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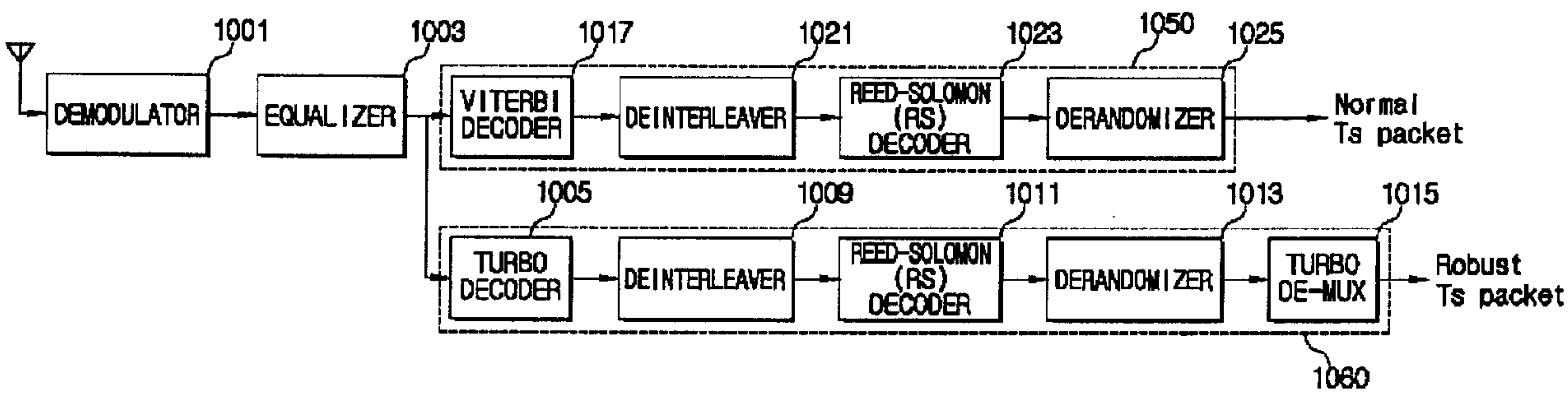
(54) Titre : PROCEDE DE TURBO-EMISSION DE FLUX DE TRANSPORT DE DIFFUSION NUMERIQUE, SYSTEME D'EMISSION ET DE RECEPTION DE DIFFUSION NUMERIQUE ET PROCEDE DE TRAITEMENT DE SIGNAL ASSOCIE

(54) Title: METHOD FOR TURBO TRANSMISSION OF DIGITAL BROADCASTING TRANSPORT STREAM, A DIGITAL BROADCASTING TRANSMISSION AND RECEPTION SYSTEM, AND A SIGNAL PROCESSING METHOD THEREOF



(57) Abrégé/Abstract:
A digital broadcast receiver and a method for processing a stream in a digital broadcast receiver are provided. The digital broadcast receiver includes a receiver for receiving a transport stream, a turbo decoder for detecting and turbo-decoding an additional data stream in the received transport stream, and a processor for deinterleaving and Reed-Solomon decoding the turbo-decoded additional data stream. The transport stream comprises the additional data stream, a normal data stream, known data and control information, which is information on the transport stream.

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ABSTRACT

A digital broadcast receiver and a method for processing a stream in a digital broadcast receiver are provided. The digital broadcast receiver includes a receiver for receiving a transport stream, a turbo decoder for detecting and turbo-decoding an additional data stream in the received transport stream, and a processor for deinterleaving and Reed-Solomon decoding the turbo-decoded additional data stream. The transport stream comprises the additional data stream, a normal data stream, known data and control information, which is information on the transport stream.

Description

METHOD FOR TURBO TRANSMISSION OF DIGITAL BROADCASTING TRANSPORT STREAM, A DIGITAL BROADCASTING TRANSMISSION AND RECEPTION SYSTEM, AND A SIGNAL PROCESSING METHOD THEREOF

This is a divisional of Canadian National Phase Patent Application Serial No. 2,624,477 filed October 11, 2006.

Technical Field

[1] Aspects of the invention relate to a method for turbo processing and transmitting a digital broadcasting transport stream, a digital broadcasting reception and transmission system, and a method of processing signals thereof. More particularly, aspects of the invention relate to a method for turbo processing and transmitting a digital broadcasting transport stream to enhance reception performance of a terrestrial-wave digital television (DTV) system in the U.S. in accordance with the Advanced Television Systems Committee (ATSC) vestigial sideband (VSB) transmission system through information exchange and mapping with respect to a dual transport stream (TS) which includes normal data and turbo data, and a digital broadcasting transmission and reception system.

Background Art

[2] The Advanced Television Systems Committee (ATSC) vestigial sideband (VSB) transmission system, which is used in a terrestrial-wave digital television (DTV) system in the U.S., is a single-carrier system that transmits one field synchronization (sync) segment for each unit of 312 data segments. Therefore, reception performance of the ATSC VSB system is inferior over weak channels, especially over a Doppler-fading channel.

[3] FIG. 1 is a block diagram of an ATSC VSB digital broadcasting transceiver of the related art. The digital broadcasting transceiver shown in FIG. 1 is configured in accordance with an enhanced VSB (E-VSB) system proposed by Phillips, and produces and transmits a dual stream configured by adding enhanced or robust data to normal data of the standard ATSC VSB system.

[4] As shown in FIG. 1, a digital broadcasting transmitter includes a randomizer 11, a Reed-Solomon (RS) encoder 12 having a concatenated encoder form adding parity bytes to a dual transport stream to enable errors generated by channel impairments during transmission to be corrected during reception, an interleaver 13 interleaving the RS-encoded data according to a predetermined pattern, and a 2/3 rate trellis encoder 14 performing trellis-encoding at a rate of 2/3 with respect to the interleaved data and mapping the interleaved data to 8-level symbols. With this structure, the digital

broadcasting transmitter performs error-correction encoding with respect to the dual stream.

[5] The digital broadcasting transmitter further includes a multiplexer 15 inserting field synchronization (sync) and segment sync in the error-correction encoded data according to a data format shown in FIG. 2, and a modulator 16 inserting a pilot by adding a predetermined direct current (DC) value to the data symbols and the inserted segment sync and field sync, amplitude-modulating the resulting signal onto an intermediate frequency (IF) carrier, filtering the resulting IF signal to produce a vestigial sideband (VSB) signal, up-converting the VSB signal to a radio-frequency (RF) signal having a frequency of a desired channel, and transmitting the RF signal through the channel.

[6] Accordingly, in the digital broadcasting transmitter, the normal data and the enhanced or robust data are multiplexed according to the dual stream system that transmits the normal data and the enhanced or robust data on one channel and are inputted to the randomizer 11. The inputted data is randomized by the randomizer 11, and the randomized data is outer-encoded by the RS encoder 12 which is an outer encoder. The interleaver 13 distributes the encoded data according to the predetermined pattern. The interleaved data is inner-encoded by the trellis encoder 14 in 12-symbol units. The inner-encoded data is mapped to 8-level symbols. The field sync and the segment sync are inserted in the mapped data. The pilot is inserted and the VSB modulation is performed. The VSB signal is up-converted to the RF signal, and the RF signal is transmitted through the channel.

[7] A digital broadcasting receiver shown in FIG. 1 includes a tuner (not shown) converting the RF signal received through the channel to a baseband signal, a demodulator 21 performing synchronization detection and demodulation with respect to the baseband signal, an equalizer 22 compensating for channel distortion generated by multiple transmission paths with respect to the demodulated signal, a Viterbi decoder 23 correcting errors of the equalized signal and decoding the error-corrected signal to symbol data, a deinterleaver 24 rearranging the symbol data according to the predetermined pattern by which data was distributed by the interleaver 13 of the digital broadcasting transmitter, an RS decoder 25 correcting errors, and a derandomizer 26 derandomizing the data corrected by the RS decoder 25 and outputting an MPEG-2 (Moving Picture Experts Group) transport stream. Therefore, the digital broadcasting receiver of FIG. 1 down-converts the RF signal to the baseband signal in a reverse order relative to the digital broadcasting transmitter, demodulates and equalizes the converted signal, and performs channel-decoding, thereby recovering the original signal.

[8] FIG. 2 shows a VSB data frame where the segment sync and the field sync are

inserted according to an 8-VSB system which is used in the DTV system in the U.S. As shown in FIG. 2, one frame includes two fields. One field includes one field sync segment which is a first segment of the field, and 312 data segments. In the VSB data frame, one segment corresponding to one MPEG-2 packet comprises a 4-symbol segment sync and 828 data symbols. The segment sync and the field sync in FIG. 2 are used for synchronization and equalization in the digital broadcasting receiver. More specifically, the segment sync and the field sync, which are known to the digital broadcasting transmitter and receiver, are used as reference signals when the receiver performs synchronization and equalization. The U.S. terrestrial-wave digital broadcasting system of FIG. 1 is configured to produce and transmit the dual stream by adding the enhanced or robust data to the normal data of the ATSC VSB system of the related art. Therefore, the U.S. terrestrial-wave digital broadcasting system transmits the enhanced or robust data as well as the normal data.

Disclosure of Invention

Technical Problem

[9] Although the enhanced or robust data is transmitted in the dual stream in addition to the normal data, inferior reception performance due to multipath channel distortion caused by transmission of the normal data stream is not remarkably improved. In fact, almost no improvement in the reception performance is obtained by the improved normal data stream. Moreover, reception performance is not much improved with respect to the enhanced or robust stream, either.

Technical Solution

[10] Accordingly, an aspect of the invention is to provide a method for turbo processing and transmitting a digital broadcasting transport stream to enhance reception performance of a terrestrial-wave digital television (DTV) in the US in accordance with the advanced television system committee (ATSC) vestigial sideband (VSB) through information exchange and mapping with respect to a dual transport stream (TS) which includes normal data and turbo data, a digital broadcasting transmission and reception system, and a signal-processing method thereof.

[11] The above aspects and/or other features of the invention can substantially be achieved by providing a method of processing a digital broadcasting signal, comprising: preparing a first area for parity insertion with respect to a dual transport stream (TS) which includes a normal stream multiplexed with a turbo stream, interleaving the dual TS which includes the first area, detecting the turbo stream from the interleaved dual TS, exclusively encoding the detected turbo stream, and stuffing the encoded turbo stream in the dual TS for turbo processing, deinterleaving the turbo-processed dual TS, transmitting the deinterleaved turbo-processed dual TS, receiving

the transmitted dual TS, demodulating the received dual TS, equalizing the demodulated dual TS, decoding the normal stream of the equalized dual TS to recover a normal data packet, and decoding the turbo stream of the equalized dual TS to recover a turbo data packet.

[12] According to one aspect of the invention, the method of processing a digital broadcasting signal, further comprises, before preparing the first area, preparing a second area for parity insertion with respect to the turbo stream; and generating the dual TS by multiplexing the turbo stream having the second area for parity insertion therein with the normal stream.

[13] According to one aspect of the invention, the detecting the turbo stream comprises detecting the turbo stream by demultiplexing the dual TS which is interleaved, encoding the detected turbo stream by inserting a parity with respect to the detected turbo stream into a second area created for parity insertion, interleaving the encoded turbo stream, and generating the dual TS by multiplexing the interleaved turbo stream, and the normal stream.

[14] According to one aspect of the invention, the detecting the turbo stream further comprises converting a basic unit of the interleaved dual TS from a byte to a symbol, and converting a basic unit of the generated dual TS from a symbol to a byte.

[15] According to one aspect of the invention, the transmitting of the deinterleaved dual TS comprises encoding by inserting a parity with respect to the deinterleaved dual TS into the first area for parity insertion, interleaving the encoded dual TS, trellis-encoding the interleaved dual TS, multiplexing by adding a synchronization signal to the trellis-encoded dual TS, and channel-modulating the multiplexed dual TS and transmitting a resulting stream.

[16] According to one aspect of the invention, the dual TS comprises a field containing a plurality of consecutive packets, an option field recording a predetermined type of packet information therein, is arranged in the packet which is located in a predetermined position on the field without overlapping with the turbo stream, and the option field comprises a program clock reference (PCR), an original program clock reference (OPCR), a splice countdown which indicates a number of macro blocks, a transport private data length, and/or an adaptation field extension length.

[17] According to one aspect of the invention, the dual TS comprises a field containing a plurality of consecutive packets, and the turbo stream and the normal stream are arranged in the plurality of packets, respectively.

[18] According to one aspect of the invention, the decoding the normal stream comprises decoding in which an error is corrected with respect to the normal stream of the equalized dual TS and the error-corrected normal stream is decoded, deinterleaving the normal stream which is decoded by the viterbi decoder, correcting an error of the dein-

terleaved normal stream, and recovering the normal data packet by derandomizing the error-corrected normal stream.

[19] According to one aspect of the invention, the decoding the turbo stream comprises turbo decoding the turbo stream of the equalized dual TS, deinterleaving the turbo-decoded turbo stream, Reed-Solomon decoding the deinterleaved turbo stream, and de-randomizing the Reed-Solomon decoded turbo stream.

[20] According to one aspect of the invention, the method of processing a digital broadcasting signal, further comprises, inserting a supplementary reference sequence in a stuffing area of the dual TS which includes a normal stream multiplexed with a turbo stream, and equalizing the demodulated dual TS using the supplementary reference sequence retrieved from the stuffing area as compared to a supplementary reference sequence stored at a receiver.

[21] According to one aspect of the invention, the method of processing a digital broadcasting signal, further comprises, multiplexing the normal stream and the turbo stream to generate the dual TS, and preparing the stuffing area in the dual TS.

[22] According to one aspect of the invention, the method of processing a digital broadcasting signal, further comprises, before the inserting the supplementary reference sequence, randomizing the dual TS which has the stuffing area therein.

[23] According to one aspect of the invention, multiplexing the normal stream and the turbo stream comprises preparing a second area for parity insertion with respect to the turbo stream.

[24] According to one aspect of the invention, the dual TS is in a form of a frame comprising a plurality of consecutive packets, each packet comprising an adaptation field, and the stuffing area is at least a part of the adaptation field.

[25] According to one aspect of the invention, the dual TS comprises the turbo stream arranged in the packets of the frame at predetermined packet intervals.

[26] According to one aspect of the invention, the dual TS comprises an option field arranged in the packet located in a predetermined position of the field which does not overlap with the turbo stream, the stuffing area is at least a part of the adaptation field excluding the option field, and the option field comprises a program clock reference (PCR), an original program clock reference (OPCR), a splice countdown which indicates a number of macro blocks, a transport private data length, and/or an adaptation field extension length.

[27] According to one aspect of the invention, the field comprises 312 packets, and when the 312 packets are divided into units of 52 packets each, the option field is located in the field as follows, Program clock reference (PCR): 52n+15, n=0; Original program clock reference (OPCR): 52n+15, n=1; Adaptation field extension length: 52n+15, n=2; Transport private data length: 52n+15, n=3,4,5; and Splice countdown: 52n+19,

n=0,1,2,3,4,5.

[28] In another aspect of the present invention, a digital broadcasting system comprises: a transmission source comprises: a parity area generating unit preparing a first area for parity insertion with respect to a dual transport stream (TS) which includes a normal stream multiplexed with a turbo stream, a first interleaver interleaving the dual TS which is transmitted from the parity area generating unit, a turbo processing unit detecting the turbo stream from the interleaved dual TS, exclusively encoding the detected turbo stream for turbo-processing, and stuffing the encoded turbo stream into the dual TS, a deinterleaver deinterleaving the dual TS which is processed by the turbo processing unit, and a transmitting unit transmitting the dual TS which is processed at the deinterleaver, and a digital broadcasting receiver system comprising: a demodulator receiving a dual transport stream (TS) and demodulating the received dual TS, an equalizer equalizing the demodulated dual TS, a first processor decoding the normal stream of the equalized dual TS and outputting a normal data packet, and a second processor decoding the turbo stream of the equalized dual TS and outputting a turbo data packet.

[29] According to one aspect of the invention, the first processor comprises, a viterbi decoder correcting an error with respect to the normal stream of the equalized dual TS and decoding the error-corrected normal stream, a first deinterleaver deinterleaving the normal stream which is decoded by the viterbi decoder, a first Reed-Solomon decoder correcting an error of the normal stream which is processed at the first deinterleaver, and a derandomizer recovering the normal data packet by derandomizing the error-corrected normal stream, and the second processor comprises, a turbo decoder decoding the turbo stream of the equalized dual TS, a second deinterleaver deinterleaving the turbo-decoded turbo stream, a second Reed-Solomon decoder decoding the deinterleaved turbo stream, and a derandomizer derandomizing the Reed-Solomon decoded turbo stream.

[30] According to one aspect of the invention, the dual TS comprises a field containing a plurality of consecutive packets, and the turbo stream and the normal stream are arranged in the plurality of packets, respectively.

[31] According to one aspect of the invention, the dual TS comprises; a field containing a plurality of consecutive packets, an option field recording a predetermined type of packet information therein, is arranged in the packet at a predetermined position of the field which does not overlap with the turbo stream, and the option field comprises at least one of a program clock reference (PCR), an original program clock reference (OPCR), a splice countdown which indicates a number of macro blocks, a transport private data length and an adaptation field extension length.

[32] According to one aspect of the invention, the digital broadcasting system, further

comprises, a TS structure unit generating the dual TS by multiplexing the normal stream and the turbo stream, and a randomizing unit randomizing the dual TS which is generated at the TS structure unit, and providing the generated dual TS to the parity area generating unit.

[33] According to one aspect of the invention, the TS structure unit comprises a duplicator preparing a second area for parity insertion with respect to the turbo stream, and a service MUX multiplexing the turbo stream which is processed at the duplicator, and the normal stream, and outputting the resultant stream.

[34] According to one aspect of the invention, the TS structure unit further comprises a first Reed-Solomon encoder encoding an externally-received turbo stream, and a pre-interleaver interleaving the encoded turbo stream and providing the resultant stream to the duplicator.

[35] According to one aspect of the invention, the turbo processing unit comprises a de-MUX demultiplexing the dual TS which is interleaved in the first interleaver and detecting the turbo stream, a turbo encoder encoding the turbo stream by inserting a parity with respect to the turbo stream which is detected by the de-MUX, into the second area for parity insertion, a turbo interleaver interleaving the turbo stream which is processed at the turbo encoder, and a turbo data MUX structuring a dual transport stream (TS) by multiplexing the turbo stream which is processed at the turbo interleaver, and the normal stream which is demultiplexed at the de-MUX.

[36] According to one aspect of the invention, the transmission source further comprises an additional reference signal inserting unit receiving the dual TS, and inserting an additional reference signal in a stuffing area provided in the dual TS, and the equalizer equalizes the demodulated dual TS using the additional reference signal extracted from the stuffing area in comparison with an additional reference signal stored at the receiver.

[37] According to one aspect of the invention, the digital broadcasting system, further comprises; a transport stream (TS) structure unit generating the dual TS by multiplexing the normal stream and the turbo stream, and preparing the stuffing area in the dual TS, and a randomizing unit randomizing the dual TS provided from the TS structure unit and providing the randomized stream to the additional reference signal inserting unit.

[38] According to one aspect of the invention, the TS structure unit comprises a duplicator preparing a second area for parity insertion with respect to the turbo stream, and a service MUX multiplexing the turbo stream and the normal stream which are processed at the duplicator, preparing the stuffing area, and outputting the resultant stream.

[39] According to one aspect of the invention, the TS structure unit further comprises a

first Reed-Solomon encoder performing Reed-Solomon encoding with respect to an externally-received turbo stream, and a pre-interleaver interleaving the encoded turbo stream and providing the resultant stream to the duplicator.

[40] According to one aspect of the invention, the dual TS comprises a frame containing a plurality of consecutive packets, with each packet comprising an adaptation field, and the stuffing area is at least a part of the adaptation field.

[41] According to one aspect of the invention, the dual TS comprises an option field arranged in the packet at a location of the adaptation field which does not overlap with the turbo stream, the stuffing area is at least a part of the adaptation field excluding the option field, and the option field comprises a program clock reference (PCR), an original program clock reference (OPCR), a splice countdown which indicates a number of macro blocks, a transport private data length, and/or an adaptation field extension length.

[42] According to one aspect of the invention, the field comprises 312 packets, and when the 312 packets are divided into units of 52 packets each, the option field is located in the field as follows, Program clock reference (PCR): 52n+15, n=0; Original program clock reference (OPCR): 52n+15, n=1; Adaptation field extension length: 52n+15, n=2; Transport private data length: 52n+15, n=3,4,5; and Splice countdown: 52n+19, n=0,1,2,3,4,5.

Advantageous Effects

[43] As can be appreciated from the above description of the method for turbo-processing and transmitting the TS for digital broadcasting, the digital broadcasting transmission/reception system, and the signal processing method thereof, according to certain embodiments of the invention, reception performance of a terrestrial-wave digital television (DTV) in the US in accordance with the advanced television system committee (ATSC) vestigial sideband (VSB) can be enhanced through information exchange and mapping with respect to a dual transport stream (TS) which includes normal data and turbo data. As a result, the digital broadcasting transmission system provides not only the compatibility with existing normal data transmission systems, but also the improved receptivity under a variety of reception environments.

[44] While not required, it is understood that aspects of the invention can be implemented using software, hardware, and combinations thereof. While described in terms of a broadcast signal sent through air or cable, it is understood that, the transmission can be made through recording on a medium for delayed playback in other aspects of the invention.

[45] While the invention has been shown and described with reference to certain embodiments thereof, it will be understood by those skilled in the art that various changes

in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

Summary of the Invention

[45a] According to an aspect of the present invention, there is provided a digital broadcast receiver, comprising: a receiver receiving a transport stream; a turbo decoder detecting and turbo-decoding an additional data stream in the received transport stream; and a processor deinterleaving and Reed-Solomon-decoding the turbo-decoded additional data stream, wherein the transport stream comprises the additional data stream, a normal data stream, known data, and control information, which is information on the transport stream.

[45b] According to another aspect of the present invention, there is provided a method for processing a stream in a digital broadcast receiver, the method comprising: receiving a transport stream; detecting and turbo-decoding an additional data stream in the received transport stream; and deinterleaving and Reed-Solomon-decoding the turbo-decoded additional data stream, wherein the transport stream comprises the additional data stream, a normal data stream, known data, and control information, which is information on the transport stream.

Brief Description of the Drawings

[46] These and/or other aspects and advantages of the invention will become apparent and more readily appreciated from the following description of embodiments of the invention, taken in conjunction with the accompanying drawings, of which:

[47] FIG. 1 is a block diagram showing a digital broadcasting transceiver of the related art according to the Advanced Television Systems Committee (ATSC) vestigial sideband (VSB) system;

[48] FIG. 2 shows an exemplary frame structure of a VSB data frame used in the digital broadcasting transceiver of the related art shown in FIG. 1;

[49] FIG. 3 is a block diagram showing a digital broadcasting transmission system according to an embodiment of the invention;

[50] FIG. 4 is a block diagram provided to explain in detail the structure of the digital broadcasting transmission system of FIG. 3;

[51] FIG. 5 is a block diagram showing a transport stream (TS) constructing unit of the digital broadcasting transmission system of FIG. 4;

[52] FIG. 6 is a block diagram showing in detail the structure of a transmitting unit of the digital broadcasting transmission system of FIG. 4;

[53] FIG. 7 is a block diagram showing an example of a turbo processing unit of the digital broadcasting transmission system of FIG. 4;

[54] FIG. 8 is a block diagram showing the structure of a turbo encoder of the turbo processing unit of FIG. 7;

[55] FIGS. 9 through 15 show exemplary structures of a dual transport stream packet of the digital broadcasting transmission system of FIG. 4;

[56] FIG. 16 is a block diagram showing a digital broadcasting transmission system that transmits a supplementary reference sequence (SRS) according to an embodiment of the invention;

[57] FIGS. 17 through 23 show exemplary structures of a dual transport stream packet including the supplementary reference sequence (SRS) of the digital broadcasting transmission system of FIG. 16;

[58] FIG. 24 is a block diagram showing the structure of a digital broadcasting reception system according to an embodiment of the invention;

[59] FIG. 25 is a block diagram of a turbo decode of the digital broadcasting reception system of FIG. 24;

[60] FIG. 26 is a flowchart for explaining an example of a signal processing method in the digital broadcasting transmission system of FIG. 6;

[61] FIG. 27 is a flowchart for explaining an example of a signal processing method in the turbo processing unit of FIG. 7;

[62] FIG. 28 is a flowchart for explaining an example of a signal processing method in the digital broadcasting reception system of FIG. 24; and

[63] FIG. 29 is a flowchart for explaining an example of a signal processing method in the turbo decoder of FIG. 25.

Best Mode for Carrying Out the Invention

[64] Reference will now be made in detail to embodiments of the invention, examples of which are shown in the accompanying drawings, wherein like reference numerals refer to like elements throughout. The embodiments are described below in order to explain the invention by referring to the figures. The specific structures and elements in the following description are merely to assist in obtaining a comprehensive understanding of the invention. Thus, it is apparent that the invention can be implemented without using these specific structures and elements. Also, well-known functions, structures, and elements have not been described in detail in the following description to avoid obscuring the invention with unnecessary details.

[65] The following description presumes a familiarity with the Advanced Television Systems Committee (ATSC) Digital Television (DTV) System which incorporates aspects of the MPEG-2 system, details of which are described in the corresponding standards. Examples of such standards which may be relevant are ATSC A/52B, Digital Audio Compression Standard (AC-3, E-AC-3), Revision B, 14 June 2005; ATSC A/53E, ATSC Digital Television Standard (A/53), Revision E, 27 December 2005; ATSC A/54A, Recommended Practice: Guide to the Use of the ATSC Digital Television Standard, 4 December 2003; ISO/IEC IS 13818-1:2000(E), Information technology-Generic coding of moving pictures and associated audio information: Systems (second edition) (MPEG-2); and ISO/IEC IS 13818-2:2000(E), Information technology-Generic coding of moving pictures and associated audio information: Video (second edition) (MPEG-2), the contents and disclosures of which are incorporated herein by reference. However, it is understood that aspects of the invention can be implemented according to other standards and systems without restriction. Moreover, the following description uses the terms "turbo" and "turbo data" which are represented in some of the drawings by the terms "robust" and "robust data".

[66] FIG. 3 is a block diagram showing a digital broadcasting transmission system according to an embodiment of the invention. Referring to FIG. 3, the digital broadcasting transmission system includes a parity area generating unit 110, a first interleaver 120, a turbo processing unit 130, a deinterleaver 140, and a transmitting unit 150. The parity area generating unit 110 provides an area for the insertion of parity

bytes in a dual transport stream (TS), which includes a normal stream and a turbo stream. In other words, the parity is computed with respect to the dual TS, and inserted (that is, recorded in bits) into the parity area. The parity area provided by the parity area generating unit 110 will be called "a first parity insertion area" in the following description.

[67] The first interleaver 120 interleaves the dual TS which has an area provided by the parity area generating unit 110 for parity insertion. The turbo processing unit 130 detects the turbo stream included in the interleaved dual TS, turbo-processes the detected turbo TS, and stuffs the dual TS. While not required in all aspects, it is understood that the turbo processing of the turbo processing unit 130 may include encoding processes such as convolution encoding with respect to the turbo TS to make the data turbo.

[68] The deinterleaver 140 deinterleaves the dual TS outputted from the turbo processing unit 130. The transmitting unit 200 transmits the dual TS after it has been processed in the deinterleaver 140. The structure of the transmitting unit 200 will be described below in detail.

[69] According to the embodiment shown in FIG. 3, a turbo stream, which has been treated with a separate turbo processing, is transmitted together with the normal stream. Therefore, reception performance under multipath conditions or in a mobile environment improves, and at the same time, compatibility with existing normal stream transmission/reception system is provided. It is further understood that the turbo data can be various forms of data, such as audio, video, computer software, game data, music, shopping information, internet data, text, voice data, and other types of data transmitted in addition to the normal data. Additionally, the normal data can include other data in addition to or instead of the audio-video data used in digital broadcasting according to aspects of the invention.

[70] The digital broadcasting transmission system of FIG. 3 will be explained in greater detail below with reference to the block diagram of FIG. 4. Referring to FIG. 4, the digital broadcasting transmission system further includes a transport stream (TS) generating unit 300 and a randomizer unit 150. The TS generating unit 300 generates a dual TS by receiving a normal stream and a turbo stream, processing the turbo stream, and multiplexing the normal stream and the processed turbo stream. While not required in all aspects, the normal stream and the turbo stream may be received from an external module such as a broadcasting camera, or internal modules such as compression module such as MPEG-2 module, a video encoder, and an audio encoder.

[71] The randomizer unit 150 randomizes the dual TS generated by the TS generating unit 300 and provides it to the parity area generating unit 110. Accordingly, the parity area generating unit 110 provides a parity area for the dual TS. Since the elements in

FIG. 4 other than the TS generating unit 300 and the randomizer unit 150 are same in function as those of the above-described embodiment of FIG. 3, additional description will be omitted for the sake of brevity.

[72] An exemplary structure of the TS generating unit 300 will be described below with reference to FIG. 5. The TS generating unit 300 includes a first Reed-Solomon encoder 310, a pre-interleaver 320, a duplicator 330, and a service MUX (multiplexer) 340. Although the example shown in FIG. 5 uses the first Reed-Solomon encoder 310 and the pre-interleaver 320, these can be omitted or replaced with other elements (not shown). It is preferable, but not required, that the first Reed-Solomon encoder 310, when used, be used together with the pre-interleaver 320. The position of the pre-interleaver 320 is interchangeable with that of the duplicator 330.

[73] The first Reed-Solomon encoder 310 performs encoding by adding parity bytes to the received turbo stream. The pre-interleaver 320 interleaves the turbo stream having the added parity bytes. The duplicator 330 provides a parity area with respect to the interleaved turbo stream. The parity area provided by the duplicator 330 will be called a "second parity area" in the following description.

[74] In order to provide the second parity area, the byte, which is the basic unit of the turbo stream, is divided into two or four bytes. A part of bits of one byte, and null data such as 0, are then stuffed in each of the bytes. The area stuffed with the null data becomes the parity area.

[75] The service MUX 340 multiplexes the normal stream which is separately received with the turbo stream processed in the duplicator 330. As the dual TS is generated, the service MUX 340 provides the dual TS to the randomizer unit 150.

[76] An exemplary structure of the transmitting unit 200 of the digital broadcasting transmission system of FIG. 4 will be explained below with reference to the block diagram of FIG. 6. As shown in FIG. 6, the transmitting unit 200 includes a second Reed-Solomon encoder 210, a second interleaver 220, a trellis encoder 230, a MUX 240, and a modulator 250. The second Reed-Solomon encoder 210 encodes the dual TS received from the deinterleaver 140 by adding the parity bytes to the dual TS. More specifically, the second Reed-Solomon encoder 210 inserts parity bytes computed with respect to the dual TS in the first parity area provided by the parity area generating unit 110.

[77] The second interleaver 220 interleaves the dual TS having the added parity bytes added by the second Reed-Solomon encoder 210. The trellis encoder 230 encodes the dual TS after the dual TS is interleaved by the second interleaver 220. The MUX 240 multiplexes the dual TS after the trellis encoding by adding segment sync and field sync to the dual TS. The modulator 250 modulates channel of the dual TS after the multiplexing, and up-converts into a signal of RF channel band. Accordingly, the dual

TS is transmitted to a variety of reception systems via the channel. Although not shown in FIG. 6 and while not required in all aspects, the transmission unit 200 may additionally include general components for the signal transmission, such as a power amplifier (not shown) which amplifies the power of the modulated signal of the modulator 250, and an antenna (not shown), and may further include elements used to broadcast within cable, internet, and/or satellite systems and media through which digital broadcasts can be implemented.

[78] An exemplary structure of the turbo processing unit 130 of the digital broadcasting transmission system of FIG. 4 will be explained below with reference to the block diagram of FIG. 7. With reference to FIG. 7, the turbo processing unit 130 includes a byte/symbol converting unit 131, a de-MUX 132, a turbo encoder 133, a turbo interleaver 134, a turbo data MUX 135, and a symbol/byte converting unit 136. The byte/symbol converting unit 131, the de-MUX 132, the turbo data MUX 135, and the symbol/byte converting unit 136 may be omitted, or replaced with other components in other aspects of the invention.

[79] The byte/symbol converting unit 131 converts the basic unit of the interleaved dual TS of the first interleaver 120 from bytes to symbols. Conversion of the basic unit from byte to symbol will be easily understood with reference to the table D5.2 of U.S. ATSC DTV standard (A/53), the contents of which are incorporated herein by reference in their entirety.

[80] The de-MUX 132 demultiplexes the dual TS of symbol unit to recover the turbo stream. The turbo encoder 133 computes parity bytes with respect to the detected turbo stream, and encodes the turbo stream by stuffing the second parity area with the computed parity bytes. In this particular example, the turbo encoder 133 performs encoding in the unit of each byte of the turbo stream. However, it is understood that other units can be used.

[81] The turbo interleaver 134 interleaves the turbo stream which is convolution - encoded. In this example, the turbo interleaver 134 interleaves in the unit of bit. The turbo data MUX 135 generates a dual TS by multiplexing the interleaved turbo stream and the normal stream. More specifically, the turbo data MUX 135 constructs a dual TS by stuffing the turbo stream to the place before it is detected by the de-MUX 132. The symbol/byte converting unit 136 converts the basic unit of the dual TS from symbols to bytes. This conversion will be easily understood with reference to the table D5.2 of the U.S. ATSC DTV standard (A/53), the disclosure of which is incorporated by reference.

[82] An example of the byte-to-symbol table of table D5.2 is as follows:

[83]

Symbol	Segment 0			Segment 1			Segment 2			Segment 3			Segment 4		
	Trellis	Byte	Bits	Trellis	Byte	Bits	Trellis	Byte	Bits	Trellis	Byte	Bits	Trellis	Byte	Bits
0	0	0	7.6	4	208	5,4	8	412	3,2	0	616	1,0	4	628	7,6
1	1	1	7.6	5	209	5,4	9	413	3,2	1	617	1,0	5	629	7,6
2	2	2	7.6	6	210	5,4	10	414	3,2	2	618	1,0	6	630	7,6
3	3	3	7.6	7	211	5,4	11	415	3,2	3	619	1,0	...	.	..
4	4	4	7.6	8	212	5,4	0	416	3,2	4	620	1,0	..	..	.
5	5	5	7.6	9	213	5,4	1	417	3,2	5	621	1,0	...	..	...
6	6	6	7.6	10	214	5,4	2	418	3,2	6	622	1,0	...	.	..
7	7	7	7.6	11	215	5,4	3	419	3,2	7	623	1,0	...	.	..
8	8	8	7.6	0	204	5,4	4	408	3,2	8	612	1,0	...	..	...
9	9	9	7.6	1	205	5,4	5	409	3,2	9	613	1,0	...	..	...
10	10	10	7,6	2	206	5,4	6	410	3,2	10	614	1,0	...	..	...
11	11	11	7,6	3	207	5,4	7	411	3,2	11	615	1,0	...	..	...
12	0	0	5.4	4	208	3,2	8	412	1,0	0	624	7,6	...	..	...
13	1	1	5.4	5	209	3,2	9	413	1,0	1	625	7,6	...	...	...
...	...	...	...	..	...	..	...	...	...	...	...	...	...	...	...
19	7	7	5.4	11	215	3,2	3	419	1,0	7	631	7,6	...	...	...
20	8	8	5.4	0	204	3,2	4	408	1,0	8	632	7,6	...	...	...
21	9	9	5.4	1	205	3,2	5	409	1,0	9	633	7,6	...	...	...
22	10	10	5,4	2	206	3,2	6	410	1,0	10	634	7,6	...	...	...
23	11	11	5,4	3	207	3,2	7	411	1,0	11	635	7,6	...	...	...
24	0	0	3.2	4	208	1,0	8	420	7,6	0	624	5,4	...	...	...
25	1	1	3.2	5	209	1,0	9	421	7,6	1	625	5,4	...	...	...
..	...	..	...	..	..	..	..	...	.	...	..	...	..	.	..
31	7	7	3,2	11	215	1,0	3	427	7,6	...	...	...	...	...	...
32	8	8	3,2	0	204	1,0	4	428	7,6	...	...	...	...	...	...
33	9	9	3,2	1	205	1,0	5	429	7,6	...	.	..	..	.	..
34	10	10	3,2	2	206	1,0	6	430	7,6	...	.	..	..	.	..
35	11	11	3,2	3	207	1,0	7	431	7,6	...	..	...	...	..	...
36	0	0	1,0	4	216	7,6	8	420	5,4	...	.	..	..	.	..
37	1	1	1,0	5	217	7,6	9	421	5,4	...	..	...	...	..	...
..	...	...	...	..	..	..	..	...	.	...	.	...	...	..	...
47	11	11	1,0	3	227	7,6	...	...	...	...	...	...	...	...	...
48	0	12	7,6	4	216	5,4	..	...	.	...	..	...	...	..	..
49	1	13	7,6	5	217	5,4	..	...	.	...	..	...	...	..	..
..	..	..	...	..	..	..	..	...	.	..	..	...	..	.	.
95	11	23	1,0	..	..	..	..	...	.	.	..	...	..	.	.

[84]

96	0	24	7,6	...	...	...	...	...	...	...	...	...	...	...	...
97	1	25	7,6	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
767	11	191	1,0	...	...	...	...	...	...	...	...	...	...	...	...
768	0	192	7,6	...	...	...	...	...	...	...	...	...	...	...	...
769	1	193	7,6	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
815	11	203	1,0	3	419	7,6	7	623	5,4	11	827	3,2	...	...	...
816	0	204	7,6	4	408	5,4	8	612	3,2	0	816	1,0	...	...	...
817	1	205	7,6	5	409	5,4	9	613	3,2	1	817	1,0	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
827	11	215	7,6	3	419	5,4	7	623	3,2	11	827	1,0	...	...	...

[85] An exemplary structure of the turbo encoder 133 of the turbo processing unit 130 of FIG. 7 will now be explained with reference to the block diagram of FIG. 8. According to FIG. 8, the turbo encoder 133 includes a shift register having three elements D and two adders. Accordingly, the turbo encoder 133 convolution-encodes the data to

recursive systematic convolutional (RSC) code, to insert parities in the second parity area.

[86] FIGS. 9 through 15 show exemplary structures of the dual TS of the digital broadcasting transmission system of FIG. 4. FIG. 9 shows an example of a turbo stream packet received by the TS structure unit 300. The turbo stream packet may comprise 188 bytes, for example. In this case, more particularly, the turbo stream packet comprises 1 byte of sync which is a header, 3 bytes of packet identity (PID), and 184 bytes of turbo data.

[87] FIG. 10 shows an example of a normal stream packet received by the TS structure unit 300. The normal stream packet may comprise 188 bytes, more particularly, 1 byte of sync that is a header, 2 bytes of an adaptation field (AF) header, N bytes of null data, and 182-N bytes of normal data. The AF header is an area where information about an adaptation field is recorded, so it contains information such as a location, a size, and so on of the adaptation field.

[88] FIG. 11 shows an example of a dual TS (or, a stream packet) generated by the TS generating unit 300. In FIG. 11, a part of the turbo stream packet of FIG. 9 is inserted in the null data of the normal stream packet of FIG. 10. In this embodiment, the dual TS comprises 188 bytes, more particularly, 1 byte of sync which is a header, 3 bytes of PID, 2 bytes of an AF header, N bytes of null data, and 182-N bytes of normal data which is a payload. The inserted turbo data shown in FIG. 11 may be a part of the turbo stream packet of FIG. 9. For example, the inserted turbo data of FIG. 11 may be at least one of the sync, the PID, and the turbo data of FIG. 9.

[89] FIG. 12 shows a dual TS generated by the TS generating unit 300 according to another embodiment of the invention. According to the embodiment shown in FIG. 12, the dual TS includes a plurality of consecutive packets. Turbo data is arranged with respect to a predetermined number of packets. That is, FIG. 12 shows that 78-packet turbo streams are inserted in 312-segment packets of one field of the dual TS. The dual TS comprises 1 packet (188 bytes) of the turbo stream and 3 consecutive packets (188 bytes) of the normal streams which are repeatedly arranged at the rate of 1:3.

[90] In case that 70-packet turbo streams are inserted in 312-segment packets of the dual TS, the dual TS is structured in a manner that 4 packets comprising 1 packet (188 bytes) of the turbo streams and 3 consecutive packets (188 bytes) of the normal streams are repeatedly arranged 70 times, and the rest 32 packets comprise the normal stream packets.

[91] FIG. 13 shows a dual TS packet structured by the TS structure unit 300, according to yet another embodiment of the invention. 88 packets of the turbo streams are inserted in 312 segments of the packets of one field of the dual TS. The dual TS is structured in a manner that 4 packets comprising 2 packets (188 bytes) of the turbo

streams and 2 packets (188 bytes) of the normal streams are repeatedly arranged 10 times, and 4 packets comprising 1 packet (188 bytes) of the turbo stream and 3 consecutive packets (188 bytes) of the normal streams are repeatedly arranged at the rate of 1:3 as shown in FIG. 12.

[92] FIG. 14 shows a dual TS structured by the TS structure unit 300, according to still another embodiment of the invention, which is a combined form of the dual TS shown in FIGS. 11 and 12. The dual TS is structured in a manner that 4 packets are repeatedly arranged, the 4 packets comprising 1 packet (188 bytes) of the turbo stream, 1 packet of the normal stream wherein SRS data and the turbo data are inserted in a part of the AF of the normal stream packet, and 2 packets (188 bytes) of the normal stream packets.

[93] FIG. 15 shows the dual TS which is structured in the form of 312-segment packets. As shown in FIG. 15, packet information, along with the turbo data and the normal data, is included in the dual TS. The packet information may be recorded in the option field. In this case, locations of option field can be designated and fixed so as not to overlap with the turbo data. In FIG. 15, "m" denotes a possible length (byte) of the turbo data.

[94] According to FIG. 15, the option fields recording the number of macro blocks (splice countdown) are arranged in the segments 11, 63, 115, 167, 219, 271, while the option fields recoding program clock reference (PCR) are arranged in the segments 15, 67, 119.

[95] When dividing the 312 segments into 52-segment units, the locations of the option fields can be expressed as follows:

[96] Program clock reference (PCR) (using 6 bytes): 52n+15, n=0;

[97] Original program clock reference (OPCR) (using 6 bytes): 52n+15, n=1;

[98] Adaptation field extension length (using 2 bytes): 52n+15, n=2;

[99] Transport private data length (using 5 bytes): 52n+15, n=3, 4, 5; and

[100] a number of macro blocks (splice countdown) (using 1 byte): 52n+15, n=0, 1, 2, 3, 4, 5

[101] The "Transport private data length" among these, for example, exists in the segments 171, 223, 275. The dual TS in which the turbo data is inserted in the null data except the option fields can be structured in various ways besides the above-introduced ways. Additionally, the structural rate of the turbo data can be adjusted according to the structure of the dual TS packet.

[102] FIG. 16 is a block diagram showing a digital broadcasting transmission system that transmits a supplementary reference sequence (SRS). While described in the context of SRS, it is understood that other training sequences and/or sets of known data can be implemented in other aspects of the invention. Referring to FIG. 16, the digital

broadcasting transmission system includes a TS structure unit 801 including a stuffing region to insert SRS data in respective packets of the dual TS, a randomizer 803 randomizing the dual TS packet (hereinafter, referred to as merely "packet"), a supplementary reference sequence inserting unit 805 inserting the SRS data in the stuffing region of the randomized packet, a parity area generating unit 807 generating a first area for inserting a parity for error correction, a first interleaver 809 primarily interleaving the packet where the first area is generated, a turbo processing unit 811 convolution-encoding and interleaving the turbo stream included in the primarily interleaved packet, a deinterleaver 813 deinterleaving the packet processed by the turbo processing unit 811, a Reed-Solomon (RS) encoder 815 inserting the parity in the first area of the deinterleaved packet, a second interleaver 817 secondarily interleaving the packet where the parity is inserted, a trellis encoder 819 trellis encoding the interleaved packet, a MUX 823 multiplexing the trellis-encoded packet by adding a sync, and a modulator 825 channel-modulating and transmitting the multiplexed packet. Additionally, a backwards compatibility parity generator 821 generating a compatible parity may be further included.

[103] Known SRS data for synchronization and/or channel equalization may be inserted in the dual TS packet received by the digital broadcasting transmission, which will be described in detail with reference to FIG. 9. The TS structure unit 801 receives the normal stream and the turbo stream and structures the dual TS packet. According to an embodiment of the invention, the dual TS packet may include a stuffing region for inserting therein the known SRS data for synchronization and/or channel equalization. The TS structure unit 801 may be constructed in the same way as explained above with reference to FIG. 5, and therefore, description thereof will be omitted for the sake of brevity. If the TS structure unit 801 includes the first Reed-Solomon encoder 310 as in the above embodiment shown in FIG. 5, the Reed-Solomon encoder 815 of FIG. 16 will be called as a second Reed-Solomon encoder for the convenience in explanation.

[104] The stuffing region for inserting therein the known SRS data for synchronization and/or channel equalization will now be described. The stuffing region may be a part of the packet including a header and a payload. More particularly, the packet further includes an adaptation field (AF). The stuffing region as part of the AF is positioned not to be overlapped with the option field included in the AF. The option field comprises a program clock reference (PCR) used for synchronization of a demodulator of a receiver, an original PCR (OPCR) used for recording, reservation, and reproduction of a program in the receiver, four circuit blocks, the number of macro blocks (splice countdown) denoting the number of consecutive macro blocks comprising one Cr block and one Cb block, transport private data length denoting length of text data for teletext broadcasting, and AF extension length.

[105] According to an embodiment of the invention, the AF of the packet may further include a stuffing region for inserting therein data for initializing the trellis encoder 809 that will be described hereinafter. The randomizer 803 randomizes the packet including the stuffing region.

[106] The SRS inserting unit 805 inserts the SRS data in the stuffing region of the randomized packet. Here, the SRS data is a reference signal, that is, specific sequence data having a pattern predetermined by the transmitter and the receiver. Since the SRS data is different from general payload data transceiving the pattern of the reference signal, the SRS data can be detected easily from general packets to be transmitted and thereby used for synchronization of the receiver and/or channel equalization. The insertion of the SRS data in the stuffing region can be controlled by a predetermined controlling signal.

[107] The parity area generating unit 807 generates a first area for inserting the parity for error correction in the packet where the SRS data is inserted. As shown, the first area is for inserting therein the parity added by the RS encoder 815. The first interleaver 809 primarily interleaves the packet where the parity area is generated. The turbo processing unit 811 convolution-encodes the turbo stream included in the primarily interleaved packet and interleaves the convolution-encoded turbo stream. The turbo processing unit 811 is configured as shown in FIG. 7 and operates in the same manner as described with reference to FIG. 7.

[108] The deinterleaver 813 deinterleaves the packet output from the turbo processing unit 811. The RS encoder 815 adds the parity to the deinterleaved dual TS. According to an embodiment of the invention, the RS encoder 815, being structured in the form of concatenated code, inserts the parity to correct errors generated by the channel at the first area of the packet where the SRS data is inserted. The second interleaver 817 secondarily interleaves the packet where the parity is inserted. The trellis encoder 819 trellis encodes the secondarily interleaved packet.

[109] According to an embodiment of the invention, the trellis encoder 819 can be initialized to a predetermined value right before the SRS data included in the interleaved packet is trellis-encoded. The initialization is required due to the SRS data. More specifically, the trellis encoder 819 may generate different encoded results for the same data depending on the previously encoded data. Therefore, the result of trellis encoding of the SRS data may vary according to data previous to the SRS data and in this case, the receiver cannot discriminate the SRS data. To solve such a problem, the trellis encoder 819 is initialized to the predetermined value right before trellis encoding of the SRS data. In other words, the predetermined value is trellis encoded right before the SRS data is trellis-encoded.

[110] The trellis encoder 819 according to an embodiment of the invention may include i)

a general mode that trellis encodes the packet interleaved by the interleaver, ii) an initialization mode that initializes the trellis encoder 819, and iii) a parity replacement mode that trellis-encodes the compatible parity substituted for the whole or a part of the parity applied by the RS encoder 815. For this purpose, the trellis encoder 819 may receive a control signal from a control signal generation unit (not shown), the control signal operated in the general mode, the initialization mode, or the parity replacement mode.

[111] When the trellis encoder 819 receives a control signal commanding the initialization mode while operating in the general mode, the trellis encoder 819 is operated in the initialization mode. If it receives a control signal commanding the parity replacement mode while it is operating in the general mode, the trellis encoder 819 is operated in the parity replacement mode. The control signal may be supplied from the control signal generation unit (not shown) which is aware of location of the inserted SRS data, location of the inserted value for initializing the trellis encoder 819, and location for replacing the compatible parity.

[112] The backwards compatibility parity generating unit 821 receives the packet where the parity is added by the RS encoder 815 and the packet encoded by the trellis encoder 819, and generates the compatible parity based on the received packets. More specifically, the backwards compatibility parity generating unit 821 includes a symbol decoder (not shown) receiving the packet encoded by the trellis encoder 819 and converting a symbol-mapped packet to a byte form, a deinterleaver (not shown) deinterleaving the decoded packet, and a memory (not shown) replacing at least a part of the received packet with the deinterleaved packet and storing the deinterleaved packet. Preferably, the memory (not shown) may replace and store only the different part between the received packet and the deinterleaved packet. For this, the backwards compatibility parity generating unit 821 may receive a predetermined control signal from the control signal generation unit (not shown), for example. The memory (not shown) may include an RS encoder (not shown) adding the compatible parity to the packet stored in the memory, an interleaver (not shown) interleaving the packet where the compatible parity is added, and a symbol encoder (not shown) symbol-mapping the packet in the byte form in order to transmit the interleaved packet to the trellis encoder 819.

[113] The MUX 823 multiplexes the trellis-encoded packet by adding the segment sync and the field sync to the trellis-encoded packet. The modulator 825 performs channel-modulation with respect to the packet where the segment sync and the field sync are added, up-converts the modulated packet to a signal of an RF channel band, and transmits the converted signals.

[114] FIGS. 17 through 23 show the structure of a TS packet including the SRS,

according to an embodiment of the invention. FIG. 17 shows a turbo stream packet received by the TS structure unit 801. The turbo stream packet (188 bytes) comprises 1 byte of sync which is a header, 3 bytes of PID, and 184 bytes of turbo data. FIG. 18 shows a normal stream packet including a stuffing region for inserting the known SRS signal for synchronization in the TS structure unit. The normal stream packet (188 bytes) comprises 1 byte of sync which is a header, 3 bytes of PID, 2 bytes of AF header, S-bytes of stuffing region, N-bytes of null data, and 182-N-S bytes of normal data which is a payload. FIG. 19 shows a dual TS packet including the stuffing region for inserting the known SRS signal for synchronization in the TS structure unit, according to an embodiment of the invention. More specifically, in FIG. 19, part of the turbo stream packet of FIG. 17 is inserted in the null data of the normal stream packet of FIG. 11B, and the SRS data is inserted in the stuffing region. In this embodiment, the dual TS comprises 188 bytes, more particularly, 1 byte of sync which is a header, 3 bytes of PID, 2 bytes of AF header, S-bytes of SRS data, N-bytes of null data, and a 182-N-S bytes of normal data which is a payload.

[115] FIG. 20 shows a dual TS packet including the stuffing region for inserting the known SRS signal for synchronization in the TS structure unit, according to another embodiment of the invention. Differently from the dual TS packet of FIG. 11, 78-packet turbo streams are inserted in 312-segment packets of one field of the dual TS. The dual TS is structured in a manner that 4 packets comprising 1 packet (188 bytes) of the turbo stream and 3 consecutive packets (188 bytes) of the normal streams are repeatedly arranged at the rate of 1:3. When 70 packets of the turbo streams are inserted in 312 segments of the packets of the dual TS, on the other hand, the dual TS is structured in a manner that 4 packets comprising 1 packet (188 bytes) of the turbo streams and 3 consecutive packets (188 bytes) of the normal streams are repeatedly arranged 70 times, and the rest 32 packets comprise the normal stream packets.

[116] FIG. 21 shows a dual TS packet including the stuffing region for inserting the known SRS signal for synchronization in the TS structure unit, according to yet another embodiment of the invention. Differently from the dual TS packet of FIG. 11, 88-packet turbo streams are inserted in 312-segment packets of one field of the dual TS. The dual TS is structured in a manner that 4 packets comprising 2 packets (188 bytes) of the turbo streams and 2 packets (188 bytes) of the normal streams are repeatedly arranged 10 times, and 4 packets comprising 1 packet (188 bytes) of the turbo stream and 3 consecutive packets (188 bytes) of the normal streams are repeatedly arranged at the rate of 1:3 as shown in FIG. 12.

[117] FIG. 22 shows a dual TS packet including the stuffing region for inserting the known SRS signal for synchronization in the TS structure unit, according to still another embodiment of the invention, which is a combined form of the dual TS packets

shown in FIGS. 19 and 20. The dual TS packet is structured in a manner that 4 packets are repeatedly arranged, the 4 packets comprising 1 packet (188 bytes) of the turbo stream, 1 packet of the normal stream wherein the SRS data and the turbo data are inserted in a part of the AF of the normal stream packet, and 2 packets (188 bytes) of the normal stream packets.

[118] FIG. 23 shows the dual TS packet including the stuffing region for inserting the known SRS signal for synchronization in the TS structure unit, in the form of segment packets as shown in FIG. 19. Among 312-segment packets of one field of dual TS, the turbo data is inserted in a non-option field part of the packet including data of the option field. In FIG. 23, 'k' denotes a possible length (byte) of the SRS data. In addition, the turbo data is inserted next to the SRS data. Here, 'm' denotes a possible length (byte) of the turbo data.

[119] When dividing the 312 segments by 52-segment unit, location of the option field can be expressed as follows:

[120] Program clock reference (PCR) (using 6 bytes): 52n+15, n=0;

[121] Original program clock reference (OPCR) (using 6 bytes): 52n+15, n=1;

[122] Adaptation field extension length (using 2 bytes): 52n+15, n=2;

[123] Transport private data length (using 5 bytes): 52n+15, n=3, 4, 5; and

[124] The number of macro blocks (splice countdown) (using 1 byte): 52n+15, n=0, 1, 2, 3, 4, 5.

[125] The "Transport private data length" among these, for example, exists on the location where n=3, 4, or 5.

[126] The dual TS in which the turbo data is inserted in the null data except the option field can be structured in various ways besides the above-introduced ways. Additionally, the structural rate of the turbo data can be adjusted according to the structure of the dual TS packet.

[127] FIG. 24 is a block diagram showing a digital broadcasting reception system according to an embodiment of the invention. Referring to FIG. 24, the digital broadcasting reception system comprises a modulator 1001, an equalizer 1003, a first processor 1050, and a second processor 1060. The digital broadcasting reception system receives the dual TS, demodulates the received dual TS, equalizes the demodulated dual TS, Viterbi-decodes and deinterleaves the normal stream of the equalized dual TS, RS-decodes the deinterleaved normal stream, and derandomizes the RS-decoded normal stream. The digital broadcasting reception system turbo-decodes and deinterleaves the turbo stream of the equalized dual TS, RS-decodes the deinterleaved turbo stream, and derandomizes the RS-decoded turbo stream. The modulator 1001 performs synchronization detection and demodulation with respect to the baseband signal of the received dual TS. The equalizer 1003 compensates for channel

distortion generated by multipaths of the channel from the demodulated dual TS, thereby removing interference between the received symbols.

[128] The first processor 1050 includes a Viterbi decoder 1017, a deinterleaver 1021, an RS decoder 1023, and a derandomizer 1025. The Viterbi decoder 1017 performs error correction with respect to the normal stream of the equalized dual TS and decodes the error-corrected symbols, thereby outputting the symbol packet. The distributed decoded packet can be rearranged by the deinterleaver 1021. The RS decoder 1023 performs error correction with respect to the deinterleaved packet. The derandomizer 1025 derandomizes the packet error-corrected by the RS decoder 1023. Accordingly, the normal stream of the dual TS is restored.

[129] The second processor 1060 includes a turbo decoder 1005, a second deinterleaver 1009, an RS decoder 1011, a derandomizer 1013, and a turbo DE-MUX 1015. However, it is understood that the second processor 1060 need not include all shown elements, such as the turbo DE-MUX 1015, in all aspects of the invention. The turbo decoder 1005 turbo-decodes the turbo stream of the equalized dual TS. The turbo decoding is performed by trellis-decoding the turbo stream of the equalized dual TS, deinterleaving and convolution-decoding the trellis-decoded turbo stream, frame-formatting the convolution-decoded turbo stream, and thereby converting the turbo stream in the symbol form to the byte form.

[130] Meanwhile, the turbo decoder 1005 is capable of trellis-decoding the normal stream of the equalized dual TS. The trellis-decoded normal stream is converted from the symbol form to the byte form using a symbol-byte converter (not shown). The converted normal stream is deinterleaved to remove the parity. The parity-removed normal stream is derandomized, thereby being restored.

[131] The deinterleaver 1009 deinterleaves the turbo-decoded turbo stream. The RS decoder 1011 removes the parity added to the deinterleaved turbo stream. The derandomizer 1013 derandomizes the parity-removed turbo stream. The turbo DE-MUX 1015 demultiplexes the derandomized turbo stream. The turbo stream herein is capable of receiving the turbo data among the turbo stream demultiplexed and formatted to the frame form.

[132] FIG. 25 is a block diagram of the turbo decoder of the digital broadcasting reception system of FIG. 24. Referring to FIGS. 24 and 25, the turbo decoder 1005 comprises a trellis decoder 2001, a turbo deinterleaver 2003, a turbo decoder 2005, a turbo interleaver 2007, a frame formatter 2009, and a symbol/bye converting unit 2011.

[133] The trellis decoder 2007 trellis-decodes the equalized dual TS. According to this embodiment, the trellis decoder 2007 may trellis-decode the turbo stream of the dual TS and also a soft decision turbo stream which is turbo-interleaved. The turbo deinterleaver 2003 deinterleaves the trellis-decoded turbo stream. The turbo decoder 2005

convolution-decodes the deinterleaved turbo stream, thereby outputting a soft decision or a hard decision. "Soft decision" refers to a value including information on a metric of the turbo stream. For example, when the metric of the turbo stream is "1"and when the metric of the turbo stream results in "0.8" the soft decision value "0.8" is output. When the metric of the turbo stream results in "1" the hard decision, that is, the turbo stream, is output.

[134] The turbo interleaver 2007 interleaves the hard decision turbo stream that is convolution-decoded. The frame formatter 2009 formats the convolution-decoded hard decision turbo stream corresponding to the frame of the dual TS.

[135] The operation of the symbol/byte converter 2011 to convert the frame-formatted turbo stream from the symbol form to the byte form can be easily understood by referring to Table D5.2 of the 'ATSC DTV standard (A/53)' as set forth above.

[136] FIG. 26 is a flowchart for explaining an example of a signal processing method in the digital broadcasting transmission system of FIG. 6. Referring to FIG. 26 and FIG. 6, the TS structure unit 300 receives the normal stream and the turbo stream, generates the second area for inserting the parity in the received turbo stream, and multiplexes the received normal stream and the turbo stream where the second area is generated, thereby structuring the dual TS (S1201). The randomizer 150 randomizes the dual TS output from the TS structure unit 300 (S1203). The parity area generator 110 generates the first area for inserting the parity for error correction in the randomized dual TS (S1205). The first interleaver 120 primarily interleaves the dual TS where the parity area is generated (S1207), and the turbo processing unit 130 convolution-encodes the turbo stream included in the primarily interleaved dual TS and interleaves the convolution-encoded turbo stream (S1209). The deinterleaver 140 deinterleaves the dual TS output from the turbo processing unit 130 (S1211). The RS encoder 210 inserts the parity in the first area of the deinterleaved dual TS (S1213).

[137] The second interleaver 220 secondarily interleaves the dual TS where the parity is inserted (S1215). The trellis-encoder 230 trellis-encodes the secondarily interleaved dual TS (S1217). The MUX 240 multiplexes the trellis-encoded dual TS by adding the segment sync and the field sync (S1219). The modulator 250 channel-modulates the multiplexed dual TS, up-converts the dual TS to a signal of a radio frequency (RF) channel band, and transmits the up-converted signal (S1221).

[138] FIG. 27 is a flowchart for explaining an example of a signal processing method in the turbo processing unit of FIG. 7. Referring to FIG. 27 and FIG. 7, the byte-symbol converter 131 converts the primarily interleaved dual TS from the byte form to the symbol form (S1301). The TS DE-MUX 132 demultiplexes the dual TS converted to the symbol form into the normal stream and the turbo stream (S1303). The turbo encoder 133 convolution-encodes the turbo stream of the demultiplexed dual TS

(S1305).

[139] Through the convolution-encoding, the parity with respect to the turbo stream is additionally generated and inserted in the second area of the turbo stream. The turbo interleaver 134 interleaves the convolution-encoded turbo stream (S1307). The turbo data MUX 135 multiplexes the interleaved turbo stream and the demultiplexed normal stream, thereby structuring the dual TS (S1309). The symbol-byte converter 136 converts the dual TS from the symbol form to the byte form (S1311).

[140] FIG. 28 is a flowchart for explaining an example of a signal processing method in the digital broadcasting reception system of FIG. 24. Referring to FIG. 28 and FIG. 24, the demodulator 1001 detects and demodulates synchronization according to the sync added to the signal of the baseband of the received dual TS (S1401). The equalizer 1003 compensates channel distortion generated by multipaths of the channel from the demodulated dual TS, thereby removing interference between the received symbols (S1403).

[141] The Viterbi decoder 1005 of the first processor 1050 performs error correction with respect to the normal stream of the equalized dual TS, decodes the error-corrected symbol, and outputs the symbol packet (S1405). The distributed decoded packet is rearranged by the deinterleaver 1009 (S1407). The RS decoder 1023 performs error correction with respect to the deinterleaved packet (S1409). The derandomizer 1025 derandomizes the packet error-corrected by the RS decoder 1023 (S1411). Accordingly, the normal stream of the dual TS is restored.

[142] The turbo decoder 1005 of the second processor 1060 turbo-decodes the turbo stream of the equalized dual TS (S1413). The turbo decoding is performed by trellis-decoding the turbo stream of the equalized dual TS, deinterleaving and convolution-decoding the trellis-decoded turbo stream, frame-formatting the convolution-decoded turbo stream, and thereby converting the turbo stream from the symbol form to the byte form. The deinterleaver 1009 deinterleaves the turbo-decoded turbo stream (S1415). The RS decoder 1011 removes the parity added to the deinterleaved turbo stream (S1417). The derandomizer 1013 derandomizes the parity-removed turbo stream (S1419). The turbo DE-MUX 1015 demultiplexes the derandomized turbo stream (S1421). The turbo stream herein is capable of receiving the turbo data among the turbo stream demultiplexed and formatted to the frame form.

[143] FIG. 29 is a flowchart for explaining an example of a signal processing method in the turbo decoder of FIG. 25. Referring to FIG. 29 and FIG. 25, the trellis-decoder 2007 of the turbo decoder 1005 trellis-decodes the equalized dual TS (S1501), the turbo deinterleaver 2003 deinterleaves the trellis-decoded turbo stream (S1503), and the turbo decoder 2005 convolution-decodes the deinterleaved turbo stream (S1507), thereby outputting soft decision or hard decision. Here, the soft decision refers to a

value including information on a metric of the turbo stream. For example, when the metric of the turbo stream is "1" and when the metric of the turbo stream results in "0.8", the soft decision value "0.8" is output. When the metric of the turbo stream results in "1" the hard decision, that is, the turbo stream is output. The output soft decision is interleaved through the turbo interleaver 2007 (S1505) and trellis-decoded for error correction. Therefore, the above processes are repeated until the metric of the turbo stream becomes "1" to output the hard decision. Details of turbo coding per se are not provided because they are well known in the art. Moreover, the invention is not limited to turbo coding, and aspects of the invention may use other types of coding in place of or in addition to turbo coding.

[144] The frame formatter 2009 formats the convolution-decoded hard decision turbo stream corresponding to the frame of the dual TS (S1509). The symbol-byte converter 2011 may convert the frame-formatted turbo stream from the symbol form to the byte form (S1511).

CLAIMS:

1. A digital broadcast receiver, comprising:

a receiver receiving a transport stream;

a turbo decoder detecting and turbo-decoding an additional data stream in the received transport stream; and

a processor deinterleaving and Reed-Solomon-decoding the turbo-decoded additional data stream,

wherein the transport stream comprises the additional data stream, a normal data stream, known data, and control information, which is information on the transport stream.

2. The digital broadcast receiver according to claim 1, wherein the transport stream is constituted by repeating a packet in which the additional data stream and the known data are mixed, and is interleaved.

3. The digital broadcast receiver according to claim 1, wherein the transport stream is constituted by periodically repeating a packet, comprising only the additional data stream in a data area, and is interleaved.

4. The digital broadcast receiver according to claim 1, wherein the transport stream is constituted by repeating at least two packets from among a packet in which the additional data stream and the known data are mixed, a packet comprising only the known data in a data area, a packet comprising only the additional data stream in the data area, and a packet comprising only the normal data stream in the data area, at a preset number of times, and is interleaved.

5. A method for processing a stream in a digital broadcast receiver, the method comprising:

receiving a transport stream;

detecting and turbo-decoding an additional data stream in the received transport stream; and

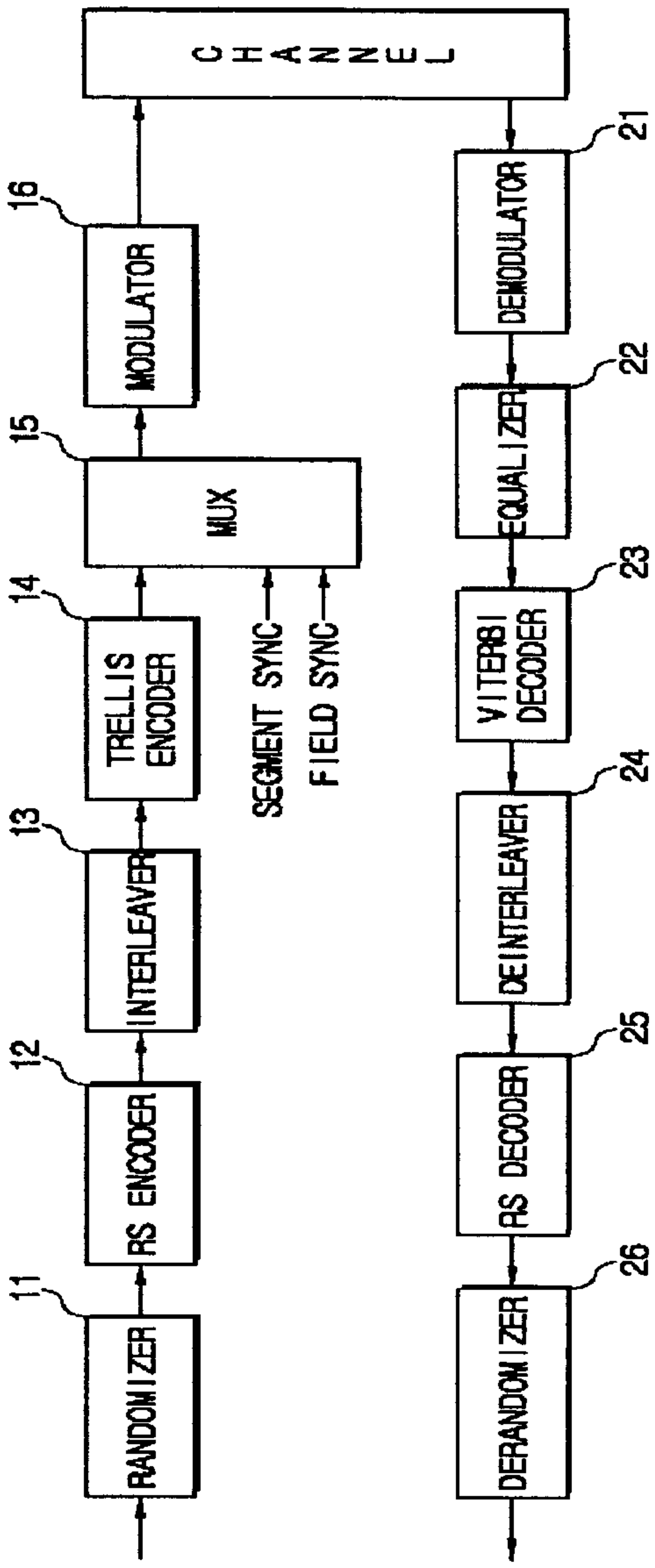
deinterleaving and Reed-Solomon-decoding the turbo-decoded additional data stream, wherein the transport stream comprises the additional data stream, a normal data stream, known data, and control information, which is information on the transport stream.

6. The method according to claim 5, wherein the transport stream is constituted by, at a digital broadcast transmitter, repeating a packet in which the additional data stream and the known data are mixed, and is interleaved.

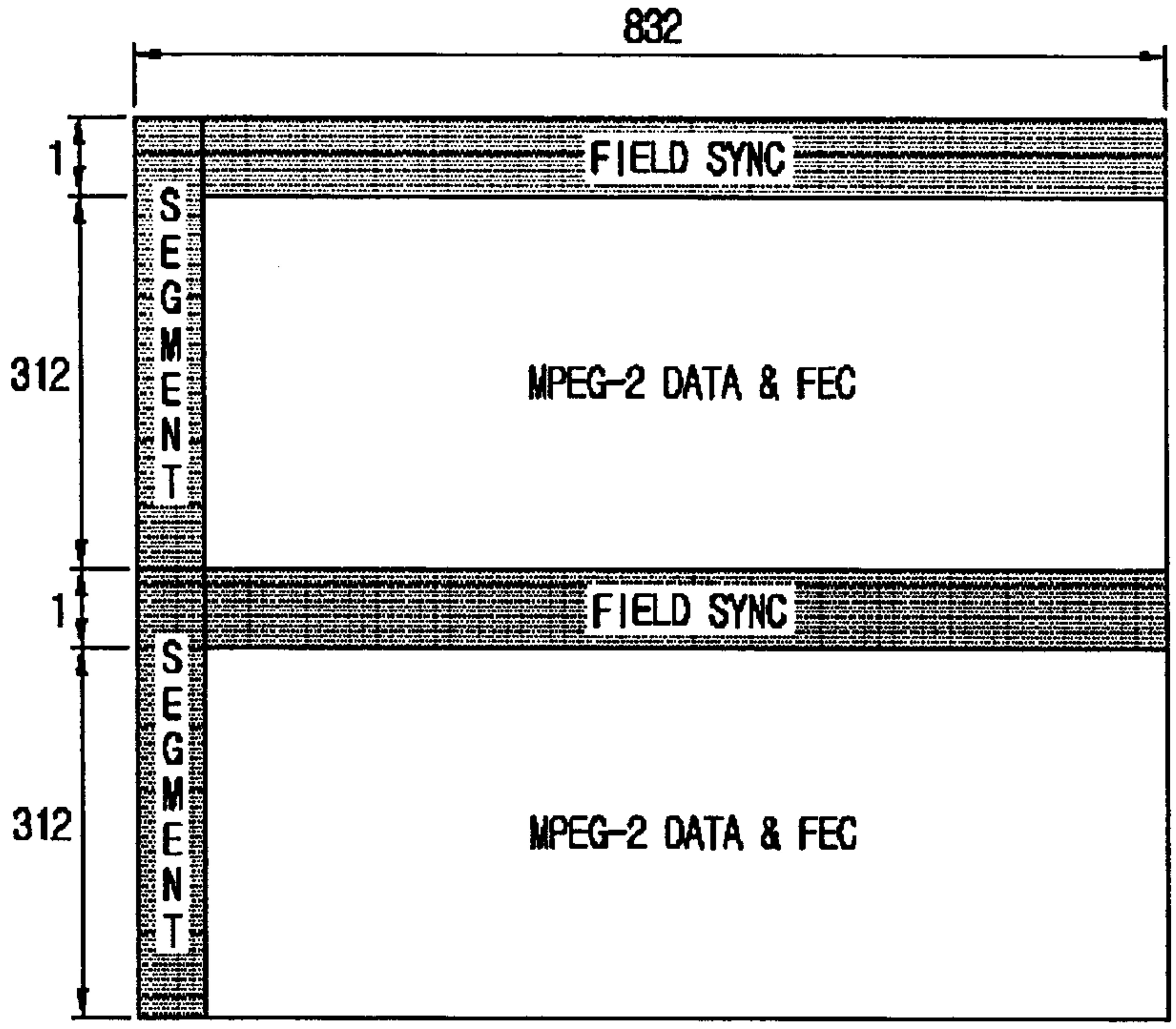
7. The method according to claim 5, wherein the transport stream is constituted by, at a digital broadcast transmitter, periodically repeating a packet, comprising only the additional data stream in a data area, and is interleaved.

8. The method according to claim 5, wherein the transport stream is constituted by, at a digital broadcast transmitter, repeating at least two packets from among a packet in which the additional data stream and the known data are mixed, a packet comprising only the known data in a data area, a packet comprising only the additional data stream in the data area, and a packet comprising only the normal data stream in the data area, at a preset number of times, and is interleaved.

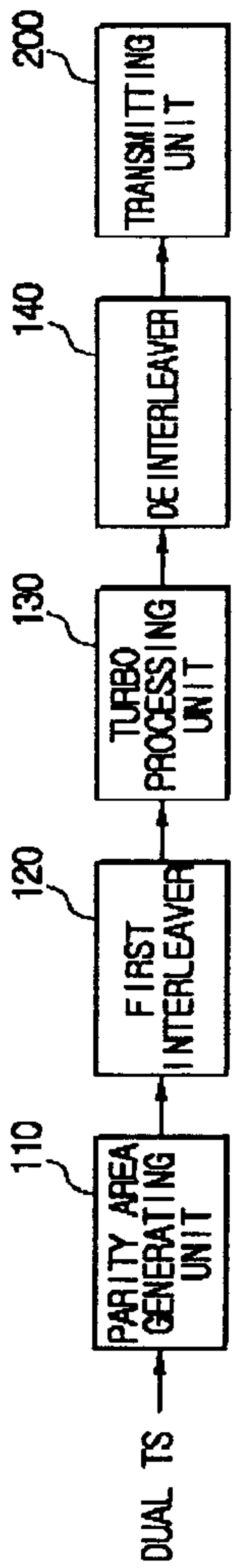
[Fig. 1]


CHANNEL
MODULATOR
MUX
TRELLIS ENCODER
INTERLEAVER
RS ENCODER
RANDOMIZER
SEGMENT SYNC
FIELD SYNC
DEMODULATOR
EQUALIZER
VITERBI DECODER
DEINTERLEAVER
RS DECODER
DERANDOMIZER
11
12
13
14
15
16
21
22
23
24
25
26

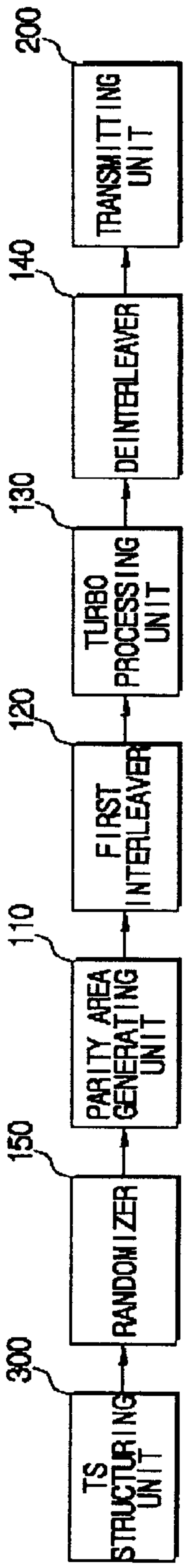
[Fig. 2]


832
1
FIELD SYNC
312
SEGMENT
MPEG-2 DATA & FEC
1
FIELD SYNC
312
SEGMENT
MPEG-2 DATA & FEC

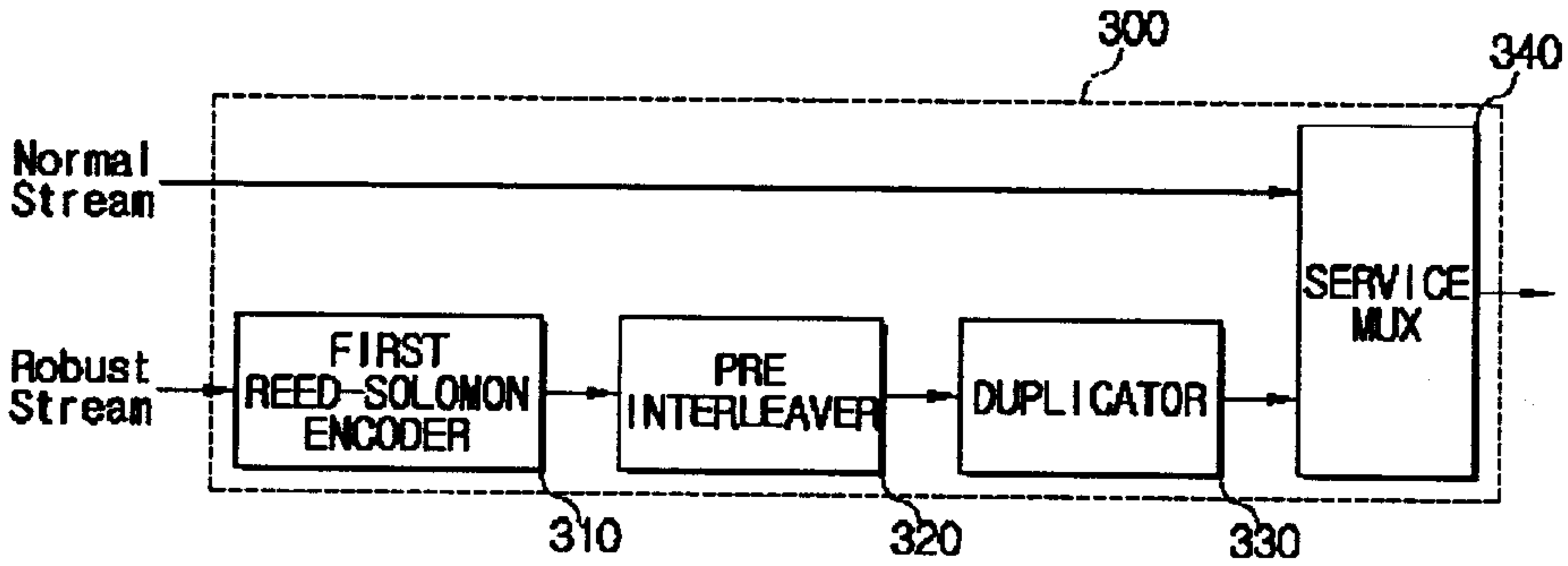
[Fig. 3]


DUAL TS
110
PARITY AREA GENERATING UNIT
120
FIRST INTERLEAVER
130
TURBO PROCESSING UNIT
140
DEINTERLEAVER
200
TRANSMITTING UNIT

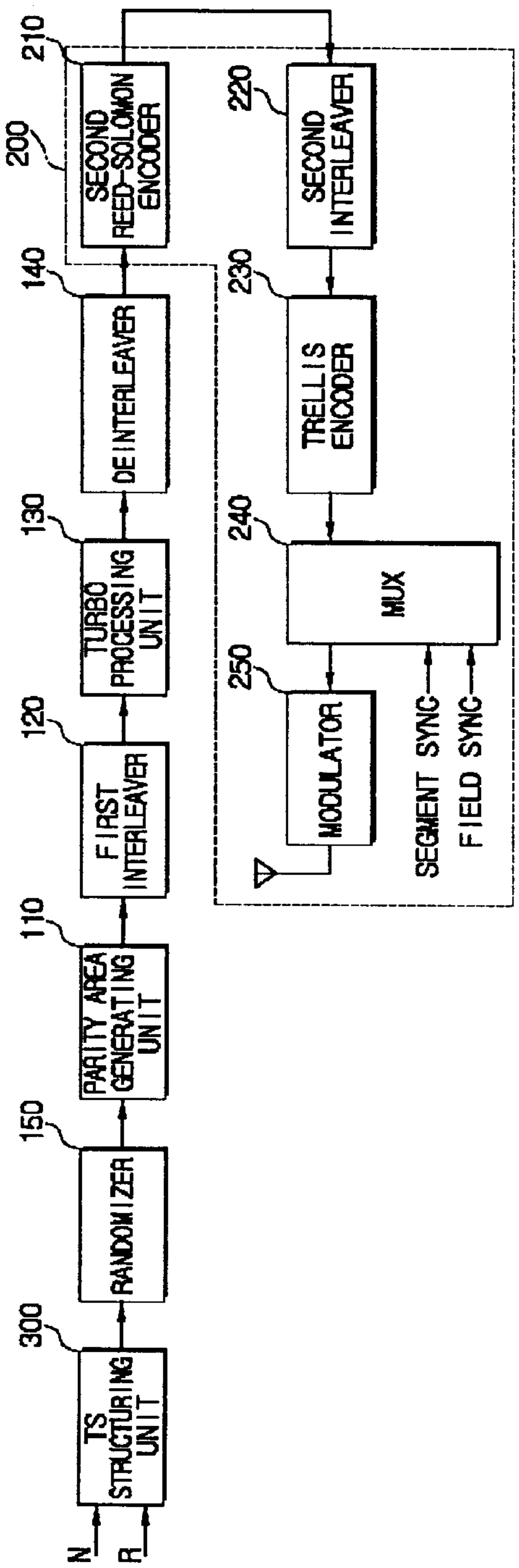
[Fig. 4]


200
TRANSMITTING UNIT
140
DEINTERLEAVER
130
TURBO PROCESSING UNIT
120
FIRST INTERLEAVER
110
PARITY AREA GENERATING UNIT
150
RANDOMIZER
300
TS STRUCTURING UNIT

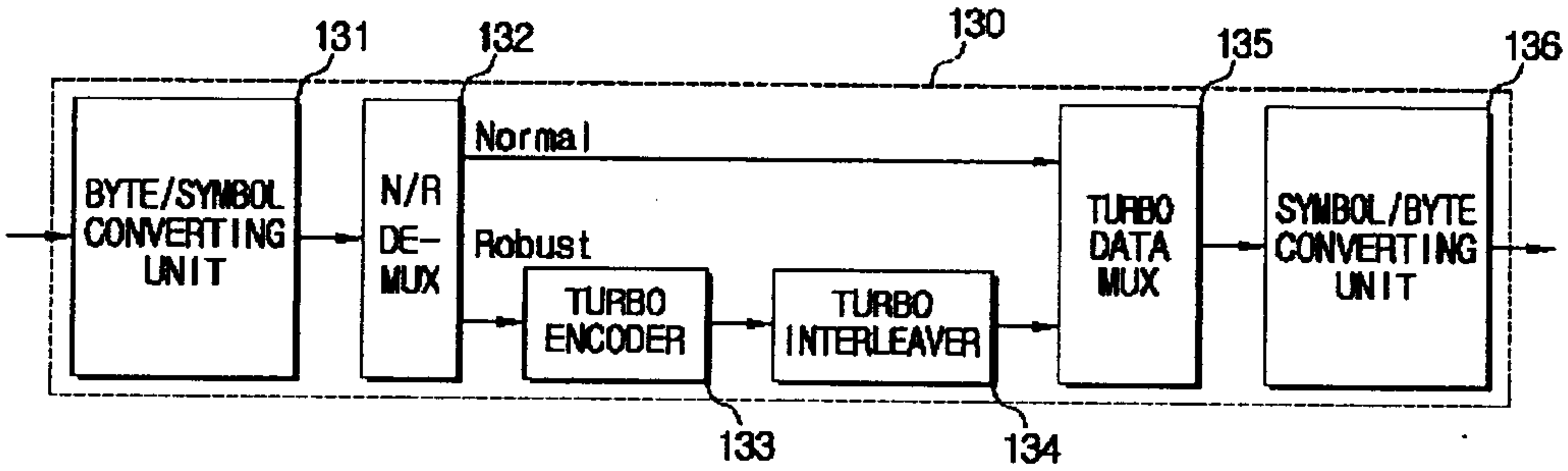
[Fig. 5]


300
340
Normal Stream
Robust Stream
FIRST REED-SOLOMON ENCODER
PRE INTERLEAVER
DUPLICATOR
SERVICE MUX
310
320
330

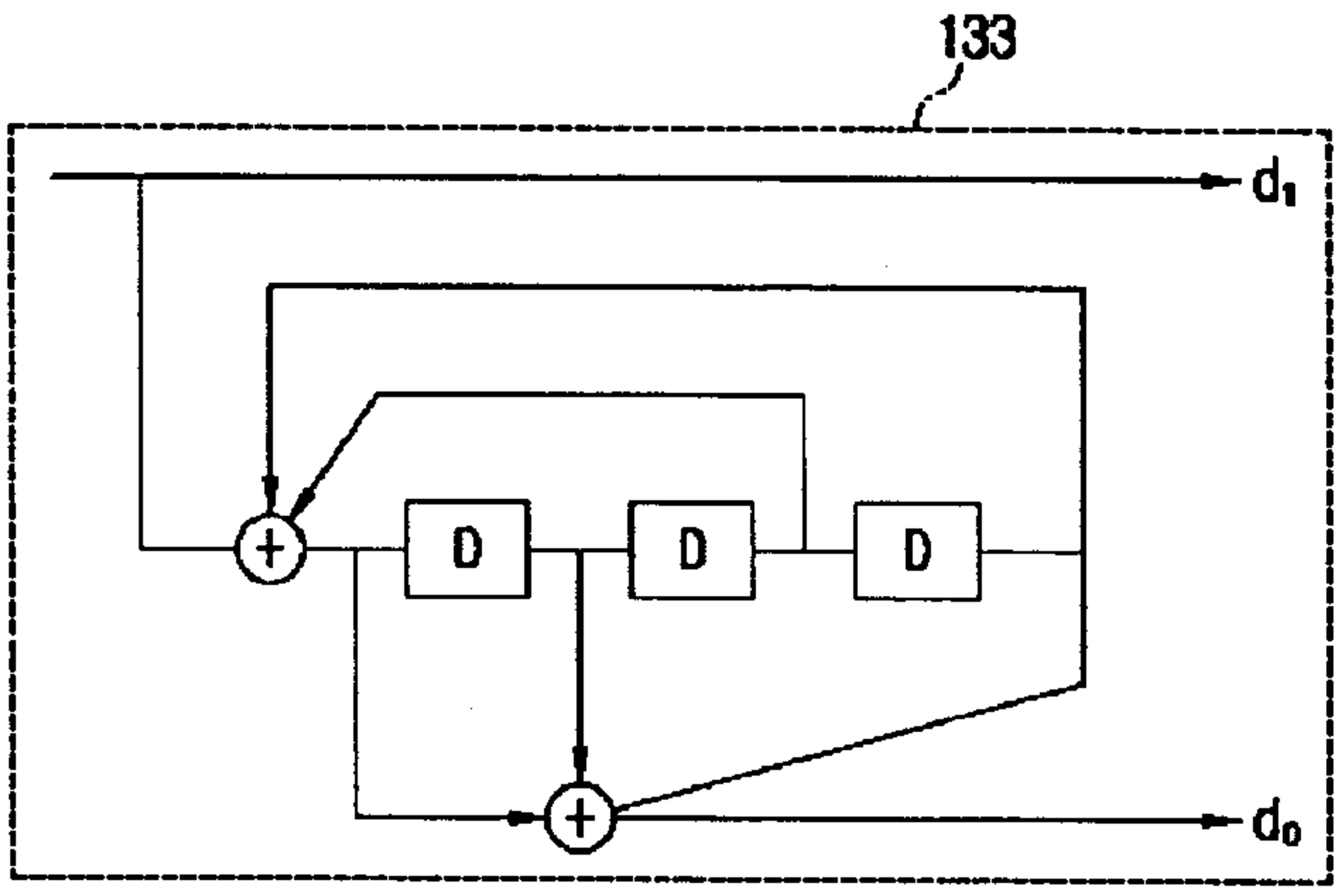
[Fig. 6]


N
R
TS STRUCTURING UNIT
300
RANDOMIZER
150
PARITY AREA GENERATING UNIT
110
FIRST INTERLEAVER
120
TURBO PROCESSING UNIT
130
DEINTERLEAVER
140
SECOND REED-SOLOMON ENCODER
210
200
SECOND INTERLEAVER
220
TRELLIS ENCODER
230
MUX
240
MODULATOR
250
SEGMENT SYNC
FIELD SYNC

[Fig. 7]


130
131
BYTE/SYMBOL CONVERTING UNIT
132
N/R DE-MUX
Normal
Robust
TURBO ENCODER
133
TURBO INTERLEAVER
134
TURBO DATA MUX
135
SYMBOL/BYTE CONVERTING UNIT
136

[Fig. 8]



[Fig. 9]

SYNC	PID	Robust Data
1	3	

[Fig. 10]

SYNC	PID	AF Header	Null data	Normal Data
1	3	2	N	182-N

[Fig. 11]

SYNC	PID	AF Header	Robust Data	Normal Data
1	3	2	N	182-N

[Fig. 12]

1	3	184
SYNC	PID	Robust Data
SYNC	PID	Normal Data
SYNC	PID	Normal Data
SYNC	PID	Normal Data

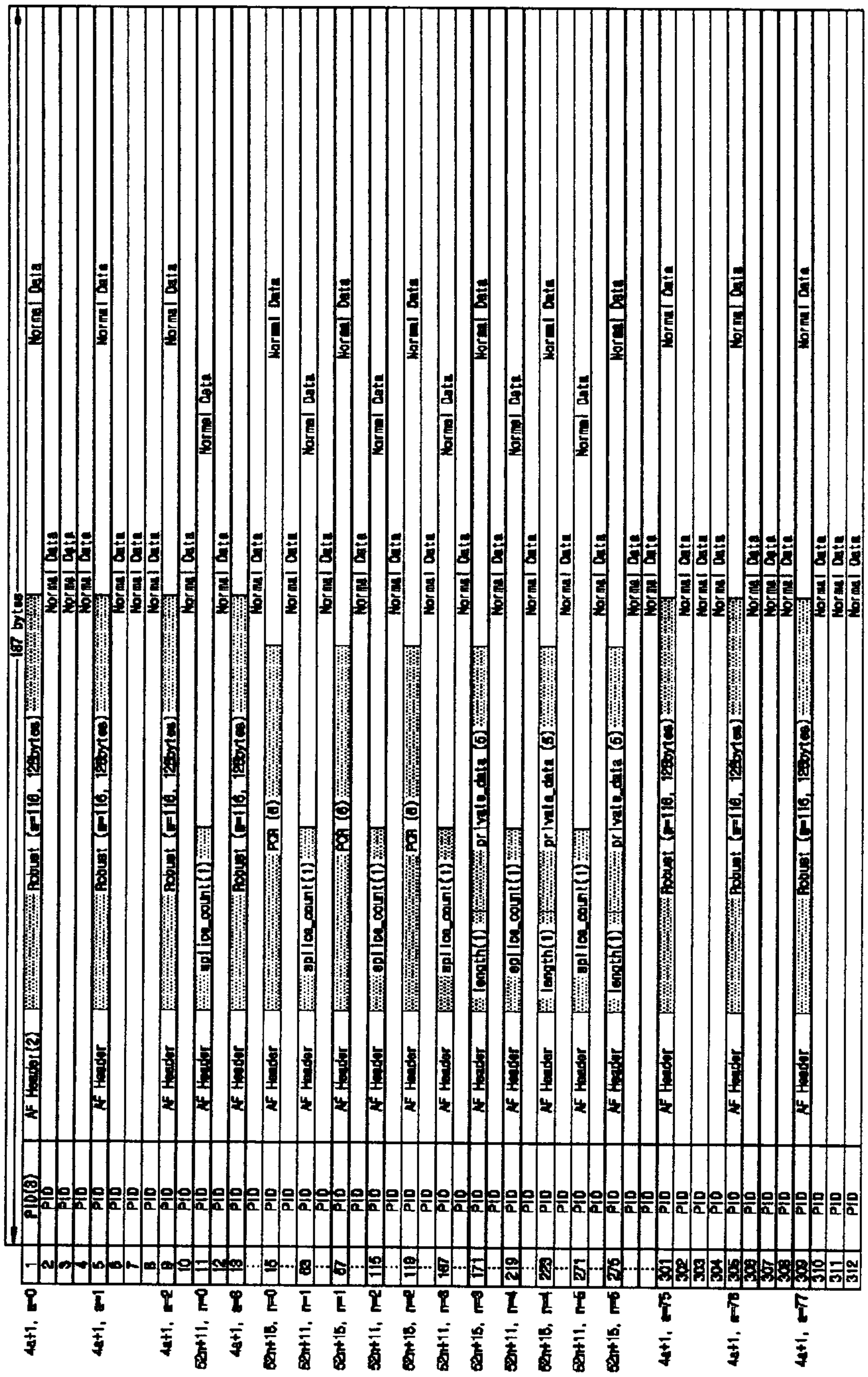
[Fig. 13]

1	3	184
SYNC	PID	Robust Data
SYNC	PID	Robust Data
SYNC	PID	Normal Data
SYNC	PID	Normal Data

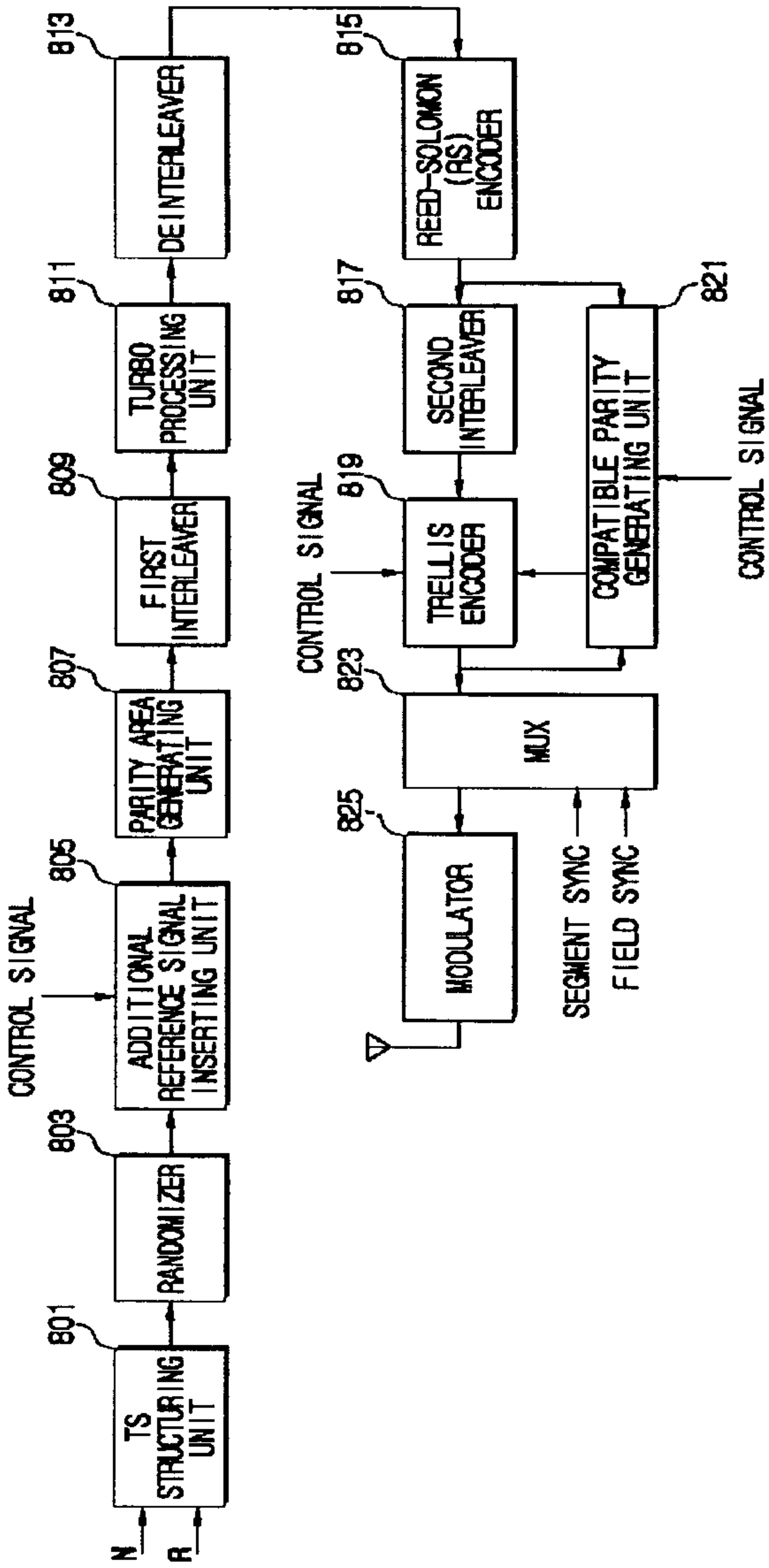
[Fig. 14]

1	3	2		184
SYNC	PID	Robust Data		
SYNC	PID	AF Header	Robust Data	Normal Data
SYNC	PID	Normal Data		
SYNC	PID	Normal Data		

[Fig. 15]



[Fig. 16]



[Fig. 17]

SYNC	PID	Robust Data
1	3	

[Fig. 18]

SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Null data	Normal Data
1	3	2	s	N	182-N-S

[Fig. 19]

SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Robust Data	Normal Data
1	3	2	S	N	182-N-S

[Fig. 20]

1	3	2	S	182-S
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Robust Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data

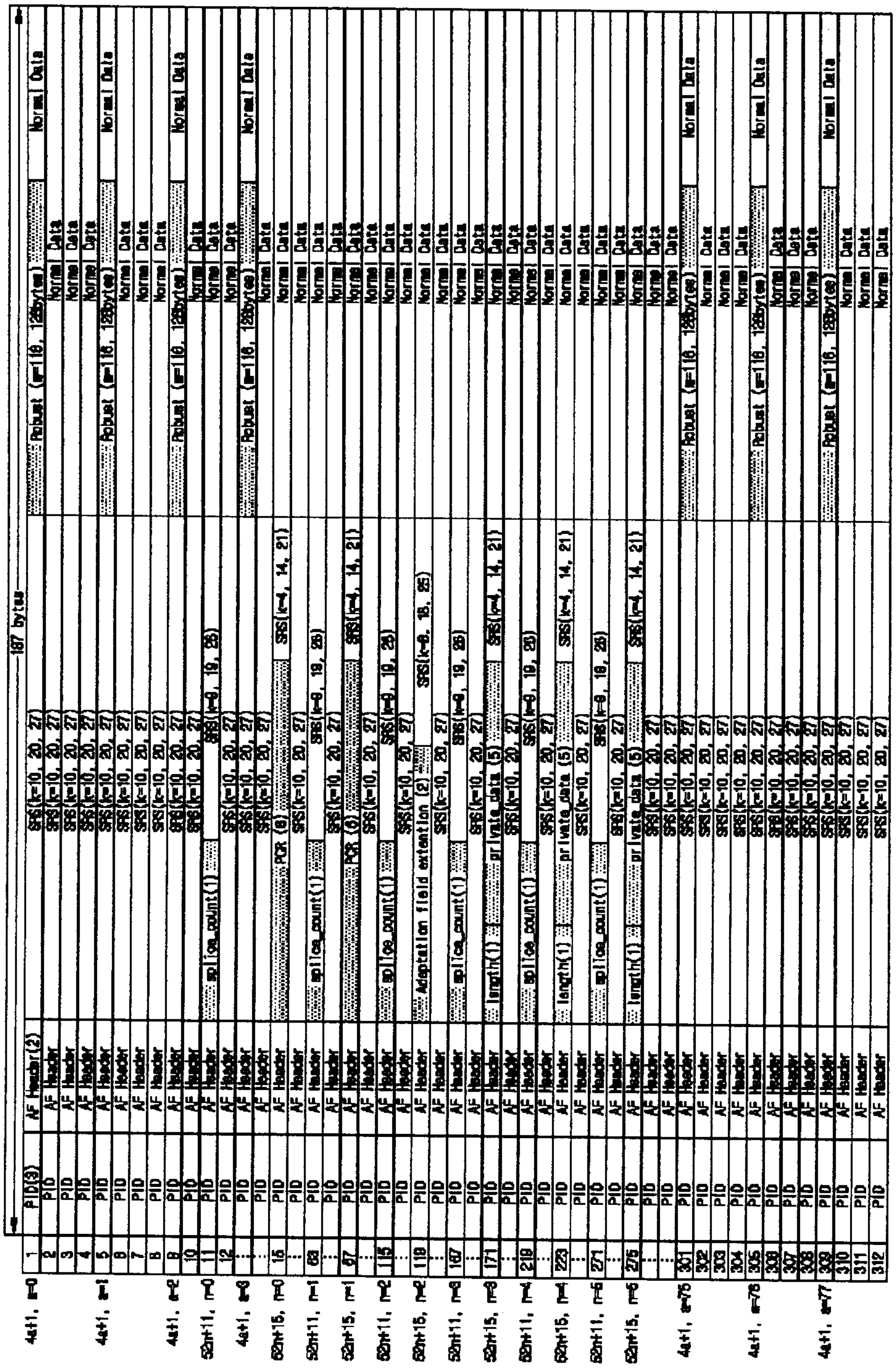
[Fig. 21]

1	3	2	S	182-S
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Robust Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Robust Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data

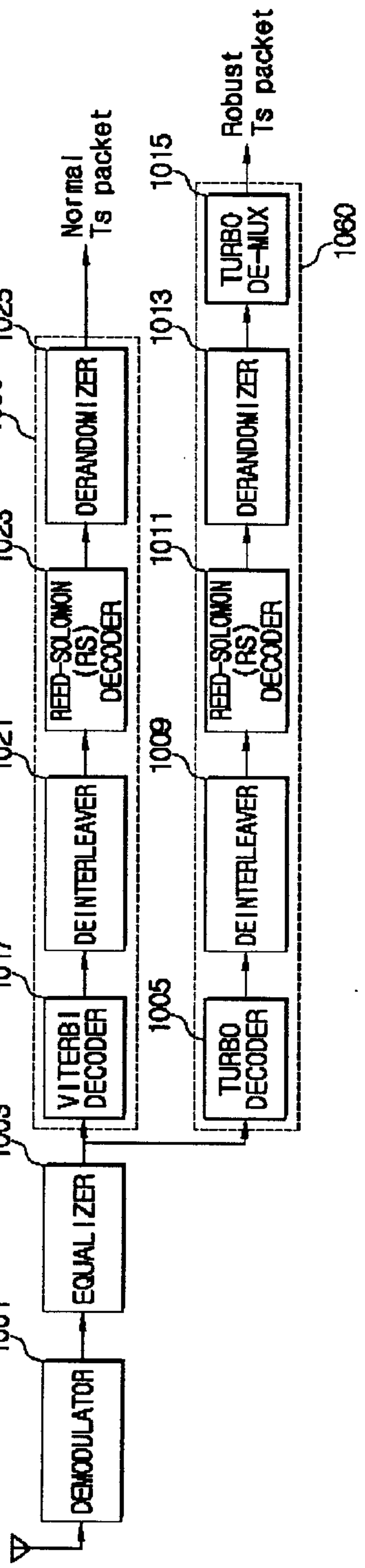
[Fig. 22]

1	3	2	S	182-S	
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Robust Data	
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Robust Data	Normal Data
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data	
SYNC	PID	AF Header	SRS (Supplementary Reference Sequence)	Normal Data	

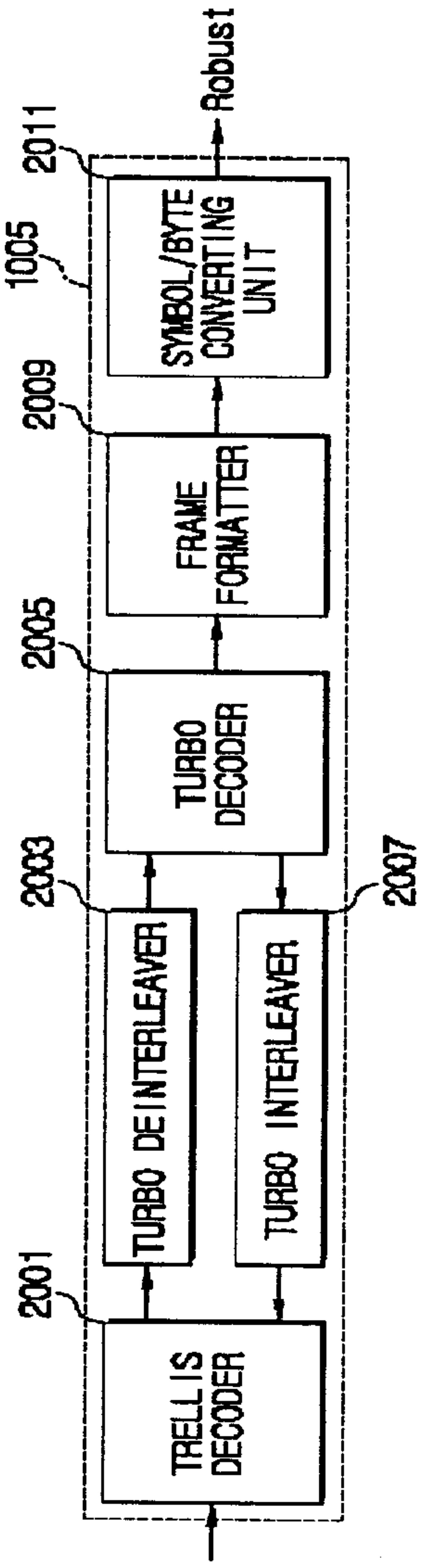
[Fig. 23]


187 bytes
PID(3)
AF Header(2)
AF Header
Normal Data
Robust (m=118, 128bytes)
splice_count(1)
PCR (6)
Adaptation field extention (2)
length(1)
private data (5)

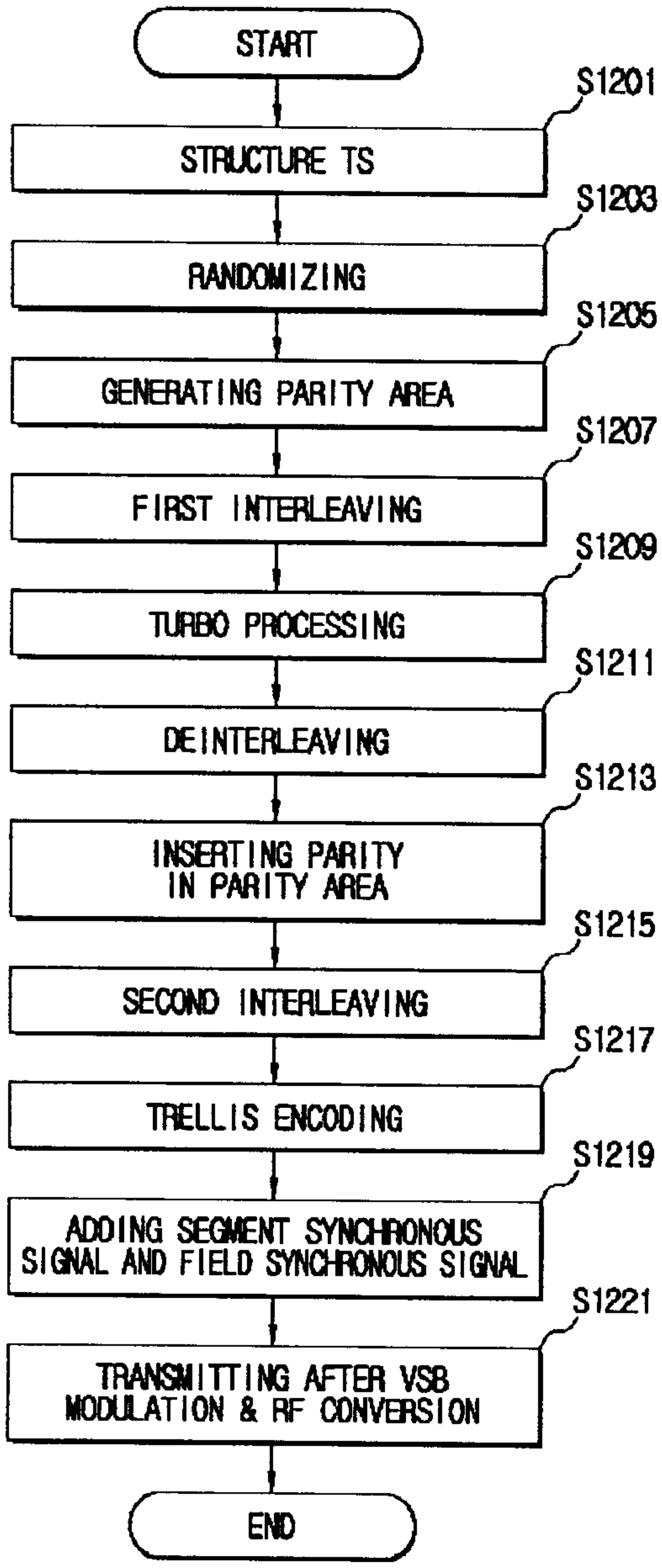
[Fig. 24]


DEMODULATOR
1001
EQUALIZER
1003
VITERBI DECODER
1017
DEINTERLEAVER
1021
REED-SOLOMON (RS) DECODER
1023
DERANDOMIZER
1025
1050
Normal Ts packet
TURBO DECODER
1005
DEINTERLEAVER
1009
REED-SOLOMON (RS) DECODER
1011
DERANDOMIZER
1013
TURBO DE-MUX
1015
1060
Robust Ts packet

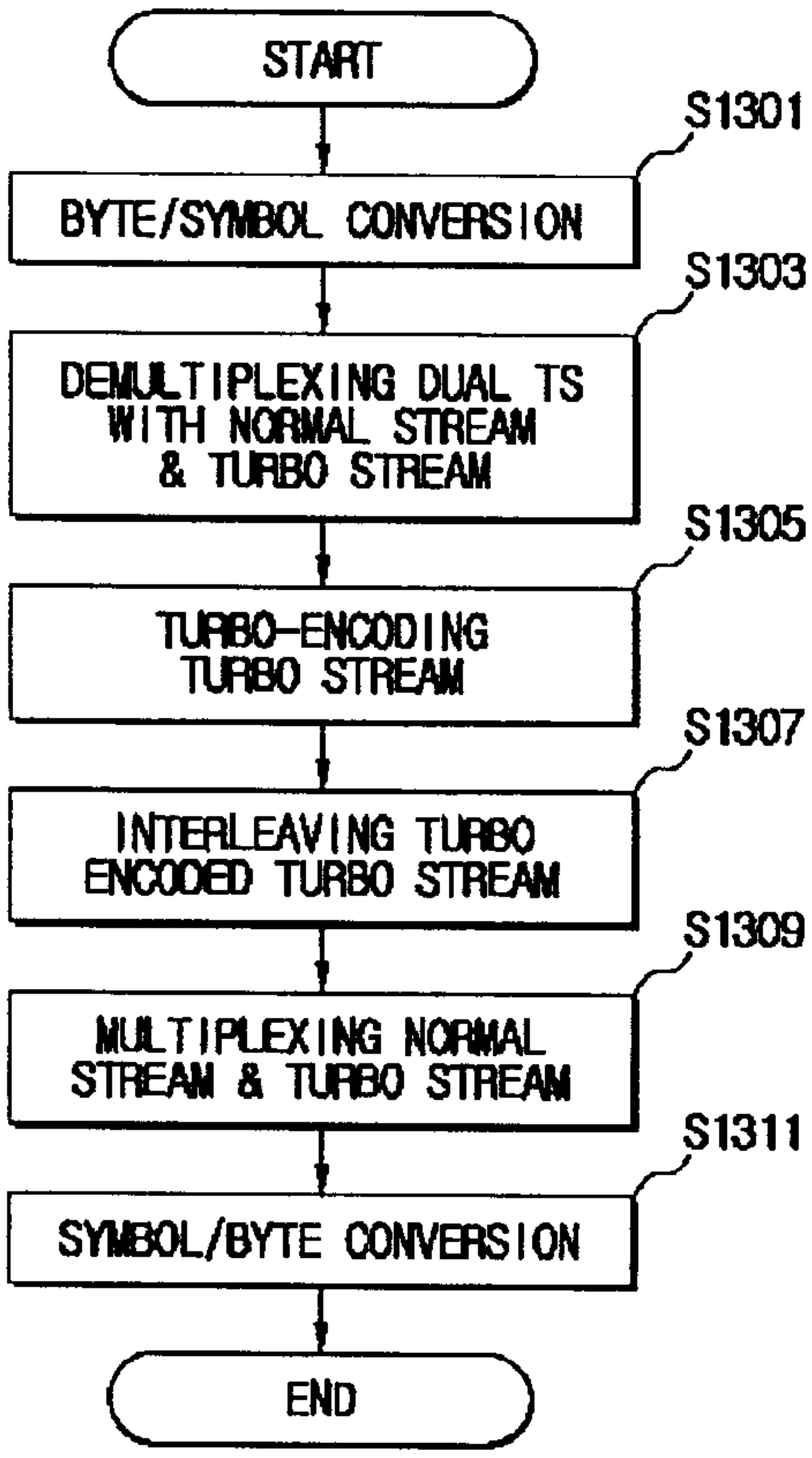
[Fig. 25]


Robust
2011
1005
SYMBOL/BYTE CONVERTING UNIT
2009
FRAME FORMATTER
2005
TURBO DECODER
2003
TURBO DEINTERLEAVER
2007
TURBO INTERLEAVER
2001
TRELLIS DECODER

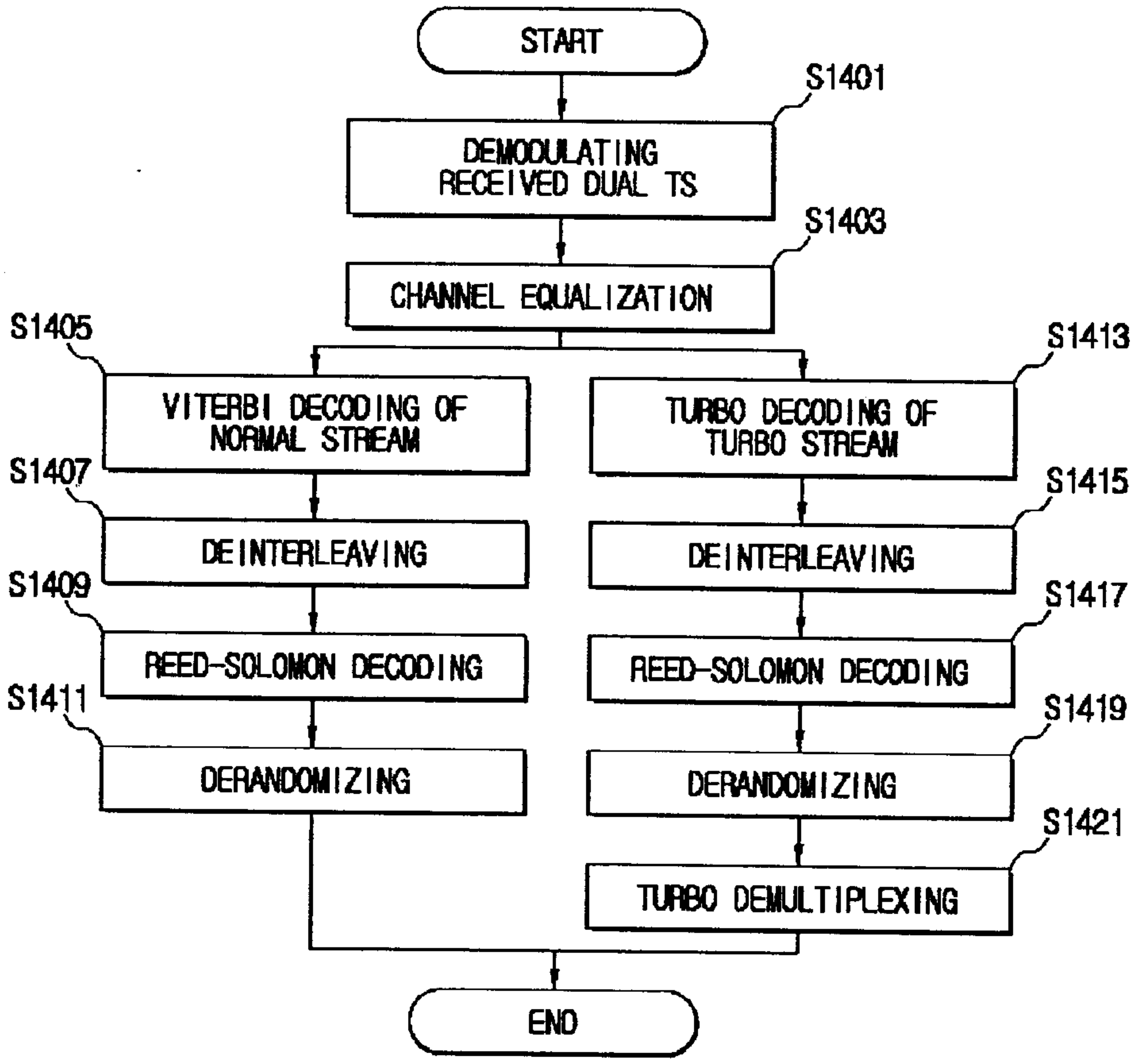
[Fig. 26]


START
S1201
STRUCTURE TS
S1203
RANDOMIZING
S1205
GENERATING PARITY AREA
S1207
FIRST INTERLEAVING
S1209
TURBO PROCESSING
S1211
DEINTERLEAVING
S1213
INSERTING PARITY IN PARITY AREA
S1215
SECOND INTERLEAVING
S1217
TRELLIS ENCODING
S1219
ADDING SEGMENT SYNCHRONOUS SIGNAL AND FIELD SYNCHRONOUS SIGNAL
S1221
TRANSMITTING AFTER VSB MODULATION & RF CONVERSION
END

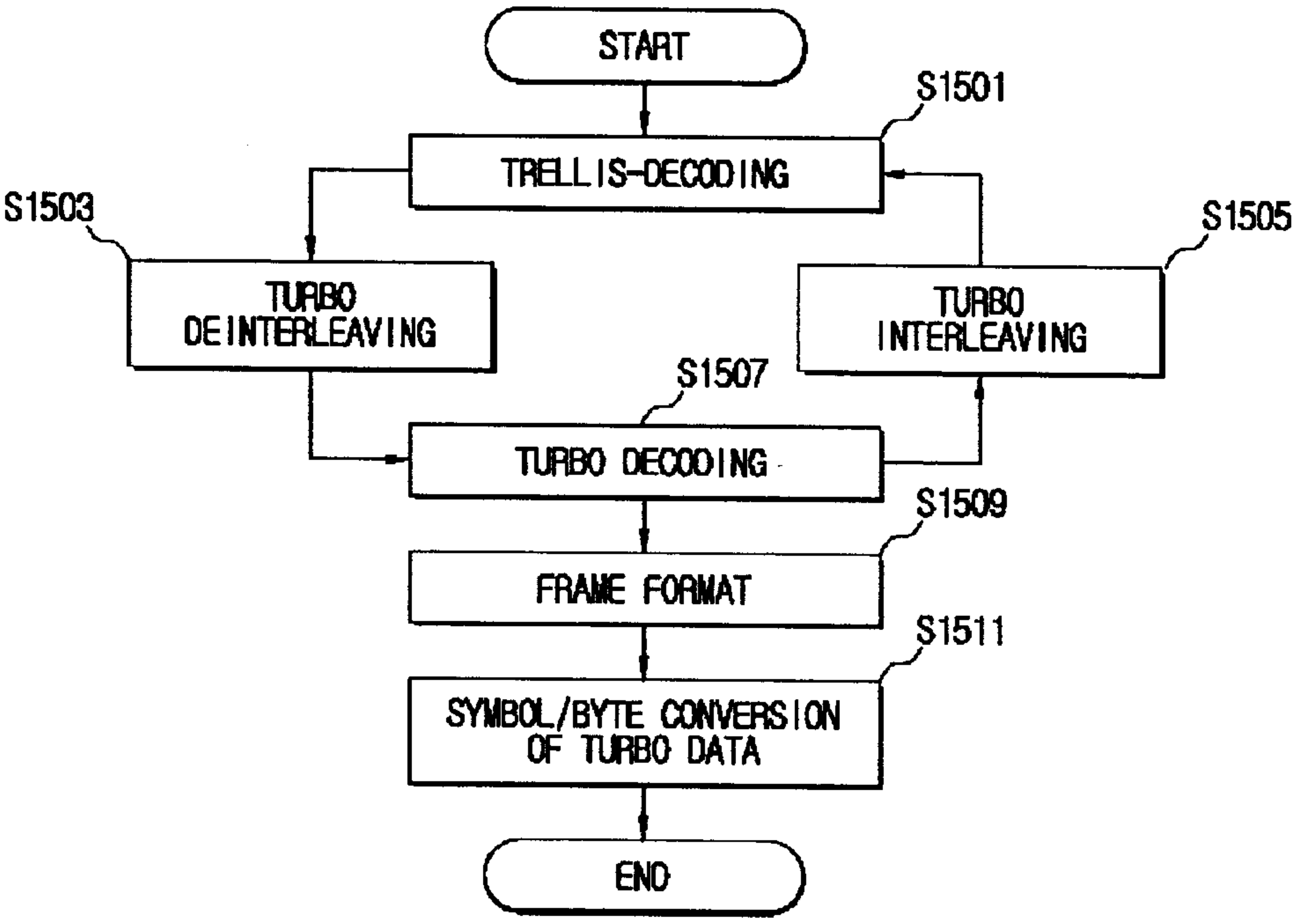
[Fig. 27]


START
S1301
BYTE/SYMBOL CONVERSION
S1303
DEMULTIPLEXING DUAL TS WITH NORMAL STREAM & TURBO STREAM
S1305
TURBO-ENCODING TURBO STREAM
S1307
INTERLEAVING TURBO ENCODED TURBO STREAM
S1309
MULTIPLEXING NORMAL STREAM & TURBO STREAM
S1311
SYMBOL/BYTE CONVERSION
END

[Fig. 28]


START
S1401
DEMODULATING RECEIVED DUAL TS
S1403
CHANNEL EQUALIZATION
S1405
VITERBI DECODING OF NORMAL STREAM
S1407
DEINTERLEAVING
S1409
REED-SOLOMON DECODING
S1411
DERANDOMIZING
S1413
TURBO DECODING OF TURBO STREAM
S1415
DEINTERLEAVING
S1417
REED-SOLOMON DECODING
S1419
DERANDOMIZING
S1421
TURBO DEMULTIPLEXING
END

[Fig. 29]


START
S1501
TRELLIS-DECODING
S1503
TURBO DEINTERLEAVING
S1505
TURBO INTERLEAVING
S1507
TURBO DECODING
S1509
FRAME FORMAT
S1511
SYMBOL/BYTE CONVERSION OF TURBO DATA
END

1001
1003
1017
1021
1023
1050
1025
DEMODULATOR
EQUALIZER
VITERBI DECODER
DEINTERLEAVER
REED-SOLOMON (RS) DECODER
DERANDOMIZER
Normal Ts packet
1005
1009
1011
1013
1015
TURBO DECODER
DEINTERLEAVER
REED-SOLOMON (RS) DECODER
DERANDOMIZER
TURBO DE-MUX
Robust Ts packet
1060