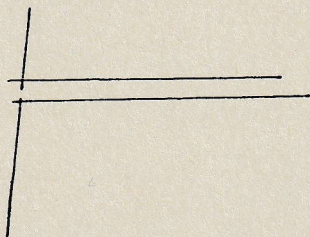
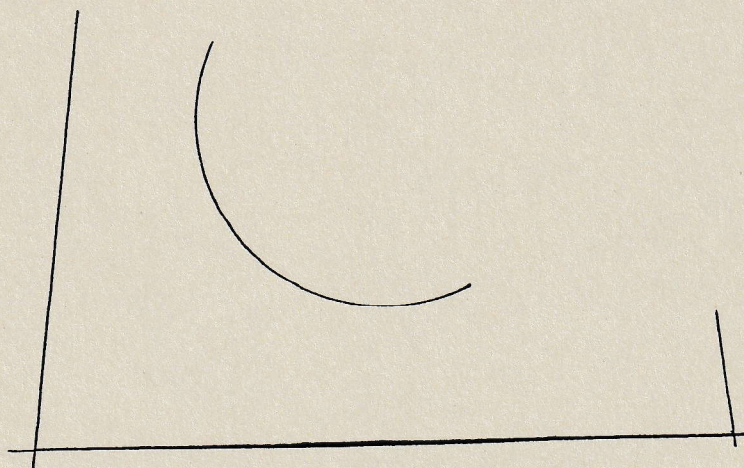


 **PIONEER / TAD**

SWEDISH REFERENCE



☆ *A DESIGN STUDY* ☆





## INTRODUCTION

The digital audio techniques has increased the technical requirements on reproduction equipment. This is especially the case for loudspeakers. When very low audible distortion is required, the dynamic performance and power handling of loudspeaker systems must be considered.

MARK TWO Studioteknik has performed a design study for PIONEER Electronic Sweden AB, where a loudspeaker system for larger-than-average listening rooms has been developed. The basic idea has been to achieve a neutral sound with low distortion at low as well as high power levels.

Loudspeakers utilizing exponential horns are frequently used for these applications. However, despite their high efficiency and power handling, the result is seldom a neutral sound character.

Named the "Swedish PIONEER/TAD Reference", these systems have been successfully demonstrated at various fairs and exhibitions in Sweden by PIONEER.

## MISSION

The basic idea of the design study was to use PIONEER and Technical Audio Devices (TAD) products to design a loudspeaker system with a very neutral sound character. Even if large speaker systems are available from TAD, they did not have the characteristics that we were aiming for.

In this respect, the design is focused between the high fidelity and the professional audio range. "High End" audio products can reproduce a neutral sound image, but are rarely capable of producing continuous high power levels with low distortion. Professional equipment can, but the sound character is often less transparent.

The design should allow for high quality stereo reproduction in various audio environments, mainly mid-sized auditoriums. Hence, it was required that the frequency response could be adjusted in order to achieve a neutral sound image.

The design is merely designed after extensive listening tests than "ruler flat" laboratory responses. A spectrum analyzer has been frequently used to check the response from the loudspeaker system fed with pink noise in the actual listening rooms.

PIONEER and TAD products were used throughout the system except for active filtering and bridging of the power amplifiers. The reason being that such products were not marketed by PIONEER in Sweden.

## DESIGN

### Loudspeakers

The design of the loudspeaker system are shown in the attached pictures. The design criteria was to focus an all relevant parameters affecting the reproduction.

A wide sound distribution character at all frequencies also set requirements on the enclosure. A vertical line structure was therefore chosen. There were other possibilities, e.g. the horizontal Bessel panel arrangement, which has a favourable directivity pattern. However, the system should be used at different sites and be easy to set up - a more "compact" solution was desired.

Each of the two loudspeakers was made as a four-way system for

- bass (B)
- lower midrange (LM)
- high midrange (HM)
- treble (T)

As can be seen, the loudspeaker units are mounted in three separate enclosures to minimize interference. The B and LM enclosures are asymmetrical in order to attenuate standing waves. The HM and T units are mounted close together in a solid wooden structure.

Furthermore, the enclosures for LM and HM/T are individually "tiltable". This will make it possible to focus the main lobe axis of the loudspeaker units.

The design also minimizes diffraction effects, which is advantageous for the transient response.

### Enclosures

Attention was made to the enclosures, which should be acoustically "dead". It is common that big loudspeaker enclosure panels radiate the same power as the loudspeaker unit itself at certain frequencies! A major design drawback for many "professional" loudspeakers...! The TAD TSM-1 and TSM-2 seems well-designed in this respect.

Each side of the bass and low midrange enclosure is made out of two 12 mm plywood panels glued together with a layer of attenuating material, named ANTIPHON D1D. Hence, the Q of the resonances are effectively attenuated, see Figure 1.

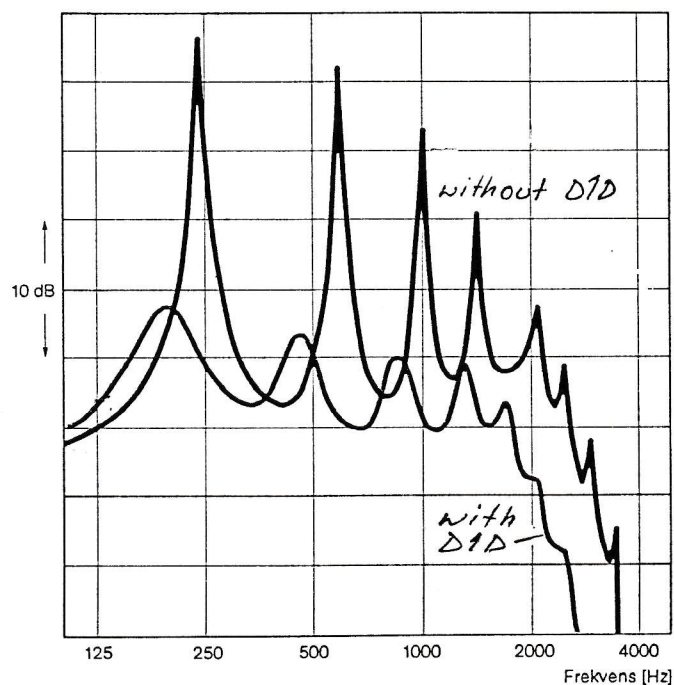


Figure 1: Attenuation with ANTIPHON D1D

Furthermore, bituminous damping layers together with felted cloths are attached to the insides of all six panels. Vibration modes are almost non-existent.

The enclosure was spray laquered with a light yellow paint for best appearance at public displays. The paint is normally used by Porsche for their excellent sports cars - this does not however effect the transient response of the loudspeakers...

#### Amplification and Filtering

Active filtering together with powerful amplifiers, the PIONEER M-90, were used. A stereo amplifier in bridge mode is used for the bass range. The bridge unit is made by SENTEC, Sweden.



The bass range loudspeaker should represent an easy load to the amplifier due to the active filtering (provided that Q-values for the speaker/enclosure resonances are well-behaved). It seems that very powerful amplifiers give better listening results although regarded as "design overkill" seen from power requirements.

Three PIONEER M-90's are used for each left and right channel. The power demand is less for the HM and T ranges. As the M-90's were available and scored well on listening tests, we set for this alternative.

Bandpass filtering is used for all bands. The Linkwitz-Riley characteristics with a slope of 24 dB/octave was found to give the best performance.

#### **THE BASS RANGE**

The TAD unit TL 1601a was chosen and put in an asymmetric reflex cabinet. The well-known Small equations for a QB3 response was calculated - the enclosure was tuned to approximately 30 Hz.

The enclosure is braced inside in all three dimensions. The standing wave between top and bottom is attenuated by a sound absorbing material used for studios; SONEX. Before this absorber was installed, the actual frequency was only attenuated 7 dB by the loudspeaker cone. A small speaker (fed with swept, low frequencies) was mounted inside the enclosure to detect resonances.

The vent has a large diameter to avoid turbulent airflow at high power levels. It is made out of cardboard and filled with drinking straws (!); approximately 5 mm in diameter. This is by no means unique, but has to our knowledge, not been used for larger systems.

The straws contribute to a more linear airflow resulting in a firmer bass response. The airflow resistance is somewhat increased. However, it cannot be compared to aperiodic systems, where Q-damping is the main objective.

### THE LOW MID RANGE

The midrange is a most critical part of a loudspeaker system, often "ignored" by designers. To perform a neutral response over a wide frequency band at high power levels is difficult for one single unit. That's why two mid ranges were preferred.

Many three-way (or two-way) systems sound veiled in the lower frequency range. The main reason being that the resonance frequency is placed too close to the lower cross-over frequency.

The TAD TM-1201 was an excellent choice for this application. The unit is mounted in a closed box completely filled with different damping materials. It is placed on a damping pad to attenuate vibrations from the bass enclosure. The tilt angle can be adjusted by means of a rigging screw, which is also fitted with rubber absorbers.

### HIGH MID RANGE

A natural solution would have been to utilize the TAD TH-4001/TD-4001 horn-driver combination. Although these units possess very good qualities, we preferred another solution.

The midrange dome from the PIONEER PROLOGUE series was chosen. This unit has very smooth, pleasant characteristics. Tests were performed with one, two, three and four units mounted in a vertical line together with the treble unit (also mounted in different positions).

Best listening results was achieved with three units, resulting in a very good horizontal directivity angle. The four unit combination had a very narrow vertical directivity angle, which wasn't favoured when only two loudspeakers would be used for a large audience.

The three units was connected in parallel. The efficiency and power handling in thus increased - the amplifier load moderate at these frequencies.

### HIGH RANGE

A short horn unit, named 703, from the PIONEER EXCLUSIVE series was set to handle the high frequency range. It was placed at the upper end of the solid wooden HM/T structure. The efficiency of the unit, 107 dB/W, is impressive. Other units were tried, but the 703 gave the best results together with the other units.

### ACTIVE CROSS-OVER FILTER

Extensive listening tests were carried out with different filter slopes and level settings. The final solution was a 4th order Linkwitz-Riley filter. One advantage of this filter is that the direction of the main lobe doesn't change at the crossover frequencies. The frequency "overlap" between the four bands are narrow due to the 24 dB/octave slope characteristic. It is also an advantage when high power levels are considered.

The product to use was the FDS 360 from BROOKE-SIREN SYSTEMS (England). The filter is of professional quality and very flexible to use. Crossover frequencies are selected by changing small circuit boards. Individual equalizing can be done. The crossover frequencies was set to 220, 1600 and 5000 Hz respectively. The low and high ends are "protected" by filtering at 27 Hz and 50 kHz respectively.

Level controls are available for each band. The use of an equalizer was not necessary; a short audio chain will give better listening results in most cases.

Furthermore, the phase response can be continuously adjusted. Even if the acoustic centres for the different units are set in the same vertical plane, they possess different phase responses. The FDS 360 can compensate for this. Limiter functions for each band is also included.



### INTERCONNECTIONS

All cabling and connections are based on the latest technology. This includes internal connections as well as connections between amplifiers, filters and program sources. LC-OFC cables are used. All contact surfaces are gold plated.

### CONCLUSION

"The TAD/PIONEER Swedish Reference" is a result of ideas and experience showing what is possible to achieve. By careful design and extensive listening tests MARK TWO Studioteknik has together with PIONEER/Sweden presented a loudspeaker system capable of reproducing a natural sound image at high power levels.