32
444	27	240	6.506538	12	52	0.704875	292	1.24311913	20
446	27	240	6.506538	14	68	0.921760	308	0.24862383	4
433	26	224	6.072769	1	4	0.054221	228	5.22110035	84
435	26	224	6.072769	3	12	0.162663	236	4.72385270	76
437	26	224	6.072769	5	20	0.271106	244	4.22660505	68
439	26	224	6.072769	7	28	0.379548	252	3.72935740	60
441	26	224	6.072769	9	36	0.487990	260	3.23210974	52
443	26	224	6.072769	11	44	0.596433	268	2.73486209	44
445	26	224	6.072769	13	60	0.813317	284	1.74036678	28
447	26	224	6.072769	15	76	1.030202	300	0.74587148	12
501	26	224	6.072769	16	84	1.138644	308	0.24862383	4
416	25	208	5.639000	0	0	0.000000	208	6.46421949	104
418	25	208	5.639000	2	8	0.108442	216	5.96697183	96
420	25	208	5.639000	4	16	0.216885	224	5.46972418	88
422	25	208	5.639000	6	24	0.325327	232	4.97247653	80
424	25	208	5.639000	8	32	0.433769	240	4.47522888	72
426	25	208	5.639000	10	40	0.542212	248	3.97798122	64
428	25	208	5.639000	12	52	0.704875	260	3.23210974	52
430	25	208	5.639000	14	68	0.921760	276	2.23761444	36
500	25	208	5.639000	16	84	1.138644	292	1.24311913	20
508	25	208	5.639000	18	100	1.355529	308	0.24862383	4
417	24	192	5.205231	1	4	0.054221	196	7.21009097	116
419	24	192	5.205231	3	12	0.162663	204	6.71284331	108
421	24	192	5.205231	5	20	0.271106	212	6.21559566	100
423	24	192	5.205231	7	28	0.379548	220	5.71834801	92
425	24	192	5.205231	9	36	0.487990	228	5.22110035	84
427	24	192	5.205231	11	44	0.596433	236	4.72385270	76
429	24	192	5.205231	13	60	0.813317	252	3.72935740	60
431	24	192	5.205231	15	76	1.030202	268	2.73486209	44
499	24	192	5.205231	17	92	1.247087	284	1.74036678	28
507	24	192	5.205231	19	116	1.572413	308	0.24862383	4
368	23	176	4.771462	0	0	0.000000	176	8.45321010	136
370	23	176	4.771462	2	8	0.108442	184	7.95596245	128
372	23	176	4.771462	4	16	0.216885	192	7.45871479	120
374	23	176	4.771462	6	24	0.325327	200	6.96146714	112
376	23	176	4.771462	8	32	0.433769	208	6.46421949	104
378	23	176	4.771462	10	40	0.542212	216	5.96697183	96
380	23	176	4.771462	12	52	0.704875	228	5.22110035	84
382	23	176	4.771462	14	68	0.921760	244	4.22660505	68
498	23	176	4.771462	16	84	1.138644	260	3.23210974	52
506	23	176	4.771462	18	100	1.355529	276	2.23761444	36

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
511	23	176	4.771462	20	132	1.789298	308	0.24862383	4
369	22	160	4.337692	1	4	0.054221	164	9.19908158	148
371	22	160	4.337692	3	12	0.162663	172	8.70183392	140
373	22	160	4.337692	5	20	0.271106	180	8.20458627	132
375	22	160	4.337692	7	28	0.379548	188	7.70733862	124
377	22	160	4.337692	9	36	0.487990	196	7.21009097	116
379	22	160	4.337692	11	44	0.596433	204	6.71284331	108
381	22	160	4.337692	13	60	0.813317	220	5.71834801	92
383	22	160	4.337692	15	76	1.030202	236	4.72385270	76
497	22	160	4.337692	17	92	1.247087	252	3.72935740	60
505	22	160	4.337692	19	116	1.572413	276	2.23761444	36
510	22	160	4.337692	21	148	2.006183	308	0.24862383	4
352	21	144	3.903923	0	0	0.000000	144	10.44220071	168
354	21	144	3.903923	2	8	0.108442	152	9.94495306	160
356	21	144	3.903923	4	16	0.216885	160	9.44770540	152
358	21	144	3.903923	6	24	0.325327	168	8.95045775	144
360	21	144	3.903923	8	32	0.433769	176	8.45321010	136
362	21	144	3.903923	10	40	0.542212	184	7.95596245	128
364	21	144	3.903923	12	52	0.704875	196	7.21009097	116
366	21	144	3.903923	14	68	0.921760	212	6.21559566	100
496	21	144	3.903923	16	84	1.138644	228	5.22110035	84
504	21	144	3.903923	18	100	1.355529	244	4.22660505	68
509	21	144	3.903923	20	132	1.789298	276	2.23761444	36
478	21	144	3.903923	22	164	2.223067	308	0.24862383	4
353	20	128	3.470154	1	4	0.054221	132	11.18807219	180
355	20	128	3.470154	3	12	0.162663	140	10.69082454	172
357	20	128	3.470154	5	20	0.271106	148	10.19357688	164
359	20	128	3.470154	7	28	0.379548	156	9.69632923	156
361	20	128	3.470154	9	36	0.487990	164	9.19908158	148
363	20	128	3.470154	11	44	0.596433	172	8.70183392	140
365	20	128	3.470154	13	60	0.813317	188	7.70733862	124
367	20	128	3.470154	15	76	1.030202	204	6.71284331	108
495	20	128	3.470154	17	92	1.247087	220	5.71834801	92
503	20	128	3.470154	19	116	1.572413	244	4.22660505	68
477	20	128	3.470154	21	148	2.006183	276	2.23761444	36
479	20	128	3.470154	23	180	2.439952	308	0.24862383	4
336	19	112	3.036385	0	0	0.000000	112	12.43119132	200
338	19	112	3.036385	2	8	0.108442	120	11.93394367	192
340	19	112	3.036385	4	16	0.216885	128	11.43669601	184
342	19	112	3.036385	6	24	0.325327	136	10.93944836	176
344	19	112	3.036385	8	32	0.433769	144	10.44220071	168
346	19	112	3.036385	10	40	0.542212	152	9.94495306	160
348	19	112	3.036385	12	52	0.704875	164	9.19908158	148
350	19	112	3.036385	14	68	0.921760	180	8.20458627	132
494	19	112	3.036385	16	84	1.138644	196	7.21009097	116
502	19	112	3.036385	18	100	1.355529	212	6.21559566	100

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
471	19	112	3.036385	20	132	1.789298	244	4.22660505	68
473	19	112	3.036385	22	164	2.223067	276	2.23761444	36
475	19	112	3.036385	24	196	2.656837	308	0.24862383	4
337	18	96	2.602615	1	4	0.054221	100	13.17706280	212
339	18	96	2.602615	3	12	0.162663	108	12.67981515	204
341	18	96	2.602615	5	20	0.271106	116	12.18256749	196
343	18	96	2.602615	7	28	0.379548	124	11.68531984	188
345	18	96	2.602615	9	36	0.487990	132	11.18807219	180
347	18	96	2.602615	11	44	0.596433	140	10.69082454	172
349	18	96	2.602615	13	60	0.813317	156	9.69632923	156
351	18	96	2.602615	15	76	1.030202	172	8.70183392	140
493	18	96	2.602615	17	92	1.247087	188	7.70733862	124
470	18	96	2.602615	19	116	1.572413	212	6.21559566	100
472	18	96	2.602615	21	148	2.006183	244	4.22660505	68
474	18	96	2.602615	23	180	2.439952	276	2.23761444	36
476	18	96	2.602615	25	212	2.873721	308	0.24862383	4
320	17	88	2.385731	0	0	0.000000	88	13.92293428	224
322	17	88	2.385731	2	8	0.108442	96	13.42568663	216
324	17	88	2.385731	4	16	0.216885	104	12.92843897	208
326	17	88	2.385731	6	24	0.325327	112	12.43119132	200
328	17	88	2.385731	8	32	0.433769	120	11.93394367	192
330	17	88	2.385731	10	40	0.542212	128	11.43669601	184
332	17	88	2.385731	12	52	0.704875	140	10.69082454	172
334	17	88	2.385731	14	68	0.921760	156	9.69632923	156
492	17	88	2.385731	16	84	1.138644	172	8.70183392	140
461	17	88	2.385731	18	100	1.355529	188	7.70733862	124
463	17	88	2.385731	20	132	1.789298	220	5.71834801	92
465	17	88	2.385731	22	164	2.223067	252	3.72935740	60
467	17	88	2.385731	24	196	2.656837	284	1.74036678	28
321	16	80	2.168846	1	4	0.054221	84	14.17155811	228
323	16	80	2.168846	3	12	0.162663	92	13.67431045	220
325	16	80	2.168846	5	20	0.271106	100	13.17706280	212
327	16	80	2.168846	7	28	0.379548	108	12.67981515	204
329	16	80	2.168846	9	36	0.487990	116	12.18256749	196
331	16	80	2.168846	11	44	0.596433	124	11.68531984	188
333	16	80	2.168846	13	60	0.813317	140	10.69082454	172
335	16	80	2.168846	15	76	1.030202	156	9.69632923	156
460	16	80	2.168846	17	92	1.247087	172	8.70183392	140
462	16	80	2.168846	19	116	1.572413	196	7.21009097	116
464	16	80	2.168846	21	148	2.006183	228	5.22110035	84
466	16	80	2.168846	23	180	2.439952	260	3.23210974	52
468	16	80	2.168846	25	212	2.873721	292	1.24311913	20
469	16	80	2.168846	26	228	3.090606	308	0.24862383	4
135	15	72	1.951962	0	0	0.000000	72	14.91742958	240
143	15	72	1.951962	1	4	0.054221	76	14.66880576	236
151	15	72	1.951962	2	8	0.108442	80	14.42018193	232

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
159	15	72	1.951962	3	12	0.162663	84	14.17155811	228
167	15	72	1.951962	4	16	0.216885	88	13.92293428	224
175	15	72	1.951962	5	20	0.271106	92	13.67431045	220
183	15	72	1.951962	6	24	0.325327	96	13.42568663	216
191	15	72	1.951962	7	28	0.379548	100	13.17706280	212
199	15	72	1.951962	8	32	0.433769	104	12.92843897	208
207	15	72	1.951962	9	36	0.487990	108	12.67981515	204
215	15	72	1.951962	10	40	0.542212	112	12.43119132	200
223	15	72	1.951962	11	44	0.596433	116	12.18256749	196
231	15	72	1.951962	12	52	0.704875	124	11.68531984	188
239	15	72	1.951962	13	60	0.813317	132	11.18807219	180
247	15	72	1.951962	14	68	0.921760	140	10.69082454	172
255	15	72	1.951962	15	76	1.030202	148	10.19357688	164
271	15	72	1.951962	16	84	1.138644	156	9.69632923	156
287	15	72	1.951962	18	100	1.355529	172	8.70183392	140
303	15	72	1.951962	20	132	1.789298	204	6.71284331	108
319	15	72	1.951962	22	164	2.223067	236	4.72385270	76
399	15	72	1.951962	24	196	2.656837	268	2.73486209	44
415	15	72	1.951962	26	228	3.090606	300	0.74587148	12
134	14	64	1.735077	0	0	0.000000	64	15.41467724	248
142	14	64	1.735077	1	4	0.054221	68	15.16605341	244
150	14	64	1.735077	2	8	0.108442	72	14.91742958	240
158	14	64	1.735077	3	12	0.162663	76	14.66880576	236
166	14	64	1.735077	4	16	0.216885	80	14.42018193	232
174	14	64	1.735077	5	20	0.271106	84	14.17155811	228
182	14	64	1.735077	6	24	0.325327	88	13.92293428	224
190	14	64	1.735077	7	28	0.379548	92	13.67431045	220
198	14	64	1.735077	8	32	0.433769	96	13.42568663	216
206	14	64	1.735077	9	36	0.487990	100	13.17706280	212
214	14	64	1.735077	10	40	0.542212	104	12.92843897	208
222	14	64	1.735077	11	44	0.596433	108	12.67981515	204
230	14	64	1.735077	12	52	0.704875	116	12.18256749	196
238	14	64	1.735077	13	60	0.813317	124	11.68531984	188
246	14	64	1.735077	14	68	0.921760	132	11.18807219	180
254	14	64	1.735077	15	76	1.030202	140	10.69082454	172
270	14	64	1.735077	17	92	1.247087	156	9.69632923	156
286	14	64	1.735077	19	116	1.572413	180	8.20458627	132
302	14	64	1.735077	21	148	2.006183	212	6.21559566	100
318	14	64	1.735077	23	180	2.439952	244	4.22660505	68
398	14	64	1.735077	25	212	2.873721	276	2.23761444	36
414	14	64	1.735077	27	244	3.307490	308	0.24862383	4
133	13	56	1.518192	0	0	0.000000	56	15.91192489	256
141	13	56	1.518192	1	4	0.054221	60	15.66330106	252
149	13	56	1.518192	2	8	0.108442	64	15.41467724	248
157	13	56	1.518192	3	12	0.162663	68	15.16605341	244
165	13	56	1.518192	4	16	0.216885	72	14.91742958	240

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
173	13	56	1.518192	5	20	0.271106	76	14.66880576	236
181	13	56	1.518192	6	24	0.325327	80	14.42018193	232
189	13	56	1.518192	7	28	0.379548	84	14.17155811	228
197	13	56	1.518192	8	32	0.433769	88	13.92293428	224
205	13	56	1.518192	9	36	0.487990	92	13.67431045	220
213	13	56	1.518192	10	40	0.542212	96	13.42568663	216
221	13	56	1.518192	11	44	0.596433	100	13.17706280	212
229	13	56	1.518192	12	52	0.704875	108	12.67981515	204
237	13	56	1.518192	13	60	0.813317	116	12.18256749	196
245	13	56	1.518192	14	68	0.921760	124	11.68531984	188
253	13	56	1.518192	15	76	1.030202	132	11.18807219	180
269	13	56	1.518192	16	84	1.138644	140	10.69082454	172
285	13	56	1.518192	18	100	1.355529	156	9.69632923	156
301	13	56	1.518192	20	132	1.789298	188	7.70733862	124
317	13	56	1.518192	22	164	2.223067	220	5.71834801	92
397	13	56	1.518192	24	196	2.656837	252	3.72935740	60
413	13	56	1.518192	26	228	3.090606	284	1.74036678	28
132	12	48	1.301308	0	0	0.000000	48	16.40917254	264
140	12	48	1.301308	1	4	0.054221	52	16.16054872	260
148	12	48	1.301308	2	8	0.108442	56	15.91192489	256
156	12	48	1.301308	3	12	0.162663	60	15.66330106	252
164	12	48	1.301308	4	16	0.216885	64	15.41467724	248
172	12	48	1.301308	5	20	0.271106	68	15.16605341	244
180	12	48	1.301308	6	24	0.325327	72	14.91742958	240
188	12	48	1.301308	7	28	0.379548	76	14.66880576	236
196	12	48	1.301308	8	32	0.433769	80	14.42018193	232
204	12	48	1.301308	9	36	0.487990	84	14.17155811	228
212	12	48	1.301308	10	40	0.542212	88	13.92293428	224
220	12	48	1.301308	11	44	0.596433	92	13.67431045	220
228	12	48	1.301308	12	52	0.704875	100	13.17706280	212
236	12	48	1.301308	13	60	0.813317	108	12.67981515	204
244	12	48	1.301308	14	68	0.921760	116	12.18256749	196
252	12	48	1.301308	15	76	1.030202	124	11.68531984	188
268	12	48	1.301308	17	92	1.247087	140	10.69082454	172
284	12	48	1.301308	19	116	1.572413	164	9.19908158	148
300	12	48	1.301308	21	148	2.006183	196	7.21009097	116
316	12	48	1.301308	23	180	2.439952	228	5.22110035	84
396	12	48	1.301308	25	212	2.873721	260	3.23210974	52
412	12	48	1.301308	27	244	3.307490	292	1.24311913	20
456	12	48	1.301308	28	260	3.524375	308	0.24862383	4
131	11	40	1.084423	0	0	0.000000	40	16.90642020	272
139	11	40	1.084423	1	4	0.054221	44	16.65779637	268
147	11	40	1.084423	2	8	0.108442	48	16.40917254	264
155	11	40	1.084423	3	12	0.162663	52	16.16054872	260
163	11	40	1.084423	4	16	0.216885	56	15.91192489	256
171	11	40	1.084423	5	20	0.271106	60	15.66330106	252

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
179	11	40	1.084423	6	24	0.325327	64	15.41467724	248
187	11	40	1.084423	7	28	0.379548	68	15.16605341	244
195	11	40	1.084423	8	32	0.433769	72	14.91742958	240
203	11	40	1.084423	9	36	0.487990	76	14.66880576	236
211	11	40	1.084423	10	40	0.542212	80	14.42018193	232
219	11	40	1.084423	11	44	0.596433	84	14.17155811	228
227	11	40	1.084423	12	52	0.704875	92	13.67431045	220
235	11	40	1.084423	13	60	0.813317	100	13.17706280	212
243	11	40	1.084423	14	68	0.921760	108	12.67981515	204
251	11	40	1.084423	15	76	1.030202	116	12.18256749	196
267	11	40	1.084423	16	84	1.138644	124	11.68531984	188
283	11	40	1.084423	18	100	1.355529	140	10.69082454	172
299	11	40	1.084423	20	132	1.789298	172	8.70183392	140
315	11	40	1.084423	22	164	2.223067	204	6.71284331	108
395	11	40	1.084423	24	196	2.656837	236	4.72385270	76
411	11	40	1.084423	26	228	3.090606	268	2.73486209	44
130	10	32	0.867538	0	0	0.000000	32	17.40366785	280
138	10	32	0.867538	1	4	0.054221	36	17.15504402	276
146	10	32	0.867538	2	8	0.108442	40	16.90642020	272
154	10	32	0.867538	3	12	0.162663	44	16.65779637	268
162	10	32	0.867538	4	16	0.216885	48	16.40917254	264
170	10	32	0.867538	5	20	0.271106	52	16.16054872	260
178	10	32	0.867538	6	24	0.325327	56	15.91192489	256
186	10	32	0.867538	7	28	0.379548	60	15.66330106	252
194	10	32	0.867538	8	32	0.433769	64	15.41467724	248
202	10	32	0.867538	9	36	0.487990	68	15.16605341	244
210	10	32	0.867538	10	40	0.542212	72	14.91742958	240
218	10	32	0.867538	11	44	0.596433	76	14.66880576	236
226	10	32	0.867538	12	52	0.704875	84	14.17155811	228
234	10	32	0.867538	13	60	0.813317	92	13.67431045	220
242	10	32	0.867538	14	68	0.921760	100	13.17706280	212
250	10	32	0.867538	15	76	1.030202	108	12.67981515	204
266	10	32	0.867538	17	92	1.247087	124	11.68531984	188
282	10	32	0.867538	19	116	1.572413	148	10.19357688	164
298	10	32	0.867538	21	148	2.006183	180	8.20458627	132
314	10	32	0.867538	23	180	2.439952	212	6.21559566	100
394	10	32	0.867538	25	212	2.873721	244	4.22660505	68
410	10	32	0.867538	27	244	3.307490	276	2.23761444	36
455	10	32	0.867538	28	260	3.524375	292	1.24311913	20
129	9	28	0.759096	0	0	0.000000	28	17.65229167	284
137	9	28	0.759096	1	4	0.054221	32	17.40366785	280
145	9	28	0.759096	2	8	0.108442	36	17.15504402	276
153	9	28	0.759096	3	12	0.162663	40	16.90642020	272
161	9	28	0.759096	4	16	0.216885	44	16.65779637	268
169	9	28	0.759096	5	20	0.271106	48	16.40917254	264
177	9	28	0.759096	6	24	0.325327	52	16.16054872	260

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
185	9	28	0.759096	7	28	0.379548	56	15.91192489	256
193	9	28	0.759096	8	32	0.433769	60	15.66330106	252
201	9	28	0.759096	9	36	0.487990	64	15.41467724	248
209	9	28	0.759096	10	40	0.542212	68	15.16605341	244
217	9	28	0.759096	11	44	0.596433	72	14.91742958	240
225	9	28	0.759096	12	52	0.704875	80	14.42018193	232
233	9	28	0.759096	13	60	0.813317	88	13.92293428	224
241	9	28	0.759096	14	68	0.921760	96	13.42568663	216
249	9	28	0.759096	15	76	1.030202	104	12.92843897	208
265	9	28	0.759096	16	84	1.138644	112	12.43119132	200
281	9	28	0.759096	18	100	1.355529	128	11.43669601	184
297	9	28	0.759096	20	132	1.789298	160	9.44770540	152
313	9	28	0.759096	22	164	2.223067	192	7.45871479	120
393	9	28	0.759096	24	196	2.656837	224	5.46972418	88
409	9	28	0.759096	26	228	3.090606	256	3.48073357	56
454	9	28	0.759096	29	276	3.741260	304	0.49724765	8
128	8	24	0.650654	0	0	0.000000	24	17.90091550	288
136	8	24	0.650654	1	4	0.054221	28	17.65229167	284
144	8	24	0.650654	2	8	0.108442	32	17.40366785	280
152	8	24	0.650654	3	12	0.162663	36	17.15504402	276
160	8	24	0.650654	4	16	0.216885	40	16.90642020	272
168	8	24	0.650654	5	20	0.271106	44	16.65779637	268
176	8	24	0.650654	6	24	0.325327	48	16.40917254	264
184	8	24	0.650654	7	28	0.379548	52	16.16054872	260
192	8	24	0.650654	8	32	0.433769	56	15.91192489	256
200	8	24	0.650654	9	36	0.487990	60	15.66330106	252
208	8	24	0.650654	10	40	0.542212	64	15.41467724	248
216	8	24	0.650654	11	44	0.596433	68	15.16605341	244
224	8	24	0.650654	12	52	0.704875	76	14.66880576	236
232	8	24	0.650654	13	60	0.813317	84	14.17155811	228
240	8	24	0.650654	14	68	0.921760	92	13.67431045	220
248	8	24	0.650654	15	76	1.030202	100	13.17706280	212
264	8	24	0.650654	17	92	1.247087	116	12.18256749	196
280	8	24	0.650654	19	116	1.572413	140	10.69082454	172
296	8	24	0.650654	21	148	2.006183	172	8.70183392	140
312	8	24	0.650654	23	180	2.439952	204	6.71284331	108
392	8	24	0.650654	25	212	2.873721	236	4.72385270	76
408	8	24	0.650654	27	244	3.307490	268	2.73486209	44
7	7	20	0.542212	0	0	0.000000	20	18.14953933	292
15	7	20	0.542212	1	4	0.054221	24	17.90091550	288
23	7	20	0.542212	2	8	0.108442	28	17.65229167	284
31	7	20	0.542212	3	12	0.162663	32	17.40366785	280
39	7	20	0.542212	4	16	0.216885	36	17.15504402	276
47	7	20	0.542212	5	20	0.271106	40	16.90642020	272
55	7	20	0.542212	6	24	0.325327	44	16.65779637	268
63	7	20	0.542212	7	28	0.379548	48	16.40917254	264

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
71	7	20	0.542212	8	32	0.433769	52	16.16054872	260
79	7	20	0.542212	9	36	0.487990	56	15.91192489	256
87	7	20	0.542212	10	40	0.542212	60	15.66330106	252
95	7	20	0.542212	11	44	0.596433	64	15.41467724	248
103	7	20	0.542212	12	52	0.704875	72	14.91742958	240
111	7	20	0.542212	13	60	0.813317	80	14.42018193	232
119	7	20	0.542212	14	68	0.921760	88	13.92293428	224
127	7	20	0.542212	15	76	1.030202	96	13.42568663	216
263	7	20	0.542212	16	84	1.138644	104	12.92843897	208
279	7	20	0.542212	18	100	1.355529	120	11.93394367	192
295	7	20	0.542212	20	132	1.789298	152	9.94495306	160
311	7	20	0.542212	22	164	2.223067	184	7.95596245	128
391	7	20	0.542212	24	196	2.656837	216	5.96697183	96
407	7	20	0.542212	26	228	3.090606	248	3.97798122	64
453	7	20	0.542212	28	260	3.524375	280	1.98899061	32
6	6	16	0.433769	0	0	0.000000	16	18.39816315	296
14	6	16	0.433769	1	4	0.054221	20	18.14953933	292
22	6	16	0.433769	2	8	0.108442	24	17.90091550	288
30	6	16	0.433769	3	12	0.162663	28	17.65229167	284
38	6	16	0.433769	4	16	0.216885	32	17.40366785	280
46	6	16	0.433769	5	20	0.271106	36	17.15504402	276
54	6	16	0.433769	6	24	0.325327	40	16.90642020	272
62	6	16	0.433769	7	28	0.379548	44	16.65779637	268
70	6	16	0.433769	8	32	0.433769	48	16.40917254	264
78	6	16	0.433769	9	36	0.487990	52	16.16054872	260
86	6	16	0.433769	10	40	0.542212	56	15.91192489	256
94	6	16	0.433769	11	44	0.596433	60	15.66330106	252
102	6	16	0.433769	12	52	0.704875	68	15.16605341	244
110	6	16	0.433769	13	60	0.813317	76	14.66880576	236
118	6	16	0.433769	14	68	0.921760	84	14.17155811	228
126	6	16	0.433769	15	76	1.030202	92	13.67431045	220
262	6	16	0.433769	17	92	1.247087	108	12.67981515	204
278	6	16	0.433769	19	116	1.572413	132	11.18807219	180
294	6	16	0.433769	21	148	2.006183	164	9.19908158	148
310	6	16	0.433769	23	180	2.439952	196	7.21009097	116
390	6	16	0.433769	25	212	2.873721	228	5.22110035	84
406	6	16	0.433769	27	244	3.307490	260	3.23210974	52
452	6	16	0.433769	29	276	3.741260	292	1.24311913	20
5	5	12	0.325327	0	0	0.000000	12	18.64678698	300
13	5	12	0.325327	1	4	0.054221	16	18.39816315	296
21	5	12	0.325327	2	8	0.108442	20	18.14953933	292
29	5	12	0.325327	3	12	0.162663	24	17.90091550	288
37	5	12	0.325327	4	16	0.216885	28	17.65229167	284
45	5	12	0.325327	5	20	0.271106	32	17.40366785	280
53	5	12	0.325327	6	24	0.325327	36	17.15504402	276
61	5	12	0.325327	7	28	0.379548	40	16.90642020	272

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
69	5	12	0.325327	8	32	0.433769	44	16.65779637	268
77	5	12	0.325327	9	36	0.487990	48	16.40917254	264
85	5	12	0.325327	10	40	0.542212	52	16.16054872	260
93	5	12	0.325327	11	44	0.596433	56	15.91192489	256
101	5	12	0.325327	12	52	0.704875	64	15.41467724	248
109	5	12	0.325327	13	60	0.813317	72	14.91742958	240
117	5	12	0.325327	14	68	0.921760	80	14.42018193	232
125	5	12	0.325327	15	76	1.030202	88	13.92293428	224
261	5	12	0.325327	16	84	1.138644	96	13.42568663	216
277	5	12	0.325327	18	100	1.355529	112	12.43119132	200
293	5	12	0.325327	20	132	1.789298	144	10.44220071	168
309	5	12	0.325327	22	164	2.223067	176	8.45321010	136
389	5	12	0.325327	24	196	2.656837	208	6.46421949	104
405	5	12	0.325327	26	228	3.090606	240	4.47522888	72
459	5	12	0.325327	30	292	3.958144	304	0.49724765	8
4	4	8	0.216885	0	0	0.000000	8	18.89541081	304
12	4	8	0.216885	1	4	0.054221	12	18.64678698	300
20	4	8	0.216885	2	8	0.108442	16	18.39816315	296
28	4	8	0.216885	3	12	0.162663	20	18.14953933	292
36	4	8	0.216885	4	16	0.216885	24	17.90091550	288
44	4	8	0.216885	5	20	0.271106	28	17.65229167	284
52	4	8	0.216885	6	24	0.325327	32	17.40366785	280
60	4	8	0.216885	7	28	0.379548	36	17.15504402	276
68	4	8	0.216885	8	32	0.433769	40	16.90642020	272
76	4	8	0.216885	9	36	0.487990	44	16.65779637	268
84	4	8	0.216885	10	40	0.542212	48	16.40917254	264
92	4	8	0.216885	11	44	0.596433	52	16.16054872	260
100	4	8	0.216885	12	52	0.704875	60	15.66330106	252
108	4	8	0.216885	13	60	0.813317	68	15.16605341	244
116	4	8	0.216885	14	68	0.921760	76	14.66880576	236
124	4	8	0.216885	15	76	1.030202	84	14.17155811	228
260	4	8	0.216885	17	92	1.247087	100	13.17706280	212
276	4	8	0.216885	19	116	1.572413	124	11.68531984	188
292	4	8	0.216885	21	148	2.006183	156	9.69632923	156
308	4	8	0.216885	23	180	2.439952	188	7.70733862	124
388	4	8	0.216885	25	212	2.873721	220	5.71834801	92
404	4	8	0.216885	27	244	3.307490	252	3.72935740	60
451	4	8	0.216885	28	260	3.524375	268	2.73486209	44
3	3	6	0.162663	0	0	0.000000	6	19.01972272	306
11	3	6	0.162663	1	4	0.054221	10	18.77109889	302
19	3	6	0.162663	2	8	0.108442	14	18.52247507	298
27	3	6	0.162663	3	12	0.162663	18	18.27385124	294
35	3	6	0.162663	4	16	0.216885	22	18.02522741	290
43	3	6	0.162663	5	20	0.271106	26	17.77660359	286
51	3	6	0.162663	6	24	0.325327	30	17.52797976	282
59	3	6	0.162663	7	28	0.379548	34	17.27935594	278

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
67	3	6	0.162663	8	32	0.433769	38	17.03073211	274
75	3	6	0.162663	9	36	0.487990	42	16.78210828	270
83	3	6	0.162663	10	40	0.542212	46	16.53348446	266
91	3	6	0.162663	11	44	0.596433	50	16.28486063	262
99	3	6	0.162663	12	52	0.704875	58	15.78761298	254
107	3	6	0.162663	13	60	0.813317	66	15.29036532	246
115	3	6	0.162663	14	68	0.921760	74	14.79311767	238
123	3	6	0.162663	15	76	1.030202	82	14.29587002	230
259	3	6	0.162663	16	84	1.138644	90	13.79862237	222
275	3	6	0.162663	18	100	1.355529	106	12.80412706	206
291	3	6	0.162663	20	132	1.789298	138	10.81513645	174
307	3	6	0.162663	22	164	2.223067	170	8.82614584	142
387	3	6	0.162663	24	196	2.656837	202	6.83715523	110
403	3	6	0.162663	26	228	3.090606	234	4.84816461	78
450	3	6	0.162663	29	276	3.741260	282	1.86467870	30
2	2	4	0.108442	0	0	0.000000	4	19.14403463	308
10	2	4	0.108442	1	4	0.054221	8	18.89541081	304
18	2	4	0.108442	2	8	0.108442	12	18.64678698	300
26	2	4	0.108442	3	12	0.162663	16	18.39816315	296
34	2	4	0.108442	4	16	0.216885	20	18.14953933	292
42	2	4	0.108442	5	20	0.271106	24	17.90091550	288
50	2	4	0.108442	6	24	0.325327	28	17.65229167	284
58	2	4	0.108442	7	28	0.379548	32	17.40366785	280
66	2	4	0.108442	8	32	0.433769	36	17.15504402	276
74	2	4	0.108442	9	36	0.487990	40	16.90642020	272
82	2	4	0.108442	10	40	0.542212	44	16.65779637	268
90	2	4	0.108442	11	44	0.596433	48	16.40917254	264
98	2	4	0.108442	12	52	0.704875	56	15.91192489	256
106	2	4	0.108442	13	60	0.813317	64	15.41467724	248
114	2	4	0.108442	14	68	0.921760	72	14.91742958	240
122	2	4	0.108442	15	76	1.030202	80	14.42018193	232
258	2	4	0.108442	17	92	1.247087	96	13.42568663	216
274	2	4	0.108442	19	116	1.572413	120	11.93394367	192
290	2	4	0.108442	21	148	2.006183	152	9.94495306	160
306	2	4	0.108442	23	180	2.439952	184	7.95596245	128
386	2	4	0.108442	25	212	2.873721	216	5.96697183	96
402	2	4	0.108442	27	244	3.307490	248	3.97798122	64
458	2	4	0.108442	30	292	3.958144	296	0.99449531	16
1	1	2	0.054221	0	0	0.000000	2	19.26834655	310
9	1	2	0.054221	1	4	0.054221	6	19.01972272	306
17	1	2	0.054221	2	8	0.108442	10	18.77109889	302
25	1	2	0.054221	3	12	0.162663	14	18.52247507	298
33	1	2	0.054221	4	16	0.216885	18	18.27385124	294
41	1	2	0.054221	5	20	0.271106	22	18.02522741	290
49	1	2	0.054221	6	24	0.325327	26	17.77660359	286
57	1	2	0.054221	7	28	0.379548	30	17.52797976	282

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
65	1	2	0.054221	8	32	0.433769	34	17.27935594	278
73	1	2	0.054221	9	36	0.487990	38	17.03073211	274
81	1	2	0.054221	10	40	0.542212	42	16.78210828	270
89	1	2	0.054221	11	44	0.596433	46	16.53348446	266
97	1	2	0.054221	12	52	0.704875	54	16.03623680	258
105	1	2	0.054221	13	60	0.813317	62	15.53898915	250
113	1	2	0.054221	14	68	0.921760	70	15.04174150	242
121	1	2	0.054221	15	76	1.030202	78	14.54449384	234
257	1	2	0.054221	16	84	1.138644	86	14.04724619	226
273	1	2	0.054221	18	100	1.355529	102	13.05275089	210
289	1	2	0.054221	20	132	1.789298	134	11.06376028	178
305	1	2	0.054221	22	164	2.223067	166	9.07476966	146
385	1	2	0.054221	24	196	2.656837	198	7.08577905	114
401	1	2	0.054221	26	228	3.090606	230	5.09678844	82
449	1	2	0.054221	28	260	3.524375	262	3.10779783	50
0	0	0	0.000000	0	0	0.000000	0	19.39265846	312
8	0	0	0.000000	1	4	0.054221	4	19.14403463	308
16	0	0	0.000000	2	8	0.108442	8	18.89541081	304
24	0	0	0.000000	3	12	0.162663	12	18.64678698	300
32	0	0	0.000000	4	16	0.216885	16	18.39816315	296
40	0	0	0.000000	5	20	0.271106	20	18.14953933	292
48	0	0	0.000000	6	24	0.325327	24	17.90091550	288
56	0	0	0.000000	7	28	0.379548	28	17.65229167	284
64	0	0	0.000000	8	32	0.433769	32	17.40366785	280
72	0	0	0.000000	9	36	0.487990	36	17.15504402	276
80	0	0	0.000000	10	40	0.542212	40	16.90642020	272
88	0	0	0.000000	11	44	0.596433	44	16.65779637	268
96	0	0	0.000000	12	52	0.704875	52	16.16054872	260
104	0	0	0.000000	13	60	0.813317	60	15.66330106	252
112	0	0	0.000000	14	68	0.921760	68	15.16605341	244
120	0	0	0.000000	15	76	1.030202	76	14.66880576	236
256	0	0	0.000000	17	92	1.247087	92	13.67431045	220
272	0	0	0.000000	19	116	1.572413	116	12.18256749	196
288	0	0	0.000000	21	148	2.006183	148	10.19357688	164
304	0	0	0.000000	23	180	2.439952	180	8.20458627	132
384	0	0	0.000000	25	212	2.873721	212	6.21559566	100
400	0	0	0.000000	27	244	3.307490	244	4.22660505	68
448	0	0	0.000000	29	276	3.741260	276	2.23761444	36
457	0	0	0.000000	31	312	4.229250	312	0.00000000	0

Table A4 Sorted by 1/4 Bit Rate

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
457	0	0	0.000000	31	312	4.229250	312	0.00000000	0
458	2	4	0.108442	30	292	3.958144	296	0.99449531	16
459	5	12	0.325327	30	292	3.958144	304	0.49724765	8

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
448	0	0	0.000000	29	276	3.741260	276	2.23761444	36
450	3	6	0.162663	29	276	3.741260	282	1.86467870	30
452	6	16	0.433769	29	276	3.741260	292	1.24311913	20
454	9	28	0.759096	29	276	3.741260	304	0.49724765	8
449	1	2	0.054221	28	260	3.524375	262	3.10779783	50
451	4	8	0.216885	28	260	3.524375	268	2.73486209	44
453	7	20	0.542212	28	260	3.524375	280	1.98899061	32
455	10	32	0.867538	28	260	3.524375	292	1.24311913	20
456	12	48	1.301308	28	260	3.524375	308	0.24862383	4
400	0	0	0.000000	27	244	3.307490	244	4.22660505	68
402	2	4	0.108442	27	244	3.307490	248	3.97798122	64
404	4	8	0.216885	27	244	3.307490	252	3.72935740	60
406	6	16	0.433769	27	244	3.307490	260	3.23210974	52
408	8	24	0.650654	27	244	3.307490	268	2.73486209	44
410	10	32	0.867538	27	244	3.307490	276	2.23761444	36
412	12	48	1.301308	27	244	3.307490	292	1.24311913	20
414	14	64	1.735077	27	244	3.307490	308	0.24862383	4
401	1	2	0.054221	26	228	3.090606	230	5.09678844	82
403	3	6	0.162663	26	228	3.090606	234	4.84816461	78
405	5	12	0.325327	26	228	3.090606	240	4.47522888	72
407	7	20	0.542212	26	228	3.090606	248	3.97798122	64
409	9	28	0.759096	26	228	3.090606	256	3.48073357	56
411	11	40	1.084423	26	228	3.090606	268	2.73486209	44
413	13	56	1.518192	26	228	3.090606	284	1.74036678	28
415	15	72	1.951962	26	228	3.090606	300	0.74587148	12
469	16	80	2.168846	26	228	3.090606	308	0.24862383	4
384	0	0	0.000000	25	212	2.873721	212	6.21559566	100
386	2	4	0.108442	25	212	2.873721	216	5.96697183	96
388	4	8	0.216885	25	212	2.873721	220	5.71834801	92
390	6	16	0.433769	25	212	2.873721	228	5.22110035	84
392	8	24	0.650654	25	212	2.873721	236	4.72385270	76
394	10	32	0.867538	25	212	2.873721	244	4.22660505	68
396	12	48	1.301308	25	212	2.873721	260	3.23210974	52
398	14	64	1.735077	25	212	2.873721	276	2.23761444	36
468	16	80	2.168846	25	212	2.873721	292	1.24311913	20
476	18	96	2.602615	25	212	2.873721	308	0.24862383	4
385	1	2	0.054221	24	196	2.656837	198	7.08577905	114
387	3	6	0.162663	24	196	2.656837	202	6.83715523	110
389	5	12	0.325327	24	196	2.656837	208	6.46421949	104
391	7	20	0.542212	24	196	2.656837	216	5.96697183	96
393	9	28	0.759096	24	196	2.656837	224	5.46972418	88
395	11	40	1.084423	24	196	2.656837	236	4.72385270	76
397	13	56	1.518192	24	196	2.656837	252	3.72935740	60
399	15	72	1.951962	24	196	2.656837	268	2.73486209	44
467	17	88	2.385731	24	196	2.656837	284	1.74036678	28
475	19	112	3.036385	24	196	2.656837	308	0.24862383	4

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
304	0	0	0.000000	23	180	2.439952	180	8.20458627	132
306	2	4	0.108442	23	180	2.439952	184	7.95596245	128
308	4	8	0.216885	23	180	2.439952	188	7.70733862	124
310	6	16	0.433769	23	180	2.439952	196	7.21009097	116
312	8	24	0.650654	23	180	2.439952	204	6.71284331	108
314	10	32	0.867538	23	180	2.439952	212	6.21559566	100
316	12	48	1.301308	23	180	2.439952	228	5.22110035	84
318	14	64	1.735077	23	180	2.439952	244	4.22660505	68
466	16	80	2.168846	23	180	2.439952	260	3.23210974	52
474	18	96	2.602615	23	180	2.439952	276	2.23761444	36
479	20	128	3.470154	23	180	2.439952	308	0.24862383	4
305	1	2	0.054221	22	164	2.223067	166	9.07476966	146
307	3	6	0.162663	22	164	2.223067	170	8.82614584	142
309	5	12	0.325327	22	164	2.223067	176	8.45321010	136
311	7	20	0.542212	22	164	2.223067	184	7.95596245	128
313	9	28	0.759096	22	164	2.223067	192	7.45871479	120
315	11	40	1.084423	22	164	2.223067	204	6.71284331	108
317	13	56	1.518192	22	164	2.223067	220	5.71834801	92
319	15	72	1.951962	22	164	2.223067	236	4.72385270	76
465	17	88	2.385731	22	164	2.223067	252	3.72935740	60
473	19	112	3.036385	22	164	2.223067	276	2.23761444	36
478	21	144	3.903923	22	164	2.223067	308	0.24862383	4
288	0	0	0.000000	21	148	2.006183	148	10.19357688	164
290	2	4	0.108442	21	148	2.006183	152	9.94495306	160
292	4	8	0.216885	21	148	2.006183	156	9.69632923	156
294	6	16	0.433769	21	148	2.006183	164	9.19908158	148
296	8	24	0.650654	21	148	2.006183	172	8.70183392	140
298	10	32	0.867538	21	148	2.006183	180	8.20458627	132
300	12	48	1.301308	21	148	2.006183	196	7.21009097	116
302	14	64	1.735077	21	148	2.006183	212	6.21559566	100
464	16	80	2.168846	21	148	2.006183	228	5.22110035	84
472	18	96	2.602615	21	148	2.006183	244	4.22660505	68
477	20	128	3.470154	21	148	2.006183	276	2.23761444	36
510	22	160	4.337692	21	148	2.006183	308	0.24862383	4
289	1	2	0.054221	20	132	1.789298	134	11.06376028	178
291	3	6	0.162663	20	132	1.789298	138	10.81513645	174
293	5	12	0.325327	20	132	1.789298	144	10.44220071	168
295	7	20	0.542212	20	132	1.789298	152	9.94495306	160
297	9	28	0.759096	20	132	1.789298	160	9.44770540	152
299	11	40	1.084423	20	132	1.789298	172	8.70183392	140
301	13	56	1.518192	20	132	1.789298	188	7.70733862	124
303	15	72	1.951962	20	132	1.789298	204	6.71284331	108
463	17	88	2.385731	20	132	1.789298	220	5.71834801	92
471	19	112	3.036385	20	132	1.789298	244	4.22660505	68
509	21	144	3.903923	20	132	1.789298	276	2.23761444	36
511	23	176	4.771462	20	132	1.789298	308	0.24862383	4

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
272	0	0	0.000000	19	116	1.572413	116	12.18256749	196
274	2	4	0.108442	19	116	1.572413	120	11.93394367	192
276	4	8	0.216885	19	116	1.572413	124	11.68531984	188
278	6	16	0.433769	19	116	1.572413	132	11.18807219	180
280	8	24	0.650654	19	116	1.572413	140	10.69082454	172
282	10	32	0.867538	19	116	1.572413	148	10.19357688	164
284	12	48	1.301308	19	116	1.572413	164	9.19908158	148
286	14	64	1.735077	19	116	1.572413	180	8.20458627	132
462	16	80	2.168846	19	116	1.572413	196	7.21009097	116
470	18	96	2.602615	19	116	1.572413	212	6.21559566	100
503	20	128	3.470154	19	116	1.572413	244	4.22660505	68
505	22	160	4.337692	19	116	1.572413	276	2.23761444	36
507	24	192	5.205231	19	116	1.572413	308	0.24862383	4
273	1	2	0.054221	18	100	1.355529	102	13.05275089	210
275	3	6	0.162663	18	100	1.355529	106	12.80412706	206
277	5	12	0.325327	18	100	1.355529	112	12.43119132	200
279	7	20	0.542212	18	100	1.355529	120	11.93394367	192
281	9	28	0.759096	18	100	1.355529	128	11.43669601	184
283	11	40	1.084423	18	100	1.355529	140	10.69082454	172
285	13	56	1.518192	18	100	1.355529	156	9.69632923	156
287	15	72	1.951962	18	100	1.355529	172	8.70183392	140
461	17	88	2.385731	18	100	1.355529	188	7.70733862	124
502	19	112	3.036385	18	100	1.355529	212	6.21559566	100
504	21	144	3.903923	18	100	1.355529	244	4.22660505	68
506	23	176	4.771462	18	100	1.355529	276	2.23761444	36
508	25	208	5.639000	18	100	1.355529	308	0.24862383	4
256	0	0	0.000000	17	92	1.247087	92	13.67431045	220
258	2	4	0.108442	17	92	1.247087	96	13.42568663	216
260	4	8	0.216885	17	92	1.247087	100	13.17706280	212
262	6	16	0.433769	17	92	1.247087	108	12.67981515	204
264	8	24	0.650654	17	92	1.247087	116	12.18256749	196
266	10	32	0.867538	17	92	1.247087	124	11.68531984	188
268	12	48	1.301308	17	92	1.247087	140	10.69082454	172
270	14	64	1.735077	17	92	1.247087	156	9.69632923	156
460	16	80	2.168846	17	92	1.247087	172	8.70183392	140
493	18	96	2.602615	17	92	1.247087	188	7.70733862	124
495	20	128	3.470154	17	92	1.247087	220	5.71834801	92
497	22	160	4.337692	17	92	1.247087	252	3.72935740	60
499	24	192	5.205231	17	92	1.247087	284	1.74036678	28
257	1	2	0.054221	16	84	1.138644	86	14.04724619	226
259	3	6	0.162663	16	84	1.138644	90	13.79862237	222
261	5	12	0.325327	16	84	1.138644	96	13.42568663	216
263	7	20	0.542212	16	84	1.138644	104	12.92843897	208
265	9	28	0.759096	16	84	1.138644	112	12.43119132	200
267	11	40	1.084423	16	84	1.138644	124	11.68531984	188
269	13	56	1.518192	16	84	1.138644	140	10.69082454	172

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
271	15	72	1.951962	16	84	1.138644	156	9.69632923	156
492	17	88	2.385731	16	84	1.138644	172	8.70183392	140
494	19	112	3.036385	16	84	1.138644	196	7.21009097	116
496	21	144	3.903923	16	84	1.138644	228	5.22110035	84
498	23	176	4.771462	16	84	1.138644	260	3.23210974	52
500	25	208	5.639000	16	84	1.138644	292	1.24311913	20
501	26	224	6.072769	16	84	1.138644	308	0.24862383	4
120	0	0	0.000000	15	76	1.030202	76	14.66880576	236
121	1	2	0.054221	15	76	1.030202	78	14.54449384	234
122	2	4	0.108442	15	76	1.030202	80	14.42018193	232
123	3	6	0.162663	15	76	1.030202	82	14.29587002	230
124	4	8	0.216885	15	76	1.030202	84	14.17155811	228
125	5	12	0.325327	15	76	1.030202	88	13.92293428	224
126	6	16	0.433769	15	76	1.030202	92	13.67431045	220
127	7	20	0.542212	15	76	1.030202	96	13.42568663	216
248	8	24	0.650654	15	76	1.030202	100	13.17706280	212
249	9	28	0.759096	15	76	1.030202	104	12.92843897	208
250	10	32	0.867538	15	76	1.030202	108	12.67981515	204
251	11	40	1.084423	15	76	1.030202	116	12.18256749	196
252	12	48	1.301308	15	76	1.030202	124	11.68531984	188
253	13	56	1.518192	15	76	1.030202	132	11.18807219	180
254	14	64	1.735077	15	76	1.030202	140	10.69082454	172
255	15	72	1.951962	15	76	1.030202	148	10.19357688	164
335	16	80	2.168846	15	76	1.030202	156	9.69632923	156
351	18	96	2.602615	15	76	1.030202	172	8.70183392	140
367	20	128	3.470154	15	76	1.030202	204	6.71284331	108
383	22	160	4.337692	15	76	1.030202	236	4.72385270	76
431	24	192	5.205231	15	76	1.030202	268	2.73486209	44
447	26	224	6.072769	15	76	1.030202	300	0.74587148	12
112	0	0	0.000000	14	68	0.921760	68	15.16605341	244
113	1	2	0.054221	14	68	0.921760	70	15.04174150	242
114	2	4	0.108442	14	68	0.921760	72	14.91742958	240
115	3	6	0.162663	14	68	0.921760	74	14.79311767	238
116	4	8	0.216885	14	68	0.921760	76	14.66880576	236
117	5	12	0.325327	14	68	0.921760	80	14.42018193	232
118	6	16	0.433769	14	68	0.921760	84	14.17155811	228
119	7	20	0.542212	14	68	0.921760	88	13.92293428	224
240	8	24	0.650654	14	68	0.921760	92	13.67431045	220
241	9	28	0.759096	14	68	0.921760	96	13.42568663	216
242	10	32	0.867538	14	68	0.921760	100	13.17706280	212
243	11	40	1.084423	14	68	0.921760	108	12.67981515	204
244	12	48	1.301308	14	68	0.921760	116	12.18256749	196
245	13	56	1.518192	14	68	0.921760	124	11.68531984	188
246	14	64	1.735077	14	68	0.921760	132	11.18807219	180
247	15	72	1.951962	14	68	0.921760	140	10.69082454	172
334	17	88	2.385731	14	68	0.921760	156	9.69632923	156

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
350	19	112	3.036385	14	68	0.921760	180	8.20458627	132
366	21	144	3.903923	14	68	0.921760	212	6.21559566	100
382	23	176	4.771462	14	68	0.921760	244	4.22660505	68
430	25	208	5.639000	14	68	0.921760	276	2.23761444	36
446	27	240	6.506538	14	68	0.921760	308	0.24862383	4
104	0	0	0.000000	13	60	0.813317	60	15.66330106	252
105	1	2	0.054221	13	60	0.813317	62	15.53898915	250
106	2	4	0.108442	13	60	0.813317	64	15.41467724	248
107	3	6	0.162663	13	60	0.813317	66	15.29036532	246
108	4	8	0.216885	13	60	0.813317	68	15.16605341	244
109	5	12	0.325327	13	60	0.813317	72	14.91742958	240
110	6	16	0.433769	13	60	0.813317	76	14.66880576	236
111	7	20	0.542212	13	60	0.813317	80	14.42018193	232
232	8	24	0.650654	13	60	0.813317	84	14.17155811	228
233	9	28	0.759096	13	60	0.813317	88	13.92293428	224
234	10	32	0.867538	13	60	0.813317	92	13.67431045	220
235	11	40	1.084423	13	60	0.813317	100	13.17706280	212
236	12	48	1.301308	13	60	0.813317	108	12.67981515	204
237	13	56	1.518192	13	60	0.813317	116	12.18256749	196
238	14	64	1.735077	13	60	0.813317	124	11.68531984	188
239	15	72	1.951962	13	60	0.813317	132	11.18807219	180
333	16	80	2.168846	13	60	0.813317	140	10.69082454	172
349	18	96	2.602615	13	60	0.813317	156	9.69632923	156
365	20	128	3.470154	13	60	0.813317	188	7.70733862	124
381	22	160	4.337692	13	60	0.813317	220	5.71834801	92
429	24	192	5.205231	13	60	0.813317	252	3.72935740	60
445	26	224	6.072769	13	60	0.813317	284	1.74036678	28
96	0	0	0.000000	12	52	0.704875	52	16.16054872	260
97	1	2	0.054221	12	52	0.704875	54	16.03623680	258
98	2	4	0.108442	12	52	0.704875	56	15.91192489	256
99	3	6	0.162663	12	52	0.704875	58	15.78761298	254
100	4	8	0.216885	12	52	0.704875	60	15.66330106	252
101	5	12	0.325327	12	52	0.704875	64	15.41467724	248
102	6	16	0.433769	12	52	0.704875	68	15.16605341	244
103	7	20	0.542212	12	52	0.704875	72	14.91742958	240
224	8	24	0.650654	12	52	0.704875	76	14.66880576	236
225	9	28	0.759096	12	52	0.704875	80	14.42018193	232
226	10	32	0.867538	12	52	0.704875	84	14.17155811	228
227	11	40	1.084423	12	52	0.704875	92	13.67431045	220
228	12	48	1.301308	12	52	0.704875	100	13.17706280	212
229	13	56	1.518192	12	52	0.704875	108	12.67981515	204
230	14	64	1.735077	12	52	0.704875	116	12.18256749	196
231	15	72	1.951962	12	52	0.704875	124	11.68531984	188
332	17	88	2.385731	12	52	0.704875	140	10.69082454	172
348	19	112	3.036385	12	52	0.704875	164	9.19908158	148
364	21	144	3.903923	12	52	0.704875	196	7.21009097	116

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
380	23	176	4.771462	12	52	0.704875	228	5.22110035	84
428	25	208	5.639000	12	52	0.704875	260	3.23210974	52
444	27	240	6.506538	12	52	0.704875	292	1.24311913	20
488	28	256	6.940308	12	52	0.704875	308	0.24862383	4
88	0	0	0.000000	11	44	0.596433	44	16.65779637	268
89	1	2	0.054221	11	44	0.596433	46	16.53348446	266
90	2	4	0.108442	11	44	0.596433	48	16.40917254	264
91	3	6	0.162663	11	44	0.596433	50	16.28486063	262
92	4	8	0.216885	11	44	0.596433	52	16.16054872	260
93	5	12	0.325327	11	44	0.596433	56	15.91192489	256
94	6	16	0.433769	11	44	0.596433	60	15.66330106	252
95	7	20	0.542212	11	44	0.596433	64	15.41467724	248
216	8	24	0.650654	11	44	0.596433	68	15.16605341	244
217	9	28	0.759096	11	44	0.596433	72	14.91742958	240
218	10	32	0.867538	11	44	0.596433	76	14.66880576	236
219	11	40	1.084423	11	44	0.596433	84	14.17155811	228
220	12	48	1.301308	11	44	0.596433	92	13.67431045	220
221	13	56	1.518192	11	44	0.596433	100	13.17706280	212
222	14	64	1.735077	11	44	0.596433	108	12.67981515	204
223	15	72	1.951962	11	44	0.596433	116	12.18256749	196
331	16	80	2.168846	11	44	0.596433	124	11.68531984	188
347	18	96	2.602615	11	44	0.596433	140	10.69082454	172
363	20	128	3.470154	11	44	0.596433	172	8.70183392	140
379	22	160	4.337692	11	44	0.596433	204	6.71284331	108
427	24	192	5.205231	11	44	0.596433	236	4.72385270	76
443	26	224	6.072769	11	44	0.596433	268	2.73486209	44
80	0	0	0.000000	10	40	0.542212	40	16.90642020	272
81	1	2	0.054221	10	40	0.542212	42	16.78210828	270
82	2	4	0.108442	10	40	0.542212	44	16.65779637	268
83	3	6	0.162663	10	40	0.542212	46	16.53348446	266
84	4	8	0.216885	10	40	0.542212	48	16.40917254	264
85	5	12	0.325327	10	40	0.542212	52	16.16054872	260
86	6	16	0.433769	10	40	0.542212	56	15.91192489	256
87	7	20	0.542212	10	40	0.542212	60	15.66330106	252
208	8	24	0.650654	10	40	0.542212	64	15.41467724	248
209	9	28	0.759096	10	40	0.542212	68	15.16605341	244
210	10	32	0.867538	10	40	0.542212	72	14.91742958	240
211	11	40	1.084423	10	40	0.542212	80	14.42018193	232
212	12	48	1.301308	10	40	0.542212	88	13.92293428	224
213	13	56	1.518192	10	40	0.542212	96	13.42568663	216
214	14	64	1.735077	10	40	0.542212	104	12.92843897	208
215	15	72	1.951962	10	40	0.542212	112	12.43119132	200
330	17	88	2.385731	10	40	0.542212	128	11.43669601	184
346	19	112	3.036385	10	40	0.542212	152	9.94495306	160
362	21	144	3.903923	10	40	0.542212	184	7.95596245	128
378	23	176	4.771462	10	40	0.542212	216	5.96697183	96

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
426	25	208	5.639000	10	40	0.542212	248	3.97798122	64
442	27	240	6.506538	10	40	0.542212	280	1.98899061	32
487	28	256	6.940308	10	40	0.542212	296	0.99449531	16
72	0	0	0.000000	9	36	0.487990	36	17.15504402	276
73	1	2	0.054221	9	36	0.487990	38	17.03073211	274
74	2	4	0.108442	9	36	0.487990	40	16.90642020	272
75	3	6	0.162663	9	36	0.487990	42	16.78210828	270
76	4	8	0.216885	9	36	0.487990	44	16.65779637	268
77	5	12	0.325327	9	36	0.487990	48	16.40917254	264
78	6	16	0.433769	9	36	0.487990	52	16.16054872	260
79	7	20	0.542212	9	36	0.487990	56	15.91192489	256
200	8	24	0.650654	9	36	0.487990	60	15.66330106	252
201	9	28	0.759096	9	36	0.487990	64	15.41467724	248
202	10	32	0.867538	9	36	0.487990	68	15.16605341	244
203	11	40	1.084423	9	36	0.487990	76	14.66880576	236
204	12	48	1.301308	9	36	0.487990	84	14.17155811	228
205	13	56	1.518192	9	36	0.487990	92	13.67431045	220
206	14	64	1.735077	9	36	0.487990	100	13.17706280	212
207	15	72	1.951962	9	36	0.487990	108	12.67981515	204
329	16	80	2.168846	9	36	0.487990	116	12.18256749	196
345	18	96	2.602615	9	36	0.487990	132	11.18807219	180
361	20	128	3.470154	9	36	0.487990	164	9.19908158	148
377	22	160	4.337692	9	36	0.487990	196	7.21009097	116
425	24	192	5.205231	9	36	0.487990	228	5.22110035	84
441	26	224	6.072769	9	36	0.487990	260	3.23210974	52
486	29	272	7.374077	9	36	0.487990	308	0.24862383	4
64	0	0	0.000000	8	32	0.433769	32	17.40366785	280
65	1	2	0.054221	8	32	0.433769	34	17.27935594	278
66	2	4	0.108442	8	32	0.433769	36	17.15504402	276
67	3	6	0.162663	8	32	0.433769	38	17.03073211	274
68	4	8	0.216885	8	32	0.433769	40	16.90642020	272
69	5	12	0.325327	8	32	0.433769	44	16.65779637	268
70	6	16	0.433769	8	32	0.433769	48	16.40917254	264
71	7	20	0.542212	8	32	0.433769	52	16.16054872	260
192	8	24	0.650654	8	32	0.433769	56	15.91192489	256
193	9	28	0.759096	8	32	0.433769	60	15.66330106	252
194	10	32	0.867538	8	32	0.433769	64	15.41467724	248
195	11	40	1.084423	8	32	0.433769	72	14.91742958	240
196	12	48	1.301308	8	32	0.433769	80	14.42018193	232
197	13	56	1.518192	8	32	0.433769	88	13.92293428	224
198	14	64	1.735077	8	32	0.433769	96	13.42568663	216
199	15	72	1.951962	8	32	0.433769	104	12.92843897	208
328	17	88	2.385731	8	32	0.433769	120	11.93394367	192
344	19	112	3.036385	8	32	0.433769	144	10.44220071	168
360	21	144	3.903923	8	32	0.433769	176	8.45321010	136
376	23	176	4.771462	8	32	0.433769	208	6.46421949	104

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
424	25	208	5.639000	8	32	0.433769	240	4.47522888	72
440	27	240	6.506538	8	32	0.433769	272	2.48623826	40
56	0	0	0.000000	7	28	0.379548	28	17.65229167	284
57	1	2	0.054221	7	28	0.379548	30	17.52797976	282
58	2	4	0.108442	7	28	0.379548	32	17.40366785	280
59	3	6	0.162663	7	28	0.379548	34	17.27935594	278
60	4	8	0.216885	7	28	0.379548	36	17.15504402	276
61	5	12	0.325327	7	28	0.379548	40	16.90642020	272
62	6	16	0.433769	7	28	0.379548	44	16.65779637	268
63	7	20	0.542212	7	28	0.379548	48	16.40917254	264
184	8	24	0.650654	7	28	0.379548	52	16.16054872	260
185	9	28	0.759096	7	28	0.379548	56	15.91192489	256
186	10	32	0.867538	7	28	0.379548	60	15.66330106	252
187	11	40	1.084423	7	28	0.379548	68	15.16605341	244
188	12	48	1.301308	7	28	0.379548	76	14.66880576	236
189	13	56	1.518192	7	28	0.379548	84	14.17155811	228
190	14	64	1.735077	7	28	0.379548	92	13.67431045	220
191	15	72	1.951962	7	28	0.379548	100	13.17706280	212
327	16	80	2.168846	7	28	0.379548	108	12.67981515	204
343	18	96	2.602615	7	28	0.379548	124	11.68531984	188
359	20	128	3.470154	7	28	0.379548	156	9.69632923	156
375	22	160	4.337692	7	28	0.379548	188	7.70733862	124
423	24	192	5.205231	7	28	0.379548	220	5.71834801	92
439	26	224	6.072769	7	28	0.379548	252	3.72935740	60
485	28	256	6.940308	7	28	0.379548	284	1.74036678	28
48	0	0	0.000000	6	24	0.325327	24	17.90091550	288
49	1	2	0.054221	6	24	0.325327	26	17.77660359	286
50	2	4	0.108442	6	24	0.325327	28	17.65229167	284
51	3	6	0.162663	6	24	0.325327	30	17.52797976	282
52	4	8	0.216885	6	24	0.325327	32	17.40366785	280
53	5	12	0.325327	6	24	0.325327	36	17.15504402	276
54	6	16	0.433769	6	24	0.325327	40	16.90642020	272
55	7	20	0.542212	6	24	0.325327	44	16.65779637	268
176	8	24	0.650654	6	24	0.325327	48	16.40917254	264
177	9	28	0.759096	6	24	0.325327	52	16.16054872	260
178	10	32	0.867538	6	24	0.325327	56	15.91192489	256
179	11	40	1.084423	6	24	0.325327	64	15.41467724	248
180	12	48	1.301308	6	24	0.325327	72	14.91742958	240
181	13	56	1.518192	6	24	0.325327	80	14.42018193	232
182	14	64	1.735077	6	24	0.325327	88	13.92293428	224
183	15	72	1.951962	6	24	0.325327	96	13.42568663	216
326	17	88	2.385731	6	24	0.325327	112	12.43119132	200
342	19	112	3.036385	6	24	0.325327	136	10.93944836	176
358	21	144	3.903923	6	24	0.325327	168	8.95045775	144
374	23	176	4.771462	6	24	0.325327	200	6.96146714	112
422	25	208	5.639000	6	24	0.325327	232	4.97247653	80

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
438	27	240	6.506538	6	24	0.325327	264	2.98348592	48
484	29	272	7.374077	6	24	0.325327	296	0.99449531	16
40	0	0	0.000000	5	20	0.271106	20	18.14953933	292
41	1	2	0.054221	5	20	0.271106	22	18.02522741	290
42	2	4	0.108442	5	20	0.271106	24	17.90091550	288
43	3	6	0.162663	5	20	0.271106	26	17.77660359	286
44	4	8	0.216885	5	20	0.271106	28	17.65229167	284
45	5	12	0.325327	5	20	0.271106	32	17.40366785	280
46	6	16	0.433769	5	20	0.271106	36	17.15504402	276
47	7	20	0.542212	5	20	0.271106	40	16.90642020	272
168	8	24	0.650654	5	20	0.271106	44	16.65779637	268
169	9	28	0.759096	5	20	0.271106	48	16.40917254	264
170	10	32	0.867538	5	20	0.271106	52	16.16054872	260
171	11	40	1.084423	5	20	0.271106	60	15.66330106	252
172	12	48	1.301308	5	20	0.271106	68	15.16605341	244
173	13	56	1.518192	5	20	0.271106	76	14.66880576	236
174	14	64	1.735077	5	20	0.271106	84	14.17155811	228
175	15	72	1.951962	5	20	0.271106	92	13.67431045	220
325	16	80	2.168846	5	20	0.271106	100	13.17706280	212
341	18	96	2.602615	5	20	0.271106	116	12.18256749	196
357	20	128	3.470154	5	20	0.271106	148	10.19357688	164
373	22	160	4.337692	5	20	0.271106	180	8.20458627	132
421	24	192	5.205231	5	20	0.271106	212	6.21559566	100
437	26	224	6.072769	5	20	0.271106	244	4.22660505	68
491	30	288	7.807846	5	20	0.271106	308	0.24862383	4
32	0	0	0.000000	4	16	0.216885	16	18.39816315	296
33	1	2	0.054221	4	16	0.216885	18	18.27385124	294
34	2	4	0.108442	4	16	0.216885	20	18.14953933	292
35	3	6	0.162663	4	16	0.216885	22	18.02522741	290
36	4	8	0.216885	4	16	0.216885	24	17.90091550	288
37	5	12	0.325327	4	16	0.216885	28	17.65229167	284
38	6	16	0.433769	4	16	0.216885	32	17.40366785	280
39	7	20	0.542212	4	16	0.216885	36	17.15504402	276
160	8	24	0.650654	4	16	0.216885	40	16.90642020	272
161	9	28	0.759096	4	16	0.216885	44	16.65779637	268
162	10	32	0.867538	4	16	0.216885	48	16.40917254	264
163	11	40	1.084423	4	16	0.216885	56	15.91192489	256
164	12	48	1.301308	4	16	0.216885	64	15.41467724	248
165	13	56	1.518192	4	16	0.216885	72	14.91742958	240
166	14	64	1.735077	4	16	0.216885	80	14.42018193	232
167	15	72	1.951962	4	16	0.216885	88	13.92293428	224
324	17	88	2.385731	4	16	0.216885	104	12.92843897	208
340	19	112	3.036385	4	16	0.216885	128	11.43669601	184
356	21	144	3.903923	4	16	0.216885	160	9.44770540	152
372	23	176	4.771462	4	16	0.216885	192	7.45871479	120
420	25	208	5.639000	4	16	0.216885	224	5.46972418	88

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
436	27	240	6.506538	4	16	0.216885	256	3.48073357	56
483	28	256	6.940308	4	16	0.216885	272	2.48623826	40
24	0	0	0.000000	3	12	0.162663	12	18.64678698	300
25	1	2	0.054221	3	12	0.162663	14	18.52247507	298
26	2	4	0.108442	3	12	0.162663	16	18.39816315	296
27	3	6	0.162663	3	12	0.162663	18	18.27385124	294
28	4	8	0.216885	3	12	0.162663	20	18.14953933	292
29	5	12	0.325327	3	12	0.162663	24	17.90091550	288
30	6	16	0.433769	3	12	0.162663	28	17.65229167	284
31	7	20	0.542212	3	12	0.162663	32	17.40366785	280
152	8	24	0.650654	3	12	0.162663	36	17.15504402	276
153	9	28	0.759096	3	12	0.162663	40	16.90642020	272
154	10	32	0.867538	3	12	0.162663	44	16.65779637	268
155	11	40	1.084423	3	12	0.162663	52	16.16054872	260
156	12	48	1.301308	3	12	0.162663	60	15.66330106	252
157	13	56	1.518192	3	12	0.162663	68	15.16605341	244
158	14	64	1.735077	3	12	0.162663	76	14.66880576	236
159	15	72	1.951962	3	12	0.162663	84	14.17155811	228
323	16	80	2.168846	3	12	0.162663	92	13.67431045	220
339	18	96	2.602615	3	12	0.162663	108	12.67981515	204
355	20	128	3.470154	3	12	0.162663	140	10.69082454	172
371	22	160	4.337692	3	12	0.162663	172	8.70183392	140
419	24	192	5.205231	3	12	0.162663	204	6.71284331	108
435	26	224	6.072769	3	12	0.162663	236	4.72385270	76
482	29	272	7.374077	3	12	0.162663	284	1.74036678	28
16	0	0	0.000000	2	8	0.108442	8	18.89541081	304
17	1	2	0.054221	2	8	0.108442	10	18.77109889	302
18	2	4	0.108442	2	8	0.108442	12	18.64678698	300
19	3	6	0.162663	2	8	0.108442	14	18.52247507	298
20	4	8	0.216885	2	8	0.108442	16	18.39816315	296
21	5	12	0.325327	2	8	0.108442	20	18.14953933	292
22	6	16	0.433769	2	8	0.108442	24	17.90091550	288
23	7	20	0.542212	2	8	0.108442	28	17.65229167	284
144	8	24	0.650654	2	8	0.108442	32	17.40366785	280
145	9	28	0.759096	2	8	0.108442	36	17.15504402	276
146	10	32	0.867538	2	8	0.108442	40	16.90642020	272
147	11	40	1.084423	2	8	0.108442	48	16.40917254	264
148	12	48	1.301308	2	8	0.108442	56	15.91192489	256
149	13	56	1.518192	2	8	0.108442	64	15.41467724	248
150	14	64	1.735077	2	8	0.108442	72	14.91742958	240
151	15	72	1.951962	2	8	0.108442	80	14.42018193	232
322	17	88	2.385731	2	8	0.108442	96	13.42568663	216
338	19	112	3.036385	2	8	0.108442	120	11.93394367	192
354	21	144	3.903923	2	8	0.108442	152	9.94495306	160
370	23	176	4.771462	2	8	0.108442	184	7.95596245	128
418	25	208	5.639000	2	8	0.108442	216	5.96697183	96

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
434	27	240	6.506538	2	8	0.108442	248	3.97798122	64
490	30	288	7.807846	2	8	0.108442	296	0.99449531	16
8	0	0	0.000000	1	4	0.054221	4	19.14403463	308
9	1	2	0.054221	1	4	0.054221	6	19.01972272	306
10	2	4	0.108442	1	4	0.054221	8	18.89541081	304
11	3	6	0.162663	1	4	0.054221	10	18.77109889	302
12	4	8	0.216885	1	4	0.054221	12	18.64678698	300
13	5	12	0.325327	1	4	0.054221	16	18.39816315	296
14	6	16	0.433769	1	4	0.054221	20	18.14953933	292
15	7	20	0.542212	1	4	0.054221	24	17.90091550	288
136	8	24	0.650654	1	4	0.054221	28	17.65229167	284
137	9	28	0.759096	1	4	0.054221	32	17.40366785	280
138	10	32	0.867538	1	4	0.054221	36	17.15504402	276
139	11	40	1.084423	1	4	0.054221	44	16.65779637	268
140	12	48	1.301308	1	4	0.054221	52	16.16054872	260
141	13	56	1.518192	1	4	0.054221	60	15.66330106	252
142	14	64	1.735077	1	4	0.054221	68	15.16605341	244
143	15	72	1.951962	1	4	0.054221	76	14.66880576	236
321	16	80	2.168846	1	4	0.054221	84	14.17155811	228
337	18	96	2.602615	1	4	0.054221	100	13.17706280	212
353	20	128	3.470154	1	4	0.054221	132	11.18807219	180
369	22	160	4.337692	1	4	0.054221	164	9.19908158	148
417	24	192	5.205231	1	4	0.054221	196	7.21009097	116
433	26	224	6.072769	1	4	0.054221	228	5.22110035	84
481	28	256	6.940308	1	4	0.054221	260	3.23210974	52
0	0	0	0.000000	0	0	0.000000	0	19.39265846	312
1	1	2	0.054221	0	0	0.000000	2	19.26834655	310
2	2	4	0.108442	0	0	0.000000	4	19.14403463	308
3	3	6	0.162663	0	0	0.000000	6	19.01972272	306
4	4	8	0.216885	0	0	0.000000	8	18.89541081	304
5	5	12	0.325327	0	0	0.000000	12	18.64678698	300
6	6	16	0.433769	0	0	0.000000	16	18.39816315	296
7	7	20	0.542212	0	0	0.000000	20	18.14953933	292
128	8	24	0.650654	0	0	0.000000	24	17.90091550	288
129	9	28	0.759096	0	0	0.000000	28	17.65229167	284
130	10	32	0.867538	0	0	0.000000	32	17.40366785	280
131	11	40	1.084423	0	0	0.000000	40	16.90642020	272
132	12	48	1.301308	0	0	0.000000	48	16.40917254	264
133	13	56	1.518192	0	0	0.000000	56	15.91192489	256
134	14	64	1.735077	0	0	0.000000	64	15.41467724	248
135	15	72	1.951962	0	0	0.000000	72	14.91742958	240
320	17	88	2.385731	0	0	0.000000	88	13.92293428	224
336	19	112	3.036385	0	0	0.000000	112	12.43119132	200
352	21	144	3.903923	0	0	0.000000	144	10.44220071	168
368	23	176	4.771462	0	0	0.000000	176	8.45321010	136
416	25	208	5.639000	0	0	0.000000	208	6.46421949	104

9 Bit Value	1/2 Rate, # Steps	Segments	Bitrate	1/4 Rate, # Steps	Segments	Bitrate	Total EVSB Segments	Normal Stream Bitrate	Total Main Segs
432	27	240	6.506538	0	0	0.000000	240	4.47522888	72
480	29	272	7.374077	0	0	0.000000	272	2.48623826	40
489	31	312	8.458500	0	0	0.000000	312	0.00000000	0

Annex B:
Alignment Delay

The E-VSB reference receiver does not contain buffers to compensate all the delays introduced in the E-VSB processing before transmission. Therefore, before transmission, each stream should be delayed by a number of bytes to allow for synchronization of the streams in the receiver for fallback modes. The actual values needed are dependent on the particular mix of the enhanced and main rates defined in A/53D Annex D [2]. The amount of the delay required is per Table B1 below. The maximum physical buffer size for each of the three streams is:

- 1/2 rate stream: 128 kB
- 1/4 rate stream: 128 kB
- Main stream: 3 MB

These delays compensate for the E-VSB interleaver delay and 164/188 byte packing delay.

Table 5.1 includes the delays necessary to synchronize between TS, TS-EA, and TS-EB for fallback modes. The implementation is more easily understood with the help of Figure B1. This drawing represents the path of any one particular stream mode (1/2 rate, 1/4 rate, or main).

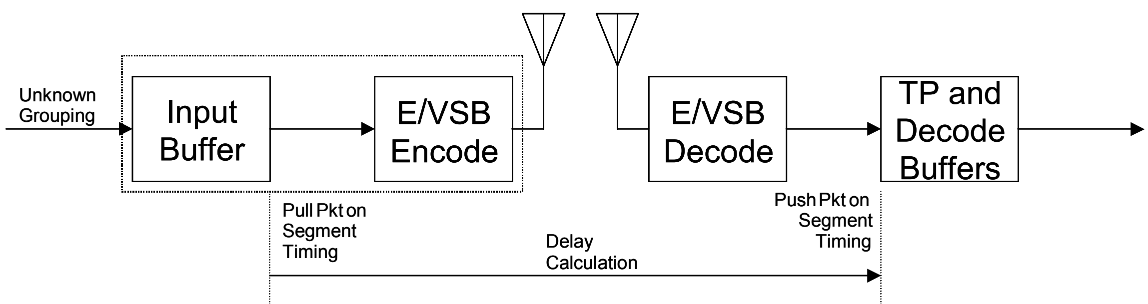


Figure B1 Alignment delay calculation points.

The table entries (B and U) represent compensation of the delay from the encoder pull interface in Figure B1 to the receiver push interface. Conceptually, to initialize this synchronization, the next full transport packet would enter the input buffer starting at time TA. TA is based on a segment clock and is coincident for all three stream buffers. At time TA + Table Entry, the pull interface for a particular stream is enabled so that the next packet request will be honored. There is no need for resynchronization until the MAP number (that is, the mix of 1/2 rate, 1/4 rate, and main data) is changed. (The MAP number is defined in ATSC A/53D Annex D [2].)

The entries in Table B1 represent compensation of the relative delays between the three streams (main, 1/2 rate, and 1/4 rate) introduced in the E-VSB transmission processing (see A/53D Annex D [2]). The delay of each stream that is introduced by the transmission system is measured from the encoder pull interface to the receiver push interface shown in Figure B1. Each row of Table B1 corresponds to a particular mix of main, 1/2 rate, and 1/4 rate data. For each mix, the table contains the compensating delays for the two data streams with the two shortest transmission-processing delays. The entries are the delays (measured in number of data *segment*[2] times of the complete emitted signal) that must be inserted (via the input buffer of Figure B1)

[2] See A/53D Annex D [2]. For main data, one data segment corresponds to one MPEG transport packet.

into two of the streams to align them with the stream having the longest transmission system delay. Note that since each of the three streams contains packets at less than the emitted segment rate, the size of the delay in packets depends on the ratio of packet rate for the particular stream (main, 1/2 rate, or 1/4 rate) to total segment rate.

In Table B1, Columns labeled B contain the compensating delays for Option 1 E-VSB packing (see A/53D Annex D [2]); i.e., bursted packing. Columns labeled U are for Option 2 E-VSB packing (see A/53D Annex D [2]); i.e., uniform packing.

Table B1 Alignment Delay (Segments)

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
0	0	0	-	-	-	-
1	14715	14867	0	0	-	-
2	7508	7434	0	0	-	-
3	5004	4956	0	0	-	-
4	3752	3717	0	0	-	-
5	2500	2478	0	0	-	-
6	1874	1865	0	0	-	-
7	1545	1492	0	0	-	-
8	14723	14945	-	-	0	0
9	7821	7773	289	1	0	0
10	5309	5438	297	391	0	0
11	4362	4229	602	441	0	0
12	3415	3521	297	469	0	0
13	2789	2684	602	506	0	0
14	2131	2239	297	530	0	0
15	2115	1943	602	547	0	0
16	7508	7473	-	-	0	0
17	5325	5353	0	0	321	249
18	4041	3887	265	1	0	0
19	3126	3199	0	83	16	0
20	2797	2724	273	120	0	0
21	2171	2118	273	160	0	0
22	1842	1760	281	209	0	0
23	1545	1516	273	228	0	0
24	5004	4982	-	-	0	0
25	4089	4184	0	0	337	359
26	3134	3150	0	0	32	40
27	2781	2594	241	0	0	0
28	2460	2271	249	64	0	0
29	1850	1839	0	105	32	0
30	1529	1553	0	121	24	0
31	1497	1382	257	173	0	0
32	3752	3743	-	-	0	0
33	3447	3461	0	0	353	421
34	2757	2712	201	0	0	135
35	2436	2266	209	0	0	30
36	2139	1944	209	1	0	0
37	1810	1625	225	72	0	0
38	1513	1402	209	100	0	0
39	1441	1243	225	106	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
64	1874	1875	-	-	0	0
65	2195	2200	0	0	417	525
66	1649	1754	0	0	112	198
67	1569	1560	0	0	104	155
68	1449	1420	81	0	0	128
69	1248	1148	0	0	88	9
70	1136	974	81	0	0	0
71	1088	897	129	25	0	0
72	1778	1664	-	-	0	0
73	1962	2040	0	0	433	509
74	1585	1605	0	0	128	208
75	1433	1484	49	0	0	198
76	1320	1324	0	0	112	103
77	1224	1109	0	0	128	65
78	1096	933	73	0	0	12
79	935	836	0	0	72	0
80	1529	1500	-	-	0	0
81	1898	1895	0	0	449	523
82	1409	1532	9	0	0	246
83	1336	1371	0	0	136	159
84	1272	1245	0	0	128	117
85	1104	1065	17	0	0	95
86	1048	897	57	0	0	13
87	919	800	0	0	104	0
88	1449	1372	-	-	0	0
89	1713	1817	0	0	465	544
90	1352	1427	0	0	160	238
91	1288	1287	0	0	152	180
92	1240	1186	0	0	160	156
93	1064	1017	9	0	0	89
94	959	861	0	0	112	1
95	903	754	0	0	136	3
96	1184	1150	-	-	0	0
97	1617	1631	0	0	497	553
98	1256	1253	0	0	192	247
99	1135	1209	0	0	79	244
100	1087	1113	0	0	176	185
101	991	934	0	0	160	93
102	919	814	0	0	168	53
103	871	741	0	0	112	60

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
40	3094	2993	-	-	0	0
41	2869	2997	0	0	369	448
42	2243	2360	0	0	64	130
43	2123	2034	177	0	0	95
44	1866	1759	0	0	64	14
45	1545	1435	0	13	56	0
46	1465	1279	209	70	0	0
47	1192	1132	0	89	64	0
48	2500	2491	-	-	0	0
49	2556	2660	0	0	385	481
50	2099	2130	137	0	0	202
51	1874	1831	0	0	80	101
52	1770	1615	153	0	0	60
53	1481	1297	145	0	0	0
54	1232	1148	0	25	56	0
55	1168	1059	145	80	0	0
56	2171	2154	-	-	0	0
57	2275	2411	0	0	401	500
58	1882	1888	0	0	96	180
59	1633	1695	0	0	88	131
60	1561	1502	0	0	88	79
61	1425	1212	137	0	0	9
62	1208	1059	0	16	96	0
63	1128	974	137	52	0	0
128	1248	1239	0	0	-	-
129	1184	1071	0	0	-	-
130	935	936	0	0	-	-
131	839	746	0	0	-	-
132	622	623	0	0	-	-
133	558	547	0	0	-	-
134	494	468	0	0	-	-
135	430	428	0	0	-	-
136	1826	1733	602	565	0	0
137	1457	1595	297	566	0	0
138	1521	1477	602	581	0	0
139	1425	1292	602	578	0	0
140	1216	1197	602	589	0	0
141	1152	1107	602	572	0	0
142	1088	1054	602	596	0	0
143	1024	988	602	570	0	0
144	1481	1362	281	233	0	0
145	1232	1218	273	243	0	249
146	1184	1123	281	257	0	0
147	1080	974	273	264	0	0
148	887	872	281	277	0	0
149	823	801	281	278	0	0
150	759	726	281	278	0	0
151	695	698	281	285	0	0
152	1176	1225	0	169	32	0
153	1192	1123	257	209	0	359
154	1144	1051	257	225	0	40

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
104	1056	1005	-	-	0	0
105	1464	1510	0	0	529	553
106	1119	1164	0	0	224	250
107	1071	1084	0	0	216	213
108	1023	1004	0	0	208	168
109	935	893	0	0	200	132
110	887	821	0	0	160	140
111	822	694	0	0	127	71
112	887	901	-	-	0	0
113	1400	1402	0	0	561	541
114	1055	1054	0	0	256	233
115	1007	979	0	0	248	198
116	959	938	0	0	240	197
117	910	846	0	0	215	176
118	854	758	0	0	181	135
119	786	662	0	0	121	63
120	791	821	-	-	0	0
121	1336	1336	0	0	593	577
122	987	991	0	0	278	264
123	941	936	0	0	264	242
124	929	910	0	0	256	248
125	866	822	0	0	201	199
126	794	726	0	0	149	127
127	722	630	0	0	142	55
192	903	825	0	25	72	0
193	855	778	0	50	104	0
194	823	741	81	90	0	0
195	759	701	137	123	0	0
196	695	646	137	137	0	0
197	665	598	169	141	0	0
198	480	583	0	178	52	0
199	464	533	0	169	100	0
200	887	764	0	0	104	0
201	839	728	0	47	16	0
202	791	711	65	86	0	0
203	727	671	113	108	0	0
204	673	614	123	113	0	0
205	645	566	137	121	0	0
206	492	571	0	178	80	0
207	476	513	0	161	128	0
208	871	724	0	13	136	0
209	791	701	17	50	0	0
210	759	681	49	71	0	0
211	695	622	89	81	0	0
212	665	574	123	85	0	0
213	520	547	0	110	60	0
214	504	515	0	133	108	0
215	494	501	9	155	0	0
216	855	688	0	7	64	0
217	759	671	1	46	0	0
218	727	641	33	46	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
155	919	897	128	205	0	0
156	855	830	257	253	0	0
157	791	766	257	258	0	0
158	727	691	257	253	0	0
159	673	670	267	269	0	0
160	1200	1123	209	144	0	0
161	1152	1059	233	185	0	421
162	1104	974	233	173	0	135
163	887	860	209	204	0	30
164	823	781	233	218	0	0
165	759	731	233	238	0	0
166	695	686	233	241	0	0
167	665	646	249	257	0	0
168	1160	1059	201	143	0	0
169	1112	974	209	131	0	448
170	855	897	0	133	40	130
171	855	824	193	203	0	95
172	791	751	209	203	0	14
173	727	701	209	223	0	0
174	673	662	219	225	0	0
175	645	619	217	242	0	0
176	1120	974	185	89	0	0
177	1064	897	177	97	0	481
178	839	826	0	98	72	202
179	823	761	177	158	0	101
180	759	721	185	183	0	60
181	695	670	185	193	0	0
182	665	622	209	197	0	0
183	440	599	0	234	44	0
184	1080	897	161	61	0	0
185	871	825	0	61	72	500
186	855	796	32	104	0	180
187	791	731	161	143	0	131
188	727	691	161	168	0	79
189	673	638	171	169	0	9
190	645	599	177	186	0	0
191	452	583	0	230	72	0
256	654	654	-	-	0	0
257	1262	1261	0	0	585	575
258	882	890	0	0	270	268
259	910	910	0	0	249	266
260	810	802	0	0	222	209
261	802	778	0	0	206	179
262	692	653	0	0	152	127
263	676	611	0	0	128	96
264	628	539	0	0	136	61
265	620	503	0	0	120	37
266	596	462	0	0	152	32
267	572	394	0	0	160	0
268	529	346	0	12	93	0
269	481	370	0	54	37	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
219	673	590	75	57	0	0
220	645	542	97	65	0	0
221	532	535	0	110	88	0
222	516	491	0	121	136	0
223	484	490	3	156	0	0
224	790	631	0	0	63	6
225	726	590	0	9	31	0
226	673	566	11	9	0	0
227	645	518	57	9	0	0
228	572	499	0	42	96	0
229	540	473	0	85	128	0
230	508	465	0	113	160	0
231	476	466	27	150	0	0
232	758	606	0	0	85	11
233	694	565	0	0	29	0
234	645	541	15	8	0	0
235	596	493	0	8	88	0
236	564	455	0	49	120	0
237	532	438	0	68	152	0
238	497	442	0	108	29	0
239	468	442	51	137	0	0
240	714	582	0	0	69	7
241	644	549	0	0	80	2
242	620	517	0	0	80	0
243	588	437	0	13	112	0
244	556	411	0	23	144	0
245	524	417	0	65	176	0
246	465	418	0	102	5	0
247	460	418	57	122	0	0
248	660	559	0	0	104	8
249	628	521	0	0	96	42
250	612	467	0	0	104	13
251	580	412	0	6	136	0
252	548	390	0	20	168	0
253	513	394	0	60	61	0
254	452	394	17	89	0	0
255	452	394	49	107	0	0
320	341	341	0	0	-	-
321	970	963	597	598	0	0
322	622	623	265	289	0	0
323	645	631	257	281	0	0
324	574	574	209	246	0	0
325	412	595	0	257	64	0
326	526	550	161	239	0	0
327	534	538	105	204	0	0
328	496	526	131	224	0	0
329	492	514	63	198	0	0
330	488	502	149	209	0	0
331	484	490	83	185	0	0
332	476	460	137	182	0	0
333	468	442	97	155	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
270	435	335	0	45	15	0
271	428	351	25	69	0	0
272	544	538	-	-	0	0
273	1151	1151	0	0	559	558
274	740	758	0	0	224	244
275	782	809	0	0	214	250
276	708	692	0	0	216	202
277	708	701	0	0	176	175
278	644	609	0	0	200	167
279	644	576	0	0	160	98
280	604	555	0	0	208	161
281	604	510	0	0	168	80
282	572	501	0	0	224	152
283	556	411	0	0	208	53
284	499	323	0	0	119	19
285	467	311	0	13	55	0
286	429	280	0	2	55	0
287	403	311	0	35	19	0
288	416	442	-	-	0	0
289	1029	1006	0	0	565	528
290	676	663	0	0	288	245
291	692	669	0	0	252	215
292	644	628	0	0	280	253
293	644	618	0	0	240	200
294	612	571	0	0	281	228
295	604	564	0	0	248	194
296	578	515	0	0	226	196
297	579	479	0	0	207	148
298	535	451	0	0	183	147
299	525	387	0	0	162	83
300	450	323	0	0	98	43
301	439	280	0	2	76	0
302	395	256	0	2	43	0
303	373	256	0	2	10	0
304	335	335	-	-	0	0
305	956	952	0	0	601	593
306	621	621	0	0	290	294
307	628	625	0	0	289	282
308	599	597	0	0	268	278
309	610	597	0	0	268	270
310	557	541	0	0	226	237
311	567	545	0	0	225	235
312	514	485	0	0	183	193
313	525	483	0	0	183	185
314	479	429	0	0	148	149
315	461	387	0	0	119	107
316	437	318	0	0	106	62
317	415	275	0	0	73	19
318	394	266	0	0	68	34
319	373	232	0	2	39	0
384	285	292	-	-	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
334	444	383	105	117	0	0
335	436	367	65	93	0	0
336	279	285	0	0	-	-
337	911	914	602	605	0	0
338	526	556	255	275	0	0
339	566	586	257	281	0	0
340	512	526	249	251	0	0
341	518	556	209	260	0	0
342	504	496	225	227	0	0
343	500	529	189	242	0	0
344	496	466	217	203	0	0
345	492	499	181	221	0	0
346	480	436	201	179	0	0
347	484	469	173	200	0	0
348	444	415	165	177	0	0
349	452	399	141	141	0	0
350	406	383	127	149	0	0
351	404	367	93	115	0	0
352	215	239	0	0	-	-
353	821	824	578	564	0	0
354	512	460	297	227	0	0
355	516	493	269	239	0	0
356	488	487	273	279	0	0
357	508	463	261	215	0	0
358	464	471	249	265	0	0
359	484	463	237	237	0	0
360	440	453	218	251	0	0
361	460	447	213	225	0	0
362	424	435	203	237	0	0
363	436	431	189	211	0	0
364	416	405	182	213	0	0
365	411	399	161	185	0	0
366	406	365	158	175	0	0
367	400	367	131	157	0	0
368	190	190	0	0	-	-
369	797	798	603	608	0	0
370	448	451	250	261	0	0
371	468	473	266	283	0	0
372	440	431	245	241	0	0
373	444	453	234	263	0	0
374	435	411	246	221	0	0
375	432	433	224	243	0	0
376	430	391	236	201	0	0
377	427	413	224	223	0	0
378	424	376	219	186	0	0
379	422	393	204	203	0	0
380	416	364	211	178	0	0
381	411	356	184	166	0	0
382	387	348	182	170	0	0
383	393	340	167	158	0	0
448	228	228	-	-	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
385	904	904	0	0	603	600
386	557	561	0	0	280	275
387	578	579	0	0	282	277
388	543	533	0	0	271	251
389	546	537	0	0	258	239
390	523	477	0	0	262	199
391	511	481	0	0	234	195
392	501	421	0	0	248	153
393	491	425	0	0	225	151
394	476	382	0	0	223	126
395	458	350	0	0	205	94
396	417	318	0	0	175	86
397	409	294	0	0	159	62
398	374	270	0	0	148	62
399	358	246	0	0	124	38
400	255	260	-	-	0	0
401	867	840	0	0	608	568
402	536	497	0	0	283	243
403	549	515	0	0	296	247
404	521	478	0	0	271	228
405	528	473	0	0	275	211
406	492	446	0	0	250	204
407	499	430	0	0	246	176
408	463	414	0	0	229	180
409	469	398	0	0	223	148
410	438	382	0	0	212	152
411	425	350	0	0	191	118
412	406	318	0	0	196	110
413	390	294	0	0	172	86
414	374	270	0	0	180	86
415	358	246	0	0	156	62
416	163	190	0	0	-	-
417	753	734	572	544	0	0
418	446	408	289	218	0	0
419	443	409	267	219	0	0
420	440	400	278	212	0	0
421	438	396	267	206	0	0
422	433	392	270	208	0	0
423	432	388	248	198	0	0
424	417	384	254	204	0	0
425	427	380	243	194	0	0
426	401	376	239	200	0	0
427	414	372	230	190	0	0
428	390	364	223	194	0	0
429	386	356	202	182	0	0
430	382	348	194	186	0	0
431	378	340	179	174	0	0
432	128	168	0	0	-	-
433	753	719	614	537	0	0
434	422	408	289	244	0	0
435	435	404	294	226	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
449	830	807	0	0	590	567
450	490	486	0	0	270	266
451	500	478	0	0	266	244
452	470	446	0	0	260	236
453	462	430	0	0	240	208
454	446	398	0	0	248	200
455	438	382	0	0	228	172
456	406	318	0	0	212	122
457	-	-	-	-	0	0
458	494	494	0	0	288	288
459	478	462	0	0	280	264
460	390	335	19	67	0	0
461	384	311	51	57	0	0
462	374	263	23	9	0	0
463	363	232	32	2	0	0
464	352	232	1	2	0	0
465	334	208	3	2	0	0
466	343	208	0	2	17	0
467	326	198	0	0	108	14
468	342	222	0	0	132	38
469	342	222	0	0	148	50
470	374	263	62	33	0	0
471	350	252	59	58	0	0
472	342	208	30	2	0	0
473	334	216	38	46	0	0
474	326	184	14	2	0	0
475	296	168	0	19	102	0
476	312	174	0	0	118	14
477	342	240	62	78	0	0
478	334	216	70	67	0	0
479	326	192	46	43	0	0
480	128	136	0	0	-	-
481	722	719	592	569	0	0
482	410	404	280	274	0	0
483	408	400	270	256	0	0
484	404	392	274	268	0	0
485	402	388	264	250	0	0
486	398	380	262	262	0	0
487	396	376	245	244	0	0
488	390	364	238	238	0	0
489	-	-	0	0	-	-
490	412	408	296	292	0	0
491	406	396	286	286	0	0
492	396	351	57	91	0	0
493	390	335	78	89	0	0
494	395	351	104	123	0	0
495	390	335	121	135	0	0
496	395	332	147	146	0	0
497	370	324	143	150	0	0
498	374	332	164	162	0	0
499	370	324	154	166	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
436	408	400	270	240	0	0
437	419	396	278	222	0	0
438	404	392	260	236	0	0
439	403	388	257	218	0	0
440	400	384	251	232	0	0
441	398	380	246	214	0	0
442	396	376	245	228	0	0
443	394	372	237	210	0	0
444	390	364	223	222	0	0
445	386	356	208	202	0	0
446	382	348	214	214	0	0
447	378	340	194	194	0	0

MAP	Main		1/2 Rate		1/4 Rate	
	B	U	B	U	B	U
500	374	332	174	178	0	0
501	374	332	190	190	0	0
502	384	311	93	93	0	0
503	358	288	89	106	0	0
504	366	312	118	134	0	0
505	358	288	110	126	0	0
506	366	312	135	150	0	0
507	358	288	142	139	0	0
508	366	312	166	163	0	0
509	350	264	86	102	0	0
510	342	240	94	91	0	0
511	350	264	118	115	0	0

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