Application Notes on the ClearOne Beamforming Microphone Array

Question: How far away can the Beamforming Array pick up audio?

Microphone pickup distance and Critical Distance:

For any type of microphone, the critical distance is the distance from a talker to the mic where the direct sound of the talker’s voice reaching the mic equals in volume level the room’s ambient noise and the sound reflections. For optimal audio clarity and minimizing a hollow, distant sound it is best if talkers are at less than half the critical distance from the mic. As this distance approaches the critical distance the audio will become increasingly less clear and more indistinct, sounding more hollow and distant.

Factors affecting critical distance:

Room Reflectivity: Hard, reflective surfaces in a room shorten the critical distance and people will need to be closer to a mic for good audio performance. A room with high ceilings and hard walls will be more reflective than a room with lower ceilings and acoustically paneled walls because the hard walls present a larger reflective surface area and the higher ceiling increases the delay of the reflections.

Room Noise: Background noise such as HVAC or projector noise will decrease the clarity of mic audio, especially in combination with room reflectivity. The Beamformer should be mounted away from these sources of noise and care should be taken to avoid mounting the Beamformer in the path of air movement.

If speech to noise ratio is:
0 - 10 dB - intelligibility is unacceptable to poor
10 - 20 dB - intelligibility is poor to fair
20 - 30 dB - intelligibility is fair to good
30 dB + - intelligibility is good to excellent
Mic Pickup Pattern: The narrower the pickup pattern of a mic, the longer the critical distance. With a directional mic people farther from the mic will still be within half the critical distance. An omni-directional mic picks up audio from all directions, so its critical distance will be much shorter and people will need to be much closer to it. Ceiling mics tend to sound more hollow and distant because their distance from the talkers is much closer to the critical distance.

The Beamforming Mic Array and critical distance:

The ClearOne Beamforming Mic Array is an array of mic elements with an “intelligent” method for steering the pickup pattern to form a “beam” of pickup aimed in the direction of whoever is talking at any given time. Because of this, the Beamforming Mic Array will have a longer critical distance than a conventional directional mic in the same position.

So, how far exactly?

In a typical conference room, a Beamforming Array mounted on the ceiling will perform well out to 12 feet around the array, as measured across the ceiling. In rooms with low ceilings and low reflectivity, the range can be even greater since the critical distance will be longer and the Array will be closer to the talker.

In a room with high ceilings and high reflectivity or large glass surfaces, or where the Array is mounted more than 9 feet from the floor, audio quality will drop noticeably and users may complain of “hollow” sounding speech or reflections. While this may be an improvement over a conventional microphone placed in the same location, users may benefit from a different microphone type such as a wireless lapel or tabletop mounted microphone solution. The Beamforming microphone cannot transform a poor acoustical environment into an ideal acoustic environment. Fundamental room design considerations still apply. If you have a room where you would not use a traditional ceiling microphone, a ceiling mounted Beamformer will have the same considerations.

Question: Can a Beamforming Array Be Mounted Near a Ceiling Mounted Projector or Other Noise Source?

Mounting a Beamforming Array near a projector is not advised, especially if the projector has a loud fan and the Beamformer is mounted in the path of airflow. The Beamformer has a high quality noise canceller for background noise, but it will not effectively cancel out foreground noise. While there is no hard and fast rule about how far a Beamformer should be from such a noise source, typically the Beamformer should be at least 2 or 3 feet away. With especially loud noise, it may need to be even farther away. In some cases it may be helpful to turn off one of the beams aimed at the noise. Pay close attention to the path of air movement. Even if it is acoustically quiet in the position where the Beamformer is mounted, air movement over the large surface of the array can be very loud and disruptive.
The basic rules of microphone placement still apply with the Beamformer: Avoid mounting a Beamformer where it is close to a noise source and far from people talking.

Avoid mounting behind deep soffits or other obstructions. A clear line of travel should exist between the Beamformer and the talkers.

**Custom Cables:**

When using custom Cat 5 or 6 cables for connections to Beamformers it is recommended that these cables be tested with the Beamformer before installation to verify that they will work without issues. Simply put, don’t pull a cable until it has been verified to work with the Beamformer.

ClearOne recommends using solid core CAT5 or CAT6 24 AWG unshielded cables. We also recommend avoiding the pull-through type of connectors because they often don’t crimp down well to achieve good termination.

![Pull-through cable connectors](image)

**Other mounting considerations:**

For a video conferencing room, consider mounting the Beamformer at the front of the room rather than on the ceiling. This may help reduce the room reflections reaching the Beamformer. You may lose some gain for the people in the back of the room, but the trade-off can be greater intelligibility from all. This is a good technique for glass walled rooms or other reflective environments.

You can experiment with shaping the array by disabling different positions on the Beamformer. For instance, Zone 3 is the central side-to-side pickup pattern in a ceiling mount installation. Disabling this zone can eliminate reflections and echo from the sides of a narrow room with large windows or glass walls.
For Ceiling Mounting, the ClearOne Beamformer ceiling mount kit with either the 12” or 24” spanner is always recommended. Mounting a Beamformer flush to the ceiling will work for audio. However, the wall mounting kit would have to be used and as ceiling mount it is not sufficiently secure to be considered safe. If this type of mounting is considered an earthquake safety cable should be connected from the hard ceiling above the dropped ceiling to the Beamformer.

A table mounted Beamformer can be recessed into the table as long as the top surface of the Beamformer is flush with the table surface.

**Question: What do the flashing purple lights on a Beamformer Array mean?**

1) A Device ID conflict between different Beamforming Arrays will be shown as flashing purple lights.

2) If more Beamformer Arrays than are supports by the Converge units are connected together and then connected the system, all Beamforming Array lights will flash purple.

3) If more Beamforming Arrays are added to a working site than are supported by the Converge units, the lights of those additional Beamforming Arrays will flash purple.

**Question: Why Is My Beamformer Audio Not Reaching the Converge Pro Unit?**
Be sure that the Beamformer is routed to a specific expansion bus channel. And be sure that in the Converge Pro unit, this expansion bus channel is routed to the appropriate output or bus. Also, in Unit Properties for all Converge units, be sure to leave the Audio Master setting to Slave, except in special situations where the programmer clearly understands the effect of this setting.

**Question:** Why do I keep getting prompted for a firmware update on my Converge Pro system with Beamforming Arrays, since I already did one?

There is a separate firmware update for the Beamforming Arrays:

1) In the Firmware Loader Window click the button with the 3 dots (...) on it:

2) Load the file “bf_mic.mdo”. All Beamforming Mic Arrays should then appear in the list in the Firmware Loader window.

3) Update Firmware – All Beamforming Mic Arrays update at the same time. All Beamforming Mic Arrays and Converge Pro units reboot after Beamforming Mic Arrays are updated.

**Note:** Console will also bring up the Firmware Upload procedure if there is incompatible firmware in either the Converge Pro units or the Beamforming Mic Arrays. All Converge Pro DSPs and Beamformers must be on the same firmware revision. (See note below on firmware.)
Question: What is the direction of the Beamforming Array audio pick up?

A Beamforming Array has up to 6 beams, each of which can create a beam of pickup, activated by and aimed towards the person currently talking. Any 2 of those 6 beams can be active at one time.

**Angles of Beams:**

The Beams on the Beamformer angle up from the face at a 45 degree angle.

**Ceiling Mode:**

Beams 1, 2, 4, and 5 all angle down from the ceiling at a 45 degree angle. Beams 1 and 5 are spaced 60 degrees horizontally apart from each other. Beams 2 and 4 are spaced 60 degrees horizontally apart from each other. Beam 3 points straight down at the center.
Table Mode:

All 6 beams point up from the table with an angle of 45 degrees.
All 6 beams are angled 60 degrees horizontally away from each other

Wall Mode:

Wall mode is intended for video conferencing. The Beamformer should be placed directly under a video screen. In this case every participant will face the screen and speak directly toward the Beamformer. The Array would need to be above the level of the conference table or recessed into the table so it is flush with the table surface. Due consideration would need to be made for picking up people further back in the room.
Beam 3 faces directly out from the face of the Beamformer at a 90 degree angle. Beams 1 and 5 both run very close to the wall and are intended to pick up talkers at the sides of the room.

Each beam has the following angle from the face of the Beamformer pointing out into the room:
1. 30°
2. 60°
3. 90°
4. 60°
5. 30°

**Auto Mode:** To insure that the Beamformer will operate optimally in a particular type of installation, it is best to use Ceiling, Wall, or Table mode, as appropriate, rather than Auto.

**Question:** Can Beamforming Microphone Arrays be used for local room reinforcement (PA / voice lift)?

In room reinforcement, mic audio is routed into the same room where the mics are located, to help people in that room to hear each other more clearly. The main challenge is getting the room reinforcement loud enough to be useful without getting local feedback. This is known as “Gain Before Feedback”. The effectiveness of room reinforcement will depend on several factors:

1. If the mics are significantly closer to the talkers that to the loudspeakers, it is likely that room reinforcement will work. If the mics are significantly closer to the loudspeakers than to the talkers, room reinforcement will almost certainly not work with the Beamformer.
2) **Room reflectivity.** The more hard reflective surfaces there are in a room the more easily the loudspeaker audio will be reflected into the mics, lowering the possible gain before feedback in your design.

3) **Mic pickup pattern.** The Beamforming Mic Array forms a “beam” of pickup directed at the person currently talking and will attempt to reject room reflections and loudspeaker audio. A Beamforming Array cannot completely make up for an overly reflective room, an overly close mic/speaker placement, or an overly long distance from the mic to the talkers, or a combination of these factors. While beamforming technology is useful when applied correctly, the Beamformer cannot perform well for reinforcement if the fundamental acoustic properties of the room are poor. The Beamformer was designed to enhance voice clarity from longer distances in conference rooms, a feature not always desired in voice lift applications.

4) **Mix-minus routing** can reduce feedback issues. If multiple speaker zones are utilized with one or more microphones in each zone, each mic will be routed to speaker zones that are further away and not to the speaker zone or zones near were the mic is installed. Manual disabling of Beamformer pickup zones may aid the installer in such designs.

**When can a Beamformer be used for local reinforcement?**

**Table Mounted** Beamformers can perform well for local reinforcement, although the above-noted factors should still be considered.

**Wall mounted** Beamformers *may* work for reinforcement, as long as the above noted factors are very closely considered.

**Ceiling Mounted** installations will present the most problems for local reinforcement and are typically not recommended. However, a Beamformer mounted to a low ceiling in a room with low reflectivity and loudspeakers fairly distant from the Beamformer *may* work for local reinforcement, but field testing of this solution should be done before finalizing any such design.

**Further notes:**

**Converge Console version:** Currently we recommend using Converge Console version 4.2 and keeping the firmware on all Converge units and all Beamforming Microphone Arrays updated for that level of Console. We also recommend checking for software and firmware updates, and checking the release notes here:

[http://www.clearone.com/resources#professional_audio](http://www.clearone.com/resources#professional_audio)

**To receive mic gating status:** At this time the physical connection from the PC running Converge Console must be to the top (first) Converge unit in the G-Link (Expansion Bus) daisy
chain (the unit with a Link Out connection but no Link In) in order to see the gate status and to provide gate reports.

Note: If you have any pre-sales questions about installing a Beamforming Mic Array in a specific way at a specific site please call ClearOne Technical Support, 1-800-283-5936 or email tech.support@clearone.com