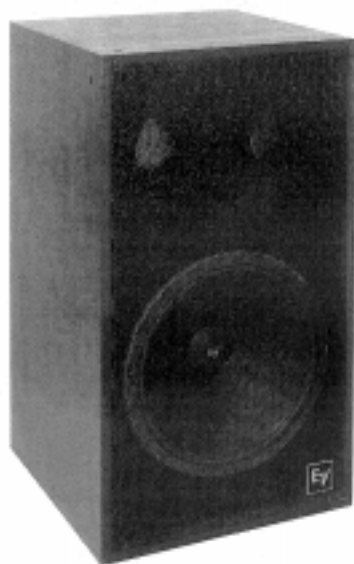




TL440

Very-Low-Frequency Speaker System

- The bass pumping ability of EVX-180A 18-inch woofer and 33-Hz f_3 make an ideal subwoofer for contemporary music applications
- THX® approved for cinema subwoofer use*
- 24-Hz f_3 in step-down, ideal for very-low-frequency synthesized effects, down-tuned bass guitars or pipe organ
- Optional HS6 or HS7 hanging kits—through-the-box steel tubes provide safe suspension

*THX is a registered trademark of Lucasfilm, Ltd.

Description

The Electro-Voice TL440 is an optimally vented, direct-radiator speaker system for high-output reproduction of very-low frequencies. The low-frequency limit of 33 Hz (3 dB down) may be extended to 24 Hz by covering one vent and applying appropriate low-frequency equalization (see Step-Down section). The TL440's design is based on the vented-enclosure modeling technique of A.N. Thiele and R.H. Small, which makes possible a combination of high efficiency, low distortion and extended low-frequency performance in an enclosure of moderate size.

The TL440 employs an EVX-180A very-low-frequency reproducer in a 9-cubic-foot (255 liter) enclosure. The EVX-180A's high linear cone-excursion ability ($X_{\max} = 0.25$ inches, zero to peak) and 600-watt long-term average power capacity contribute substantially to the TL440's high acoustic output ability (see Power Handling Capacity section). The enclosure is constructed of black, vinyl-clad particle board of 3/4-inch thickness, internally braced.

Applications

The TL440 is ideal for a wide variety of high-output subwoofer applications, in perma-

nently installed sound reinforcement and music playback systems. Typical venues include cinemas, auditoriums, theaters, performing arts centers, night clubs and concert halls. The TL440 system is THX® approved for cinema subwoofer use.* Normally, the TL440 would be used in the subwoofer frequency range, below, say, 125 Hz. However, its frequency response and dispersion make single units appropriate for crossover frequencies as high as about 800 Hz. This means that the TL440 can also be used as a system's primary low-frequency reproducer.

The Electro-Voice XEQ-2 active crossover/equalizer is a useful companion to the TL440. The XEQ-2 provides appropriate crossover frequencies by plug-in module (modules other than the supplied X500 and X800 must be purchased separately; an X125 module is available). The XEQ-2 also provides equalization for step-down operation and protection from subpassband input signals (see Step-Down and Subpassband Speaker Protection sections).

Frequency Response

TL440 frequency response was measured in an anechoic environment in the far field with swept one-third octave pink noise (see Figure 1).

Directivity

TL440 directional characteristics were measured by running a set of polar-response curves in EV's large anechoic chamber (see Figure 2). The curves show horizontal (side-to-side) dispersion when the enclosure's long axis is vertical. The vertical (up-and-down) polar responses are also shown.

Additional typical information is provided in Figure 3 which shows 6-dB-down beamwidth versus frequency. Figure 4 shows the directivity factor and directivity index versus frequency.

Distortion

Following AES (Audio Engineering Society) recommended practice, plots of second- and third-order harmonic distortion for 0.1 and 0.01 rated input power are shown in Figure 5.

Power-Handling

Electro-Voice components and systems are manufactured to exacting standards, ensuring they will hold up, not only through the most rigorous of power tests, but also through continued use in arduous, real-life conditions. The eight hour EIA Loudspeaker Power Rating Full Range (ANSI/EIA RS-

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426-A 1980) uses a noise spectrum which mimics typical music and tests the thermal and mechanical capabilities of the components. Electro-Voice will support relevant additional standards as and when they become available. Extreme, in-house power tests, which push the performance boundaries of the woofers, are also performed and passed to ensure years of trouble-free service.

Specifically, the TL440 passes ANSI/EIA RS-426-A 1980 with the following values:

$$R_{SR} = 5.9 \text{ ohms } (1.15 \times R_E)$$

$$P_{E(MAX)} = 600 \text{ watts}$$

$$\text{Test voltage} = 59.5 \text{ volts rms,} \\ 119.0 \text{ volts peak}$$

The "peak" power-handling capacity of a woofer is determined by the peak test voltage amount. For the TL440 a 59.5-volt peak test voltage translates into 2,400-watts short-term peak power-handling capacity. This is the equivalent of four times the "average" power-handling capacity, and is a peak that can be sustained for only a few milliseconds. However, this sort of short duration peak is very typical in speech and music. Provided the amplifier can reproduce the signal accurately, without clipping, the woofer will also perform accurately and reliably, even at these levels.

Step-Down

Step-down is a good way to extend system low-frequency response by increasing amplifier power at low frequencies instead of enclosure size. In step-down, the enclosure is tuned to a lower-than-normal frequency. This increases system output at the new tuning frequency and reduces output slightly in the region of original tuning. The smoothly falling frequency response which results can be equalized to provide a new system 3-dB-down point (f_3) about 0.7 that of the original. To achieve a similar response extension without equalization would require an enclosure at least twice the size, not practical in certain installations.

To step down the TL440, install the supplied port cover using the screws and pilot holes provided. This lowers the box tuning from 35 Hz to 25 Hz. If an appropriate low-frequency boost-and-cut equalization is applied, the normal f_3 of 33 Hz is reduced to 24 Hz. It

is suggested that the Electro-Voice XEQ-2 or XEQ-3 active crossover be used to provide the required equalization. The suggested equalization is an underdamped second-order high-pass filter tuned to 29 Hz with a Q of 2. This provides a boost of 6 dB at the tuning frequency and a 12-dB-per-octave roll-off below. This filter is directly available on the XEQ-2 or can be generated in the XEQ-3 by using the optional EB29/35 EQ module.

Subpassband Speaker Protection

Below the enclosure tuning frequency, cone excursion increases rapidly. Since acoustic output is also falling rapidly, there is no utility in driving the system with signals much below the tuning frequency. While such signals may be in the program material, they are often extraneous—such as from record-surface irregularities (strong 5- to 25-Hz components) or a dropped microphone. The EVX-180A very-low-frequency reproducer is ruggedly designed and has a high maximum excursion before damage (± 0.5 inch). However, high-output subwoofer systems such as the TL440 should be protected by a high-pass filter with a 3-dB-down corner frequency of about 0.8 the enclosure tuning frequency. Below the corner frequency, a roll-off of 12 dB per octave is usually sufficient.

Without protection, subpassband signals may "bottom" the EVX-180A. Damage will probably result, especially after repeated occurrences. Even if bottoming does not occur, the subpassband signals waste amplifier power and modulate (distort) the frequencies which are within the TL440's operating range. Much "woofer distortion" or "muddy bass" can be attributed to lack of subpassband protection.

The step-down equalization described in the Step-Down section provides the required protection.

If step-down mode is not used, the Electro-Voice EX-24, XEQ-2 and XEQ-3 electronic crossover/equalizers can also provide subpassband protection. The 3-dB-down points are 30 Hz (EX-24 and XEQ-2) and 16 Hz or 32 Hz (XEQ-3).

Other high-pass filters are available, and $1/3$ -octave equalizers can also be effective at providing the required protection.

Use In Multiples

TL440's may be used in multiples to increase acoustic output. In the following discussion, it is assumed that all speaker cones are operating in unison (in phase) when a common signal is applied. A 6-dB increase in maximum acoustic output results when two speakers are located side by side. For operation at very low frequencies, the woofer cones "mutually couple," acting as one speaker with cone area and power-handling capacity twice that of a single speaker. The doubling of cone area doubles efficiency, providing a 3-dB increase in sound pressure level. The second 3-dB comes from the doubling of power capacity.

Mutual coupling occurs when the frequency is such that the center-to-center distance between the two speaker cones is less than about one-quarter wavelength. For a given center-to-center distance, the highest frequency at which mutual coupling will occur can be calculated from the following formula:

$$f \cong \frac{3,000}{D_{\max}}$$

where $D_{\max}$ is the distance in inches and f is frequency in Hz. When $D_{\max}$ is greater than one-quarter wavelength, as would occur if two TL440's were widely spaced, the level increase tends to be limited to the 3-dB power-handling increase.

More than two TL440's can be used for increased output. In general, maximum acoustic power output ability increases as the square of the number of mutually coupled cones. For example, four cones would provide 4^2 or 16 times the power output of a single cone, an increase of 12 dB ($10 \log_{10} 16 = 12$ dB). Note that the associated increased efficiency ($3.4\% \times 4 = 13.6\%$) approaches that of a fully horn-loaded design, but in a much smaller enclosure.

System Positioning

Subwoofer systems such as the TL440 are often located on the floor. This is both convenient and can provide a desired high acoustic impact when the speakers are, for example, placed near the periphery of a dance floor. In other installations, such as a theater or auditorium, the audible location of a

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Figure 3—Beamwidth vs Frequency
(whole-space anechoic environment)

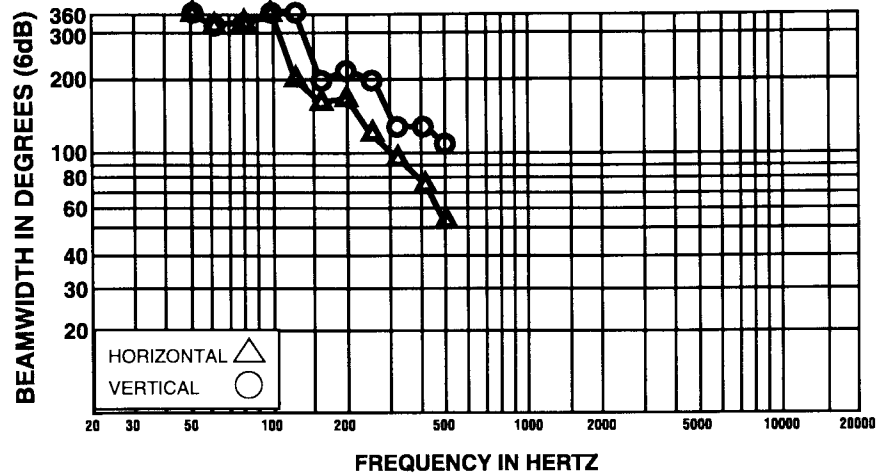


Figure 4—Directivity vs Frequency
(whole-space anechoic environment)

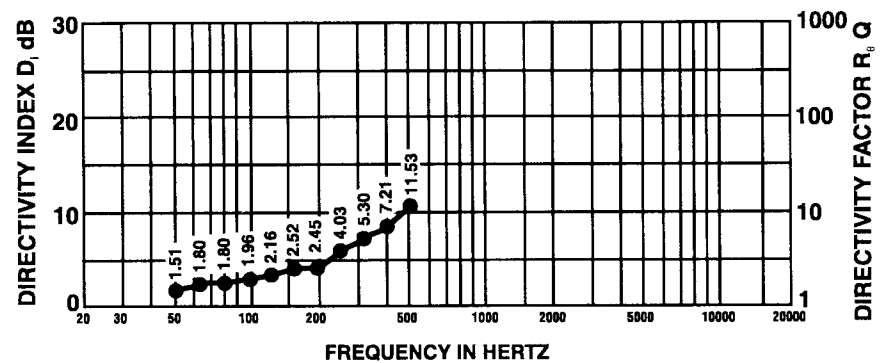


Figure 5—Harmonic Distortion, 10 Feet
on Axis 0.1 Rated Power Input
(60 watts)

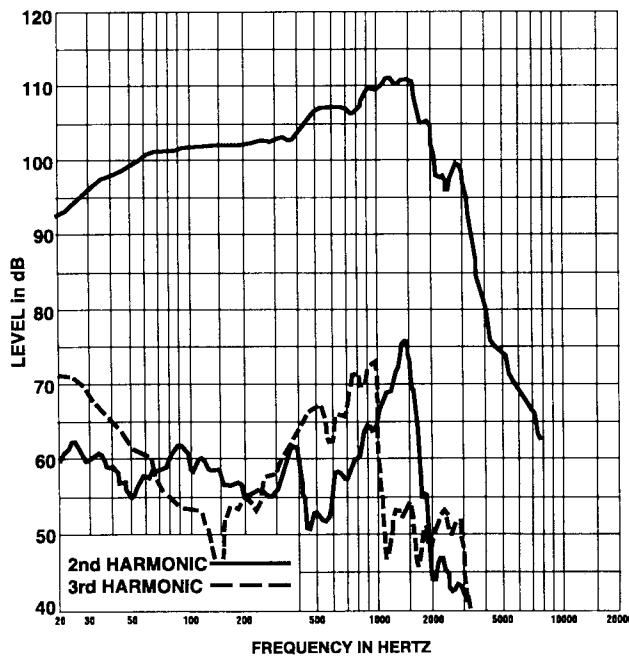
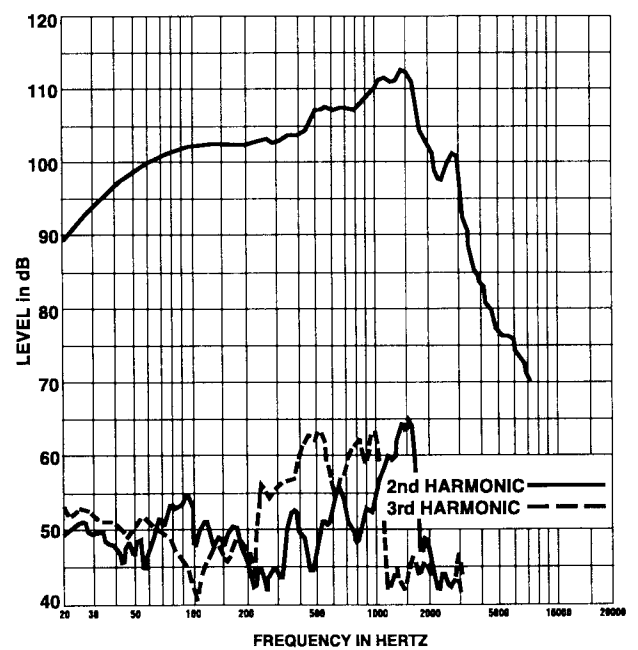


Figure 6—Harmonic Distortion, 10 Feet
on Axis 0.01 Rated Power Input
(6 watts)



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Specifications

Frequency Response (measured in far field, calculated to one watt at one meter on axis, swept one-third-octave pink noise, half-space anechoic environment; see Figure 1):

33-3,200 Hz

Low-Frequency 3-dB-Down Point,

Normal:

33 Hz

Step-Down (with equalization):

24 Hz

Half-Space Reference Efficiency:

3.4%

Long-Term Average Power Handling

Capacity per ANSI/EIA RS-426-A 1980

(see Power Handling Capacity section):

600 watts

Maximum Long-Term Average Mid-Band Acoustic Output:

20.4 watts

Sensitivity (SPL at 1 meter, 1 watt input, anechoic environment, band-limited pink-noise signal),

100-800 Hz:

98 dB

33-125 Hz:

95 dB

Dispersion Angle Included by 6-dB-

Down Points on Polar Responses,

Indicated One-Third Octave Bands of Pink Noise (see Figure 3),

36-125 Hz Horizontal and Vertical:

360°

400-800 Hz Horizontal:

105° ±5°

400-800 Hz Vertical:

110° ±5°

Directivity Factor R_0 (Q), Median over Indicated Range (see Figure 4),

33-125 Hz:

1.0

400-800 Hz:

5.7

Directivity Index D_0 , Median over Indicated Range (see Figure 4),

33-125 Hz:

0.0 dB

400-800 Hz:

7.5 dB

Distortion, 0.1 Full Power Input (see Figure 5),

Second Harmonic,

100 Hz:

0.9%

1,000 Hz:

0.9%

Third Harmonic,

100 Hz:

0.4%

1,000 Hz:

0.3%

Distortion, 0.01 Full Power Input (see Figure 6),

Second Harmonic,

100 Hz:

0.1%

1,000 Hz:

0.2%

Third Harmonic,

100 Hz:

0.3%

1,000 Hz:

0.1%

Transducer Complement:

One EVX-180A

Net Box Volume:

255 liters (9.0 ft³)

Box Tuning Frequency,

Normal:

35 Hz

Step-Down:

25 Hz

Impedance,

Nominal:

8 ohms

Minimum:

7.0 ohms

Input Connections:

Screw terminals (#10) on barrier strip

Enclosure Materials and Finish:

Black vinyl-clad particle board with metal grille

Suspension (see Suspending TL440

Enclosures section):

Two "independently certified" suspension kits are available: the HS6 and HS7

Dimensions,

Height:

100.3 cm (39.5 in.)

Width:

57.2 cm (22.5 in.)

Depth:

55.9 cm (22.0 in.)

Net Weight:

49.0 kg (108 lb)

Shipping Weight:

54.4 kg (120 lb)

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SPEAKERS—Low-Frequency Systems

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