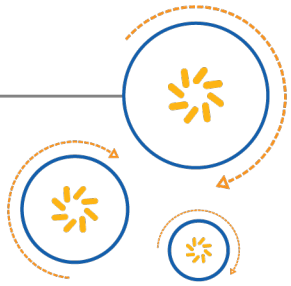
Qualcomm Technologies International, Ltd.



ADK Audio Sink Application Broadcast

User Guide

80-CF407-1 Rev. AB

November 15, 2017

Qualcomm Technologies International, Ltd. (formerly known as Cambridge Silicon Radio Limited) is a company registered in England and Wales with a registered office at: Churchill House, Cambridge Business Park, Cowley Road, Cambridge, CB4 0WZ, United Kingdom.
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Revision history

Revision	Date	Description
AA	08 November 2017	Initial release. Alternative document number CS-00406726-UG. Branched from CS-00403044-UG, for ADK 4.3 and ADK 6.1.
AB	15 November 2017	HFP support added to Changes since ADK 4.2

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1 Broadcast Audio - overview

The Broadcast Audio feature provides support for broadcasting audio from one audio source to many receivers. The audio is broadcast with a TTP to ensure that the audio is synchronized on all devices within the broadcast system. Receivers must be associated with a Broadcaster before they can receive and play back the broadcast audio.

2 Broadcast Audio streaming setup

Broadcast Audio support is built into the Speaker variant of the Sink application which can be run on QTIL CSR8670, CSR8675 and CSRA68100 ICs.

To create an initial broadcast system, use two CSR8670/CSR8675 development boards and perform the following steps:

1. Configure application for Broadcast Audio.
2. Build and download the application to two devices, Device 1 and Device 2.
3. Power On Device 1, which powers up in normal Speaker mode.
4. Switch to Broadcaster mode by triggering the `Switch to Broadcaster` user event.
   Device 1 switches to Broadcaster mode.
5. Power on Device 2, device powers up in normal Speaker mode.
6. Switch to Receiver mode by triggering the `Switch to Receiver` user event.
   Device 2 switches to Receiver mode.
7. Trigger the `Start Association` user event on both Devices to start the association process.
   The Association LED pattern is seen on both Devices.
8. A successful association on the Receiver is indicated by an LED pattern.
9. Based on the automatic audio source selection of the Sink application the respective audio source is routed at the Broadcaster, Refer to the *Audio Sink Application Peer Device User Guide.*
10. Start playing audio on Device 1.
11. Audio is heard from both Device 1 and Device 2.

2.1 Configuring application for Broadcast Audio

2.1.1 CSR8670 and CSR8675

1. Open the Speaker application within the ADK.
2. Set the Peer Device Support **Build Property** to Broadcast Audio.
3. Include the DSP projects for into the Broadcast Speaker workspace. That is:
   a. `csb_broadcaster_multi_decoder.xip`
   b. `csb_receiver.xip`
4. To support USB input audio, the Speaker project needs to include the `usb_device_class_ba` library variant instead of the regular `usb_device_class` library.

5. Configure the audio outputs using the Sink Configuration Tool.

   NOTE Only analog (DAC) and I^2S outputs are supported in Broadcast Audio.

6. Enable the `csb_broadcaster_multi_decoder.kap` and `csb_receiver.kap` files in the speaker.mak file.

2.1.2 CSRA68100

1. Open the Sink application within the ADK.
2. In the **Build Settings** set **Build Configuration** to **Speaker_Broadcast**.

3 Broadcast Audio configuration

Broadcast Audio can be configured using the Sink Configuration Tool. Broadcast Audio configuration data is held in the `sink_broadcast_audio_module_def.xml` configuration file, which is located in the **sink\module_configurations** folder.

The available Broadcast Audio configurations are:

- **Retaining Broadcast Audio Mode:** This configuration retains the Broadcast mode across a cold restart, otherwise the application defaults to normal Speaker mode on a cold restart.
  By default this configuration is enabled.
- **Continuous Sync Train:** This configuration enables a continuous synchronization train, which does not timeout and require restarting by the application.
  By default this configuration is set to enable.
- **BA volume:** This configuration defines conversion table between the Broadcast Volume Steps (0-31) and the gain value passed to the DSP expressed in dB * 60 (for example, 180 is equivalent of 3 dB).
  By default this configuration matches primary output volume curve defined in **Audio\Output** > **Group Volume**.
  The default configuration is appropriate when a broadcaster and all receivers have the same primary output volume curve. When this is not a case then it is recommended to change the BA volume configuration in such a way that relation between the Broadcast Volume Steps and the gain value passed to the DSP be linear.

3.1 Configuring I²S audio output for Broadcast Audio

Broadcast Audio supports driving a single external I²S amplifier, multichannel is not supported.

See the *ADK I2S User Guide*.

NOTE To enable I²S audio output on CSR8670 and CSR8675, the associated DSP `.kap` file needs to be rebuilt by including `audio_out_software_rate_match` library in place of `audio_out` library.

4 Broadcast Audio association

- Association between the Broadcaster and the Receivers require a GATT connection to be established. This is a temporary connection to exchange security information, when that is complete the GATT connection is no longer required.
- The Broadcaster scans for connectable adverts from Receivers which include the 16-bit UUID Broadcast Data service.
- The Broadcaster then connects to each Receiver in-turn.

NOTE The Broadcaster connecting to the Receivers helps ensure the Bluetooth low energy technology connection can be setup by the Broadcaster with minimal impact to any existing CSB stream.

To connect to Receivers in-turn the Broadcaster needs to advertise, the IV, while also scanning for Receivers to associate with, if it is also broadcasting an existing CSB stream. To allow this, the firmware supports both scanning and advertising simultaneously.

- When the Receiver has been associated with the Broadcaster, the Bluetooth address of the Broadcaster is stored using the config store library.
- The Receiver also stores the Broadcasters Service Stream Record (BSSR).
- After the Receiver receives the stream ID from the Broadcaster, it must configure the DSP application to suit the requirements of the received stream ID.
- A 16-bit, Broadcast Service UUID service is used to associate a Receiver to a Broadcaster.

Figure 4-1 shows the association sequence

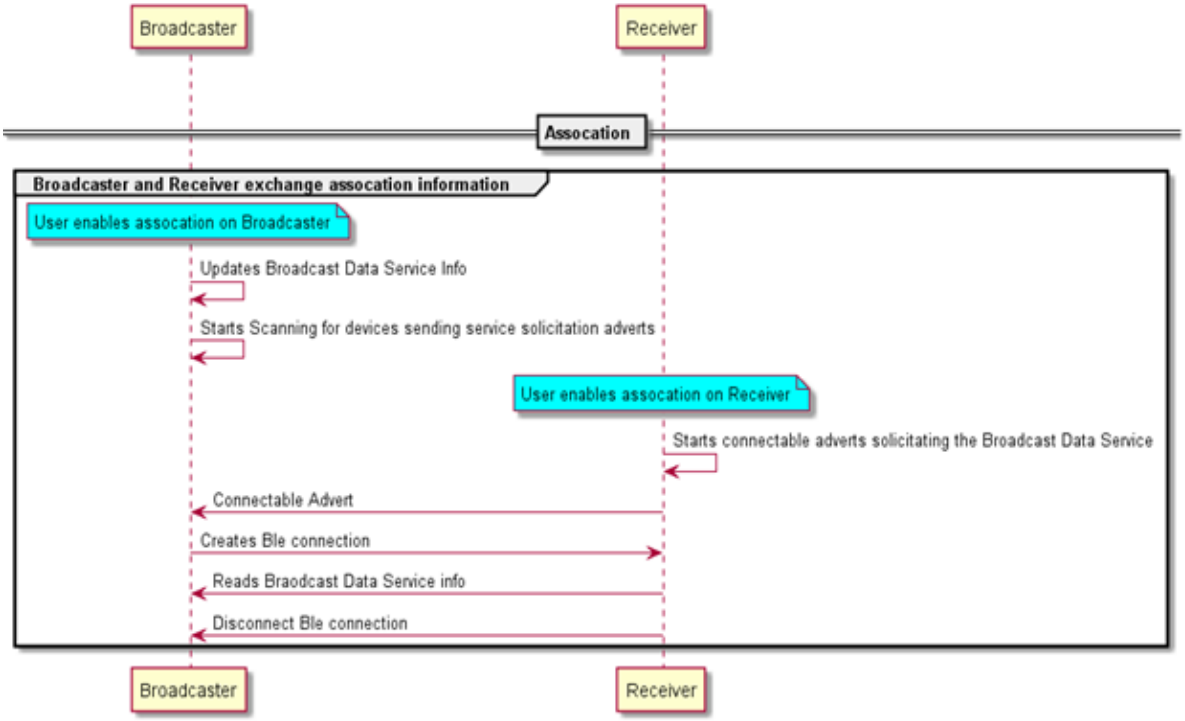

Figure 4-1 Association sequence

5 CSR8670 and CSR8675 DSP audio chain

The DSP uses metadata associated with the audio data throughout the audio chain. This metadata is maintained through each component in the audio chain and used by the audio output component to ensure a synchronized audio playback.

Table 5-1 lists the private libraries within the DSP applications. The libraries are used to implement some of the core components.

Table 5-1 DSP private libraries

Private library	Description
analogue_input	Manages the analogue input and creates the associated metadata
audio_out	Responsible for the synchronised playback of the audio
bitreader	Used to read bits from a specific buffer object
bitwriter	Used to write bits to a specific buffer object
broadcast_status	Used to provide broadcast_status messages to the VM application
csb	■ Manages the CSB input ■ Creates the associated metadata ■ Handles payload encryption and authentication
erasure_code	Encodes the broadcast data to improve system robustness
frame_info	Returns frame header information
kalimba_int	Provides integer functions used by other components
md	Used to manage and manipulate the metadata
rtp_input	■ Decodes RTP and codec frames ■ Creates the associated metadata
scm	Used to send control message from the VM
sr	Provides sample rate functions used by other components
system_time	Used to manage different time references within the system
ttp	Calculates the time-to-play for the input audio data
usb_input	■ Manages the USB input ■ Creates the associated metadata

5.1 Broadcaster DSP audio chain

Figure 5-1 shows the DSP audio chain for the Broadcaster. The broadcast frame encode uses CELT. The codec configuration parameters are exchanged with the Receiver during the association process to ensure the Broadcaster and Receiver have matching configurations.

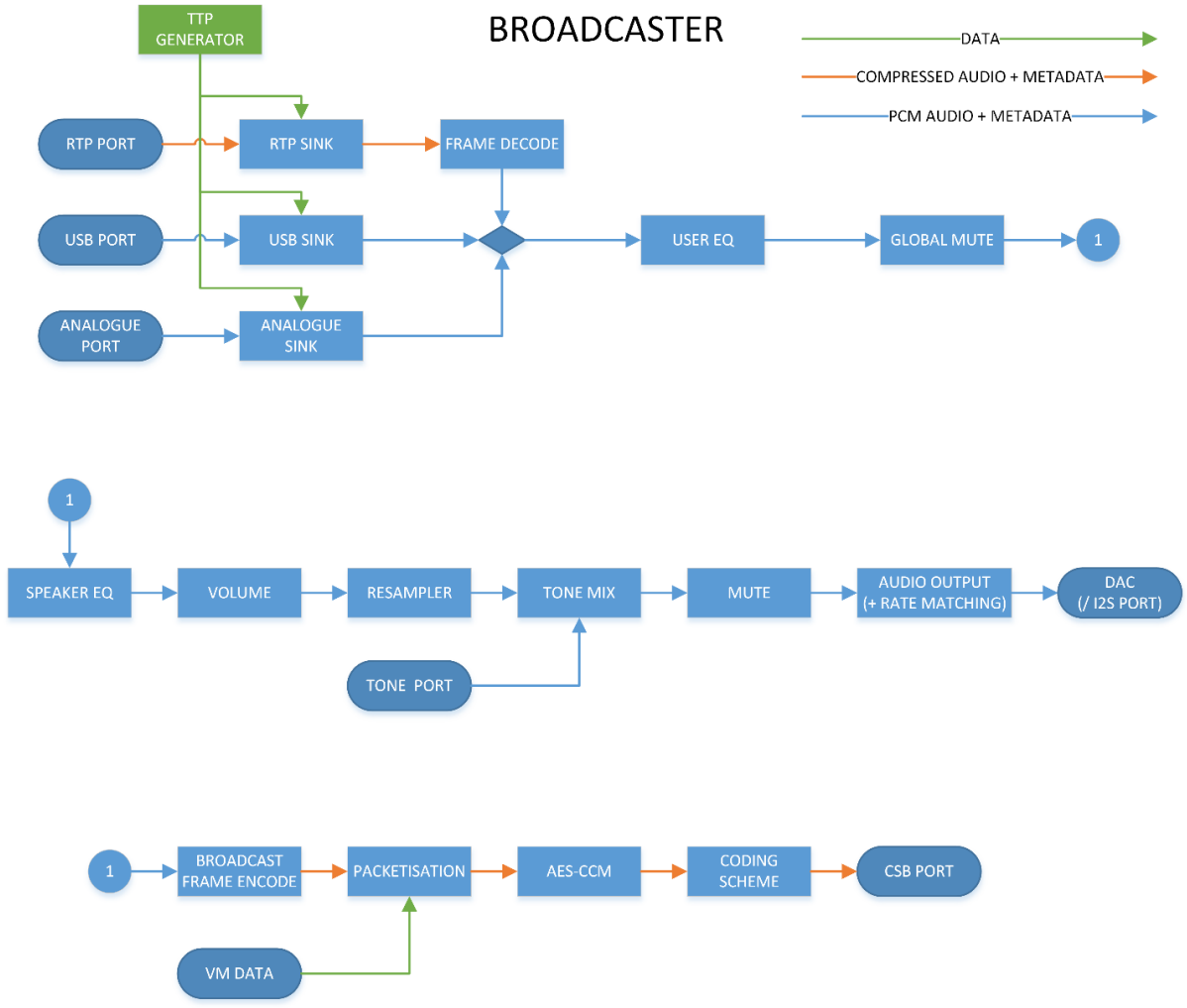

Figure 5-1 Broadcaster DSP audio chain

5.2 Receiver DSP Audio chain

Figure 5-2 shows the DSP audio chain for the Receiver. The receiver frame decode uses CELT. The codec configuration parameters are exchanged with the Receiver during the association process to ensure the Broadcaster and Receiver have matching configurations.

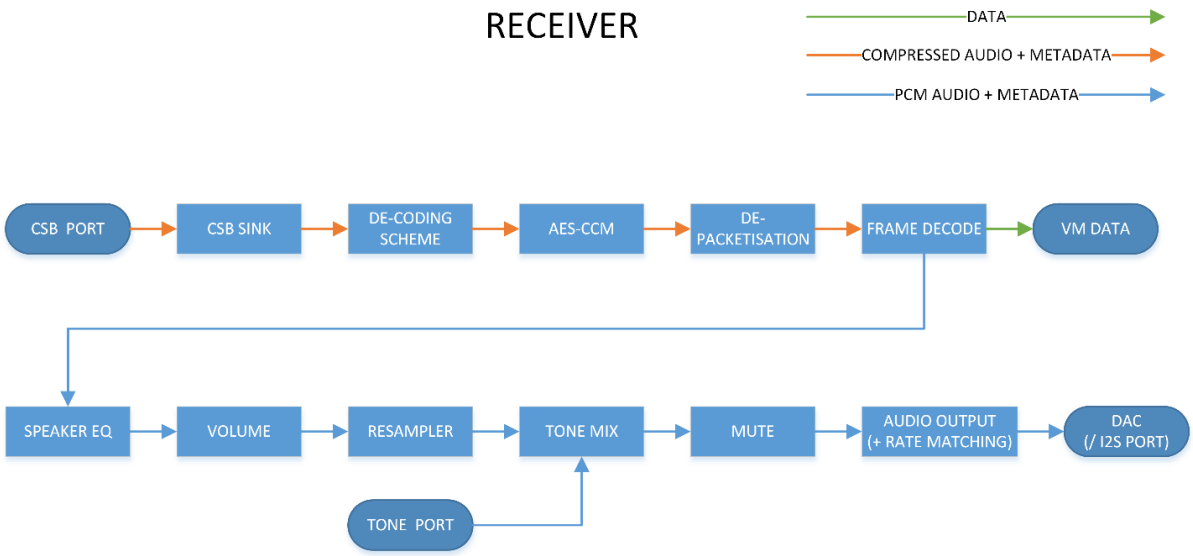

Figure 5-2 Receiver DSP Audio Chain

5.3 EQ support in Broadcast Audio

- The Broadcaster supports both User and Speaker EQ.
- The Receiver only supports Speaker EQ.
- At the Broadcaster, the local User EQ is applied to the audio frame and sent to the Receiver, before sending out the CELT encoded broadcast frame. See Broadcaster DSP audio chain
- At the Broadcaster, the configured Speaker EQ is applied before playing the audio locally over the DAC ports.
- At the Receiver, the configured Speaker EQ is applied after the broadcast frame is decoded and before sending the audio to DAC ports. See Receiver DSP Audio chain

6 GATT Broadcast Service UUID

The GATT Broadcast Service, as supplied, uses a 16-bit UUID purchased by Qualcomm® for the Service UUID.

This 16-bit UUID may be used by our customers on condition that the service and its implementation in the gatt_broadcast_client and gatt_broadcast_server libraries and sink application shall not be modified by the customer.

Alternatively, if the customer wishes to customize the service, a new service UUID may be purchased from the Bluetooth SIG and shall be used in place of our 16-bit UUID; see https://www.bluetooth.com/specifications/assigned-numbers/16-bit-uuids-for-members.

7 Compatibility with previous releases

This implementation of broadcast audio is not compatible with previous releases due to changes to audio stream encryption.

8 Changes since ADK 4.2

Support for following features were added in both the Broadcaster and Receiver modes.

- Full audio input routing. In the Receiver mode, the broadcast input has lowest priority by default.
- Voice prompts and tones. Voice prompts and tones are mixed with the audio rendered locally but not with broadcasted audio.
- I^2S output sample rate (44.1 kHz or 48 kHz) can be selected independently from the input sample rate.
- Mute. When mute is applied in the Broadcast mode silence is broadcasted.
- DSP volume API is the same as in the standard Speaker. When switching between the standard Speaker and broadcast modes output signal level do not change.
- Bluetooth low energy technology.
- Over-The-Air Upgrade.
- GAIA.
- HFP support. Broadcast Audio stops while in an HFP call.

Following features were removed:

- AFH update command over SCM command.
- User controllable volume offset in the Receiver mode.
- SCM commands are not used by the current implementation.

9 CSRA68100

Broadcast Audio is supported on CSRA68100 and it is compatible with the same implementation on CSR8670 and CSR8675.

Audio rendered on CSRA68100 is transcoded to CELT (152 kbps for 44.1 kHz and 140 kbps for 48 kHz). As a result, audio is rendered at the same quality on a broadcaster and receivers.

Audio is not transcoded on CSR8670 and CSR8675.

Support for EQ and music processing on CSRA68100 is the same in the standard Speaker and Broadcaster modes.

10 Broadcast Audio restrictions

The following restrictions apply when using Broadcast Audio compared to the standard Speaker mode:

- Supported audio input sources in broadcaster are line-in, USB and A2DP.
- Supported local audio outputs are DAC and I^2S.
- USB audio only supports 48 KHz sample rate.

NOTE Other inputs only work for 16-bit audio in 44.1/48 KHz. Therefore, in standard Speaker mode USB only works in 48 KHz if Broadcast Audio is enabled

- There is no support for other audio features such as 24-bit audio etc.
- Only supported A2DP codecs are SBC and AAC. In case when other codec is used in the standard Speaker mode, the codec will be renegotiated upon switching to one of the Broadcast Audio modes.
- Enabling multipoint is not recommended.

10.1 Restrictions specific to CSR8670 and CSR8675

- Only primary output is supported by the Broadcast Audio DSP applications.
- UFE cannot be connected while using Broadcast Audio, EQ and another configuration can only be done while in Speaker mode.
- Setting User EQ parameters over GAIA or VM application is not supported.
- No audio enhancement is supported, for example, 3D widening, Bass Boost, and so forth.

Document references

Document	Reference
Audio Sink Application Peer Device User Guide	80-CT414-1/CS-00316086-UG
ADK Applications Configuration Architecture Overview	80-CU111-1/CS-00400589-TO
ADK Application Configuration System	80-CT548-1/CS-00400610-UG
ADK Build Scripts XML Definitions User Guide	80-CT541-1/CS-00346862-UG

Terms and definitions

Term	Definition
A2DP	Advanced Audio Distribution Profile
AAC	Advanced Audio Coding
AFH	Adaptive Frequency Hopping
AVRCP	Audio/Video Remote Control Profile
Bluetooth	Set of technologies providing audio and data transfer over short-range radio connections
CELT	Constrained Energy Lapped Transform
CSB	Connectionless Slave Broadcast
DSP	Digital Signal Processor
QTIL	Qualcomm Technologies International, Ltd.
RTP	Real-time Transport Protocol
SBC	Low Complexity Sub-band Coding
SCM	Sub-channel Message
TTP	Time to Play
USB	Universal Serial Bus
UUID	Universally Unique Identifier
UFE	Universal Front End
VM	Customer modifiable software layer as oppose to firmware