ACE-BASS - AUDIO PRO'S EXCLUSIVE TECHNIQUE TO ACCOMPLISH SUPERIOR BASS

ACE-Bass is a new method that solves the problem of producing true low bass from a small box. The method utilizes the interaction between the electrical characteristics of the power amplifier and the mechanical parameters of the loudspeaker unit and makes it possible to add synthesized mass to the cone, to change the damping and to stiffen the suspension. With control over these three fundamental mechanical parameters, the frequency response can be extended and the distortion reduced.
parallel circuit and a driving current generator, instead of the voltage generator.
The negative output impedance then cancels the voice coil resistance and the new parallel circuit — consisting of Cp, Rp and Lp — will be in parallel with the old one, which is produced by the real mechanical parameters of the speaker.
There are several problems to obtain good low bass out of small boxes and many attempts have been made to solve these. Among the active methods (i.e. the amplifier is designed as a part of the loudspeaker) that have been used, are equalized or boosted systems and different types of servo feedback systems. However, most
these methods are restricted to closed box systems and some rather increase distortion instead of reducing it.
If a good method applicable for bass reflex systems were developed, it would mean a great step forward in low frequency reproduction. The bass reflex system has higher efficiency than closed box systems and can also give much more output at the lowest frequencies.
This method now exists and is called ACE-Bass. ACE-Bass gives the loudspeaker unit new mechanical parameters to obtain the desired frequency response and since the new synthesized parameters are more linear than the real ones, distortion is also reduced.
ACE-Bass was invented by Karl Erik Stahel and presented at the 61st Auadio Engineering Society Convention, New York, in November 1978. A copy of the lecture is available from Audio Pro.

A FEW WORDS ON SPEAKER THEORY

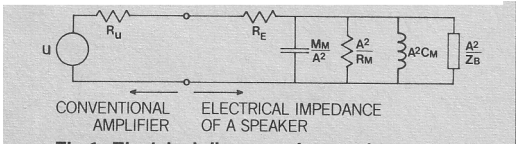

Fig 1. Electrical diagram of a speaker system.

In order to understand the following simplified explanation of ACE-Bass, some speaker theory will be necessary. The electrical characteristics of a speaker system is shown in figure 1. An amplifier drives the system with its output voltage U and output impedance RU. RE is the voice coil resistance and ZB is a mechanical parameter which depends on the box and the surrounding air. The cone and voice coil have a certain weight, known as the moving mass MM. The suspension of the cone has a compliance CM and damping RM. These mechanical parameters provide the electrical parallel resonance circuit, where A is the force factor of the driver (also called the BL factor).
It is obvious from the diagram in figure 1 that the mechanical parameters of the speaker effect the electrical impedance. As shown later, ACE-Bass takes advantage of the opposite interaction — the mechanical parameters are affected by the electrical output impedance of the amplifier.
It is also possible to look at the same system from the mechanical side, as shown in figure 2.

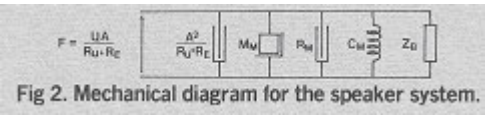

Fig 2. Mechanical diagram for the speaker system.

F is the force generated by the output voltage U of the amplifier and the "motor" of the driver. Besides the real damping RM, an extra "electrical" damping A^2/ (RU+ RE) occurs. Normally the output resistance of the amplifier, RU, is close to zero, but by making it positive or negative it is possible to give the total damping an arbitrary value. This well known technique has sometimes been used before. What is new with ACE-Bass is that, by using a similar method, the moving mass and compliance are also affected.

ACE-BASS — TO TAME THE MECHANICAL PARAMETERS OF A SPEAKER

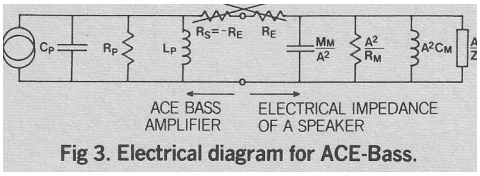

Fig 3. Electrical diagram for ACE-Bass.

In order to obtain this control over all three mechanical parameters, the conventional amplifier in figure 1 is exchanged for the special ACE-Bass amplifier, as seen in figure 3.
The ACE-Bass amplifier consists of a negative resistance RS, a new parallel circuit and a driver current generatoi, instead of the voltage generator.
The negative output impedance the cancel the voice coil resistance and a new parallel circiut – consisting of Cp, Rp and Lp – will be in parallel with the old one, which id produced by real mechanical parameters of the speaker.

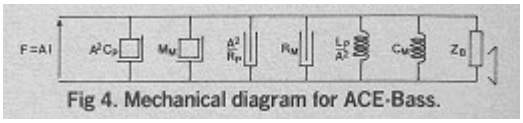
Fig 4. Mechanical diagram for ACE-Bass.

If instead the same ACE-Bass system is viewed from the mechanical side, figure 4 results. Compared to the conventional system in figure 2, it is obvious that the total moving mass has increased by A2Cp and the damping by A2/Rp and that the compliance has become stiffer by Lp/A2. By selecting suitable values for Cp, Rp and Lp in the output impedance of the amplifier, it is thus possible to achieve the desired mechanical parameters.
These apparent mechanical parameters, which are created by means of the output impedance of the ACE-Bass amplifier, are in fact so real that if a mechanical engineer should measure the mechanical parameters of the speaker, he would find the apparent parameters and not the real ones, but only as long as the amplifier is connected.

THE ACE-BASS AMPLIFIER

The ACE-Bass amplifier according to figure 3 can be realized in various ways. Since negative resistances do not exist as components, it has to be generated by the amplifier. In order to eliminate bulky and costly components, the parallel circuit (Cp, Rp and Lp) can also be generated by the amplifier. The design used in all Audio Pro ACE-Bass amplifiers is shown in
Figure 5,

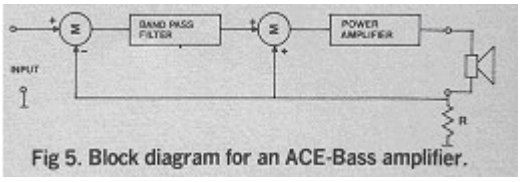

Fig 5. Block diagram for an ACE-Bass amplifier.

The current through the speaker is sensed by R and the positive feedback around the power amplifier provides the negative resistance, while the negative feedback around the band-pass filter provides the parallel circuit.
(This technique of creating the ACE-Bass amplifier by feedback loops should not be confused with motional feedback, which is not related to ACE-Bass.)

Note:
Il Motional Feedback (philips) impiega un accelerometro per rilevare il movimento del diaframma e richiede un altoparlante speciale.
In sostanza si tratta di un pilotaggio in corrente. Pilotando il woofer in corrente si elimina una causa di non linearità: quando il woofer è pilotato in tensione la corrente nella bobina dipende dalla linearità del carico

elettrico (che non è lineare per esempio a causa delle variazioni di induttanza) . La forza dipende dalla Corrente e se Bl è lineare anche Bli rimane lineare. Resta a questo punto da equalizzare il sistema perché il Qt è diventato pari a Qms (maggiore di 1). Ci sono più soluzioni:

- eliminare Re con una retroazione positiva (con rischio di oscillazioni)
- utilizzare un woofer con Qms estremamente basso
- introdurre forti perdite nel mobile
- inserire una equalizzazione molto precisa per linearizzare la risposta.
- Adottare un carico a linea di trasmissione a ¼ d'onda che richiede valori di Qt molto alti (aumentare il carico posteriore). Quest'ultima soluzione è percorribile per i diffusori domestici

Uno dei vantaggi dell'ACE-Bass è che non richiede altoparlanti speciali (doppia bobina o accelerometri) come il Motional Feedback. Per quanto riguarda la stabilità termica va notato che il riscaldamento della bobina mobile produce l'incremento di Re e quindi il sistema, aumentando la temperatura, si porta verso una maggiore stabilità (la resistenza negativa resta costante, quella positiva aumenta -> l'impedenza di uscita complessiva va verso valori positivi).