

PATENT SPECIFICATION

Confidential

01 JUN 1999

Jek-Thoon TAN and Sheng-Mei SHEN
Panasonic Singapore Laboratories Pte Ltd

IPOS.

28 May, 1999

1. TITLE OF THE INVENTION

A digital TV-Karaoke systems.

This Sheet Has Been Replaced



2. WHAT IS CLAIMED IS

- (1) An apparatus for use in encoding digital TV-Karaoke, said apparatus, comprising:

means for encoding video for Karaoke background to form video elementary stream for use with multiple Karaoke songs;

means for encoding said Karaoke songs to form audio elementary streams;

means for encoding Karaoke text display information associating with said Karaoke songs to form private data to be carried in the transport stream;

means for encoding Karaoke text scrolling information associating with said Karaoke songs to form private data to be carried in the transport stream;

means for encoding Karaoke program guide information to form private data to be carried in said transport stream;

means for multiplexing said video elementary stream, said audio elementary streams and said private data in said transport stream for broadcast;

means for producing and encoding advertisement contents into said video for Karaoke background, and adding audio for the said advertisement as a default option.

- (2) An apparatus for use in encoding digital TV-Karaoke, said apparatus, comprising:

means for encoding and making advertisement contents into video elementary stream for Karaoke background, and adding audio for the said advertisement as a default option;

means for encoding Karaoke songs to form Karaoke audio elementary streams, and storing said Karaoke audio elementary streams in database of Karaoke server;

THIS SHEET HAS BEEN
REPLACED





means for encoding and editing Karaoke text and scrolling information associated with said Karaoke songs, and storing said Karaoke text and scrolling information in database of Karaoke server;

means for encoding Karaoke program guide information;

means for encoding synchronizing information for use in decoding said Karaoke audio elementary streams and said Karaoke text and scrolling information;

means for broadcasting said advertisement contents as main video and audio elementary streams, together with the said Karaoke audio elementary streams, said Karaoke text and scrolling information, said Karaoke program guide information, and said synchronizing information in a digital TV channel.

- (3) The apparatus for encoding Karaoke songs to form audio elementary streams, and storing said audio elementary streams in database of Karaoke server of claim 2, further comprising:

means for encoding each said Karaoke song into said audio elementary stream based on certain bit rate defined in MPEG Layer II/AC-3;

means for recording down the time-length for each of the said Karaoke song;

means for assigning one index code to each of the said Karaoke song;

means for storing said audio elementary streams together with said time-length information and said index codes in database.

- (4) The apparatus for encoding and editing Karaoke text and scrolling information of claim 2, further comprising:

means for encoding said Karaoke text as pre-defined text code;

means for encoding said Karaoke scrolling information as time codes for use in the decoder;

means for integrating said pre-defined text codes and said time codes into MPEG-2 transport multiplex for use in digital TV.

- (5) The apparatus for encoding and editing Karaoke text and scrolling information of claim 2, further comprising:

means for encoding said Karaoke text as bitmap;

means for encoding said Karaoke scrolling information as time codes for use in the decoder;

means for integrating said said bitmap and said time codes into MPEG-2 transport multiplex for use in digital TV.





- (6) An apparatus for use in encoding Karaoke Text Elementary Data, said apparatus, comprising:
- means for encoding Karaoke language options;
 - means for encoding Karaoke text as pre-defined text code;
 - means for encoding said Karaoke text display information as time codes for use in the decoder;
 - means for encoding said Karaoke text scrolling information as time codes for use in the decoder;
 - means of integrating said Karaoke language options, said pre-defined text codes and said time codes into said Karaoke Text Elementary Data for decoding with a Karaoke Text Elementary Data decoder.
- (7) An apparatus for use in encoding Karaoke Text Elementary Data, said apparatus, comprising:
- means for encoding Karaoke text as bitmap;
 - means for encoding said Karaoke text display information as time codes for use in the decoder;
 - means for encoding said Karaoke text scrolling information as time codes for use in the decoder;
 - means of integrating said bitmap and said time codes into said Karaoke Text Elementary Data for decoding with a Karaoke Text Elementary Data decoder.
- (8) An apparatus for use in decoding digital TV-Karaoke, said apparatus, comprising:
- means for extracting Karaoke video elementary stream, Karaoke audio elementary streams, Karaoke program guide information, Karaoke text and scrolling information and Karaoke text and audio synchronizing information from the transport stream of a digital TV channel;
 - means for decoding said Karaoke program guide information for displaying available Karaoke programs to enable selection by the user;
 - means for decoding said Karaoke video elementary stream for displaying the Karaoke background with advertisement contents on the TV/monitor screen;
 - means for selecting and decoding said Karaoke audio elementary stream to playback Karaoke audio;
 - means for decoding said Karaoke text and scrolling information associate with the said playback Karaoke audio to generate Karaoke sing-along text display on top of said Karaoke background video;
 - means for decoding said Karaoke text and audio synchronizing information to synchronize displaying of said Karaoke sing-along text display with said Karaoke audio.





- (9) An apparatus for use in decoding Karaoke Text Elementary Data, said apparatus, comprising:
- means for extracting Karaoke language options, Karaoke text codes, Karaoke text display information and Karaoke text scrolling information from said Karaoke Text Elementary Data;
 - means for decoding said Karaoke language options;
 - means for decoding said Karaoke text codes for generating Karaoke sing-along text;
 - means for decoding said Karaoke text display information for displaying said Karaoke sing-along text;
 - means for decoding said Karaoke text scrolling information for creating scrolling effect on said Karaoke sing-along text.
- (10) An apparatus for use in decoding Karaoke Text Elementary Data, said apparatus, comprising:
- means for extracting Karaoke language options, Karaoke text codes, Karaoke text display information and Karaoke text scrolling information from said Karaoke Text Elementary Data;
 - means for decoding said Karaoke language options;
 - means for decoding said Karaoke text codes for generating Karaoke sing-along text;
 - means for decoding said Karaoke text display information for displaying said Karaoke sing-along text;
 - means for decoding said Karaoke text scrolling information for creating cursor movement effect on said Karaoke sing-along text.
- (11) An apparatus for use in decoding Karaoke Text Elementary Data, said apparatus, comprising:
- means for extracting Karaoke bitmap data, Karaoke text display information and Karaoke text scrolling information from said Karaoke Text Elementary Data;
 - means for decoding said Karaoke bitmap data for generating Karaoke sing-along text;
 - means for decoding said Karaoke text display information for displaying said Karaoke sing-along text;
 - means for decoding said Karaoke text scrolling information for creating scrolling effect on said Karaoke sing-along text.
- (12) An apparatus for use in decoding Karaoke Text Elementary Data, said apparatus, comprising:
- means for extracting Karaoke bitmap data, Karaoke text display information and Karaoke text scrolling information from said Karaoke Text Elementary Data;
 - means for decoding said Karaoke bitmap data for generating Karaoke sing-along text;





means for decoding said Karaoke text display information for displaying said Karaoke sing-along text;

means for decoding said Karaoke text scrolling information for creating cursor movement effect on said Karaoke sing-along text.

- (13) An apparatus for use in encoding interactive digital TV-Karaoke, said apparatus, comprising:

means for classifying Karaoke songs into different selection categories and associating with said songs with index codes;

means for displaying lists of available Karaoke songs to the user, enabling said user to select requested Karaoke songs by issuing said index codes via back-channel of the decoder.

means for programming Karaoke Program List, registering multiple Karaoke songs that shall be played presently, next or following, base on said index codes returned by said user;

means for multiplexing Karaoke audio elementary streams of said requested Karaoke songs registered in said Karaoke Program List into transport stream;

means for multiplexing Karaoke text and scrolling information associated to said requested Karaoke songs registered in said Karaoke Program List into transport stream;

means for multiplexing synchronizing information for use in decoding said Karaoke audio elementary streams and said Karaoke text and scrolling information into transport stream;

means for multiplexing Karaoke program guide information into transport stream;

means for multiplexing Karaoke video elementary stream for Karaoke background with advertisement content into transport stream;

means for broadcasting said Karaoke video elementary stream, said Karaoke audio elementary streams, said Karaoke program guide information, said Karaoke text and scrolling information, and said synchronizing information for use in digital TV system.

- (14) An apparatus for use in interactive digital TV-Karaoke system, said apparatus, comprising:

means for keying in the code for Karaoke song by using back-channel to request for certain time to arrange certain Karaoke song to be broadcasted;

means for checking Karaoke Program List and changing the said list if there is no request done before for the same time period;

means for re-programming and modifying the said Karaoke Program List based on the said request from users;

means for shifting the said request to another time if there is no available space in term of the time period and Karaoke program slots;





means for confirming the said request after completion of the said re-programming.

- (15) An apparatus for use in decoding interactive digital TV-Karaoke, said apparatus, comprising:

means for allowing user search for the code for Karaoke song title from OSD instruction;

means for searching for Karaoke song title based on pre-classifications in language, singer, one character/two character/three character/... for Chinese song, or the same way as conventional Karaoke application;

means for providing all the codes for all Karaoke songs with their song titles displaying on screen for back-channel interactive selection and re-programming;

means for displaying Karaoke song list with song title that is broadcasted in current, in next, or in next-next time period based on the selection of users.

- (16) Means used in digital TV-Karaoke can be applicable to digital audio broadcasting, Internet Karaoke applications, as well as other forms of digital Karaoke applications.

THIS SHEET HAS BEEN
REPLACED





3. DETAILED DESCRIPTION OF THE INVENTION

3.1. Industrial Field of Utilization

This invention can be used in digital multimedia broadcasting, especially in Digital TV and DAB Karaoke applications.

3.2. Background and Prior Art

Karaoke is a popular entertainment, especially in Asia countries. Digital broadcasting era provides opportunity to implement Indoor/Outdoor Karaoke Entertainment Applications in digital TV receivers and DAB systems. One important advantage of Digital Broadcasting over analog system is the capability of providing interactivity. In addition, Digital broadcasting allows broadcasting equipment to be integrated with computer database for automatic TV program search and selection, as well as TV program production and editing.

Digital video broadcasting or Digital TV broadcasting has been adopted and used in many countries recently. MPEG-2 video coding standard is used for video compression, and MPEG Layer II or AC-3 audio coding is used for audio compression. The transmission standard is slightly different in different countries.

The prior art is shown in Figure 1. The Video Encoding module 1.1 encodes Karaoke video containing Karaoke background and text from a Karaoke source, such as a laser disc player (LD), into video elementary stream (ES). The Audio Encoding module 1.2 encodes the associated Karaoke Audio into audio elementary stream. The Multiplexing module 1.3 multiplexes the video and audio elementary streams from multiple Karaoke sources into transport stream (TS).

Assuming the video and audio elementary streams are transmitted at about 5 Mbits/s and 192 kbits/s respectively, each Karaoke program will take up about 5.2 Mbits/s. The useful bitrate of a RF TV channel is about 19 to 22 Mbits/s (depending on transmission parameters). Thus, a maximum of four Karaoke programs can be transmitted at one time within a RF TV channel completely allocated for Karaoke applications. If three movies or other TV programs are transmitted and already uses up 15.6Mbits/s of the useful bitrate, then only one Karaoke programs can be broadcast at one time. With scarcity of available RF TV channels, there are limited choices of Karaoke programs and the Karaoke application is not economically viable.

In most cases, the Karaoke background is not of significant importance to the user. There can be different kinds of backgrounds even for the same song in existing Karaoke sources. Since video coding uses majority of the transmission bandwidth in a program, it will reduce the bandwidth requirements significantly when one Karaoke video background is used together with multiple Karaoke audio programs. The Karaoke video background can be designed or constructed to includes advertisements. In other words, many Karaoke audio songs are transmitted and broadcast at the same time, and all of them bear the same video content. In such implementations, the user will have more choices for Karaoke songs without increasing transmission bandwidth significantly. Broadcasters will also benefit from advertising as well as providing value added Karaoke application to the viewer.



To enable using one background video for various Karaoke songs, a technique of encoding the Karaoke text and its scrolling information has to be developed. Moreover, digital broadcasting allows interactive applications through OSD (On-Screen Display) and back-channel features in the decoder. This provides the opportunity to develop interactive DTV Karaoke such as song request and selection in a conventional Karaoke Application.

3.3. Problem to be Solved

As shown in Figure 1, broadcasting Karaoke programs within a RF TV channel is not economical viable, as video takes up most of the transmission bandwidth. Thus, the main problem to be solved is to reduce the overall transmission bandwidth requirements to provide an economical Karaoke application for use in digital TV.

Broadcasting Karaoke song is considered as uni-directional communication, and the operation in the existing Karaoke Application is considered as bi-directional communications, i.e. the user can select the desired songs. Realizing the bi-directional operations through interactivity of Digital broadcasting is another problem to be solved.

Besides the above problems, a scheme that fits the digital TV broadcasting standard has to be developed and the solution has to be commercially viable. It shall not only be very attractive to user, but also be beneficial and profitable to the broadcasters.

3.4. Means of Solving the Problem

As shown in Figure 2, the same video content containing advertisement is used for every Karaoke songs. The video is encoded as video elementary stream and Karaoke audio songs are encoded as audio elementary streams. MPEG-2 transport multiplex for use in digital TV can transport private data in addition to the video and audio programs. The private data section comes in the form of private section table. This invention defines the content of the private section table that delivers the Karaoke program guides, as well as the Karaoke text and scrolling information that corresponds to the audio. Karaoke Current Guide Table and Karaoke Next Guide Table are introduced to provide Karaoke program information. Karaoke Text Description Table is introduced to provide Karaoke text and scrolling information. At one time only one Karaoke video stream together with many of Karaoke audio streams and their text description data are transmitted within the limited bandwidth.

To realize interactivity for the user to select the desired Karaoke songs, each of song is assigned a unique index code. This code is stored in the database in the encoder as index for automatic search for the Karaoke songs. At the same time the time-length of Karaoke song is also stored in the same database for generating Karaoke Program List. Karaoke Program List is pre-programmed and can be re-programmed according to the request from user through back-channel. Karaoke Program List can be displayed on the screen based on the request from user through OSD function.



3.5. Operation of the Invention

In the encoder, Karaoke songs are encoded by using MPEG Layer II or AC-3, and stored as audio elementary stream, together with its code and the time-length, in database format. The Karaoke text and scrolling information are also encoded and stored as Karaoke Text Elementary Data in the same database. Karaoke background with advertisement content is produced and encoded into video elementary stream. It can be coded at lower bit rate, allowing more space for transmitting Karaoke audio songs.

The video stream is multiplexed with many Karaoke audio streams and private data that contain the Karaoke text and scrolling information. They are transmitted and broadcast to user based on the pre-programmed Karaoke Program List. The multi-plexer is integrated with Karaoke audio server. Once a request is received, Karaoke Program List in multi-plexer and Karaoke server is changed and updated.

In the decoder, the users can view all Karaoke songs that are being broadcast currently or in future time. This allows the user to select the preferred songs. To enable song request application, the users can key in the code for the Karaoke song and the time for broadcasting via back-channel to place a request. Once the request is approved, the Karaoke program list will be changed. The users can search for the code of Karaoke song from the screen via OSD function.

3.6. Embodiments

The functional modules of Digital Karaoke Broadcasting constructed in accordance with the invention are shown in Figure 2. The Video Encoding module 2.1 encodes Karaoke video for use as Karaoke background into Video Packetized Elementary Stream (Video PES) and the Audio Encoding module 2.2 encodes Karaoke audio songs into Audio Elementary Streams (Audio ES). The Karaoke Text Encoding module 2.3 encodes Karaoke text and scrolling information of the Karaoke audio songs into Karaoke Text Elementary Data (Karaoke Text ED).

Karaoke Database module 2.4 stores the Karaoke Audio Elementary Streams which are encoded in Audio Encoding module 2.2, as well as their corresponding Karaoke Text Elementary Data which are encoded in Karaoke Text Encoding module 2.3. This facilitates the Karaoke Audio Server to generate relevant Karaoke audio streams and text information for Karaoke application.

The Audio Packetized Elementary Stream Generator module 2.5 generates multiple Audio Packetized Elementary Streams (Audio PES) for the Karaoke songs that are presently playing. To allow the viewer to navigate among the multiple Karaoke songs, the Karaoke Current/Next Guide Tables Generator module 2.6 provides Karaoke program guide information carried in Karaoke Current Guide Table (KCGT) and Karaoke Next Guide Table (KNGT).

The Karaoke Time Reference Table Generator module 2.7 generates source timing reference for use in decoding to synchronize Karaoke Text and scrolling display to the Karaoke audio. The Karaoke text and scrolling information is provided by the Karaoke Text Description Table Generator module 2.8.



The Multiplexing module 2.9 multiplexes the Video Packetized Elementary Stream, Audio Packetized Elementary Streams, Karaoke Current Guide Table, Karaoke Next Guide Table, Karaoke Time Reference Table and Karaoke Text Description Tables into transport stream (TS).

Table 1 illustrates one possible data structure for Karaoke Database. Each Karaoke song is assigned with an index code, its language code, song title, singer name, the time-length for its playback duration, the audio file name of the audio elementary stream and its data size, the Karaoke text elementary data file name and its data size, as well as optional short text description of the song.

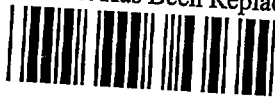
MPEG-2 bit rate ranges from 32 to 192kb/s per channel. A hi-fi quality MPEG-2 audio can be obtained from 128kb/s per channel. For Karaoke application, the left and right channels are coded with music-only and song (music+vocal) respectively. The sound quality need not be as good as hi-fi quality. Thus, the bit rate can be lowered to about 192kb/s for 2 channels. If each song duration is about 4 minutes, it works out to about 5.76Mbyte per song. Storage of 18 Gbyte can store over 3,000 song streams.

The Karaoke Current Guide Table (KCGT) provides Karaoke program guide information for the viewer to navigate among the current Karaoke programs. This is the first table that a receiver has to extract from the transport stream for running Karaoke application. The syntax of the private section table for Karaoke Current Guide Table (KCGT) is illustrated in Table 2. The Table_Id is 0x9f. The semantic definitions of the fields in the private section table that follows the generic syntax common in ISO/IEC 13818 [1] are:

- Table_Id -- This 8-bit field identifies the private table this section belongs to. ISO/IEC 13818 [1] defines specific description from 0x00 to 0x3F. The Digital Video Broadcasting (DVB); Specification for Service Information (SI) in DVB systems (EN 300 468) uses values from 0x40 to 0x7F. User defined value starts from 0x80 to 0xFE. Thus, the Table_Id for KCGT can range from 0x80 to 0xFE.
- Section_Syntax_Indicator -- Set to '0' to indicate that the private defined data bytes immediately follow the Private_Section_Length.
- Private_Indicator -- Not used
- Private_Section_Length -- This 12-bit field specifies the number of remaining bytes in the section immediately following the Private_Section_Length field up to the end of the section.
- Version_Number -- A 5-bit field specifying the version number of the section table. The Version_Number shall be increment by 1 when a change in the information carried in the section occurs.
- Current_Next_Indicator -- Set to '1' indicates that the section is the currently applicable section.
- Section_Number -- An 8-bit field value gives the section number that is running sequentially.
- Last_Section_Number -- An 8-bit field specifies the last section number.
- CRC_32 -- This 32-bit field contains CRC value. It can be used to check the correctness of the data in this section.

In this invention, the Karaoke program information is embedded in the Karaoke Current Guide Table. The semantic definitions are:

- Karaoke_Application_Code_Id -- A 16-bit unique identification. Set to 0x5459.
- Current_UTC_Time -- Local date and time in UTC format.
- Karaoke_Stream_Info_Length -- This 12-bit field specifies the length of bytes of the following descriptors().
- KTRT_Pid -- The PID value of the Karaoke Time Reference Table.
- KNGT_Pid -- The PID value of the Karaoke Next Guide Table.



- **Number_of_Karaoke_Program** --An 8-bit field specifies the number of Karaoke programs running currently.
- **Start_UTC_Time** -- Starting Time of the Karaoke program.
- **Stop_UTC_Time** -- Ending Time of the Karaoke program.
- **KFDT_Available** -- A '1' to indicate presence of Karaoke Font Download Table associated with the following Karaoke Text Description Table.
- **KTDT_Pid** -- The PID value of the Karaoke Text Description Table.
- **Audio_Pid** -- The PID value of the Audio Packetized Elementary Stream.
- **Index_Number_Length** -- Specifies the length of bytes of the following **Index_Number**.
- **Index_Number** -- Index number of the Karaoke program.
- **ISO_639_language_code** -- This 24-bit field contains 3 character ISO 639 language code of the following text fields. Each character is coded into 8 bits according to ISO 8859-1.
- **Title_Text_Length** -- This 8-bit field specifies the length of bytes of the following **Title_Text_Code**.
- **Title_Text_Code** -- Text describing the Title of the song.
- **ISO_639_language_code** -- This 24-bit field contains 3 character ISO 639 language code of the following text fields. Each character is coded into 8 bits according to ISO 8859-1.
- **Singer_Text_Length** -- This 8-bit field specifies the length of bytes of the following **Singer_Text_Code**.
- **Singer_Text_Code** -- Text describing the Singer of the song.
- **ES_Info_Length** -- This 12-bit field specifies the length of bytes of the following descriptors().

The Karaoke Next Guide Table (KNGT) provides Karaoke program guide information for the viewer to navigate among the next Karaoke programs. The syntax of the private section tables for Karaoke Next Guide Table is illustrated in Table 3. The **Table_Id** is 0x9e. The semantic definitions are similar to Karaoke Current Guide Table.

Separating current (KCGT) and next (KNGT) program guide tables allows faster retrieval of current program guide. Current program guide may list down the Karaoke programs that are playing currently, as well as for those that are starting in the coming 5 minutes. It shall be carried in the transport stream more frequently, for example every 1-2 seconds. The next program guide may list down many programs beyond the coming 5 minutes and can be carried in the transport stream less frequently.

The possible descriptors in the Karaoke Current Guide Table and Karaoke Next Guide Table are listed in Table 4. The Service descriptor provides the names of the service, the name of the service provider and the type of service. The short event descriptor provides the name of the event and a short description of the event. The Telephone descriptor may be used to indicate a telephone number for the back channel. The definitions of the descriptors can be found in Specification for Service Information (SI) in DVB systems (EN 300 468).

To enable the receiver to display the Karaoke Text together with the associated song, the timing codes, Karaoke text, and the scrolling information are carried in the Karaoke Text Description Table (KTDT) in the transport stream. The syntax of the private section tables for Karaoke Text Description Table is illustrated in Table 5. The **Table_Id** is 0x9d. The semantic definitions are:

- **Karaoke_Application_Code_Id** -- A 16-bit unique identification. Set to 0x5459.
- **Start_Decoding_Time_Reference** -- A 24-bit timer reference for start of decoding the following **Karaoke_Text_Elementary_Data()**. Use with **Karaoke_Time_Reference** carried in Karaoke Time Reference Table (KTRT). Each count is 20msec.
- **Karaoke_Text_Elementary_Data()** -- The elementary data containing the Karaoke text and scrolling information.



In this invention, the `Karaoke_Text_Elementary_Data()` is introduced as a standalone elementary data to facilitate running or testing on a Karaoke Text decoder, similar approach as video elementary stream or audio elementary stream that can be run on a audio or video decoder independently. The synchronization timing information with the audio does not reside in Karaoke Text Elementary Data. It is embedded in the Karaoke Text Description Table as 24-bit `Start_Decoding_Time` and in Karaoke Time Reference Table as 24-bit `Karaoke_Time_Reference`. The `Karaoke_Text_Elementary_Data()` describes the Karaoke text and the scrolling information and can be run without associating audio for sing along application without music. The syntax of the `Karaoke_Text_Elementary_Data()` is illustrated in Table 6. The semantic definitions are:

- **Simultaneous_Scroll** -- This 1-bit field specifies scrolling on the two text display rows to be done independently or simultaneously. A '0' refers to independently. A '1' refers to scrolling simultaneously for dual language applications.
- **Text_Bitmap** -- This 1-bit field allows provision for delivering bitmap data in addition to text data code. A '0' specifies the following codes are text. A '1' specifies the following codes are bitmap data.
- **Text_Data_Length** -- This 16-bit field specifies the length of bytes of the following Karaoke text data description.
- **Start_Display_Time** -- This 16-bit field specifies the time for displaying the two text rows. Each count is 20msec.
- **Row1_Text_Length** -- This 6-bit field specifies the number of text characters in the upper display row.
- **ISO_639_Language_Code** -- This 24-bit field contains 3 character ISO 639 language code of the following text fields. Each character is coded into 8 bits according to ISO 8859-1.
- **Text_Code** -- The code defining the text character. The number of bytes to represent each text character is determined by `ISO_639_Language_Code` field.
- **Time_Code** -- This 16-bit field specifies the scrolling information of individual text character. Each count is 20msec.
- **Row2_Text_Length** -- This 6-bit field specifies the number of text characters in the lower display row.
- **Text_Pixel_Width** -- This 6 bit field defines the number of pixels for each text character width. `Text_Pixel_Width` multiply by `Text_Pixel_Height` must be divisor by 8.
- **Text_Pixel_Height** -- This 6 bit field defines the number of pixels for each text character height. `Text_Pixel_Width` multiply by `Text_Pixel_Height` must be divisor by 8.
- **Bitmap_Code** -- The bitmap (1 bit per pixel) for the text display row, starting from top left, defining from left to right, to bottom right.

The timing for text display and scrolling is defined in the `Start_Display_Time` and `Time_Code` fields. An interpretation on `Start_Display_Time` and `Time_Code` information is shown in Figure 3. The Karaoke text decoder timer shall always start decoding from 0 count when it starts to decode a `Karaoke_Text_Elementary_Data()` and each count is 20msec time interval. When the target decoder count matches `Start_Display_Time` 3.1, for example at count 50 (1000msec), the two rows of Text shall be displayed without highlighting. The scrolling information is embedded in `Time_Code` fields for highlighting the text character display to make the scrolling effect. The decoder will use the difference between the `Time_Code[row][n]` and `Time_Code[row][n+1]` to determine the scroll speed for text character at nth position. For example, `Time_Code[0][0]` 3.2, `Time_Code[0][1]` 3.3 and `Time_Code[0][2]` 3.4 for row 1 are 75, 100 and 150 respectively. The text display shall scroll "A" 3.10 starting from decoder count 75 (at 1.5sec) to 100 (at 2.0sec), followed by "B" 3.11 from decoder count 100 (at 2.0sec)



to 150 (at 3.0sec). A pause in scrolling is done by inserting a space text character, as in between Time_Code[0][5] 3.5 and Time_Code[0][6] 3.6, as well as between Time_Code[0][8] 3.7 and Time_Code[0][9] 3.8 in row 1. At the end of scrolling at Time_Code[1][6] in row 2 3.9, the decoder remove the text display and the decoder process repeats with the next Start_Display_Time. With 16 bit Time_Code field and a resolution of 20msec per count, the maximum total time without overflow is 1310.72 sec or 21 minutes and 50.72sec.

The specification does not restrict the behaviour of the decoder model. It is up the decoder implementation to use the Start_Display_Time and Time_Code information for displaying and highlighting the Karaoke text. This enables various hardwares with different capabilities and On-Screen-Display (OSD) features to perform Karaoke Text decoding.

To synchronise the Karaoke Text display and the associated audio, the Karaoke Time Reference Table (KTRT) is introduced to set or update the Karaoke Text decoder timer with the source timing reference. The syntax of the private section table for Karaoke_Time_Reference_Table is illustrated in Table 7. The semantic definitions are:

- Karaoke_Application_Code_Id – A 16-bit unique identification. Set to 0x5459.
- Karaoke_Time_Reference – A 24-bit timer reference for the decoder to sync with Karaoke encoding time reference in order to synchronize Karaoke audio and text decoding. Each count is 20msec. Use with Start_Decoding_Time in Karaoke Text Description Table.

The Karaoke_Time_Reference is placed in Karaoke Time Reference Table (KTRT) and separated from other tables to have minimal interrupt latency and variations on setting the target Karaoke Text decoder timer reference. Typical transport decoder in the market have the capability of generating interrupt to the host processor when detecting a end of section during the process of filtering a private section. Since the Karaoke Time Reference Table always fit in a transport packet of 188 bytes, the latency involves in processing the interrupt is more predictable. The Karaoke Time Reference Table shall be carried in the transport stream frequently to allows setting or updating of decoder reference time.

For synchronization of Karaoke Text with audio, the encoder is responsible for synchronizing the Karaoke_Time_Reference in Karaoke Time Reference Table and Start_Decoding_Time in Karaoke Text Description Table. Figure 4 illustrates the synchronization mechanism for of Karaoke Text and Audio. The transport stream comprises of Video 1 Packet 4.5, Karaoke Time Reference Table (Karaoke Program 1) 4.6, Karaoke Text Description Table 4.7, Video 2 Packet 4.8, Audio1 Packet (Karaoke Program 1) 4.9, etc.

The Karaoke Time Reference Table 4.6 is inserted in the transport stream at Karaoke_Time_Reference equals 0x0a0000. This table is received by the Karaoke text decoder who set its internal Karaoke Text & Audio Synchronization Timer to 0x0a0000. This timer is constantly counting every 20msec. The Karaoke text decoder also extract the Karaoke Text Description Table 4.7 that contains the Start_Decoding_Time and Karaoke_Text_Elementary_Data() and stores them in memory. When the Start_Decoding_Time equals the internal Karaoke Text & Audio Synchronization Timer value (at 0x0a0100), the text decoder begins decoding the Karaoke_Text_Elementary_Data(). At around this instance, the audio decoder receives the audio elementary stream from the transport decoder and begins decoding the Karaoke audio 4.1. The text decoder decodes the Karaoke_Text_Elementary_Data() and generates the Karaoke Text Display 4.2, 4.3 & 4.4.



The functional blocks of the digital TV receiver constructed in accordance with the invention is shown in Figure 5. The front-end module 501 demodulates and channel decoded the RF input signal to produce the transport stream 502. The transport decoder 507 extracts the private section tables comprising of Karaoke Current Guide Table, Karaoke Next Guide Table, Karaoke Text Description Table, Karaoke Time Reference Table and Karaoke Font Download Table, from the transport stream by identifying the unique combinations of the 13-bit PID and Table_Id. When the matching transport packet is encountered, the transport decoder 507 stores the private section table in the cyclic buffer 505 via its dedicated data bus 506 and subsequently, informs the host microprocessor 503. The host microprocessor 503 begins to retrieve the private section table from the cyclic buffer 505, parses the table, checking for validity and memory requirements, and transfer the private section tables' contents from the cyclic buffer 505 to memory 508 via the host data bus 504. The Karaoke text and scrolling information in the private section tables are decoded by the host processor 503 which controls the On Screen Display (OSD) generator 513 to produce the Karaoke Text display.

The transport decoder 507 concurrently delivers the audio and video packet elementary stream (PES) payload 509 to the A/V Decoder 510 that decodes the video and audio stream to produce the decoded digital video signal 512 and audio signal 511. The decoded digital video contains Karaoke background and the decoded digital audio contains Karaoke song that is selected by the user. The decoded digital video is send to the OSD generator 513 that adds the Karaoke Text display. The digital video signal 517 and audio signal 516 from are send to the video encoder 514 and audio DAC 515 respectively to produce baseband video signal 519 and audio signal 518. The baseband video and audio signals are used by the video, audio and TV display circuitry 520 to generate the TV display and sound.

A Digital Karaoke Broadcasting application with other TV programs within one RF channel is shown Table 8. Two conventional digital TV programs (Programs 1 and 2) are multiplexed along with the Karaoke program (Program 3). Within the Karaoke program, there is one Karaoke background video, one default audio and twenty Karaoke sub-programs (Audio 1,2..20 and KTDT 1,2..20). The default audio shall be played when Karaoke programs are not selected and it can be associated with the background video to deliver advertisement content.

Assuming a Chinese song of 4 minutes having a total of 400 Chinese characters (including spaces) spread over 40 display rows of 10 Chinese characters each, the data of Karaoke_Text_Elementary_Data fields shall consists of:

▪ Simultaneous_Scroll, Text_Bitmap:	1	byte
▪ Text_Data_Length:	2	bytes
▪ Start_Display_Time	40	bytes
▪ ISO_639_Language_Code, Row1_Text_Length:	80	bytes
▪ Text_Code (Row 1):	400	bytes
▪ Time_Code (Row 1):	440	bytes
▪ ISO_639_Language_Code, Row2_Text_Length:	80	bytes
▪ Text_Code (Row 2):	400	bytes
▪ Time_Code (Row 2):	440	bytes
Total		1883 bytes

The Karaoke_Text_Description_Table fields shall consists of :



▪ Table_Id ... Last_Section_Number:	6	bytes
▪ Karaoke_Application_Code_Id	2	bytes
▪ Start_Decoding_Time	3	bytes
▪ Karaoke_Text_Elementary_Data	1883	bytes
▪ CRC	4	bytes
Total	1898	bytes

Multiple KTDTs are transmitted over the spread of 4 minutes to allow the decoder to retrieve and decodes the Karaoke program. This facilitates retrieval and decoding when the viewer switches within these intervals. The first KTDT may be transmitted 5 sec before the start of the program and so on. If KTDT is transmitted every 10 sec, then there is a total of 24 similar KTDTs over 4 minutes. This work out to have 45552 bytes of Karaoke data for 1 song of 4 minutes or 1518.4 bits/s. One audio song can be transmitted at a rate of about 192kb/s for 2 channels. Thus, 1 song with KTDT works out to be about 192K+2K or 194Kbits/s. With 1Mbits/s of available bandwidth, a total of 5 songs can be transmitted. In Table 8, with a useful bitrate of 22 Mbits/s in a RF TV channel, Program 1, Program 2 and default Program 3 use up 18 Mbits/s, reserving 4 Mbits/s for Karaoke sub-programs. With 4 Mbits/s, twenty Karaoke songs and text information can be carried in the transport stream.

Table 9 illustrate the syntax of Karaoke Font Download Table. This table allows the decoder to download fonts for decoding the Karaoke Text Elementary Data. The PID of Karaoke Font Download Table is the same as Karaoke Next Guide Table. It is differentiated by the Table_Id value. The semantic definitions are:

- Karaoke_Application_Code_Id – A 16-bit unique identification. Set to 0x5459.
- ISO_639_language_code – This 24-bit field contains 3 character ISO 639 language code of the following text fields. Each character is coded into 8 bits according to ISO 8859-1.
- Number_Byte_Code – This 1 bit field indicates the number of bytes to represent the text character. A '0' indicates one-byte code and a '1' indicates two-byte code.
- Text_Pixel_Width – This 6 bit field defines the number of pixels for each text character width. Text_Pixel_Width multiply by Text_Pixel_Height must be divisor by 8.
- Text_Pixel_Height – This 6 bit field defines the number of pixels for each text character height. Text_Pixel_Width multiply by Text_Pixel_Height must be divisor by 8.
- Font_Data_Length – This 16-bit field specifies the length of bytes of the following font description.
- Code_Id – A unique code representing the Text character.
- Bitmap_Code – The bitmap (1 bit per pixel) for the text character, starting from top left, defining from left to right, to bottom right.

Figure 6 shows a method that the Karaoke user can view and check Karaoke programs that are broadcasting currently, or in a later time period through the use of OSD feature in the decoder. The program information is available in the Karaoke Current Guide Table and Karaoke Next Guide Table. In module 6.1, the user may choose the desired method (via program numbers, time slots or current/next time frames) to navigate among the Karaoke programs. After that they can select songs base on program numbers in module 6.2, base on time slots in module 6.3, or base on current/next/next-next time frames in module 6.4.

In module 6.5, all songs within the program number selected are displayed on screen. In module 6.6, all songs in selected time slot are displayed on screen. In module 6.7, all songs that are broadcasting in current time, in next time, or in next-next time are displayed on screen. Finally, the user selects the desired song as shown in module 6.8.



Figure 7 illustrates a method that allows user to place a request by keying Karaoke code via back-channel, and the pre-programmed Karaoke list is changed accordingly. Module 7.1 is for users to place a request by keying a code for their song, and module 7.2 is for Karaoke server to accept the code. Module 7.3 will check the request with pre-programmed Karaoke List for time period and Karaoke slot. If there is available space in term of time duration and Karaoke slot for the request, the pre-programmed list is changed and re-programmed, shown in module 7.4. The pre-programmed Karaoke list in multi-plexer is also updated for the latest changes in module 7.5 for broadcasting. In module 7.6, Transmitting and broadcasting of Karaoke application with advertisement as video background and Karaoke audio and text scrolling based on the latest re-programmed Karaoke list. If there is no change for the Karaoke pre-program list, then the default Karaoke program will be transmitted and broadcasted.

Figure 8 shows an example of that allows users to search for a Karaoke song through back-channel. The menu display can be done using OSD feature of the decoder. Module 8.1 is for users to view Karaoke Main Menu List. Then they can select language in module 8.2. After they select their language, they can search for one, two, or three characters in the list in module 8.3, then all the songs are listed on screen for their selection in module 8.4. In the end they find the code for their selected song from the above list, and make selection in module 8.5.

3.7. Effects of Invention

This invention provides is very efficient and attractive to Digital Karaoke Broadcasting. It can bring economic profit and effect to broadcasters, and it is also very convenient and very useful entertainment for users. This is achieved by attracting more users or more Karaoke fans to enjoy Karaoke Lunge on the air, to exchange advertisements to be cached in and to be absorbed in users.

In this invention, the encoding and decoding of the invented Karaoke Apparatus can be simply implemented. Karaoke database is easily built, and users can place their requests via back-channel to have their own song transmitted at requested time.



4. BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a Prior Art of Conventional Digital Karaoke Broadcasting.

Figure 2 shows an Embodiment of Invented Digital Karaoke Broadcasting.

Figure 3 shows an Illustration on the use of Start_Display_Time and Time_Code Information.

Figure 4 shows an illustration on Synchronizing Karaoke Text and Audio in Karaoke Text Decoder.

Figure 5 shows the functional blocks of the digital TV receiver constructed in accordance with the invention.

Figure 6 illustrates Viewing of Pre-programmed Karaoke Program List via OSD.

Figure 7 illustrates Karaoke Song Request through Back-channel.

Figure 8 shows an example of searching for a code of Karaoke song based on Song Title.

Table 1 shows an Illustration of Data Structure of Karaoke Database.

Table 2 illustrates a proposed syntax for Karaoke Current Guide Table.

Table 3 illustrates a proposed syntax for Karaoke Next Guide Table.

Table 4 illustrates possible descriptors in Karaoke Current Guide Table and Karaoke Next Guide Table.

Table 5 illustrates a proposed syntax for Karaoke Text Description Table.

Table 6 illustrates a proposed syntax for Karaoke Text Elementary Data.

Table 7 illustrates a proposed syntax for Karaoke Time Reference Table.

Table 8 shows an example of broadcasting Karaoke application with other programs in one RF channel.

Table 9 illustrates a proposed syntax for Karaoke Font Download Table.