



### source-independent room equalization

#### Room Equalization using Brüel & Kjær Dual-Channel Signal Analyzer Type 2032.

Traditionally equalization of a sound reinforcement system has involved the use of obtrusive test signals such as clicks, chirps and pink noise. Consequently this equalization has had to be performed before the doors open to avoid annoying and unsettling the audience. Although the EQ has been set up as well as possible at this stage, the presence of an audience will inevitably alter the acoustic characteristics of the hall.

The characteristics can be further changed during a show if temperature and/or humidity change, thus affecting the air's sound absorption properties. Almost inevitably such changes occur, due to a combination of weather variation, intense heat from stage lighting and the enthusiasm of audience and band.

The sound engineer's problems do not end with variable hall-characteristics. In a typical EQ procedure the PA will be voiced with pink noise and analyzed with a third-octave analyzer. The peaks and notches evident in the results of this analysis are then compensated for using a graphic equalizer. The problem with this procedure is that the analyzer averages the energy found in each third-octave band, and so the exact frequencies of any peaks or notches of narrower bandwidth cannot be seen from the analysis —

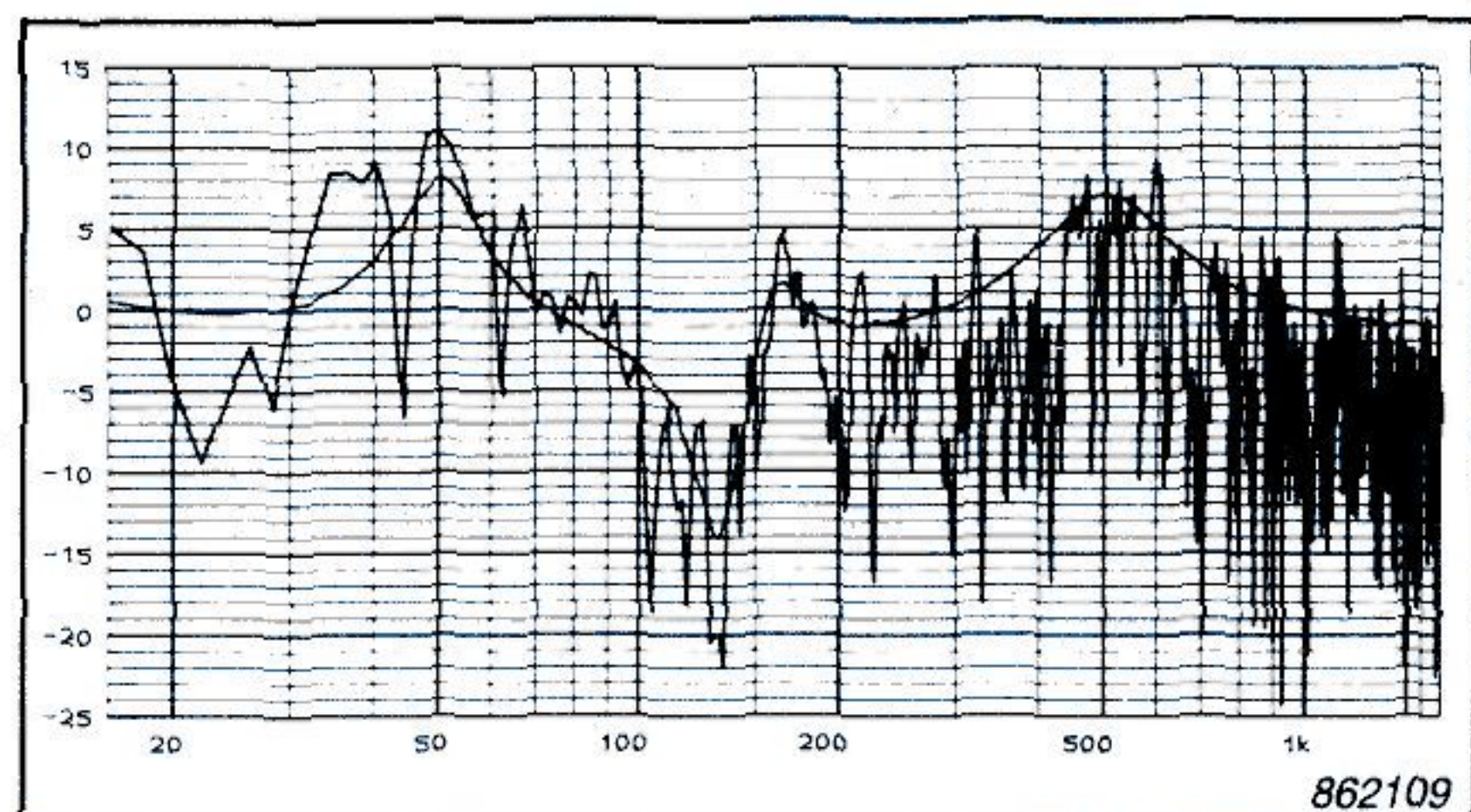


Fig. 1. The frequency response of a sound system set up in the World Theater, Minneapolis. Overlaid onto this is the inverse frequency response of the parametric equalizer as it was set for equalization of this particular speaker-room system



The Grateful Dead's sound system, including Dual-Channel Signal Analyzer Type 2032

the resolution of the analysis system is too low.

There is a similar problem with graphic equalizers in that, even if the narrow-band peaks and notches are detected, the bandwidths and centre frequencies of the graphic equalizer will most probably not match those of these peaks and notches. Hence obtaining a flat frequency response for the hall will be impossible.

So is there a solution to these problems? Fortunately yes. *Dual-channel FFT (Fast Fourier Transform) analy-*

*sis* has been used by scientists and engineers for a number of years in the investigation of cause-and-effect relationships. Applying dual-channel FFT analysis to the investigation of the characteristics of a particular speaker-room system gives excellent results and overcomes the problems encountered using traditional analysis methods. Similarly, the use of a complementary-phase parametric equalizer allows successful equalization of a sound system based on these measurements.

The Brüel & Kjær Dual-Channel Signal Analyzer Type 2032 has 801 lines of resolution which means, for example, that use of the 5 kHz range gives a resolution of 6.25 Hz — enough to prevent any room resonance peaks escaping detection. Also, the dual-channel FFT technique is independent of the test signal, meaning that music (either live or recorded) can be used, and hence equalization can be performed both before and during the show.

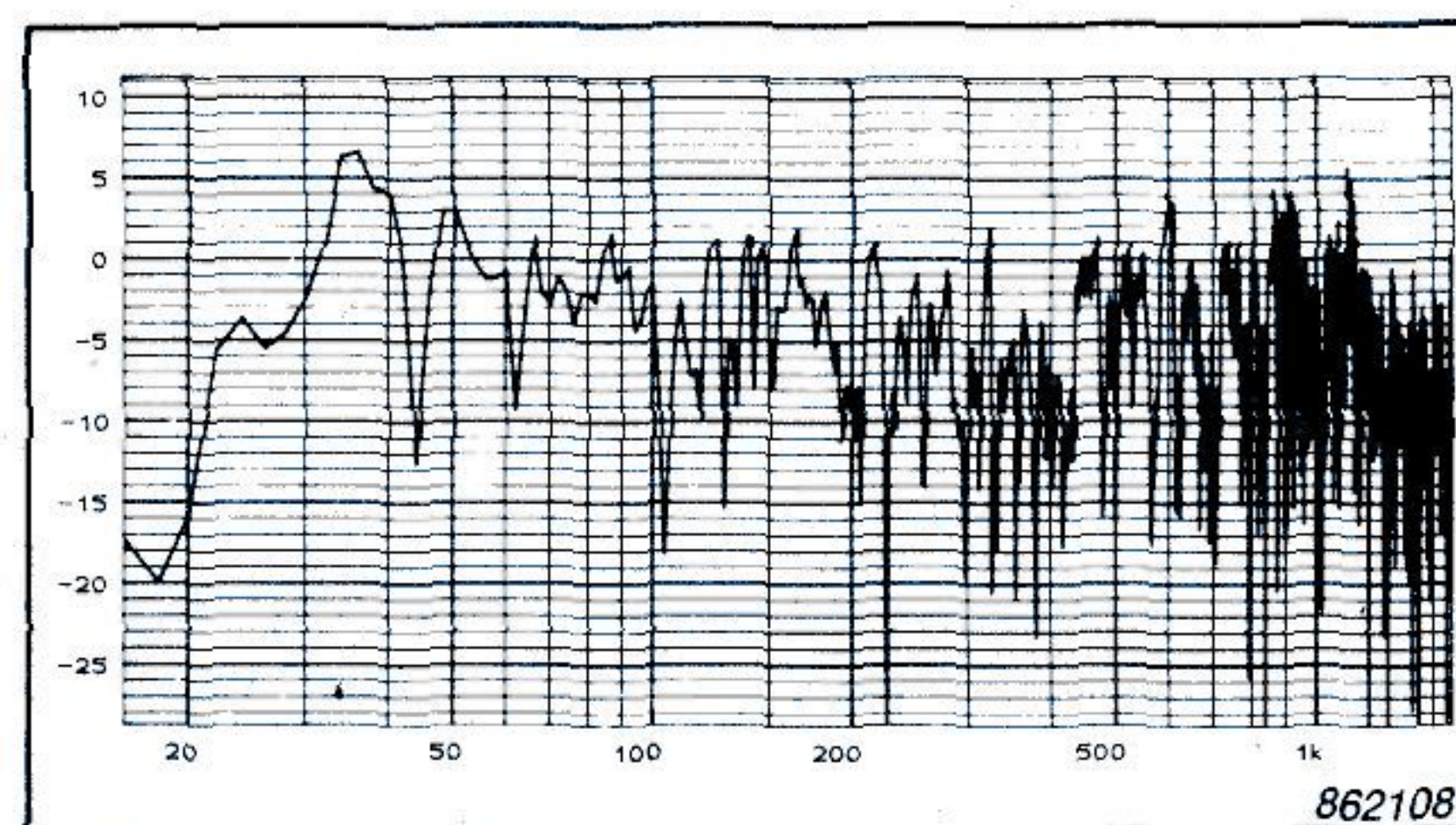


Fig. 2. The equalized speaker-room response. The dips and peaks in evidence in Fig. 1 have been smoothed out by the parametric equalizer, which was adjusted on the basis of quick, easy measurements made with the 2032

The 2032 fits into the sound system as shown in Fig. 3. Analysis is performed by feeding the test signal (the music from the output of the mixing console) to one channel of the analyzer, and



connecting a measuring microphone, situated at a "typical" audience position, to the other channel. The adjustable delay between analyzer channels is set to compensate for the propagation delay between loudspeakers and the microphone, and the analyzer then calculates and displays the frequency response of the speaker-room system,

allowing the peaks and notches to be seen. This response is then stored in the memory of the analyzer. Next the response of the parametric equalizer is measured by changing the input to channel B of the analyzer (simply through the push of a button), and displayed along with the inverse of the stored speaker-room response. Hence

the equalizer can be adjusted and the effects of the adjustment can be seen in real time. This allows the equalizer to be set so that its response matches the shape of the inverse speaker-room response, giving a flat *equalized* speaker-room response. This can be checked simply by switching the channel B input back to "preamplifier".



The 2032 in use at The World Theater, Minneapolis, Minnesota

The problem of background noise and audience reaction (i.e. cheering and applause) affecting measurements is avoided through averaging several sets of data, which eliminates the random time-varying signals. Use of the 2032 also provides the facility for checking the reliability of the measurements made by looking at the *coherence* function. A low coherence means that measurements are not valid and further averaging should be performed.

Dan Healy, live sound engineer for the Grateful Dead, often referred to as the seventh member of the band, is one man who is using this technique as part of his perpetual quest for even better live sound. Judging from comments in the press, it is certainly paying off. Talking of The Grateful Dead's sound on their 1985 tour, *db* magazine said in its January-February 1986 issue "The sound was nothing short of amazing. It was extremely loud and clear which is quite an unusual occurrence at a rock concert."

In the February 1986 issue of *Recording Engineer/Producer*, John Meyer, who has been working closely with The Grateful Dead, says that "The B & K is a very good tool" for implementing the technique. In the same article, which deals with the setting up of the sound system for The Grateful Dead's performance at the Brendan J. Byrne Arena, Meadowlands, the author concludes that "the back-wall, boomy reverberance often heard in such sports facilities was practically non-existent. The absence of muddy reverberation enabled each audience member to more fully focus on the actual music performance emanating from the stage, rather than feeling detached from it". The Brüel & Kjær Dual-Channel Analyzer is an integral part of the sound system that provides this excellent sound.

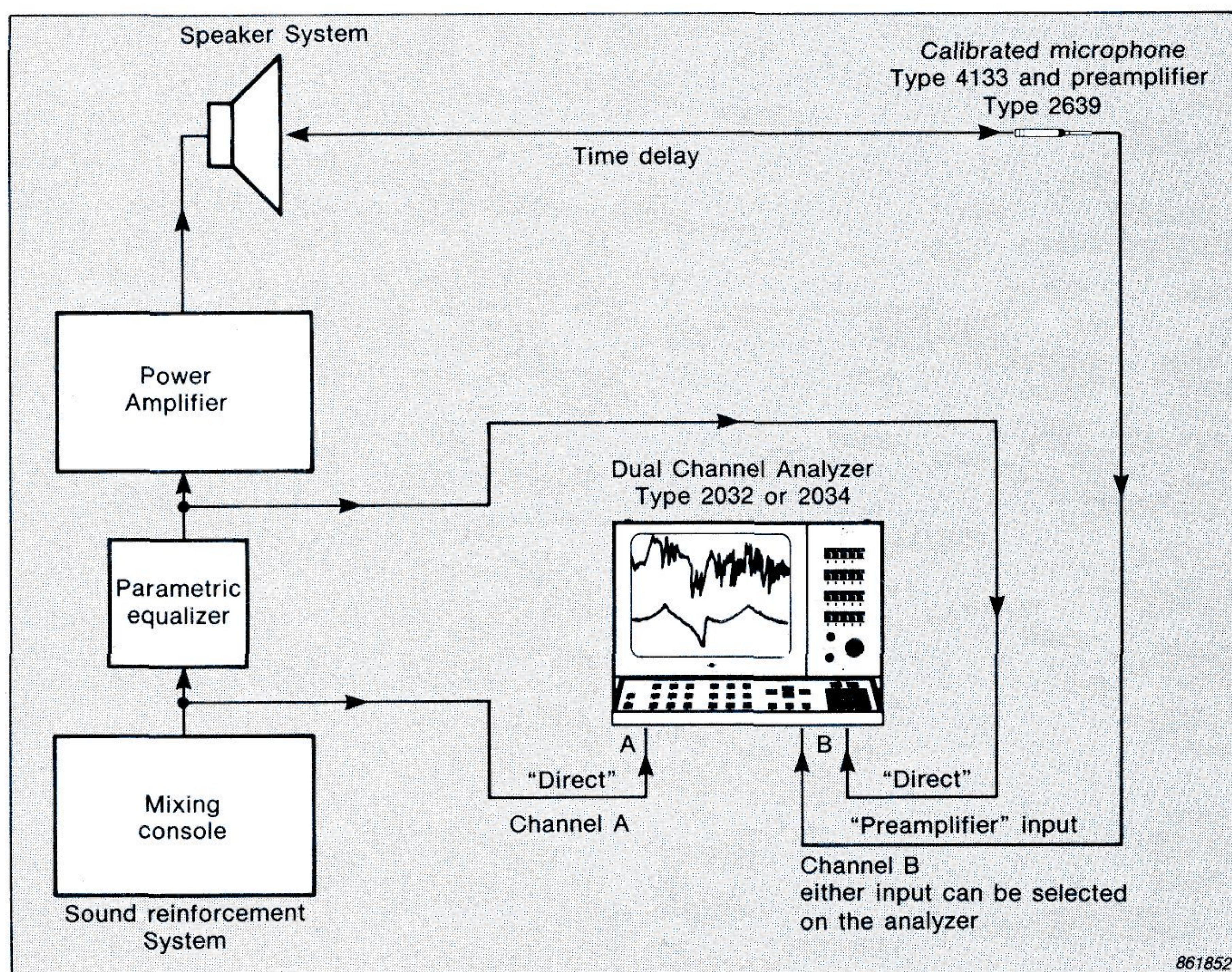


Fig. 3. Block diagram showing how the 2032 can fit into your sound system

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