



MultiBeam™ : A New Solution for the Surround Sound Experience

harman/kardon®
by HARMAN



Introduction

Today, soundbars are the mainstream consumer choice for home theater, but still cannot recreate the benefits of a traditional multi-channel surround sound system. This white paper gives a brief introduction of Harman's solution, known as MultiBeam, followed by an explanation of how the MultiBeam technology applies to the Harman Kardon Enchant soundbar series. In addition, taking into consideration how a user's room will affect the technology performance, a method named Automatic MultiBeam Calibration (AMC) is introduced to ensure the full effect of MultiBeam.

The Origin of Multi-channel Surround Sound

First appearing in commercial cinemas, then later widely applied in home theater systems, multi-channel surround sound technology is an audio reproduction method in which sound appears to surround the listener in all possible directions and thus provide them a realistic and engaging experience.

5.1-surround sound is the most widely used surround sound setup in home theater systems. Five channels of sound are produced separately in the left, right, center, left-surround and right-surround positions, along with a subwoofer (see Fig.1).

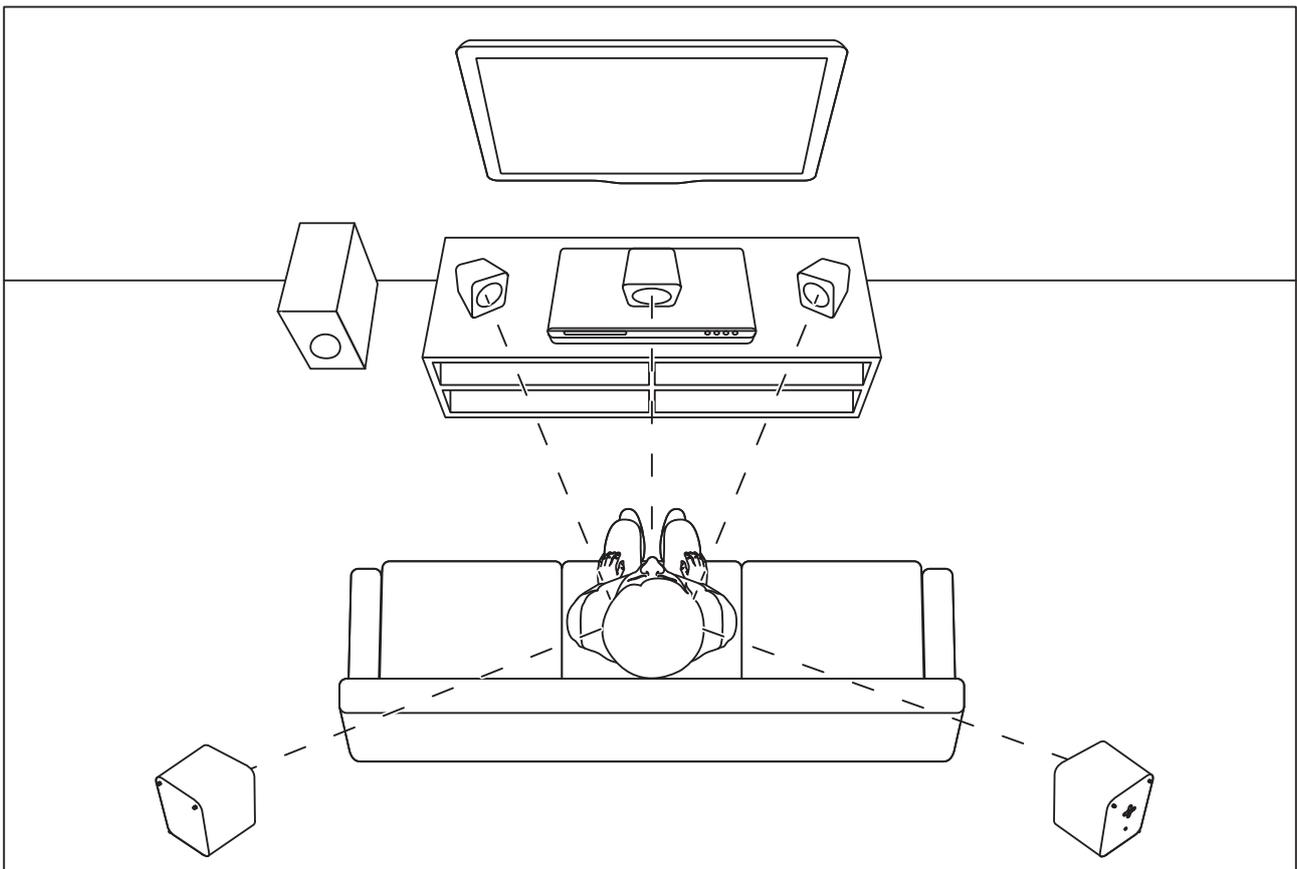


Fig.1

The more channels and speakers are added in a multi-channel audio system, the more precise the audio positioning (localization) will become; however, the complexity and cost of the system increases inevitably: more speakers and amplifiers, messy cables and the hassle of system setup.

Rise of Soundbars

As display technology has rapidly improved (LCD, LED, OLED), consumers expect to see more jumbo-sized flat-panel TVs becoming thinner and thinner, enhancing high-definition display performance, offering more content source options, and integrating with sophisticated voice assistants. As TV's have improved in feature set and video quality, the built-in sound quality has worsened. However, consumers still desire more realistic and natural surround sound effects when watching movies.

Over the past decade soundbars continue to grow in popularity as an easy solution to improving audio performance of flat panel television largely due to the convenience in comparison to discrete multi-channel audio systems—smaller size, fewer components, neater connections and a simpler setup. Soundbars are the sleekest, least-intrusive way to get sound that is as impactful as the premium picture on your TV. A high quality soundbar offers a minimalist style, tremendous sound with more refined speaker drivers, a variety of wireless connection options and multiple ways to enjoy all your favorite music, movies and TV shows.

Due to their smaller size and lack of flexibility in positioning, most common soundbars have no surround sound speakers—only left, right and (sometimes) center channels, and no dedicated rear speakers for surround sound effects. This tradeoff for convenience clearly limits the capability for a surround sound experience.

Conventional soundbars attempt to recreate the surround sound effect with a “virtual” surround sound by using digital signal processing (DSP). A common method to generate the surround effect is to employ a Head and Torso Related Transfer Function (HRTF) to apply filters and processing to create a sense of spaciousness. Another method uses a large amount of speakers (sometimes astonishingly over 50) to aim sound around the room and use room reflections to create the surround sound effect. In each method, it is clear that both performance and aesthetics can be improved.

MultiBeam: A Harman Solution

Aiming to find a solution that frees the traditional soundbar design constraints, after years of research and development, Harman's engineers have developed MultiBeam. MultiBeam is an electro-acoustic system that applies a patent-pending beamforming method to a speaker array with the benefit of a more realistic surround sound experience.

An angled speaker array is used with an immersive digital signal processing (DSP) algorithm to form a sharp directivity and “beam” the primary sound on to side walls. The key to create a spacious effect and surround experience is forming such a sharp directivity pattern in a wide-band frequency range. By generating an accurate sidewall reflection, the sound mirrors to the listening location, creating spacious sound.

Unlike conventional soundbars that emit sound with sole forward directivity, MultiBeam technology strengthens the sideward directivity while limiting the forward directivity (see Fig.2).

For any movie that features 5.1 or 7.1 surround sound, MultiBeam can reproduce the surround sound effect in your home theater system. For stereo content like music or broadcast television, a multi-channel upmixer changes the 2-channel content into a 5.1 or 7.1 mix for MultiBeam processing.

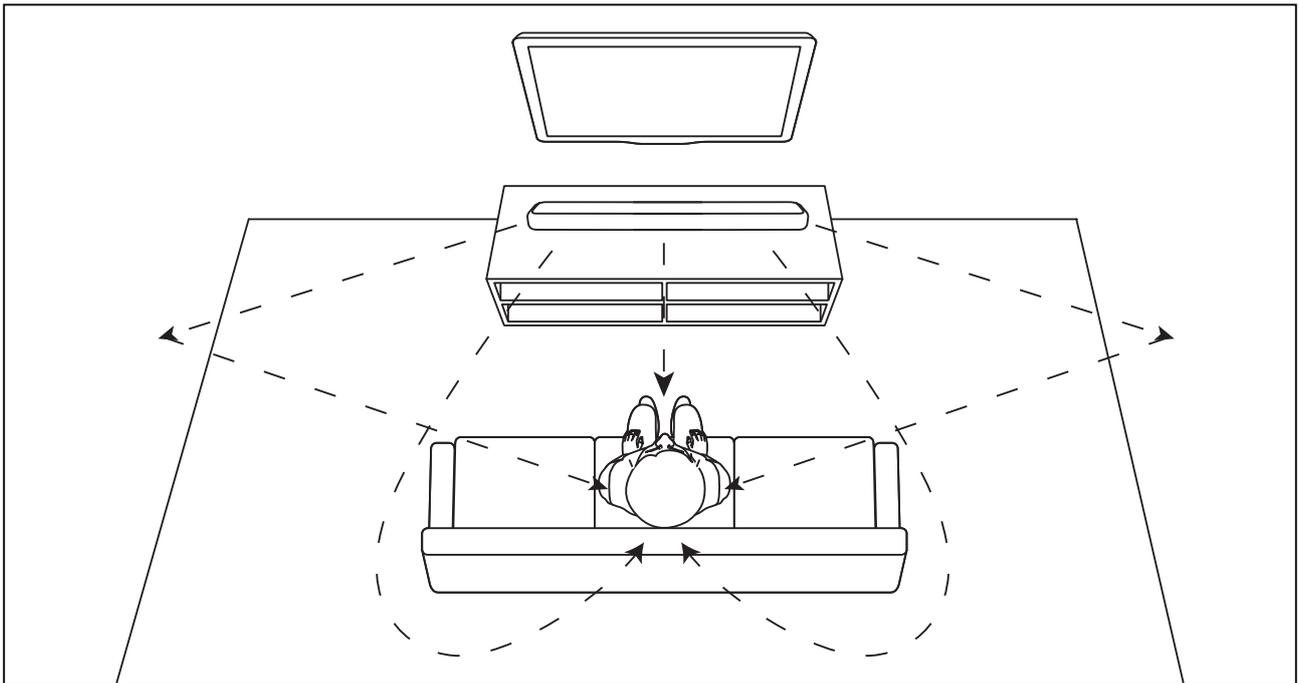


Fig.2

Application: Harman Kardon Enchant Soundbars

The brand-new Harman Kardon Enchant soundbars are the first use of MultiBeam. Each soundbar features angled low-frequency front-firing woofers, two side-firing horn tweeters in a sealed baffle integrated in both left and right ends of the same cabinet. Benefiting from such an architecture, the soundbar speaker can accurately reproduce the surround sound effect as it should perform.

The Enchant soundbars use “side horns”—tweeters coupled to a flared structure. Horns are used to control sound dispersion and couple the tweeter diaphragm to the air for higher efficiency. Horns also control the directivity of the tweeter. The Enchant side-firing tweeter allows the soundbars to create a sense of greater airiness and a wider soundstage at high frequencies — the sound effect is noticeable and impressive.

With the application of MultiBeam technology, the Enchant soundbars integrate multiple channels into a single speaker cabinet. Fig.3 and Fig.4 detail the inner structures and driver configurations in Enchant 1300 and Enchant 800 respectively.

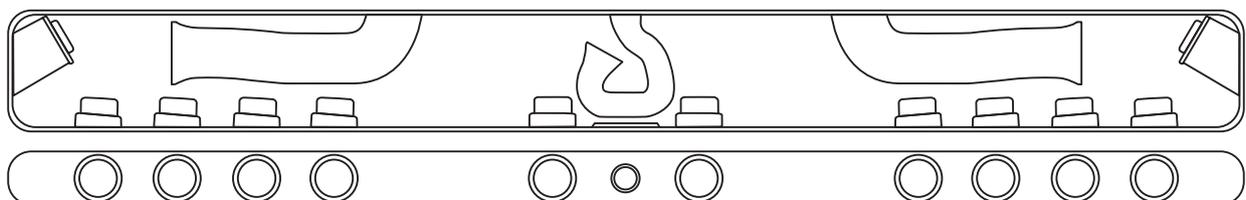


Fig.3

Fig.3 Enchant 1300: 10 woofers (4 left woofers + 4 right woofers + 2 center woofers) and 2 horn tweeters (left + right) along with 1 center channel tweeter

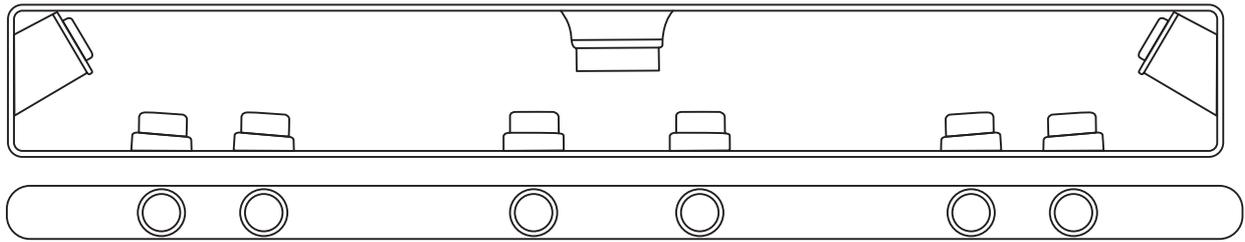


Fig.4

Fig.4 Enchant 800: 6 woofers (2 left woofers + 2 right woofers + 2 center woofers that can be reused for either left or right channels) and 2 horn tweeters (left + right)

The characteristics of the room, especially of sidewalls, determines the resulting sound field. To fulfill the MultiBeam concept, sidewall reflection or mirroring takes a big role in the process; on the contrary, the direct sound holds a low proportion in the listening area. MultiBeam works best when the maximum distance between the soundbar and sidewalls within 5m (16ft).

MultiBeam will achieve the best performance when the sidewalls are symmetrical and reflect sound in the same way. However, most rooms are not such a perfect environment, and in these cases room calibration must be conducted.

Automatic MultiBeam Calibration (AMC): A Solution to a Problem

Multi-channel audio systems typically require a method of calibration to correct for variances experienced in the real world: individual speaker distance (delay), speaker volume (level) and the room effect on the speaker timbre (EQ). Traditional calibration methods require a wired microphone positioned in the primary listening location—some methods capture one measurement, while other methods average multiple measurements over a series of listening locations. Audio calibration is often too complicated for most average users, and wired microphones may be lost or damaged.

Automatic MultiBeam Calibration (AMC) is a new solution in which a microphone is embedded inside the MultiBeam-enabled speaker cabinet, removing the need for an external wired microphone. Simply pressing the calibration button on remote control initiates the calibration (see Fig.5).

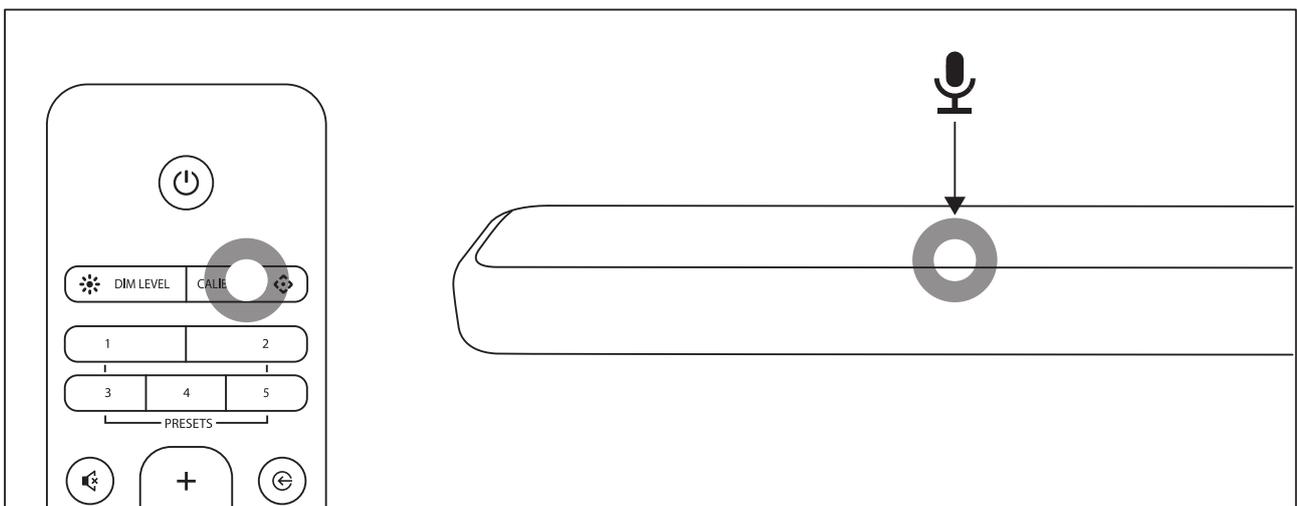


Fig.5

Fig.6 illustrates the difference between the traditional calibration methods and AMC.

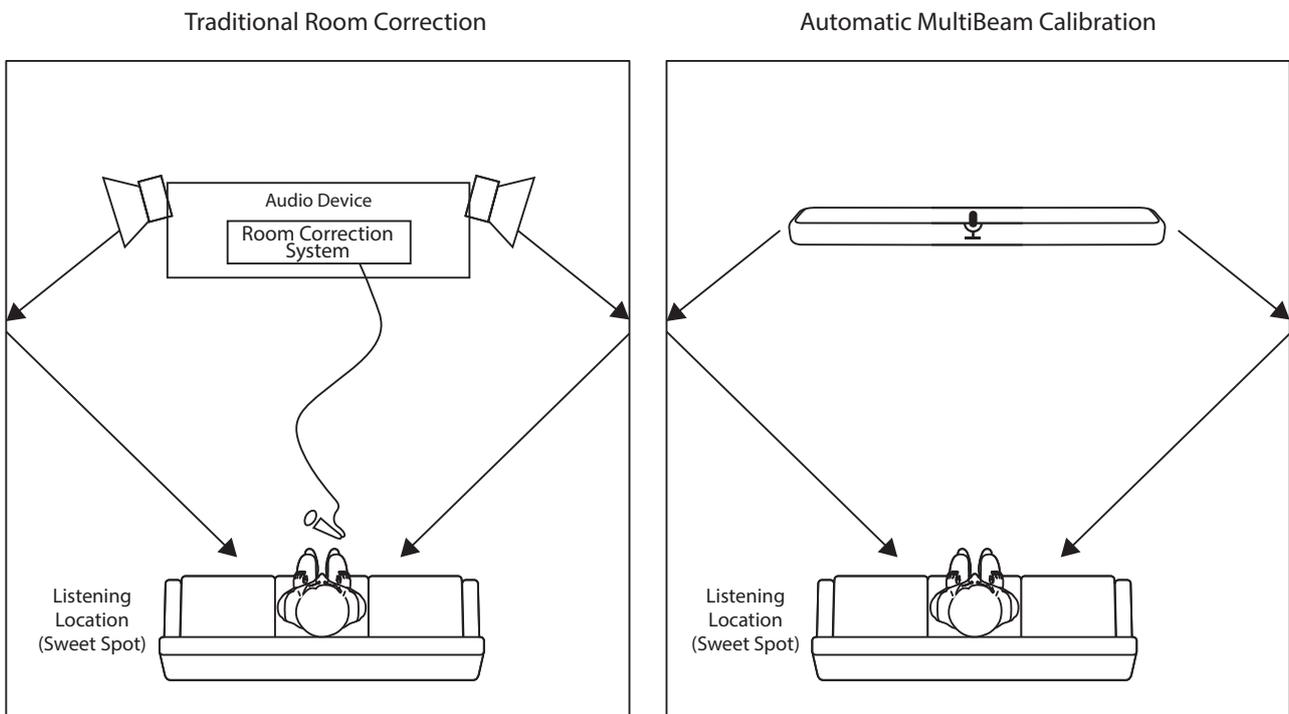


Fig.6

Although the microphone is not at the listening location (sweet spot), AMC can still collect acoustical information to correct the conditions of the room environment. After processing with the microphone signal, it transforms to a response of loudspeaker-room system. AMC measures the arrival times of the room reflections. Each room reflection arrives at the microphone on different times and then are separated, classified and analyzed. Then, the reflections are reconstructed to estimate the surround sound performance at a specific listening area. Although its target is an estimated result, it is a practical approximation derived from the sizes of typical consumers' home theater. Finally, AMC uses a set of filters to correct the loudspeaker EQ, so the soundbar sound performance can be consistent, without the dependence on the room.