



# **ATSC Mobile DTV Receiver**

## **Profile Guidelines**

*Final – December 2012*

July 2013 version

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# ATSC A/153 Mobile DTV Receiver Profile Guidelines

## Introduction

Consumers increasingly demand access to local content and enhanced television services on their portable devices, which makes Mobile DTV a great opportunity for consumer electronics device manufacturers. By developing Mobile DTV receivers, manufacturers can tap into the growing universe of consumers who want to tune in to live, local news, traffic information, weather, sporting events and entertainment programs while on the go – in their car, on the beach, or wherever they may be.

The Open Mobile Video Coalition (OMVC), working with device manufacturers through their participation in the Mobile DTV Forum, and in collaboration with broadcasters and other stakeholders in the Mobile DTV ecosystem, has developed these ATSC A/153 Mobile DTV Receiver Profile Guidelines. They provide directional guidance to consumer electronics manufacturers on the device features and functionalities that will help ensure that devices have robust reception capability and interoperability with services offered by broadcasters – and that consumers have an enjoyable and secure Mobile DTV experience.

These guidelines provide two Mobile DTV receiver profiles for illustrative purposes. The first profile represents a basic Mobile DTV receiver that can receive broadcast transmissions and that is interoperable with real-time linear Mobile DTV broadcast services. The second profile represents an enhanced Mobile DTV receiver that includes all the basic elements plus many of the advanced features and functionalities that many consumers will demand.

Consumer electronics manufacturers will be familiar with many elements of the ATSC A/153 Mobile DTV Receiver Profiles, such as digital recording and pausing functionality. However, both profiles also address three new elements that OMVC believes are critical to Mobile DTV's success, conditional access, service/audience measurement and Internet Protocol (IP) connectivity:

- **Conditional Access.** The ATSC A/153 Mobile DTV standard incorporates a conditional access system that is based on the OMA-DRM standard. Because we anticipate that some Mobile DTV services will use service protection, both profiles require support for conditional access. In both cases, registration with a Mobile DTV trust authority is required so that unique digital certificates can be issued to each Mobile DTV receiver. Short term keys are sent over the broadcast channel. In order to provide a Mobile DTV system that can effectively handle a large volume of users, OMVC believes the Mobile DTV service protection system must incorporate the use of an interaction channel.

- **Service/Audience Measurement.** To date, broadcasters have only been able to make decisions using audience estimates based on sampling techniques. Mobile DTV's new service and audience measurement tools will enable broadcasters to identify which channels are viewed, the duration and time of viewing, and channel changing and video download activity from every viewer who agrees to share such information. This data allows broadcasters to provide a more effective advertising-supported Mobile DTV service.
- **IP Connectivity.** To facilitate the operation of the conditional access system and the transmission of service and audience data, the Mobile DTV receiver must offer IP connectivity at least once every seven days using, for example, an Internet, Wi-Fi, 2G, 3G, 4G, USB, or Bluetooth connection.

Since the Advanced Television Systems Committee adopted the ATSC A/153 Mobile DTV standard in 2009, broadcasters have developed new and innovative Mobile DTV services and business models based on the standard. Ongoing innovation, in turn, drives the development of features and functionalities that consumers will demand as part of the Mobile DTV experience. These ATSC Mobile DTV Receiver Profile Guidelines are an important step in helping consumer electronics device manufacturers predict and meet this demand.

OMVC encourages manufacturers to continue working closely with broadcasters and other industry stakeholders not only in implementing the functionalities in these Receiver Profile Guidelines but also in developing exciting new features that go beyond these baseline requirements. Naturally, commercial Mobile DTV service providers may have additional device requirements and should be contacted directly. We will continue to support all key stakeholders as they work to advance Mobile DTV and ensure its commercial success.

The Open Mobile Video Coalition

*These guidelines are based on our understanding of current industry practices and technology. They are provided "as is" and without warranty of any kind. The user is responsible for obtaining any applicable licenses or authorizations to use the technologies, standards, and specifications referenced in the guidelines.*

## ATSC MOBILE DTV RECEIVER PROFILE GUIDELINES TABLE

Functions & Features	Base Profile (Required)	Enhanced Profile (Optional)	OMVC Comments and Rationale
<b>RF</b>			
Channel tuning	US Channels 7-56	US Channels 7-56	Both profiles should tune Ch. 7-56. Because of the physics of the receive system, the general power levels allowed in Low-band VHF, and the noise environment in that band, we are excluding Low-band VHF
External Antenna Connection	Desirable	Desirable	An external antenna connection is desirable in both profiles where it is practical in a specific device
Second tuner	Not Required	Desirable	In either profile the mix of capabilities is left up to the receiver designers' assessment of the market
SFCMM	Not Required	Desirable	SCFMM is acceptable in both profiles, but the mix of capabilities is left up to the receiver designers' assessment of the market
<b>Essence (Video / Audio) Decoding</b>			
H.264 profile	Base profile v1.3 & Main profile up to v3.1	Base profile v1.3 & Main profile up to v3.1	The standard specifies Main Profile, Level 3.1 for resolutions greater than 416x240, but using SVC. Since SVC is not commercially available, OTAG recommends AVC at Main Profile, Level 3.1. This capability needs to be in both profiles.
SVC	Not Used	Not Used	SVC has not appeared in the marketplace and since H.264 Level 3.1 can replace it, there is no plan to use SVC
Audio	HE-AAC V2 (w/SBR) as constrained in A/153 Part 8	HE-AAC V2 (w/SBR) as constrained in A/153 Part 8	HE-AAC V2 with SBR is part of the standard and is required in both profiles. Note that A/153 requires the average loudness of the audio to be -14 LKFS.
Multiple audio services	Required	Required	The capability to receive different audio services (one at a time) is required in both profiles. Second language and Descriptive Video Services are two currently available services

Functions & Features	Base Profile (Required)	Enhanced Profile (Optional)	OMVC Comments and Rationale
<b>Conditional Access/Service Protection</b>			
<b>CA Type</b>	<p><b>ATSC-MH Compliant-Broadcast &amp; Interactive mode</b></p> <p><i>Note: See the OMVC Service Protection White Paper for additional details on ATSC MDTV Conditional Access</i></p>	<p><b>Required</b></p> <p><i>*Note: Some commercial MDTV services require an additional application to deliver Conditional Access key source information. These applications should be deployed in addition to the standardized method.</i></p>	<p>Note that the standard requires implementation of a key delivery over an interaction channel if an interaction channel exists.</p> <p>We believe that the most likely business reality will dictate that at least some services using Mobile DTV will use service protection. We have concluded that the only large scale (10<sup>5</sup> and up units) practical way to implementation of a usable service protection scheme will require that key exchange happen over an interaction channel. This is due to the constraints on over-the-air channel capacity. Therefore we advise device manufacturers that devices without any kind of interaction channel will most likely not be able to receive at least some services that may be made available.</p>
<b>Long term key delivery</b>	<b>For practical implementation, Interaction channel is required</b>	<b>For practical implementation, Interaction channel is required</b>	OMVC members need the interaction channel for long term key delivery especially as volume scales to large values
<b>Short term key delivery</b>	<b>In Band from broadcast service</b>	<b>In Band from broadcast service</b>	Required for business plans
<b>Trust Authority Registration (Neustar)</b>	<b>Required</b>	<b>Required</b>	Required for business plans
<b>Clear-to-air (no encryption)</b>	<b>Supported</b>	<b>Supported</b>	Required for business plans
<b>Additional Connectivity (interaction channel)</b>			
<b>Periodic IP Connectivity, such as connected Internet, WIFI, 2G, 3G 4G, others or USB or Bluetooth via helper device</b>	<b>Required from one</b>	<b>Required from one</b>	Periodic IP Connectivity is required from at least one of the following: Internet, WIFI, 2G, 3G 4G, others or USB or Bluetooth via helper device. How periodic needs to be defined, but no longer than seven days.
<b>Electronic Service Guide</b>			
<b>Type</b>	<b>OMA-BCAST, as constrained by A/153</b>	<b>OMA-BCAST, as constrained by A/153</b>	OMVC members plan to use the OMA-BCAST for Service Guides delivered in band.

<b>Functions &amp; Features</b>	<b>Base Profile (Required)</b>	<b>Enhanced Profile (Optional)</b>	<b>OTAG Comments and Rationale</b>
<b>Electronic Service Guide (continued)</b>			
<b>Delivery method: Out of Band via IP connectivity</b>	<b>Not Required</b>	<b>Required</b>	OMVC members plan to use out-of-band delivery for more enhanced Service Guides.
<b>Delivery method: In Band from broadcast service</b>	<b>Required</b>	<b>Required</b>	See "ESG Guidelines"
<b>On device aggregation of ESG information collected from multiple providers</b>	<b>Required</b>	<b>Required</b>	OMVC expects different broadcasters to deliver their own services guides and therefore aggregation on devices is necessary. OMVC believes this is already referenced in the OMA-BCAST standard
<b>DVR Functionality</b>			
<b>Pause Only</b>	<b>Preferred</b>	<b>Required</b>	This feature is very useful for mobile applications given the expected behavior in mobile environments. OMVC recognizes the limitations in pause time and seeks a 'reasonable' length of time given the expected behavior.
<b>Impulse Recording</b>	<b>Not Required</b>	<b>Desired</b>	This feature would also be useful in mobile environments given the reasonable expectations of consumers
<b>Scheduled DVR</b>	<b>Not Required</b>	<b>Desired</b>	This feature would also be useful in mobile environments given the reasonable expectations of consumers
<b>Other</b>			
<b>Service/Audience Data Collection and Reporting</b>	<b>Data collected and cached on device. Data is downloaded to service agency at least once per week or the same time as CA/SP long term (encryption) key delivery. Integration TBD.</b>		This is a selected means for monetizing ad/underwriting supported services.
<b>Unique Device ID</b>	<b>Required</b>	<b>Required</b>	A Unique Device ID is required to uniquely identify the device, which then becomes an enabler of multiple features such as data collection
<b>File Based Delivery</b>	<b>Recommended for mobile aspects of NRT Candidate Standard</b>	<b>Required for mobile aspects of NRT Candidate Standard</b>	OMVC believes that file-based delivery will be an important feature of MDTV business plans. See the NON REAL TIME USE CASES.

<b>Functions &amp; Features</b>	<b>Base Profile (Required)</b>	<b>Enhanced Profile (Optional)</b>	<b>OMVC Comments and Rationale</b>
<b>Other (continued)</b>			
Closed Captioning	Required	Required	OMVC believes closed captioning to be essential for practical mobile services
Interactive Components	Not Required	RME Required	OMVC expects OMA-RME to be an essential part of enhanced services
CIT	Required	Required	CIT operations maximize consumers' services as consumers change geographical areas. These will be important features for practical mobile business operations
Geo Location	Required (if GPS or other positioning aware, i.e. cell vectoring capability is present on device)	Required (if GPS or other positioning aware, i.e. cell vectoring capability is present on device)	Broadcasters plan to use the geo-location data in various applications. OTAG notes the concerns expressed for usage of data and the possible need for opt-in capabilities. OTAG also has concerns over privacy of data.
Certification	Individual Business Discussion	Individual Business Discussion	Device certification should remain an individual business discussion and decision, and should not be a general requirement.
Instant Play	Power off settings and authorizations retained	Power off settings and authorizations retained	All settings and authorizations should be retained when devices are powered off to make the devices more useable
Wake-up Function wake up and provide emergency alert to user	Not Required	Required	Wake-up functions on Mobile 1-Seg devices were essential in the recent Japanese earthquake and tsunami. The wake-up function has been documented in A/153. See Emergency Alerting profile section below for that profile information.
Recommended Minimal Receiver Performance Criteria	Recommended that minimal performance meet or exceed the guide lines in ATSC A/174		In general the OMVC believes that the device performance should be left to the marketplace and not be required.

<b>Functions &amp; Features</b>	<b>Base Profile (Required)</b>	<b>Enhanced Profile (Optional)</b>	<b>OMVC Comments and Rationale</b>
<b>Other (continued)</b>			
<p><b>Parallel Parades:</b> The ability to receive more than one parade at the same time. This may be required if the receiver needs to receive an EMM parade for CA, or a data parade for ESG or for other purposes while it receives the A/V parade. This also enables some advance features like PIP (Picture In Picture), or reception of NRT parade while watching an A/V parade etc.</p>	<b>Not Required</b>	<b>Required</b>	<p>Parallel parades offer the potential for a better user experience in a broadcast, such as PIP</p>
<p><b>Legacy ATSC support (Device also receives A/53 broadcasts)</b></p>	<b>Not Required</b>	<b>Not Required</b>	<p>Legacy ATSC support (A/53 reception) is not required but is allowed if appropriate for the product</p>

**ATSC EMERGENCY ALERTING CAPABLE MOBILE DTV RECEIVER  
PROFILE GUIDELINES TABLE**

<b>Functions &amp; Features</b>	<b>M-EAS Profile (Required)</b>	<b>M-EAS Enhanced Profile (Optional)</b>	<b>OMVC Comments and Rationale</b>
<b>All Types of MDTV Receivers</b>			
Receiver recognizes EAT message, processes message and displays message on device screen in a manner as determined by the device manufacturer	Required	Required	
Receiver supports user selectable display options and positioning of EAS alert text		Required	
EAS alert triggers alarm that is either audible or vibration or both	Required	Required	
Receiver recognizes NRT service category, processes and stores NRT content	Required	Required	
Receiver recognizes M/H NRT announcement, processes and displays a video alert, as determined by the device manufacturer, signaling the user that that rich media message content is available	Required	Required	
M-EAS content guide listing is provided to the user listing available rich media content	Required	Required	
Positioning, style and size of M-EAS content guide is user definable		Required	

<b>Functions &amp; Features</b>	<b>M-EAS Profile (Required)</b>	<b>M-EAS Enhanced Profile (Optional)</b>	<b>OMVC Comments and Rationale</b>
Receiver supports geographic targeting of alert message through use of area element within CAP message and ge positioning information of receiver		Required	
Receiver supports Multiple Messages, Lost messages and End of Alerts as described in draft A/153 Part 10, Sect. 8	Required	Required	
Receiver supports automatic wake-up if M-EAS is sent		Required	
Receiver allows user to select desired station to monitor for wake-up alerts from list of available local stations		Required	
Type and length of M-EAS audible alarm to be as defined by the FCC	Required	Required	
Volume of M-EAS audible alarm is user selectable	Required	Required	

<b>Functions &amp; Features</b>	<b>M-EAS Profile (Required)</b>	<b>M-EAS Enhanced Profile (Optional)</b>	<b>OTAG Comments and Rationale</b>
Receiver supports hyperlink connection via internet to URL's provided as part of M-EAS CAP message or NRT rich media content		Required	
Receiver stores last alert for definable period of time allowing user recall	Required	Required	
Receiver stores all NRT rich media alert content for content defined period allowing user to return to content if needed	Required	Required	
Receiver allows turn on or off of the geographic targeting		Required	
Receiver supports multiple languages	Required	Required	
<b>Cell Phone Type MDTV Receivers Only</b>			
M-EAS message triggers alert during active phone call but does not interrupt call	Required	Required	
Receiver initially displays or alerts user to either CMAS or M-EAS message based on order received		Required	
Receiver allows user to select between CMAS or M-EAS alert		Required	

# Media Types for MEAS NRT

While a great many different media types are possible for MEAS NRT content, it is extremely desirable to limit the types in use to help guarantee that each piece of content can be rendered properly. File name extensions do little to constrain the device complexity of the decoder (primarily due to the degree of overloading of file extensions in use). ATSC standard A/103 provides capability codes to help restrict files to expected receiver capability.

Four media types are desirable for MEAS NRT content. They are video, images, audio clips and text.

## Video

This category has the greatest diversity of implementation. As a result, it is most important to comply with limitations defined in A/103 to maximize compatibility. These limitations are expressed as compatibility codes.

File Type/Wrapper: MPEG4

Compatibility codes: (0x27) for MP4 constrained container format PD2

(0x22) for DECE CFF container format, portable device resolution

(0x23) for DECE CFF container format, SD resolution

Included components:

AVC video (0x41)

HE AAC v2 audio (0x4A)

Captions (0x4E)

SMPTE TT (0x4D)

## Images

Three file types are ubiquitous in the industry and therefore do not require a compatibility code

JPEG

GIF

PNG

## Audio Clips

This category could be nearly as large as video. Fortunately, it can be narrowed down to just a couple of reasonable options fairly easily.

HE AAC v2 audio (0x4A) (already exists in all MDTV receivers)

MP3 (0x45)

## Text

This category includes web pages (which also may include images).

Web browser Profile A (CEA 2014 - 0x46)

Useful components:

ECMAScript (0x46)

Zip (for packaging - 0x21)

Plain text

## Glossary of Key MDTV Terms

<b>Base Profile Level 1.3</b>	A Profile of the Advanced Video Codec video compression algorithm for AVC video (ISO/IEC 14496-10) [1]. The allowable parameters are bounded by the upper limits specified for the Baseline Profile at Level 1.3 as further constrained by Section 7.1 of ATSC A/153 Part 7 AVC and SVC Video System Characteristics.
<b>CA</b>	<p>Conditional Access (CA) or Conditional Access System (CAS) sometimes call Service Protection is a system that selectively allows access to program services within the MDTV transmission. The ATSC MDTV standard uses a CA system that is based on the OMA-DRM standard.</p> <p>See ATSC A/153 Part 6 Service Protection.</p>
<b>Certification</b>	A process that can be performed on a product to confirm a set of capabilities exist in the product.
<b>CIT</b>	<p>The Cell Information Table for ATSC-M/H (CIT-MH), provides carrier frequency information on selected transmitters in adjacent cells that are transmitting services that are the same as, or very similar to, services in the M/H Broadcast where the CIT appears. The purpose of this table is to allow a viewer to continue watching the same service, or a very similar service, when traveling from the coverage area of one M/H transmitter to the coverage area of others. A directed channel change based on received signal strength or geo location of the receiver would utilize the CIT information.</p> <p>See ATSC A/153 Part 3 Service Multiplex and Transport Subsystem Characteristics.</p>
<b>Clear-to-air</b>	Clear-to-air is an MDTV service model where mobile transmission(s) are sent unencrypted without the use of Service Protection or Conditional Access. The MDTV viewer is able to receive the content on any basic receiver and without any enforcement of any additional action such as data collection.
<b>Free- to-air</b>	Free-to-air is an MDTV service model where mobile transmission(s) are sent with the use of Service Protection or Conditional Access. The receiver must be equipped with decryption software. The viewer must access a sign up portal and agree to the terms of use for the service(s) in exchange for the electronic keys to unlock the content.
<b>File Based Delivery</b>	The delivery of content as a file rather than as a linear stream. This delivery method allows content to be sent for viewing at a later time

and also can be used to deliver interactive and program associated content that may be user selected.

See ATSC A/153 Part 3 Service Multiplex and Transport Subsystem Characteristics.

<b>Geo Location</b>	An optional feature on an MDTV receiving device that utilizes GPS or wireless carrier signals to determine the location of the MDTV device. This information can be used to select location-based advertising, trigger receiver hand off when moving between MDTV service areas or other location sensitive applications.
<b>H.264</b>	A simplified and widely used reference to MPEG-4 Advanced Video Codec and Scalable Video Codec as described in ITU-T Rec. H.264/ISO/IEC 14496 Part 10. Note: When used in the Mobile DTV context a subset of capabilities is inferred as per ATSC A/153 Part 7 AVC and SVC Video System Characteristics.
<b>HE-AAC v2.0</b>	High Efficiency Advanced Audio Coding version 2 as described in ISO/IEC 14496-3 and constrained by ATSC A/153 Part 8 HE AAC Audio System Characteristics.
<b>Impulse Recording</b>	An MDTV receiver feature that incorporates a digital recorder function that is capable of recording a selected MDTV program stream at the push of a button based on the viewer's impulse decision.
<b>In Band</b>	Information that is delivered to MDTV receiver devices by the MDTV broadcast channel. Typically this would include linear and file-based program content, basic and advanced ESG data and short term encryption keys.
<b>Instant Play</b>	Instant Play is a feature of the MDTV receiver that remembers the previous session settings and returns to those settings upon power of the receiver. This eliminates the need to select an MDTV channel or stream and then set audio listening levels.
<b>Long Term Key Message</b>	A Long Term Key Message (LTKM) is equivalent to an EMM in CAS in subscription TV systems. It contains the Rights Encryption Keyset (REK) that is delivered to a receiver via a registration protocol and is specific to that particular receiver. The REK is used to protect the Service Encryption Key (SEK) and the Program Encryption key (PEK). LTKM's are usually delivered to the receiver via the interactive channel or out-of-band.  See ATSC A/153 Part 6 Service Protection and ATSC A/154 ATSC Mobile DTV Recommended Practice.
<b>Main Profile Level 3.1</b>	A Profile of the Advanced Video Codec (AVC) video compression

algorithm of AVC video (ISO/IEC 14496-10) [1]. The allowable parameters are bounded by the upper limits specified for the Main Profile at Level 3.1.

See ATSC A/153 Part 7 AVC and SVC Video System Characteristics.

**OMA-BCAST**

The Open Mobile Alliance – BCAST is a standard that is for the transmission of an electronic service guide for MDTV. The OMA-BCAST standard was adopted with some modification as part of the ATSC A/153 Mobile DTV Standard.

See ATSC A/153 Part 4 Announcement and ATSC A/154 ATSC Mobile DTV Recommended Practice.

**OTAG**

OMVC Technical Advisory Group (OTAG) is the technical body of the OMVC. It is made up representatives of the various broadcaster members of the OMVC. OTAG works in conjunction with the OMVF Forum, ATSC and other groups to further the ATSC MDTV technology and system architecture.

**Out of Band**

Information that is delivered to MDTV receiver devices by the interaction channel as opposed to the MDTV broadcast channel. Typically this would include advanced ESG, long term encryption keys and some file-based content.

**Pause Only**

Pause Only function on an MDTV receiver allows the viewer to go to take a break while watching a real time linear program and then resume watching at a later time. This mode requires the receiver to have recordable memory that is capable of buffering program content for a reasonable period of time e.g. >30 minutes.

**SBR**

Spectral band replication (SBR) is a technology that is part of the HE-AAC v2.0 audio codec selected for inclusion by the ATSC A/153 Standard. It is based on harmonic redundancy in the frequency domain. Some guidance information for reconstruction of the high-frequency spectral envelope is transmitted as side information.

When the audio is encoded using SBR, the replicated audio will sound “dull” due to the lack of high frequency information if SBR is not implemented in the audio decoder.

See ATSC A/153 Part 8 HE AAC Audio System Characteristics

**Scheduled DVR**

An MDTV receiver feature that incorporates a digital recorder function that is capable of being programmed to record a selected MDTV program stream at a selected time without any assistance once the information has been programmed.

**Service/Audience Measurement**

The collection of service usage data such as channel watched, duration of viewing, channel change activity, time of day for viewing

that is stored on the receiver for a period of time and then transferred via the interactive channel. The transfer of this information might be coordinated with the delivery of the LTKM. Broadcasters are expected to require viewers to opt into the transmission of this data as a condition to access some services.

**SFCMM**

Scalable Full Channel Mobile Mode is an alternative mode of MDTV operation that allows higher data rates up to the full channel capacity for mobile service without assurance of protection for legacy ATSC services.

See ATSC A/153 Part 9 Scalable Full Channel Mobile Mode.

**Short Term Key Message**

Short Term Key Messages (STKM) contain the Service Encryption Key (SEK) and the Program Encryption Key (PEK). The STKM is equivalent to an ECM in CAS in a subscription TV system. The lifetime of the SEK and PEK is very short and must be changed every few seconds. The STKM is sent via the broadcast channel and is a small message (100 to 130 bytes). Some broadcasters may send it in every RS frame to prevent it from increasing channel change time.

See ATSC A/153 Part 6 Service Protection and ATSC A/154 ATSC Mobile DTV Recommended Practice.

**Trust Authority**

The trust authority is an independent agency that administers the public key infrastructure for the service protection system. The authority issues unique digital certificates to each MDTV receiver at the time of manufacturing. In the case of ATSC MDTV, the Open Mobile Video Coalition has selected Neustar Inc. as the MDTV Trust Authority. They also will manage the full lifecycle of MDTV trust relationships from registration to ordering, delivery, authentication, status checking and revocation.

**Unique Device ID**

A Device ID is required to uniquely identify the device, which then becomes an enabler of multiple features such as data collection. This may be the subjectKeyIdentifier in the x.509 certificate assigned by the OMVC's trust authority.

**Wake-up Function**

There are two types of wake-up functions. The first is based on the user of the MDTV receiver programming in a specific time to turn on thus reminding the viewer that a desired program is available. The programming of this feature might be as simple as clicking on a specific listing from the program guide.

The second is a function in the ATSC MDTV receiver that will respond to a specific alerting message and bring the receiver to operation while it is normally not in use. The function periodically samples the broadcast transmission looking for the alert code.

## Reference Documents

ATSC: "ATSC Mobile DTV Standard, Part 3 – Service Multiplex and Transport Subsystem Characteristics," Doc. A/153 Part 3:2009, Advanced Television Systems Committee, Washington, DC, 15 October 2009.

ATSC: "ATSC Mobile DTV Standard, Part 4 – Announcement," Doc. A/153 Part 4:2009, Advanced Television Systems Committee, Washington, DC, 15 October 2009.

ATSC: "ATSC Mobile DTV Standard, Part 6 – Service Protection," Doc. A/153 Part 6:2011, Advanced Television Systems Committee, Washington, DC, 23 May 2011.

ATSC: "ATSC Mobile DTV Standard, Part 7 – AVC and SVC Video System Characteristics," Doc. A/153 Part 7:2009, Advanced Television Systems Committee, Washington, DC, 15 October 2009.

ATSC: "ATSC Mobile DTV Standard, Part 8 – HE AAC Audio System Characteristics," Doc. A/153 Part 8:2009, Advanced Television Systems Committee, Washington, DC, 15 October 2009.

ATSC: "ATSC Mobile DTV Standard, Part 9 – Scalable Full Channel Mobile Mode," Doc. A/153 Part 9:2011, Advanced Television Systems Committee, Washington, DC, 01 June 2011.

ATSC: "ATSC Mobile DTV Recommended Practice, Doc. A/154:2011, Advanced Television Systems Committee, Washington, DC, 05 May 2011.

OMA: "Service and Content Protection for Mobile Broadcast Services," Doc. OMA-TSBCAST\_SvcCntProtection-V1\_0, Open Mobile Alliance.

OMA: "Service Guide for Mobile Broadcast Services," Version 1.0, OMA-TSBCAST\_Service\_Guide-V1\_0, Open Mobile Alliance, URL: <http://www.openmobilealliance.org>