TCCxxxx Common

Application Note for HD Radio Data Service

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1   INTRODUCTION

This document describes an implementation of HD Radio Data Service provided by Telechips for HD Radio solution. This allows applications such as "Cover Art and Station Logo" and "PSD commercial Text" and "Emergency alert" to be used on Telechips devices.

- Cover Art associated with audio program
- Station Logo
- Program Service Data
- Emergency Alert

1.1 Features

Cover Art & Station Logo
A synchronized image is an image that is rendered on the receiver, in synchronization with other timed media such as audio.
Synchronized images are used for applications such as Cover Art or other visual annotations of timed media.
Cover Art can be transmitted in synchronization with the concurrently playing audio program.
Un-synchronized image is an image that is rendered on the receiver and its display is independent of the audio being played.
Un-synchronized images are used to deliver Station Logo and default images when no Cover Art is available, as well as traffic and weather map images.

Program Service Data
PSD information of HD Radio provides information such as song title, artist name, and album information.
In addition to this information, PSD messages may contain "Commercial" frames.
The "Commercial" frame is used to promote the sale of products and services and may include the seller's name and price, contact URL, and descriptive informative text.

Emergency Alert
This is a function to notify the user of emergency. It generates a beep sound and includes a warning message.
This message is sent repeatedly during state of emergency.

1.2 Terminology

Terminology	Definition
BBP	Baseband Processor
EA	Emergency Alert
JPEG	Joint Photographic Experts Group
LOT	Large Object Transfer
MIME	Multipurpose Internet Mail Extensions
MPS	Main Program Service
PNG	Portable Network Graphics
PSD	Program Service Data
SIG	Service Information Guide
SPS	Sub Program Service

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2   IMAGE SERVICE

2.1   Summary

"Cover Art" and "Station Logo" are representative image services. In the case of Primary Cover Art, XDHR information can be parsed to output an image synchronized with audio. Cover Art is included in MPS and SPS with their respective information. LOT is used as a container for image transfer.

2.2   Concept of HD Radio Image Receiver

Figure 2.1 shows an overall concept of HD Radio Image Receiver.
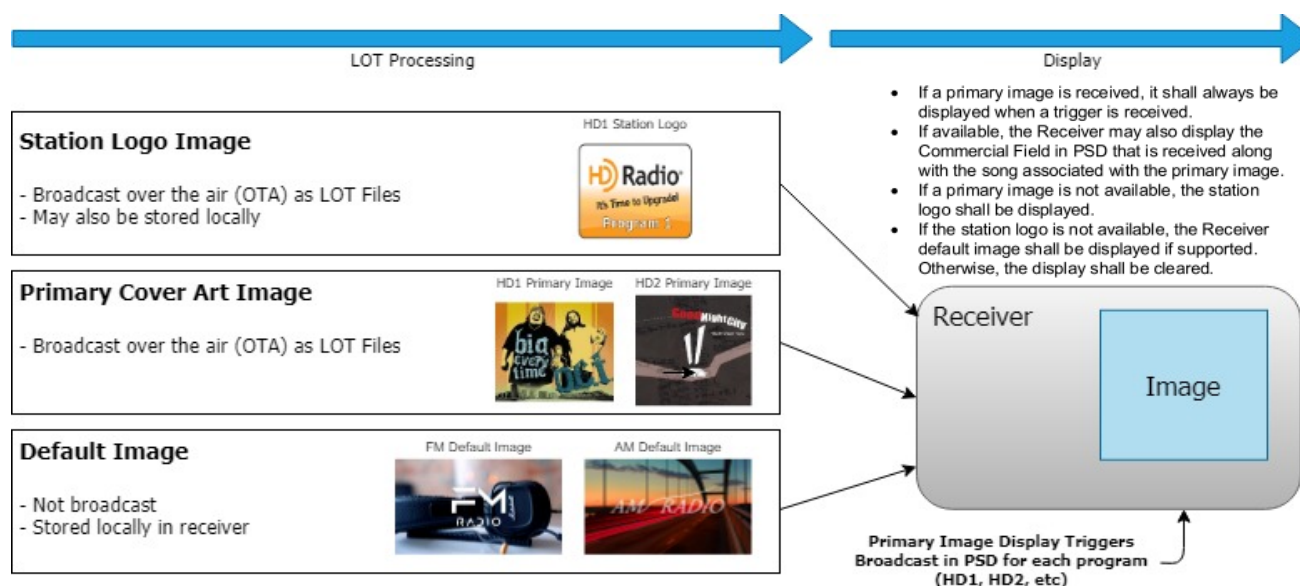

Figure 2.1 Overall Concept of HD Radio Image Receiver

The Image Receiver system supports up to three image types according to HD radio requirement.
- Primary Image
- Station Logo Image
- Default Image

Primary Image can include Cover Art. The image can be transmitted by broadcaster/service provider. It has the highest priority and is always synchronized with audio stream. The receiver can immediately display the primary image once the display trigger is received.

Station Logo Image can be also transmitted by broadcaster/service provider. The Station Logo images are not synchronized with audio. These images are typically displayed when the primary image is not available. The receiver should initially display the Station Logo when tuning station frequency before receiving the primary image. To do this, the receiver should cache Station Logo in receiver memory to retrieve them quickly. Broadcaster/service provider will typically transmit the Station Logo at a lower bit rate than the primary image.

Default Image is generally stored in the receiver memory. The receiver manufacturer can select any default image to be displayed when there are no primary image and Station Logo. If the receiver manufacturer does not support this feature, it should be assumed that the image display must be cleared in alternative way, whereas this document states that the default image must be displayed.

Display Processing
- If a primary image is received, it shall always be displayed when a trigger is received.
- If available, the Receiver may also display the Commercial Field in PSD that is received along with the song associated with the primary image.
- If a primary image is not available, the Station Logo shall be displayed.
- If the Station Logo is not available, the Receiver default image shall be displayed if supported. Otherwise, the display shall be cleared.

2.3   System Design for Image Transfer

Service Information Guide (SIG) is used to detect the presence of one or more synchronized image or un-synchronized image data service. Every image can be provided by using the Large Object Transfer (LOT) data service. The XHDR frame in the `Program Service Data` (PSD) contains instructions of detailed display.

2.4   HD Radio Data Signaling Channel

HD Radio Station Audio Service and HD Radio Advanced Data Service are supported and enhanced through two data signaling channels:

- ■ Service Information Guide (SIG)
  - ● The 'SIG' data service contains detailed information about station's audio program and data services such as port identification (PORT ID).
    "PORT ID" that enables service channel and receives data on HD radio device.

- ■ Program Service Data (PSD)
  - ● The 'PSD' triggers synchronized image events. The XHDR frame in 'PSD' indicates that a certain image may be displayed.

2.5   Transport Mechanism

An HD Radio system supports both byte-streaming and packet-based data transport mechanisms. The image transfer is achieved through the HD Radio system using the packet-based Large Object Transfer (LOT) protocol.
The LOT protocol is based on the packet delivery methods by dividing the large objects into two or more packets containing fragments of the original object. To reduce the effect of packet loss, a fragment can be broadcast several times. The LOT processor in the receiver is responsible for reassembling the packets into the original object and making the object available to the receiver application on the host controller.

In addition to repeated object transmission, the LOT protocol transmits the following information with each LOT object:

- ■ LOT ID – Two-byte numeric identifier.
  Each image must have a unique LOT ID. Note that an image is repeated multiple times through the LOT protocol. Each repetition of the same image must have the same LOT ID. Whenever an image including `Station Logo` is updated, the broadcaster changes the LOT ID. Note that the broadcaster independently assigns LOT IDs for images associated with each audio program. For example, LOT ID 0x1234 on HD-1 may represent a different image than LOT ID 0x1234 on HD-2.
- ■ File Name
- ■ Size of the object in bytes

2.6   MIME Type Definition

Two separate MIME types (Multipurpose Internet Mail Extensions), hash descriptors, and identifiers are defined in this chapter.
- Application MIME type (MIME hash) identifies the service or application.
- LOT MIME type (MIME hash) identifies the file format of the specific service data.

The 'SIG' data service provides the Application MIME type as shown in Table 2.1.

Table 2.1 Application MIME Type

Service	MIME String	32-bit MIME Hash	Comment
Cover Art	application/x-hdradio-std/image/image-sync	0xBE4B7536	synchronized image
Station Logo	application/x-hdradio-std/image/station-logo	0xD9C72536	un-synchronized image

The above MIME hash values apply to all programs. Image services described in this document are considered to be components of audio services.

The LOT MIME type can be obtained from LOT service. The currently supported image file formats with their hash values are shown in Table 2.2.

Table 2.2 LOT MIME Type

Image Format	MIME Type	LOT MIME Hash Value
JPEG	image/jpeg	0x1E653E9C
PNG	image/png	0x4F328CA0

2.7   Processing Flowchart

Figure 2.2 shows the flow of processing Cover Art and Station Logo.
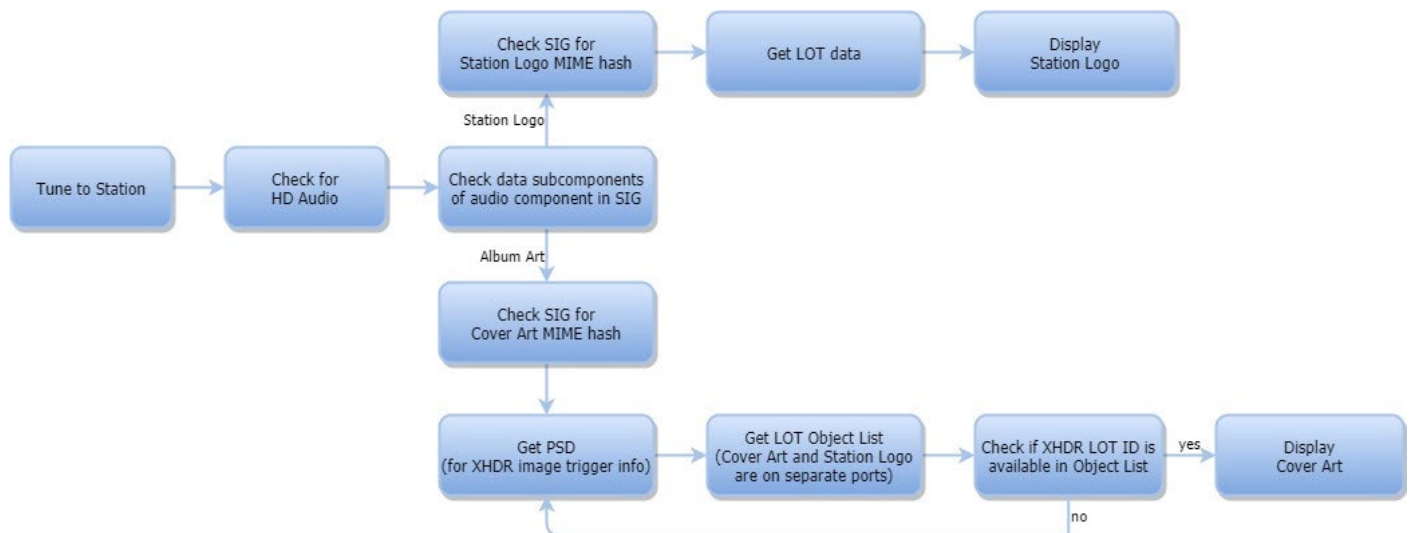

Figure 2.2 High-level Processing Flow

2.8   Image Transfer Control

Figure 2.3 shows when to receive "Cover Art: Primary Image" and "Station Logo".
It describes the mechanism where each primary image for a song is transmitted twice: once before the start of the song and once during the song.
There is no exact timing for the transmission strategy, it depends on segment of each song/program or file sizes and transmission rate. However, the first repetition of the primary image always occurs before the image trigger.
Typical image transmission time is approximately 20 seconds.

Important:
Since each image is sent twice, the LOT timeout parameter must be set properly in the receiver LOT processor for optimal performance during poor channel condition. A value of at least 300 seconds must be used and is set to 300 seconds by default in the Baseband Processor (BBP) software. This will ensure that if the first repetition is only partially received by the LOT application, it will be maintained in memory for 300 seconds before being automatically flushed. This allows sufficient time for the second repetition to be received to fill in the missing LOT packets.
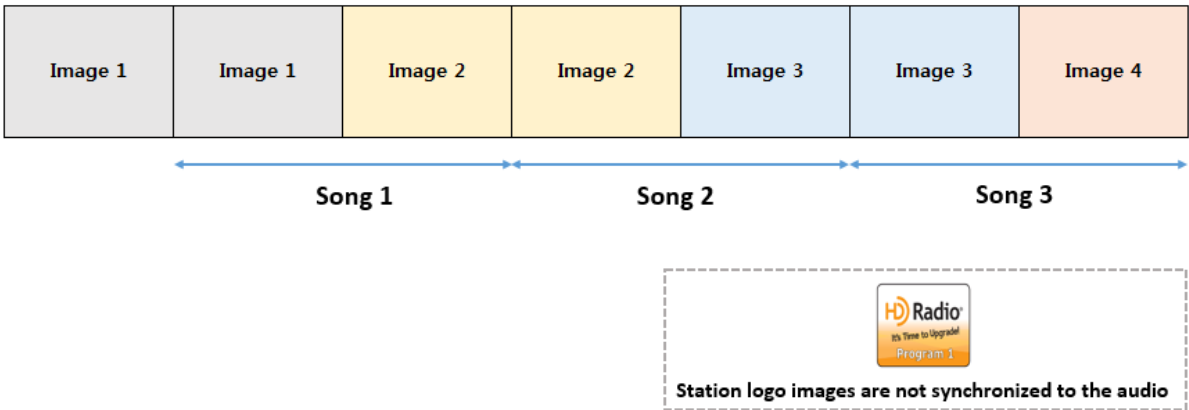

Figure 2.3 Image Transmission Overview

Figure 2.4 shows an example of multiple program image transmission. Program service supports one MPS and up to 7 SPS. MPS/SPS has separate Cover Art and LOT information that are not related to each other.

Figure 2.4 Multi-program Image Transfer

2.9   Image File Format and Display Requirements

Table 2.3 describes the image file properties. It should be noted that since broadcaster image database may contain a huge number of files, a broadcaster may occasionally send an image outside of these specifications. In such a case, the receiver should discard the image. Care must be taken not to create receiver fault condition caused by out-of-spec image. For example, an erroneous image may have a resolution of 1024x1024 or a file size of 100 kbytes. For receivers with limited memory pool, the image should be discarded to prevent a memory fault.

Note: The file size is indicated by the LOT protocol. The image (Native) resolution is indicated by the JPG or PNG file header.

Table 2.3 Image File Requirements

File Type	PNG or JPEG
Native Resolution	Maximum: 200 x 200 Minimum: 170 x 170
File Size	Average of 12 kbytes Maximum of 24 kbytes

3   IMAGES SYNCHRONIZATION SERVICE

3.1   Summary

This chapter describes how to synchronize "`Cover Art: Primary Image`" using XHDR data.
"Display Synchronization Trigger" is possible through XHDR data of ID3v2 standard.

3.2   Primary Image

The primary image can include "artist experience" images such as artist/performance images, local station images, program-related images, genre-related images, and cover art images. The primary image is always synchronized with audio stream.
The receiver can immediately display the primary image once the display trigger is received.

3.3   Display Synchronization Trigger

The time taken for displaying each primary image is solely controlled by service provider. The "Display Synchronization Trigger" does not apply to un-synchronized images such as `Station Logo`. This trigger is accomplished by including a custom ID3 frame along with other PSD information (which may include song title, artist name, and tagging information) in an ID3 tag. The custom ID3 frame uses "XHDR" as frame identifier.
Figure 3.1 shows the format for XHDR ID3 frame. The length of the XHDR ID3 frame must be limited to a maximum of 127 bytes.

The XHDR ID3 frame consists of two parts, and the order in the frame is shown in Figure 3.1:
- **MIME Hash:** The MIME Hash field contains the MIME hash of the application sending the information. The MIME hash is sent in little-endian format; that is, the least significant byte occurs first. This is the same MIME hash value broadcast in SIG.
- **Body:** The body has a list of different parameters describing action to be performed by a receiver application.
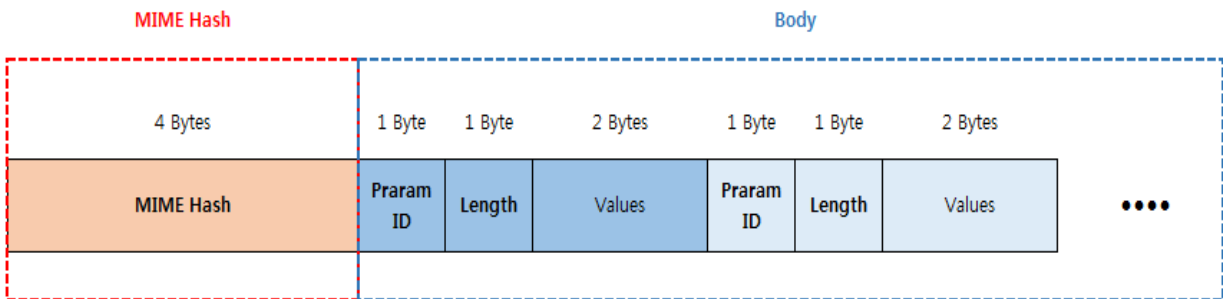

Figure 3.1 ID3 Tag with Multiple XHDR Frames

The XHDR body data consists of a list of one or more parameters as shown in Figure 3.1. Each parameter is identified by a one-byte ParameterID followed by a length byte. The length byte provides the length of the associated parameter data, if any. If there is no data value, the length is set to 0x00. There is no explicit limit on the length byte values, except that you must follow the overall XHDR size limit of 127 bytes. These parameters may be sent in any order, but they must all be associated with the same MIME hash value in the XHDR frame as shown in Figure 3.1.
These parameters describe the various actions to be performed by a receiver application. For example, an image's display is triggered by the receipt of the "XHDR" frame containing ParameterID = 0 and a matching LOT ID for the image.

The following is a description of each field in the parameter definition:
- **ParameterID**: Indicates the parameter being sent. See Table 3.1 for a description of the defined parameters.
- **Length**: Indicates the length (in bytes) of the data values associated with the given ParameterID. If there is no associated data, this field is set to 0x00.

Table 3.1 Definition of XHDR Parameter

ParameterID	Length (byes)	Value	Description
0x00	2	2-byte (LOT ID)	**Display Trigger for Image <LOT ID>** This parameter instructs the receiver application to display an image with the LOT ID specified. The associated MIME hash identifies the image service. The LOT ID is in little-endian format; that is, the least significant byte is sent first. Display trigger does not apply to Station Logo since Station Logo is not a synchronized image service.
0x01	0	None	**Blank Display** This parameter instructs the receiver application to remove any displayed image associated with the indicated MIME hash. This will only apply to images associated with the same program number as this XHDR command. Blank Display currently only applies to the primary image service. When this parameter is received, the receiver must display the Station Logo.
0x02	0	None	**Flush Memory** This parameter instructs the receiver application to clear memory of all images currently stored for the service identified by the associated MIME hash. This will only apply to images associated with the same program number as this XHDR command.
0x03 to 0xFF	Undefined	Undefined	Reserved for future use

To support fast receiver acquisition time of Cover Art images, broadcasters will normally send the XHDR frame to every ID3 tag to trigger a new image or instruct the receiver to blank the display of all synchronized images associated with a given MIME hash and program number, and then the Station Logo can be displayed. For example, if a Blank Display command is sent within the ID3 tag associated with HD-3 program and the synchronized image MIME hash is used, the receiver will blank its display of all synchronized images if it is showing such images for HD-3. The HD-3 Station Logo will then be displayed. Though the receiver missed the Blank Display command due to adverse channel conditions, the receiver will blank the display on a subsequent repetition of the XHDR frame when channel condition improves. It is recommended that the receiver polls the PSD at least once per second to provide a good user experience.

Once the Blank Display command is received, the receiver can remove the synchronized image file(s) being displayed from memory. A broadcaster will send the Flush Memory command if there is an interruption in the normal programming. For example, consider a music segment that is interrupted by a special news broadcast: sending the Flush Memory command is an efficient way to instruct the receiver to clear its memory of primary images that will not be triggered. This does not apply to Station Logo.

As shown in Figure 3.1, a single body can contain more than one XHDR frame. This may happen in the future when additional services are offered that require associated parameters to be provided in PSD. For example, the second synchronized image can be provided, which requires a display trigger. A scrolling text service is another possible example.
Each service will have its own unique XHDR frame with its unique MIME hash. Each XHDR frame may also contain more than one parameter, depending on what is required to describe the service.

There are no requirements for the order of each XHDR frame or the placement of XHDR frames within the ID3 tag. Therefore, the receiver must process all XHDR frames to check any applicable information for the services and discard any XHDR frames that cannot be decoded based on the current definition.

3.4   Additional Considerations for XHDR

It should be noted that a display trigger is sent repeatedly as long as the broadcaster desires the image to be displayed. If a new PSD message is received with no image trigger, the receiver must immediately remove the synchronized image. Then the receiver may display an image of its own choosing (either station logo, default image, or genre-related image). The exception is described as follows:

A Blank Display command is sent by the broadcaster to command the receiver to clear the display of any existing images for a certain HD Radio program. When the Blank Display command is received, the receiver must immediately display the Station Logo for that program.

There are two common use cases associated with Blank Display:

1. During the break between two songs or audio cuts – the broadcaster will terminate the image trigger associated with the previous song and send the Blank Display command for approximately 15 seconds to indicate the receiver that the Station Logo for that program must be displayed. Then the Blank Display command is terminated by the broadcaster and replaced by an image trigger for the next song.

2. During the long break (commercials, news, or talk segments) where no synchronized images are available – in this case, the broadcaster will send the Blank Display command during the break. Radio must display the Station Logo according to the requirement.

4   PROGRAM SERVICE DATA SERVICE

4.1   Summary

`Program Service Data` (PSD) within the HD Radio system provides song information such as song title, artist name, and album information. In addition to these sets of information, a `PSD` message may also contain a "Commercial" frame.
The "Commercial" frame is generally used to facilitate the sale of products and services. It includes descriptive informative text as well as information such as Contact URL, Name of Seller, and Price.
An receiver can process and display the "Commercial" frame for a particular song while displaying the Cover Art image.

The "Commercial" frame for songs/programs as well as Commercial audio segments may be populated by broadcaster/service provider.
The receiver displaying primary images may also process and display the text message in the "Commercial" frame.
Broadcaster will appropriately populate the "Commercial" frame for the "promotional message" or "supporting text" and the receiver may display it regardless of the content.

The receiver may display the content of the "Commercial" frame while playing the song/audio segment whichhas an image to be displayed.
The "PSD messages" can be displayed at any time while playing the song/audio segment and can be displayed close to the image being displayed.
The receiver may still display the primary image even if the "Commercial" frame in `PSD` is not available.

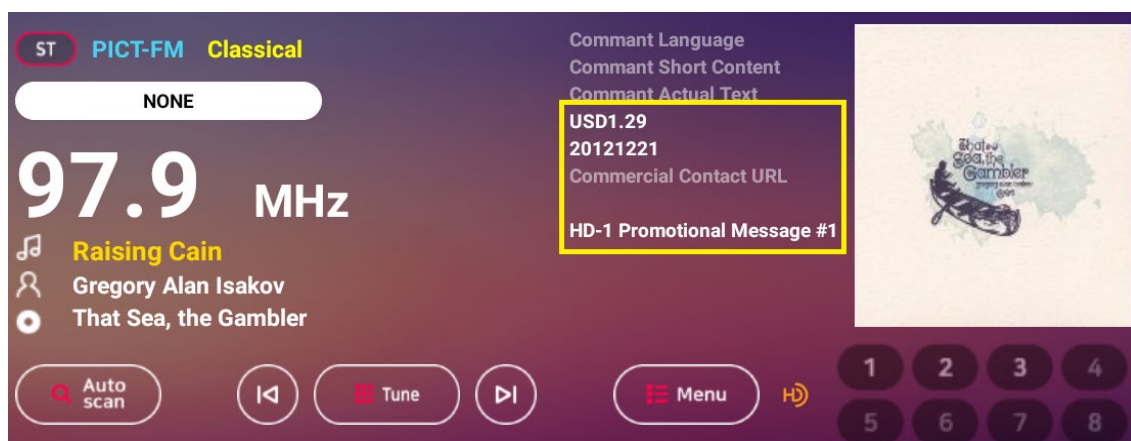Figure 4.1 shows an example of `PSD` commercial display:

Figure 4.1 PSD Commercial Message

4.2 Structure and Commercial Frame in PSD

The Commercial frame, as it is used in the HD Radio PSD, consists of the fields listed in Table 4.1.

Table 4.1 Commercial Frame – Fields used in the HD Radio PSD

Field Name	Format
Text encoding	One byte A value of 0x00 indicates ISO/IEC 8859-1:1998
Price string	Null-terminated text string One three-character currency code, encoded according to the ISO 4217 alphabetic currency code, followed by a numerical value where "." is used as decimal separator. In the U.S., the currency code is "USD".
Valid until	Eight-character date string in the format YYYYMMDD
Contact URL	Null-terminated text string
Received as	One byte (Refer to Table 4.2)
Name of seller	Null-terminated text string according to the encoding byte
Description	Null-terminated text string according to the encoding byte

Note: The "Picture MIME Type" and "Seller Logo" fields are not supported in the HD Radio PSD.
All text fields except for "Valid until" are null terminated.
Hence, "Valid until" must always be populated with eight characters per the format shown in Table 4.1.
If no data is available for an optional text string, the text string shall consist of a single null-terminator byte (0x00).
The "Description" field is the important field that will be populated with either the promotional message or the advertisement text.
The "Received as" field is defined by the values in Table 4.2.

Table 4.2 "Received as" Field – Definition in the Commercial Frame in PSD

Hexadecimal Value	Definition
0x00	Commercial frame is associated with the primary image as described in Chapter 4.1. Receivers may display the Commercial frame.
0x01 ~ 0xFF	Reserved for future use. Receivers shall not display the Commercial frame.

5 EMERGENCY ALERT SERVICE

5.1 Summery

The HD Radio `Emergency Alert (EA)` feature enables receivers with the ability to actively alert radio users of irregular situations that may be life-threatening.
Such alerting may be achieved by rendering the alert content from a currently tuned-in station.
In addition to alerting, the `EA` feature provides time-critical information that may possibly include life-saving information.
Then, the `EA` feature may also provide follow-up information on event.
A beep sound is generated in the audio with an `Emergency Alert` message.

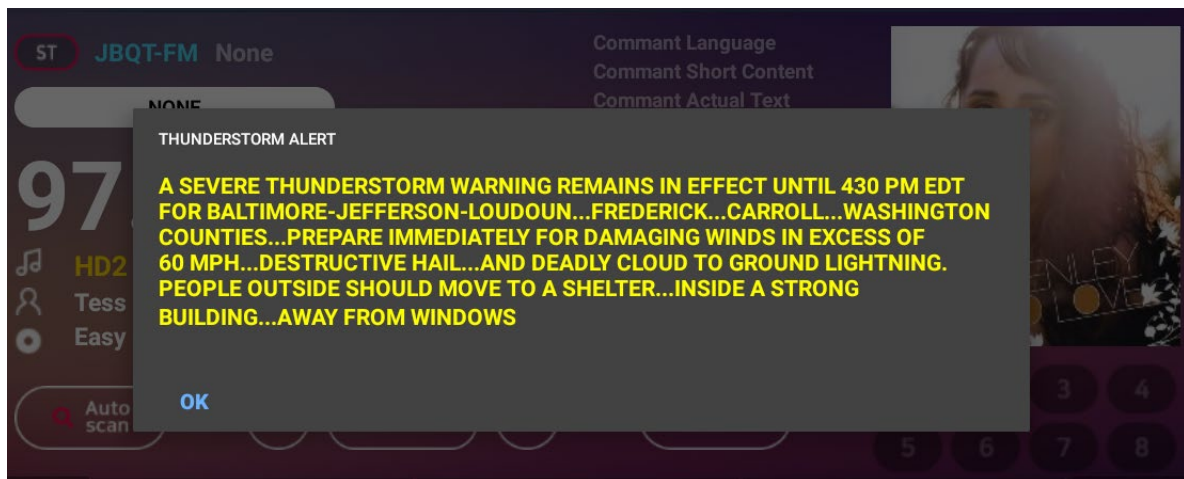Figure 5.1 shows an example of `EA` message.

Figure 5.1 Example of Emergency Alert Message

6   SUPPORTED API

6.1   Summery

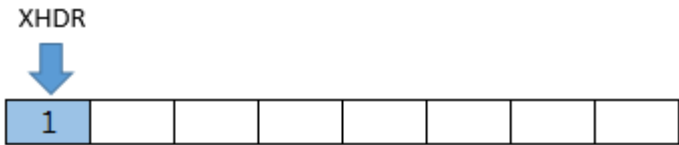This chapter describes function names with a brief description.
Refer to "*TCCxxxx Common-API Specification for HD Radio*" for detailed description.

6.2   Images Service (Cover Art/Station Logo)

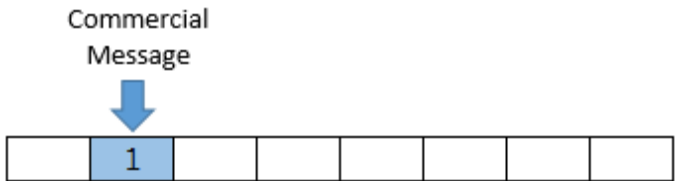| Function	Description
tchdr_enableLotNotification()	Enable/Disable Large Object Transfer (LOT) function

Notification Event	Description
eTC_HDR_NOTIFY_LOT	There are changes to the LOT. For example, when you have completed a Cover Art image.

6.3   Images Synchronization Service

Function	Description
tchdr_enablePsdNotification()	Enable/Disable XHDR function bit XHDR

Notification Event	Description
eTC_HDR_NOTIFY_PSD	PSD information includes XHDR Data.

6.4   Program Service Data (Commercial Message)

Function	Description
tchdr_enablePsdNotification()	PSD function bit set. Commercial Message

Notification Event	Description
eTC_HDR_NOTIFY_PSD	PSD information includes Commercial Message Data. (Valid when "Received As" value is 0x00)

6.5 Emergency Alert Service

Function	Description
tchdr_enableAlertNotification()	Enable/Disable Emergency Alert (EA) function

Notification Event	Description
eTC_HDR_NOTIFY_ALERT	When an emergency alert message is completed.

7   REFERENCES

[1]   Contact Telechips for more details: sales@telechips.com

8   REVISION HISTORY

Rev. 1.00: 2021-05-18

■   First version release

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