

# Pioneer/TAD Swedish Reference Speaker units, Electronics & Measurements



## Content

In this document the TAD and Pioneer speaker drivers, Pioneer M90a amplifier, BSS FDS 360 X-over network and the SENTEC PD8 Phase Divider are described. Moreover, a schematic of the complete system architecture is included as well as individual measurements of each loudspeaker unit.

## 1. Loudspeaker Drivers



### **TL-1601a** Low-Frequency Loudspeaker

The TL-1601a is a low-frequency loudspeaker conforming to the very highest technical standards. It is specifically designed to reduce all forms of distortion and coloration to a bare minimum.

**VOICE COIL.** The TL-1601a employs an edgewise-wound long-travel type voice coil. Since the coil stays completely within the magnetic gap even during peak excursions, bass output is powerful, and distortion low, at all input levels. And since the coil makes more effective use of the flux within the magnetic gap, it provides high conversion efficiency. The voice coil bobbin and adhesive materials have high heat resistance.

**MAGNETIC CIRCUIT.** The magnetic circuit is designed for low distortion and high efficiency. Thanks to the use of a powerful alnico ring magnet (3 lbs. 10 oz. or 1.65kg), it features an extremely high flux density of 11,800G. In combination with light moving parts and the long-travel coil, it results in exceptionally high efficiency for a unit of this size.

**DIAPHRAGM.** The cone diaphragm of the TL-1601a is made of a newly-developed tough and lightweight material that is capable of withstanding high amplitude levels without deformation. Corrugations are added across the cone surface to assure smooth response down to the extreme low end. The surround is coated with a damping material to ensure proper internal loss and linear excursions, and to reduce cone breakup in the high frequencies. The result is extremely low distortion and coloration.

**HOUSING.** The TL-1601a is mounted in a sturdy aluminum alloy diecast frame that supports the heavy magnetic circuit. The frame is essentially resonance-free.

#### **TL-1601a SPECIFICATIONS**

**Voice coil impedance:** 8 ohms **Lowest resonance frequency (f<sub>0</sub>):** 28Hz **Frequency range:** 28 — 1,000Hz **Rated input power:** 150 watts **Maximum input power:** 300 watts **Sound pressure level:** 97dB/W (1m) **Equivalent mass (infinite baffle):** 4.1 oz./117g **Q<sub>s</sub>:** 0.31 **Total magnetic flux:** 260,000 maxwells **Magnetic flux density:** 11,800 gauss **Baffle opening:** 13-7/8 inches/352mm **Mounting dimensions:** 14-9/16 inches/370mm (8 holes) **Weight:** 24 lbs. 4 oz./11kg **Outer dimensions (diameter × depth):** 15-3/4 × 6-9/16 inches/400 × 167mm



## TM-1201 Mid-Frequency Loudspeaker

The concept behind the TM-1201 mid-frequency loudspeaker is smooth frequency response combined with high efficiency and low distortion at all power levels. It covers a range from 200 to 3,000Hz.

**DIAPHRAGM.** The diaphragm cone of the TM-1201 is made of our exclusive Polymer Graphite (PG\*). PG is characterized by low density, high Young's modulus and high internal loss. This means it provides smooth response, high efficiency, low distortion, excellent power linearity, and, most importantly, clean sound reproduction without a hint of unnatural coloration.

The surround for the diaphragm is a corrugated cloth coated with a damping material to improve internal loss. It helps achieve ideal linear response and low overall distortion.

**VOICE COIL.** The PG cone is driven by a semi-long travel voice coil 7/16 inches (11mm) wide, edgewise-wound on the bobbin. It assures powerful, low-distortion reproduction at virtually all input levels, and high efficiency.

**MAGNETIC CIRCUIT.** The large-sized ferrite magnet (8 lbs./3.6kg) helps yield a high air gap magnetic flux density of 14,500G. It results in high efficiency with extremely low distortion.

**HOUSING.** A sturdy low-resonance aluminum alloy diecast frame is used in the TM-1201 to support the magnetic structure and moving parts of the loudspeaker.

**CROSSOVER.** It is recommended that the TM-1201 be used with an active crossover network (band-pass filter) having crossover frequencies at approximately 200Hz and 3kHz, and cutoff characteristics of 12dB/oct. or 18dB/oct.

\*PG is a trademark of Pioneer.

### TM-1201 SPECIFICATIONS

**Voice coil impedance:** 8 ohms **Lowest resonance frequency ( $f_0$ ):** 52Hz **Recommended frequency range:** 200 — 3,000Hz **Rated input power:** 150 watts **Maximum input power:** 300 watts **Sound pressure level:** 100dB/W (1m) **Equivalent mass (infinite baffle):** 2.1 oz./60g  **$Q_0$ :** 0.16 ( $f_0 = 52$ Hz) **Total magnetic flux:** 324,000 maxwells **Magnetic flux density:** 14,500 gauss **Baffle opening:** 10-7/8 inches/276mm **Mounting dimensions:** 11-9/16 inches/293mm (6 holes) **Weight:** 24 lbs. 4 oz./11kg **Outer dimensions (diameter × depth):** 12-1/2 × 4-5/16 inches/318 × 110mm



## **ET-703 Super high-frequency Loudspeaker**

The ET-703 is a compression horn super high-frequency loudspeaker designed for a wide frequency range and high input power. This makes the driver especially suitable for monitoring digital sound.

**VOICE COIL.** The voice coil is formed by edgewise-wound pure aluminum wire coated with a thin film of alumite, in order to make the most of the magnetic circuit's high magnetic flux. High input power is also achieved through the use of heat-resistant materials for the voice-coil bobbin and thermosetting resin.

**MAGNETIC CIRCUIT.** A high-energy rare-earth cobalt magnet is used in the magnetic circuit that, together with powerful soft iron for the pole yoke and plate, provides a high magnetic flux density of 20,000G.

**DIAPHRAGM.** The diaphragm and surround are made from a single piece of pure beryllium manufactured by advanced vacuum deposition. With the highest resonance frequency set at 45kHz, the sound from the driver is free of coloration that can otherwise be caused by resonance. Extremely lightweight at 0.07g, it combines a wide frequency range, superb transient response and clear-cut definition.

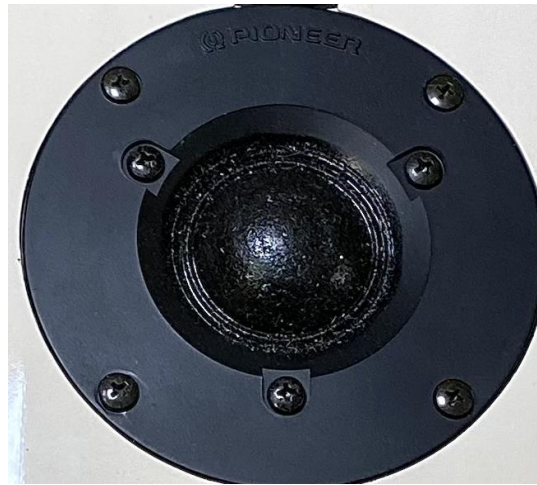
**DESIGN.** The ET-703 is a rear compression design featuring a computer-optimized precision phase plug. This ensures uniform phase response across the entire frequency range the unit covers. Moreover, because the surround is virtually vibration-free, both transparent sound and smooth, extending response are achieved.

**CROSSOVER.** We recommend that the crossover frequency for the ET-703 be higher than 5,000Hz and the cutoff response 12dB/oct. or sharper.

### **ET-703 SPECIFICATIONS**

**Voice coil impedance:** 8 ohms **Frequency range:** 5,000 to 45,000Hz **Voice coil diameter:** 1-3/8 inches/35mm across **Equalizing system:** Rear triple-slit system **Baffle opening (diameter):** 3-3/16 inches/81mm across **Mounting pitch (when mounting on baffle):** 3-7/8 inches/98mm across (using 4 M5 screws) **Mounting pitch (when setting on cabinet):** 1 inch/25mm (using 2 wood screws) **Input (when crossover frequency set at 5kHz and attenuation response at 12dB/oct.):** 15 watts (rated), 30 watts (maximum) **Sound pressure level:** 107dB/W (1m) **Maximum sound pressure level:** 122dB/W (1m) **Crossover frequency:** Higher than 5,000Hz (Attenuation response: sharper than 12dB/oct.) **Total magnetic flux:** 40,000 maxwells **Magnetic flux density:** 20,000 gauss **Magnet:** Rare-earth cobalt **Weight:** 2 lbs. 7 oz./1.1kg **Outer dimensions (diameter × depth):** 3-1/8 × 2-15/16 inches/80 × 74mm

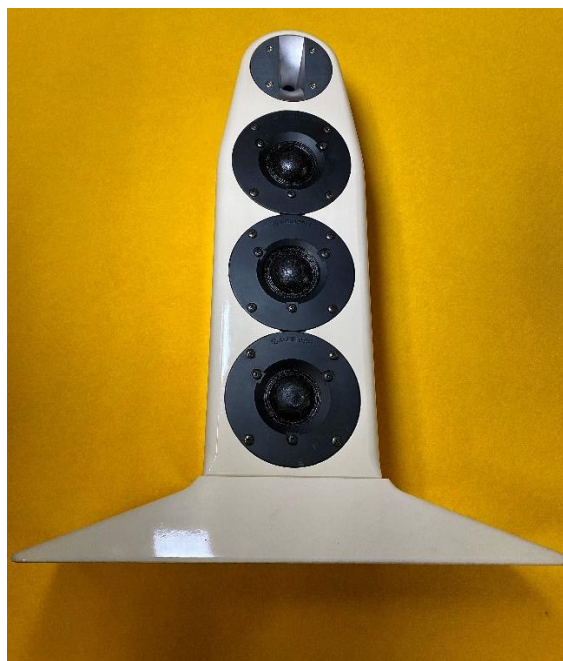
## **DS-049A Midrange Dome Loudspeaker**



This midrange dome loudspeaker from Pioneer has its unique qualities. It showed its potential already within the Pioneer Prologue range of loudspeakers. It was used for several 3-way systems and delivered – to our opinion - a performance within its frequency range far above many high end systems.

For the Pioneer TAD Swedish Reference, three drivers are operated together. The reason was to

- a) match the impressive efficiency of the TAD drivers
- b) have a wide horizontal radiation pattern
- c) limit the radiation in the vertical plane
- d) handle high power transients



## 2. Electronics



### • Pioneer M-90a

Direct construction to minimize signal paths in order to eliminate mutual interference of signals, low-load drive capability to improve dynamic drive capability of speakers, and vibration-free and resonance-free construction to reduce vibration and resonance harmful to sound.

Two large power transformers are used independently on the left and right, and a 10,000  $\mu$  Fx2 resin-coated electrolytic capacitor is used for each channel. In addition, the positive and negative sides of the power supply are divided into two parts from the winding of the power transformer, and each part is bridge rectified by high-speed low-noise diodes. This makes it possible to supply high-power music signals with low distortion. In addition, the power transistor is a  $P_c = 130W$  4-parallel push-pull configuration, realizing a large current supply capability of 47A.

In addition to the power input from the normal control amplifier, there are two input jacks, CD direct and line direct. These direct inputs are level-controllable. The CD/Line direct terminal also has a dedicated output terminal, which can be returned to a control amplifier for copying to tape.

In order to minimize the signal path, direct construction is adopted. The volume and relay itself are located near the rear panel, near the input terminals, and the volume is controlled via a brass remote shaft. As a result, the signal path can be minimized without sacrificing operability.

In order to thoroughly suppress internal and external vibrations, we have adopted a casted transformer and a unique honeycomb shape for heat sinks, chassis frames, and large insulators to disperse vibrations in various directions. The transformer case of M-90a is made of cast iron with high shielding effect. Pitch material with high thermal conductivity is filled between the cast iron case and the transformer body. Heat radiation fins are also provided to prevent internal resistance from increasing due to temperature rise.

A 1.6 mm thick honeycomb structure with copper plating is used for the transformer frame supporting the transformer. In addition, a 1.6 mm thick copper plated honeycomb punching bottom plate is used to firmly hold the frame chassis.

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The heat sink is an extruded aluminium honeycomb heat sink that suppresses resonance and vibration of the power transistor and has excellent heat radiation effect. In addition, four large-size filled type insulators made of special cell polymer are used, and a fifth insulator made of cast iron is also installed to support the heavy transformer.

The M-90a employs a non-switching circuit in which switching distortion does not occur in principle. This circuit expands the range of 0 switching distortion to increase the bandwidth. In addition, it stabilizes the idle current that is drifting due to changes in ambient temperature immediately after the power switch is turned on or when a large signal is input, and suppresses thermal distortion caused by this. In addition, by detecting and correcting the difference between the input and output signals, the nonlinear distortion of the output stage is reduced.

The copper-plated chassis greatly reduces magnetic distortion. In addition, by using copper plating, different metals are bonded together, and vibration damping is improved compared to the case of using a single metal.

Equipped with a 39mmx98mm large-size power indicator, it can directly read output changes from 2 mW to 300W (at 8  $\Omega$ ) without switching. A 0.6 second peak hold function is also built in to make it easier to read peak power.

High-quality parts such as a non-stress power cord using an oxygen-free copper wire with a polarity display that suppresses the influence of external noise, a vibration-proof film capacitor using a soft coating material, a special resin-coated electrolytic capacitor, a oxygen-free copper wire wiring material, a brass capped carbon resistor, a 70  $\mu$  m copper-foil substrate, and a gold-plated input / output pin jack are used.



Model Rating

Type	Stereo power amplifier
Effective output (both channel drive)	1 kHz : 200W + 200W (4 Ω, 0.01%) 20 Hz-20 kHz : 200W + 200W (8 Ω, 0.003%)
Dynamic Power (EIA test signal)	800W + 800W (2 Ω) 550W + 550W (4 Ω) 300W + 300W (8 Ω)
Harmonic distortion factor (20 Hz to 20 kHz)	0.003% (200W, 8 Ω)
Intermodulation distortion factor (50 Hz : 7 kHz = 4 : 1)	0.002% (at effective output)
Input Sensitivity / Impedance	Control Amp, CD Direct, Line Direct : 1V/50k Ω
Output Level / Impedance	CD/Line : 1V/1k Ω
Frequency characteristic	Control Amp, CD Direct, Line Direct : 20 Hz to 20 kHz + 0 - 0.1 db
Signal-to-noise ratio (A network, short circuit)	Control Amp, CD Direct, Line Direct : 125 dB
Power supply voltage	100 VAC, 50Hz/60Hz
Power consumption (Electrical Appliance and Material Control Law)	410W
External dimensions	Width 457x Height 163x Depth 432 mm
Weight	28kg

Source: Audio Database

### Brooke Sirens Systems Active Crossover Network



The FDS-360 is an electronic crossover system, and incorporates all the latest technology and facilities that are required for today’s high powered loudspeaker systems. This frequency dividing system (FDS) is substantially more than a basic crossover, combining a high degree of sophistication which enables accurate control of loudspeaker power, dispersion and acoustical summation around the critical crossover region.





The **FDS-360** features the following

- Stereo two-way mode, or switchable three/four way mono mode
- 24dB/Oct Linkwitz-Riley response for optimum speaker response and radiation pattern  
Separate frequency band limiters matched to the precise band of frequencies controlled
- Separate polarity switching for each band
- LED signal level monitoring
- Band insertion points for interfacing external equalisation and time delay units
- Band-edge phase adjustment allowing 360 degrees of control
- Crossover filter programming via plug-in frequency cards allowing any frequency

### SENTEC PD8 Stereo Phase Divider



The **SENTEC PD8 Stereo Phase Divider** enables a stereo power amplifier to be operated in bridge mode. This results in more than twice the output power and better control of the bass frequencies.

The PD8 is connected between the BSS FDS active crossover network and the Pioneer M90a power amplifier for the bass range. The connectors are gold-plated. The unit is set in “always-ON” mode. The PD8 has its own built-in 230 V AC mains supply.

#### Technical data:

Gain: 0 dB (signal level in equals signal level out)

Distortion (THD): < 0.01%

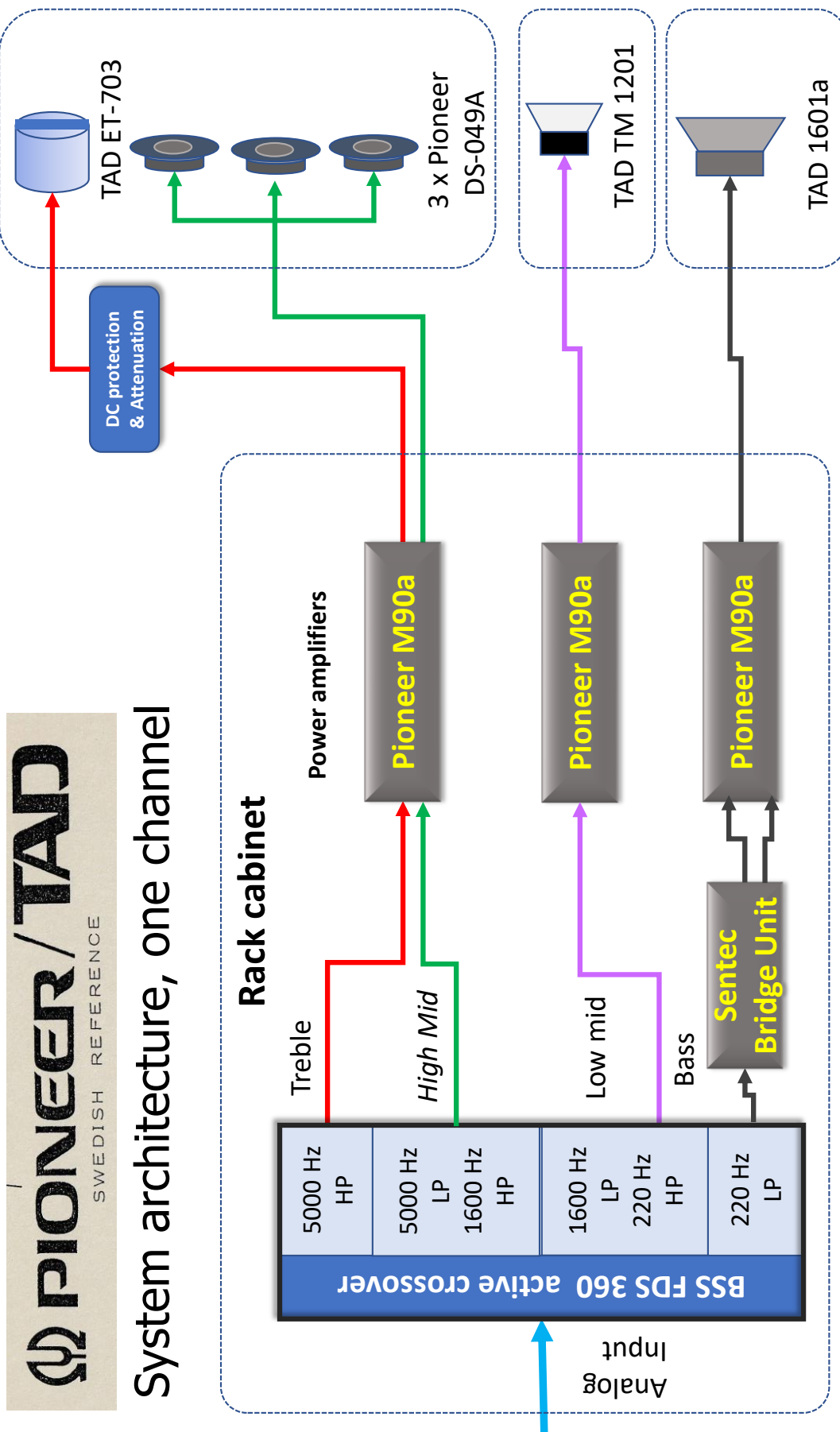
Max input signal level: 10 Volt

Input impedance: 10 kOhm

Output impedance: 600 Ohm

Dimensions: 144 x 68 x 150 mm

PD8 is a high-quality unit developed and manufactured in Sweden.



### 3. Acoustic Measurements

Audio frequency graphs and data presented in this section have been made using the XTZ Pro II h/w and s/w products. Figures are screen shots where additional information is included. Results from measurements of individual drivers are presented. All measurement has been made with the BSS FDS 360 active crossover network and Pioneer M90a amplifiers with their intended settings if not otherwise stated.

It has not been meaningful to include a total speaker system frequency response curve. This due to a) the acoustics of the room where the loudspeaker system will be performing will be totally different and b) settings of the individual phase and level of the speaker units will have impact on the total performance

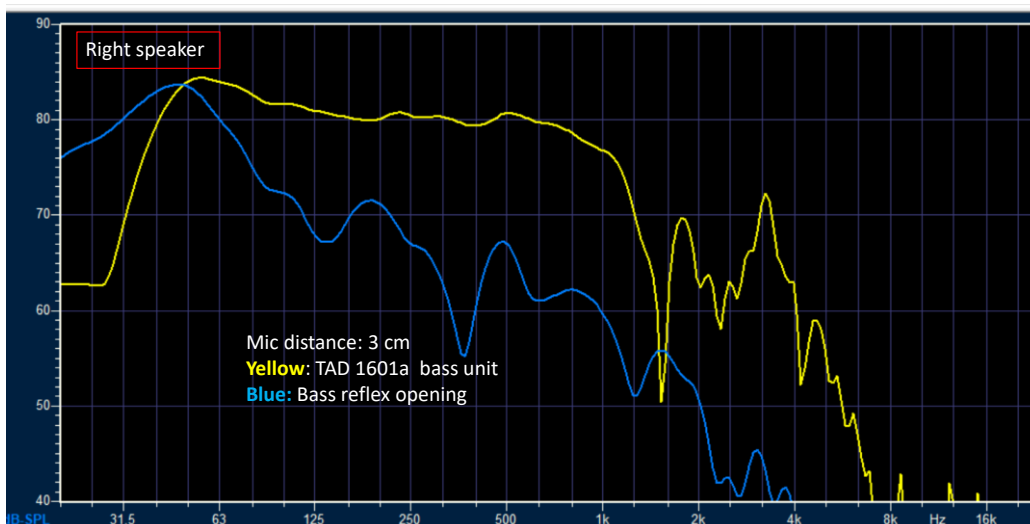


Figure 1: TAD 1601a bass unit without BSS active crossover

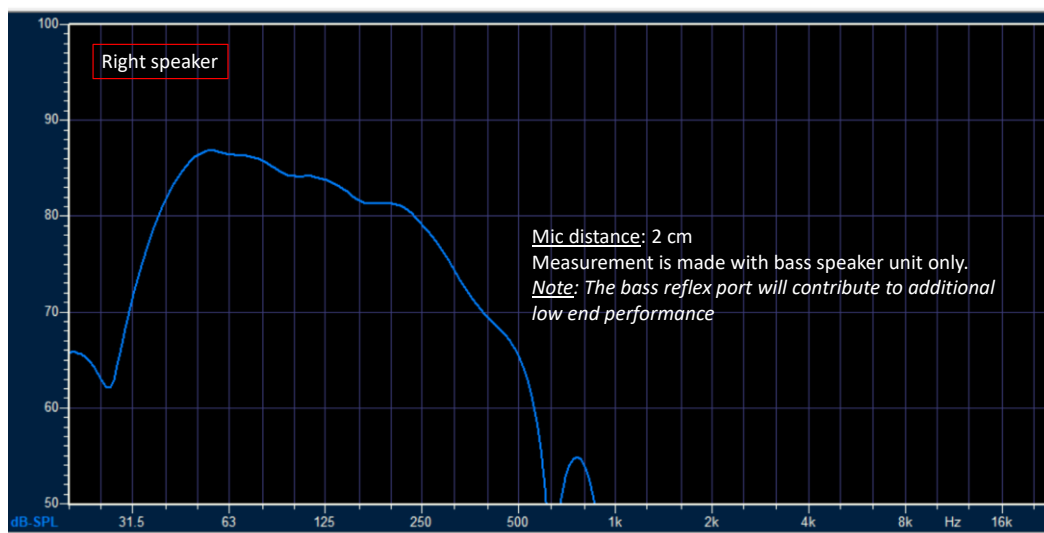


Figure 2: TAD 1601a Bass unit with BSS active crossover

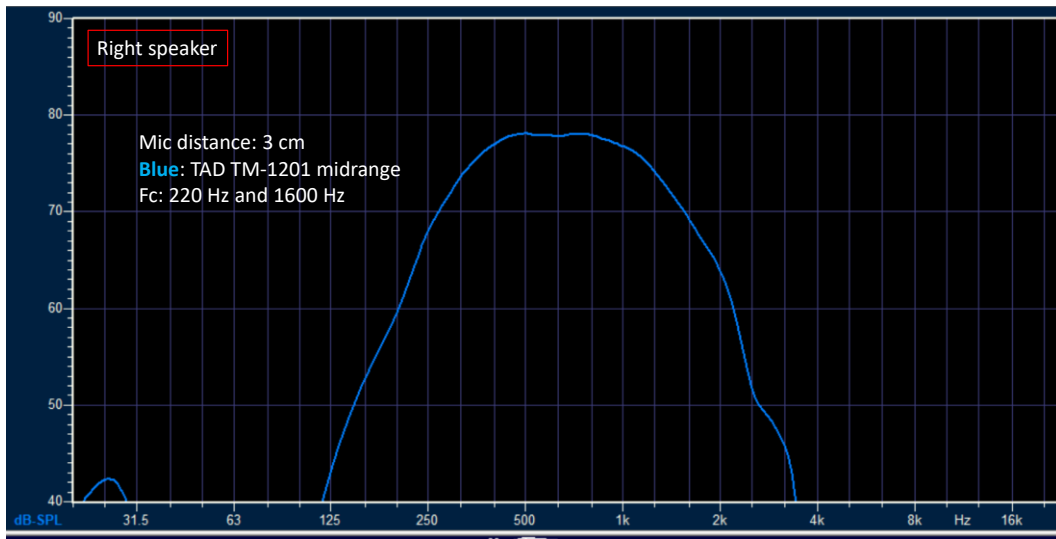


Figure 3: TAD TM-1201 midrange unit with BSS active crossover

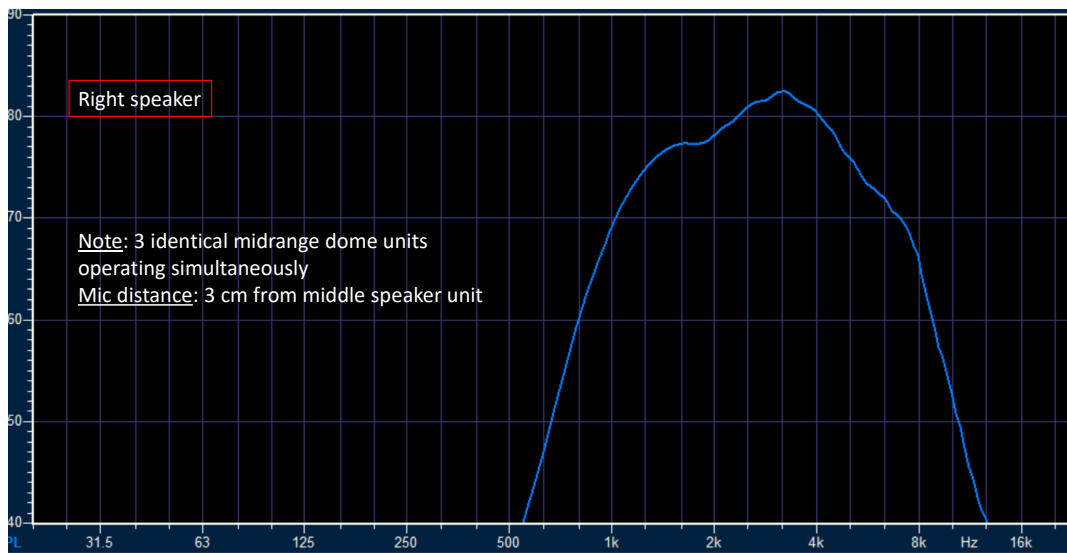


Figure 4: Pioneer MD-049A midrange unit with BSS filtering

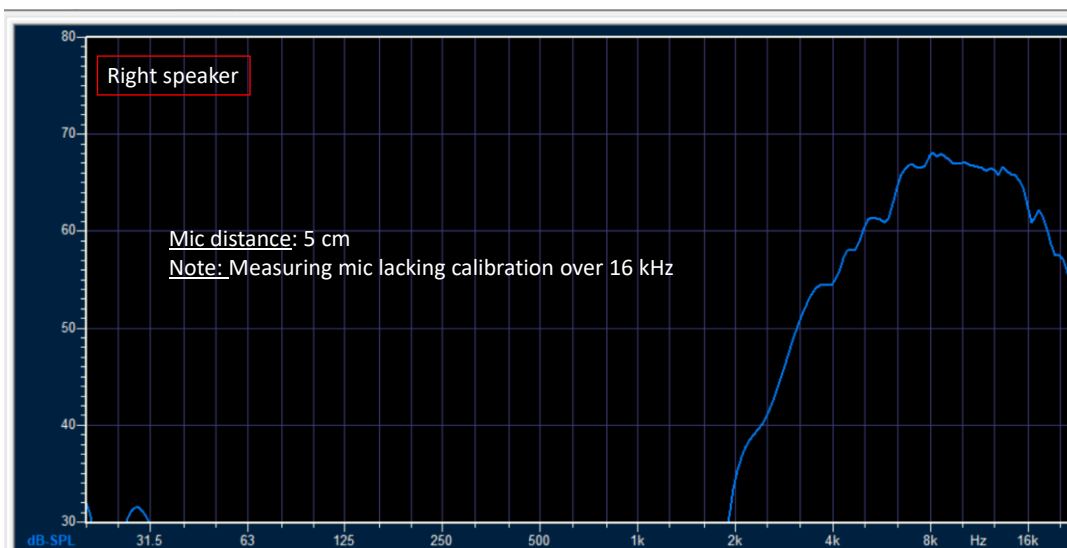


Figure 5: TAD ET-703 horn tweeter unit with BSS active crossover

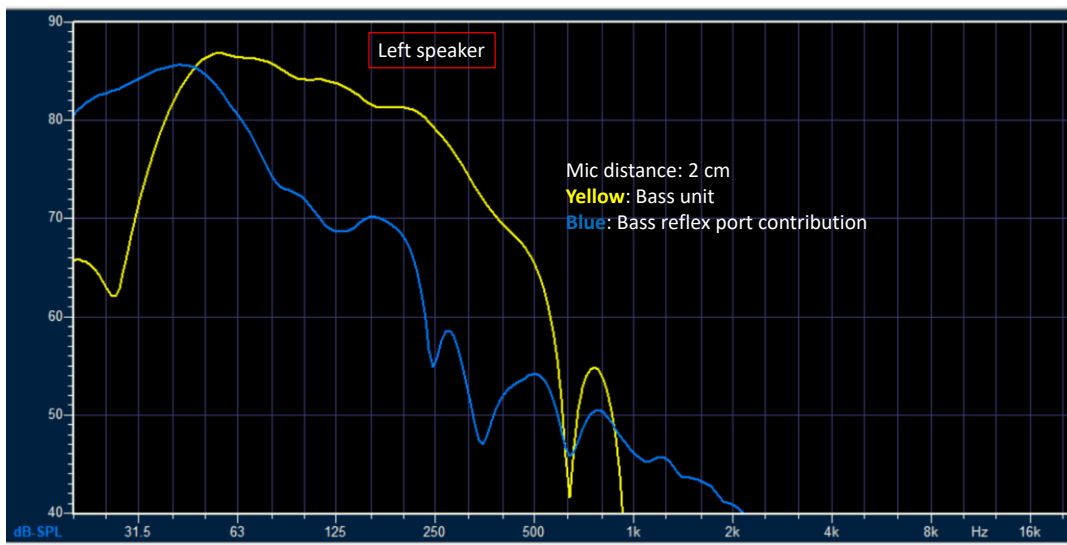


Figure 6: TAD 1601a Bass unit with BSS active crossover

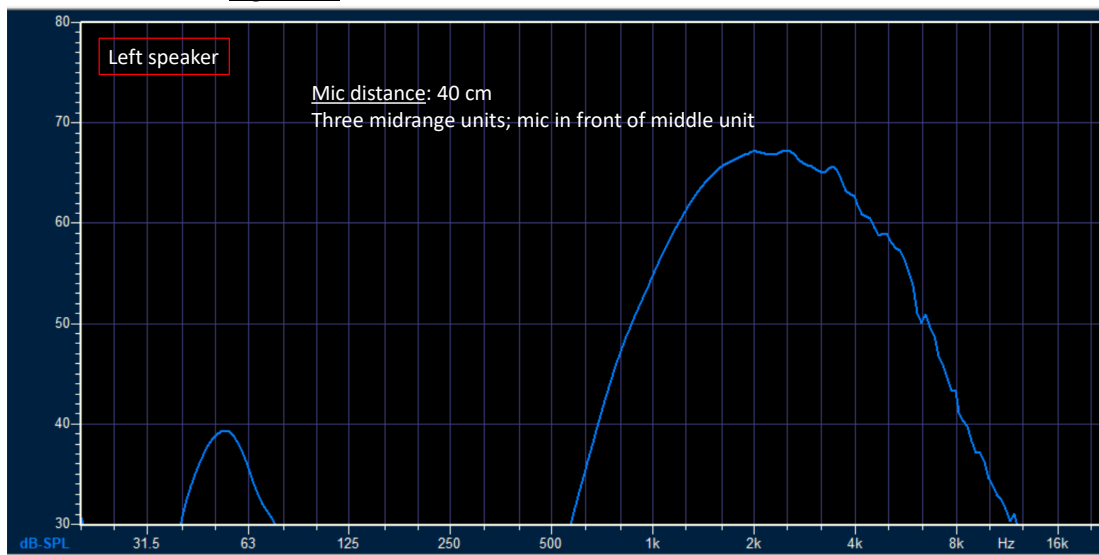


Figure 7: Pioneer Midrange units with BSS active crossover

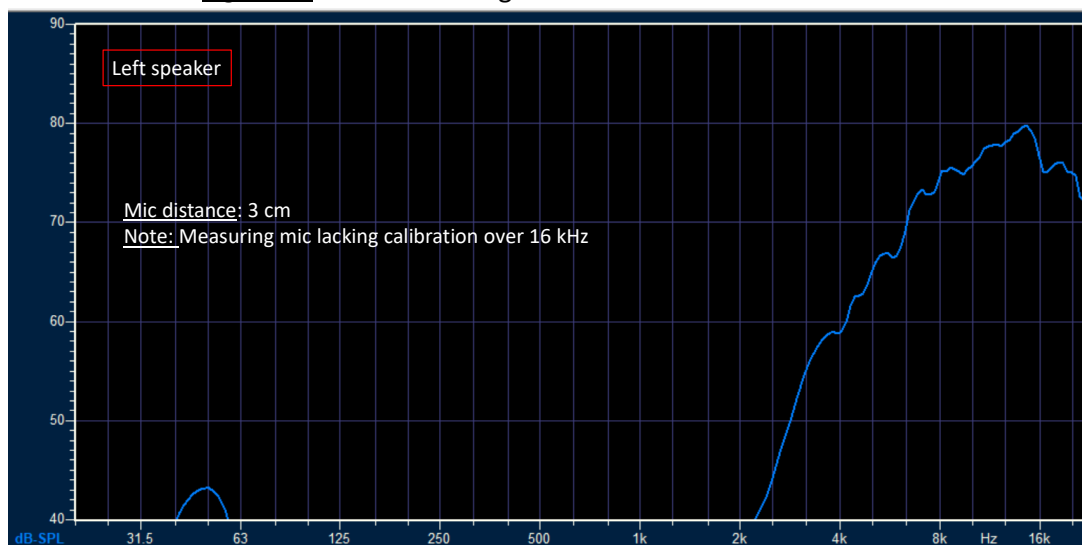


Figure 8: TAD ET-703 Tweeter unit with BSS active crossover filter