



## Technical Note Volume 1, Number 15

# Choosing the Right Studio Monitor for Specific Applications: A Discussion of JBL and UREI Monitor Loudspeakers

### INTRODUCTION:

The purpose of this Technical Note is to offer selection criteria for both large and small monitor loudspeakers. Since early 1984, JBL and UREI monitor products have been marketed through JBL Professional, and JBL's total monitor market share is larger than that of any other company. The joining of the two product lines has caused some confusion in certain quarters, and it is the aim of this Technical Note to answer all questions of performance and usage.

This Technical Note is divided into two main sections. The first deals with the large monitors, while the second section deals with the small monitors.

### LARGE MONITORS:

#### Background:

Since 1980, JBL's Bi-Radial™ and UREI's Time Align® monitors have become the most widely accepted commercial products for monitoring multi-track recording. Easily 90% of the world's 16- and 24-track studios use one or the other of the two types.

Historically, the UREI 811, 813, and 815 Time Align systems grew out of the Altec 604 Duplex (coaxial) loudspeaker, which James B. Lansing had originally developed in 1943<sup>1</sup>. The recording industry's long "love affair" with the point-source 604 had persisted through thick and thin, and in the late 1970's, Bill Putnam, the CEO of UREI, engaged the consulting services of Ed Long to come up with a dividing network for the basic 604 coaxial transducer which would correct both amplitude and time domain anomalies in the basic unit. The models 811 (single coaxial), 813 (coaxial with added woofer), and 815 (coaxial with two added woofers) were developed. During the early 1980's, UREI developed their own proprietary coaxial unit, which utilized the JBL 2425 high-frequency driver. The model 813 in particular was an industry favorite.

The JBL monitor philosophy grew out of a different tradition. Long based on HF compression drivers and horn/lens combinations, JBL's 4300 Series product line was

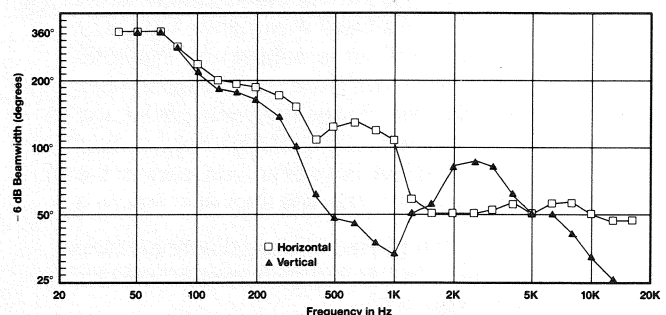
expanded during the 1970's, and the two-, three-, and four-way designs became popular throughout the world. In 1980, the Bi-Radial 4430 and 4435 monitors were introduced.<sup>2</sup> Improvements in HF drivers made it possible for extended range two-way systems to deliver substantially uniform acoustical power ( $\pm 2$  dB) from about 500 Hz to 12 kHz. The resulting systems were easy to equalize in the majority of monitoring environments, and the use of Bi-Radial horns ensured absolutely even horizontal and vertical pattern control above 1 kHz.

After the acquisition of URC, UREI's parent company, by Harman International, a new coaxial unit was developed by UREI and JBL engineers and was introduced in late 1985, and the current line of UREI Time Align monitors now takes advantage of JBL's expertise in transducer manufacture. Both Time Align and Bi-Radial monitors make use of titanium HF drivers for extended response.

### The Basic Characteristics:

The Bi-Radial and Time Align monitors have certain mutually exclusive characteristics: specifically, the Time Align monitors are effectively point sources, while the Bi-Radials maintain flat power response above 1 kHz. There is no way that both of these advantages can be embodied in a single design.

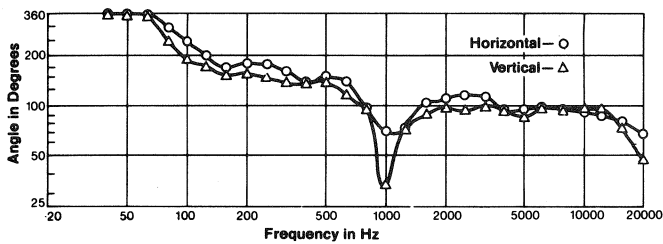
**Figure 1: Beamwidth characteristics of UREI 813C Coaxial Loudspeaker System.**



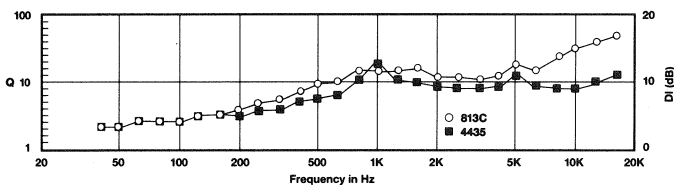
For a coaxial design to work, the HF horn must be smaller than the LF cone so as not to impede the output from the cone. This inevitably means that, at crossover, the radiation pattern from the HF section will widen in the vertical plane. This is shown in Figure 1.

If the HF section of a two-way design is to maintain the same pattern control at crossover as the LF cone, it must be approximately the same size as the cone. This is the case with the Bi-Radial designs, and obviously such a HF horn cannot be mounted coaxially with a LF cone. The resulting pattern control for a Bi-Radial design is shown in Figure 2. Note that the horizontal control is quite smooth through the transition region. Vertical pattern control narrows down just at the single frequency where the output from the HF and LF transducers is precisely equal. The resulting directivity indices (DI) of the two monitor designs are shown in Figure 3.

**Figure 2: Beamwidth (-6 dB) vs. Frequency, 4430**



**Figure 3: Directivity Factor (Q) and Directivity Index (DI) for 813C and 4435 Monitors.**

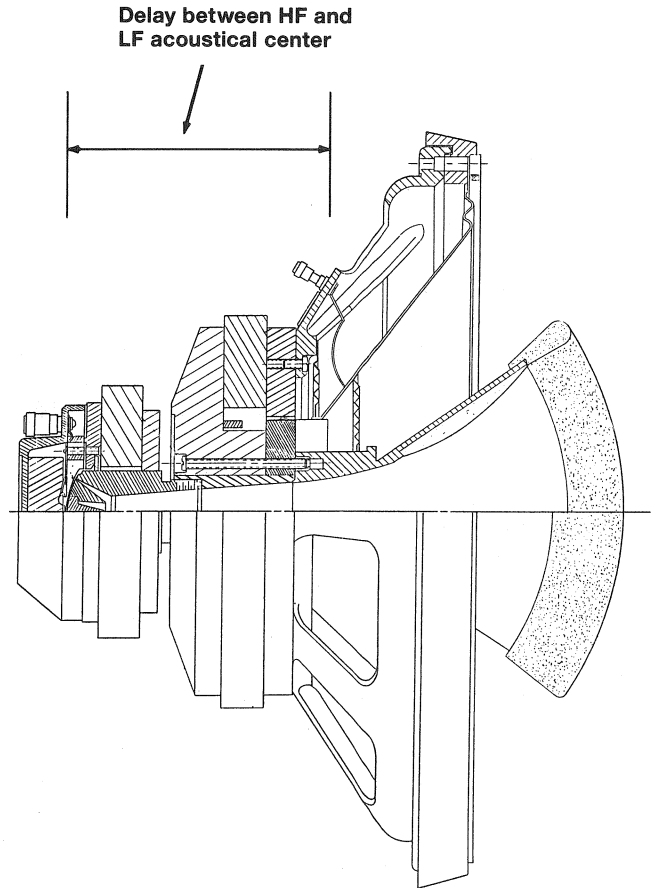


In summary, the smooth DI (and power response) of the Bi-Radial design is bought at the expense of point source radiation, and conversely the point source nature of the Time Align design is bought at the expense of smooth power response through the crossover region.

So far, we have not mentioned that characteristic of the UREI monitors which gives them their name, time alignment. In working out the dividing network for the UREI monitors, Ed Long used a multi-section low-pass filter, which acts like a delay line. It was precisely calculated to compensate for the inherent delay of high frequencies due to the fact that the HF driver is located well behind the LF acoustical center.<sup>3</sup> Details of this are shown in Figure 4.

By comparison, the Bi-Radial design accomplished similar time alignment, but at a slightly vertical off-axis angle, as shown in Figure 5<sup>4</sup>

**Figure 4:**



**Figure 5:**

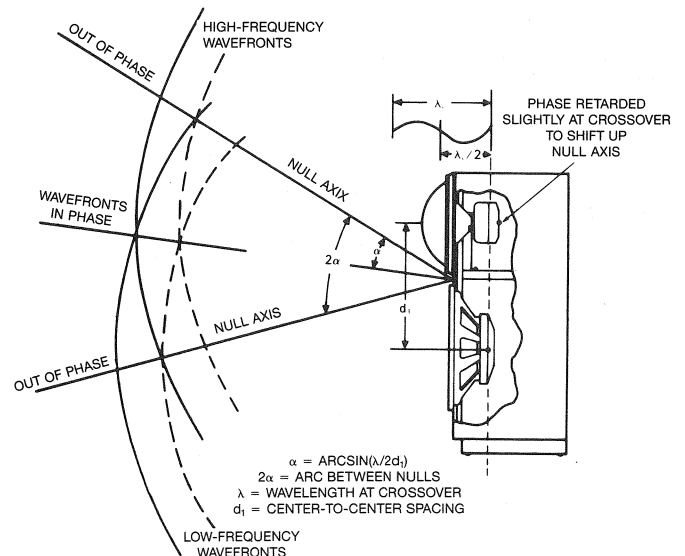


Figure 6:

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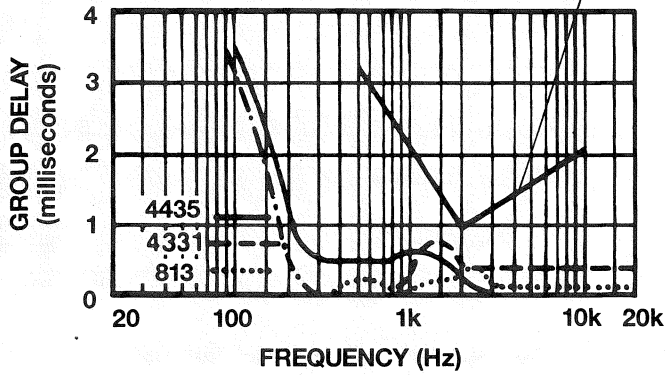
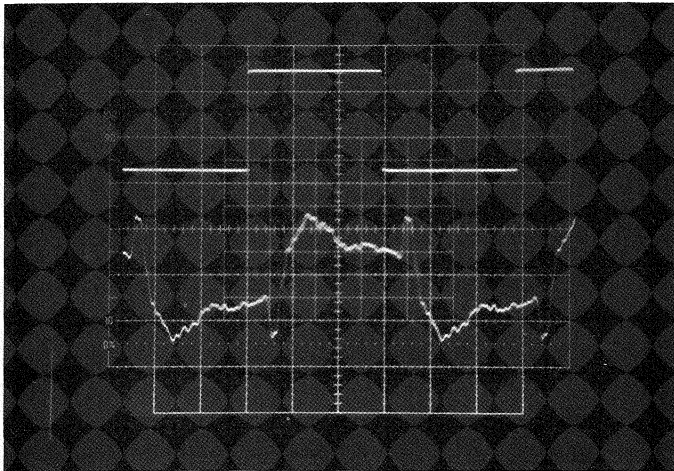


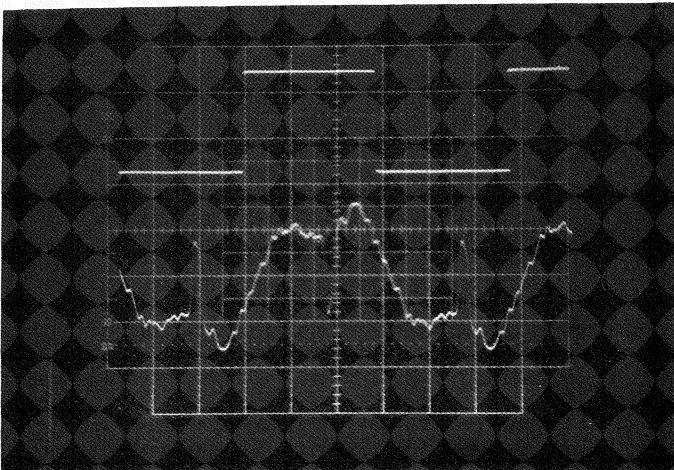
Figure 6 shows the relative time domain performance of the two design approaches, along with the Blauert and Laws criteria for audibility of group delay effects in sound reproduction. Note that both designs fall well below the criteria. As a measure of how well the systems can reproduce a square wave — and this is a difficult task for any loud-speaker — we show photographs in Figure 7.

Figure 7: Photos of square wave response at 750 Hz

A. UREI 813



B. JBL 4435



In remaining matters of response, the two basic designs are similar. Here, we are referring to on-axis response, impedance, maximum acoustical output, and distortion. Typical comparisons are shown in Figures 8 through 11.

Figure 8: 4435, 1 W at 1 meter on horn axis,  $2\pi$  mounting; Impedance.

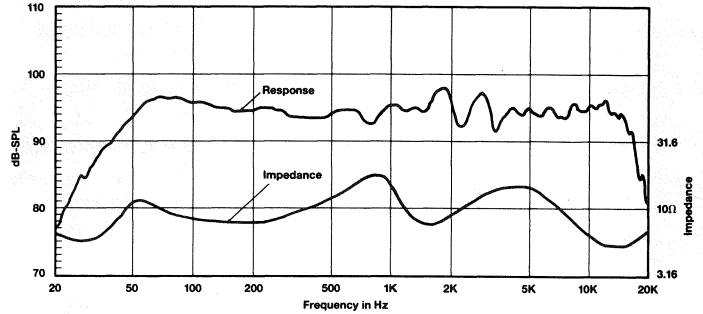


Figure 9: 813C, 1 W at 1 meter on HF axis,  $2\pi$  mounting; impedance.

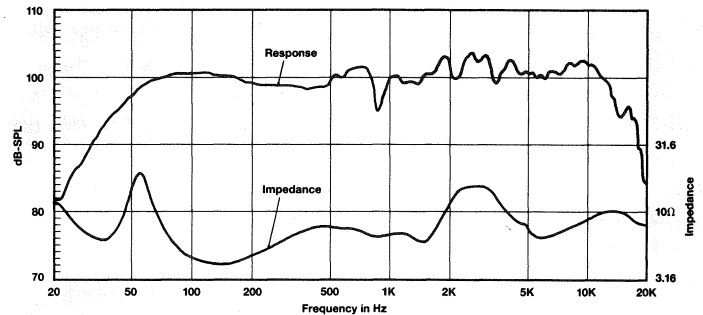


Figure 10: 4435 driven to SPL of 110 dB at 1 meter ( $\approx 16$  v RMS). Distortion raised 20 dB.

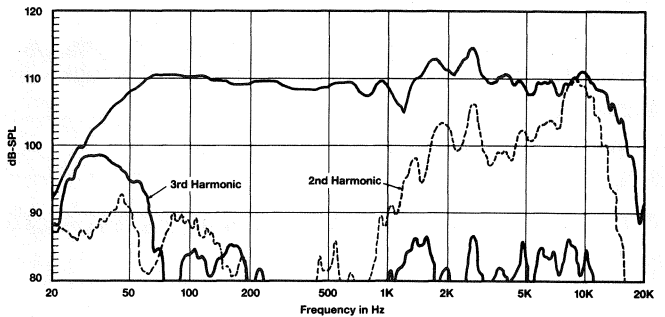
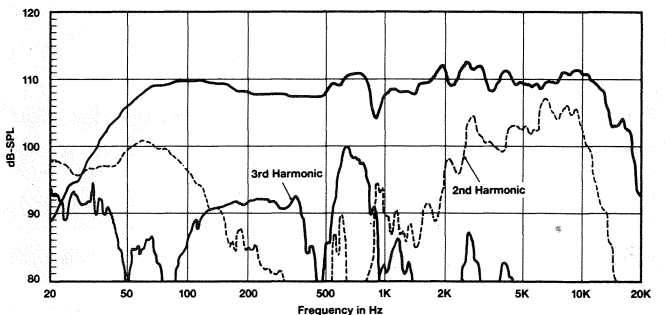


Figure 11: 813C driven to SPL of 110 dB at 1 meter ( $\approx 8.2$  v RMS). Distortion raised 20dB.



## Which Monitor to Choose?

There are no easy answers here. We recommend that the prospective user arrange an extended monitoring session with each basic design, carefully evaluating subjective performance with a wide variety of program material. Both current designs will handle almost any kind of program material in stride.

In general, the Time Align design may exhibit a little more “up front” character than the Bi-Radial, and this might favor it, in some engineers’ views, for pop or rock applications. On the other hand, the smooth power response of the Bi-Radial design will require less third-octave equalization in the typical control room environment for adapting to a given house curve. Some engineers subjectively describe the imaging of the Time Align as existing in front of the enclosures, while the Bi-Radials seem to place the image in perspective behind the plane of the enclosures.

Be absolutely sure that you are making your comparisons with the current C-versions of the UREI monitors, inasmuch as this series makes use of the new coaxial composite transducer manufactured by JBL.

Both kinds can be flush (soffit) mounted and, in fact, work better under that condition. The 4430 and 4435 can be easily biamplified, making use of the JBL 5235 electronic dividing network. Because of the passive low-pass/delay line used in the Time Align design, these models are not easily biamplified.

## Lower Cost Monitors with Compression Drivers:

The UREI 809A and JBL 4425 represent a scaling down of the superlative performance offered by the large format monitors, and they are intended largely for smaller control rooms and so-called “semi-pro” applications where the larger models cannot be accommodated. Their design characteristics are listed below:

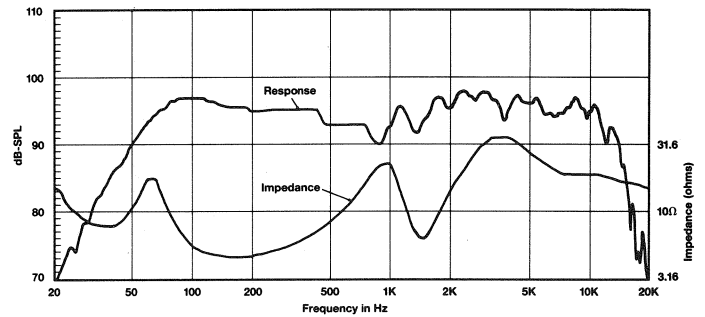
- A. Flat axial response extending to 18 kHz, with optimum low-frequency performance in a wall-mounted position.
- B. Smooth power response.
- C. Smooth phase (time domain) response.
- D. Accurate stereo imaging.
- E. System ruggedness at high frequencies, due to use of a compression driver.

Figures 12 through 15 detail the performance of these monitor systems, and Table 1 lists pertinent specifications.

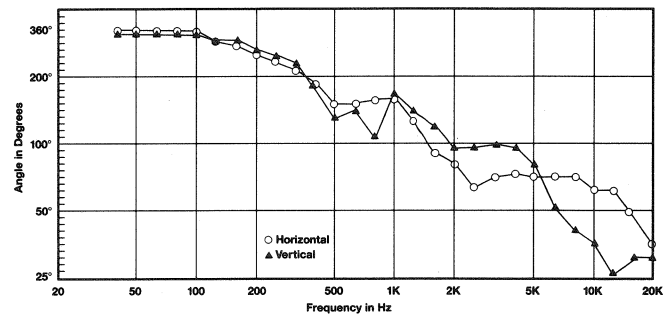
**Table 1. Characteristics of Intermediate Monitors**

Model	Description	Sensitivity (1W @ 1m)	Pink Noise Power Rating	Maximum Output* (@ 1m)
809A	Time Align	93 dB	100 watts	113 dB
4425	Bi-Radial	91	200	114

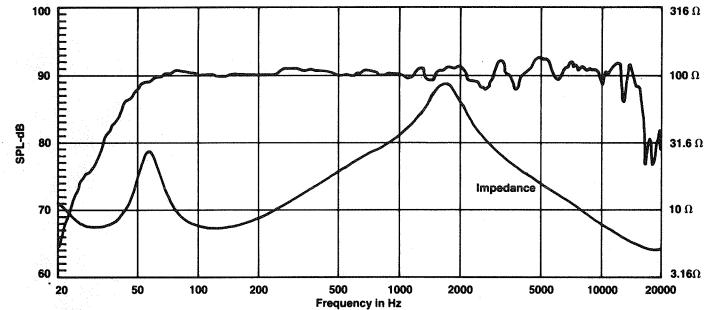
**Figure 12: UREI 809 On-axis response (1 W, 1 meter)  $2\pi$  mounting; impedance.**



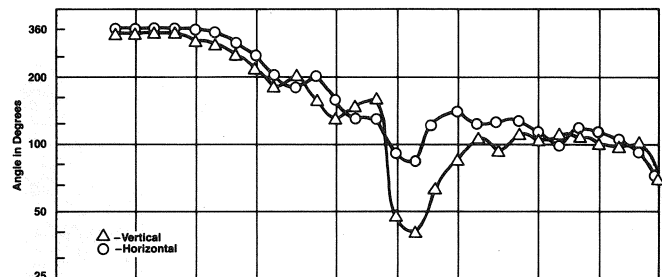
**Figure 13: Beamwidth (Horizontal and Vertical) vs. Frequency, UREI 809**



**Figure 14: JBL 4425 On-axis response (1 W at 1 meter) and Impedance.**



**Figure 15: JBL 4425 Horizontal and Vertical Beamwidth (-6 dB).**



## SMALL MONITORS:

### Background:

JBL has been the dominant force in the small studio monitor market since the introduction of the 4310 in the late 1960's. The need for a small, rugged bookshelf monitor had been expressed by many in the recording and broadcast industries, and the 4310 was designed specifically for that application. This system was of three-way design, and it used a 300 mm (12 in) low-frequency transducer, with mid- and high-frequency cone transducers. During the early 1970's, the 4310 underwent redesign, and the 4311 came into being.

Both the 4310 and 4311 were tailored to have a forward mid-range characteristic, along with a slight rise in the 40 Hz range. Recalling that the Altec 604 was the benchmark of the day, this specific system voicing was in keeping with the taste of the time.

As the 1970's progressed, and as JBL broadened its base of technical measurement, a need was generated for monitor systems with flatter overall response and increased power bandwidth. In a sense, JBL brought about this need by introducing the later models in the 4300 Series, which the industry at large took as models to match. The broad acceptance of digital recording in the early 1980's underscored the need for further system refinement, and the 4400 Series monitors were created.

Throughout this period of monitor performance refinement, however, the 4311 remained solidly in the product line. Many users favored the voicing of the 4311, since it allowed them to hear program details under less than ideal monitoring conditions. The system had a well deserved reputation for ruggedness, and the fact that there were so many of them in the field made the 4311 virtually a *de facto* standard. Every studio, whatever its principal business, had to have at least one pair!

### The Present Situation:

From its inception, the 4311 monitor carried the designation "Control Monitor," while all other models have carried the designation "Studio Monitor." Even when later refined in the mid 1980's as the 4312, it retained the same

forward voicing and low-frequency characteristics of its predecessors. Thus, JBL has maintained a distinction between Studio Monitors and Control Monitors. Recently, the small Control 1 has been added to the product line as an extension downward in size.

JBL bookshelf Studio Monitor characteristics are detailed in Table 2, and the latest versions of the Control Monitors are detailed in Table 3.

In general, the 4400 Series Studio Monitors were designed with the following performance characteristics:

- A. Flat axial response, with extended bandwidth beyond 20 kHz and optimum low-frequency performance in free-standing position.
- B. Smooth power response.
- C. Smooth phase (time domain) response.
- D. Accurate stereo imaging.

The demanding needs of digital recording, as well as stereo TV, have focused attention on these details of performance. Careful dividing network design ensures that these new monitors have controlled transitions between drivers, resulting in smooth power response for a better match between monitor and environment. Mirror-imaged (separate left and right) models ensure accurate stereo imaging.

The Control Monitors have been designed with the following characteristics as most important:

- A. Rising mid-range response.
- B. Low-frequency response relatively undamped for rising response in free-standing positions.
- C. Extended high frequency response. The latest 4312A has the same titanium dome tweeter as in the 4400 Series models.
- D. Accurate stereo imaging. The 4312A is mirror-imaged for ideal stereo reproduction.

Both Control and Studio Monitors have been designed for ruggedness and are all able to withstand normal electrical and physical stress. The Control 1 has a protective network, which allows it to carry a realistic 150-watt continuous power rating.

**Table 2. Characteristics of 4400-Series Bookshelf Monitors**

Model	Description	Sensitivity (1W @ 1m)	Pink Noise Power Rating	Maximum Output* (@ 1m)
4406	2-way 6"	87 dB	75 watts	106 dB
4408	2-way 8"	89	100	109
4410	3-way 10"	91	125	112
4412	3-way 12"	90	150	112

**Table 3. Characteristics of 4312A and Control 1**

Model	Description	Sensitivity (1W @ 1m)	Pink Noise Power Rating	Maximum Output* (@ 1m)
4312A	3-way 12"	91 dB	100 watts	111 dB
Control 1	2-way 5 1/4"	90	150	106

\*Peak output capability at rated power input

## Criteria for Choosing a Small Monitor:

Many users may already have firm ideas about which monitor is right for them, but for those who are not sure, we offer the following suggestions.

**A. Near-field monitoring:** We strongly recommend using either the 4406 or 4408 two-way system for this application. Program spectral balance is critical in recording mix-down applications, and the flat response of these models works to advantage.

**B. Monitoring outgoing broadcast signals and quality control applications:** The 4408 is the ideal broadcast monitor and may be rack-mounted in tight physical spaces. The 4312A and 809A may also be recommended here, inasmuch as they can be operated at high levels, making it easier to spot problems such as noise or distortion.

**C. Remote recording applications:** We recommend either the 4410, 4412, or the 809A because of their smooth, extended low-distortion response. This facilitates making critical decisions both in balance and critical stereo image placement. If size is a constraint, the 4408 may be used.

**D. Audio-visual applications:** We recommend the Control 1 for smaller scale applications, and either the 809A or 4312A for larger scale applications. All three of these will produce excellent speech articulation.

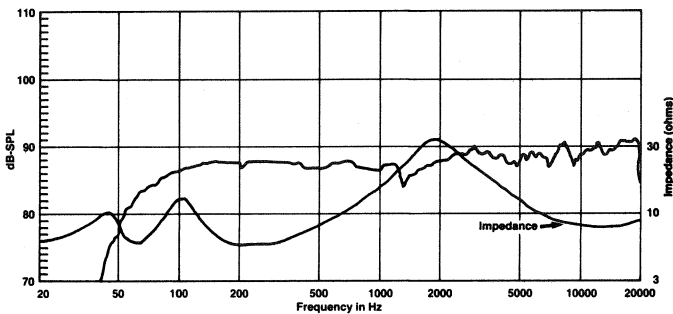
**E. General video and radio post-production work:** We recommend the 4412, 4312A, or 809A, depending largely on the taste of the user.

**F. Foreground or background music applications:** The Control 1 is ideal for this application, if space is at a premium, because of its small size and optional mounting accessories. The 4406 may be used with the MC 4401 mounting bracket for wider frequency range requirements.

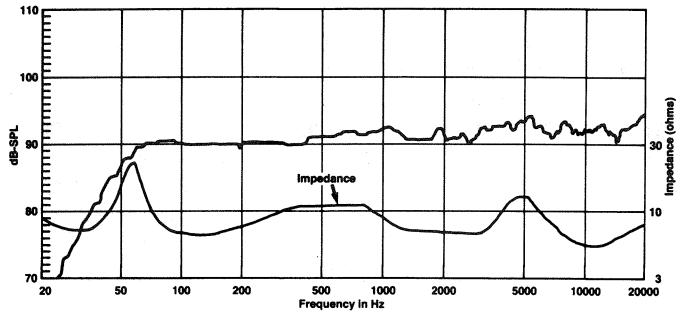
## Relevant Measurements:

Figures 16 and 17 show typical on-axis frequency response and impedance curves for the 4406 and 4412 studio monitors. Note the extremely flat and extended response.

**Figure 16: On-Axis Frequency Response and Impedance vs. Frequency, 4406**

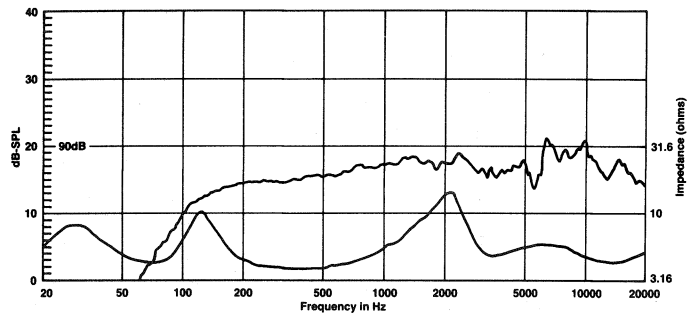


**Figure 17: On-Axis Frequency Response and Impedance vs. Frequency, 4412**



Figures 18 and 19 show typical on-axis frequency response and impedance curves for the Control 1 and the 4312A. In both cases, note the generally rising response in the 500 to 5000 Hz range.

**Figure 18: On-Axis Frequency Response and Impedance vs. Frequency, Control 1**



**Figure 19: On-Axis Frequency Response and Impedance vs. Frequency, 4312A**

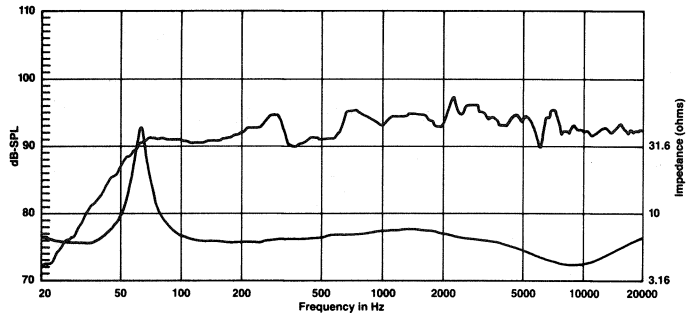
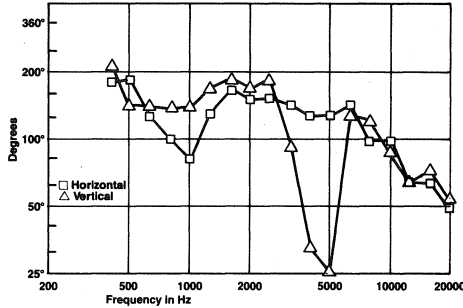
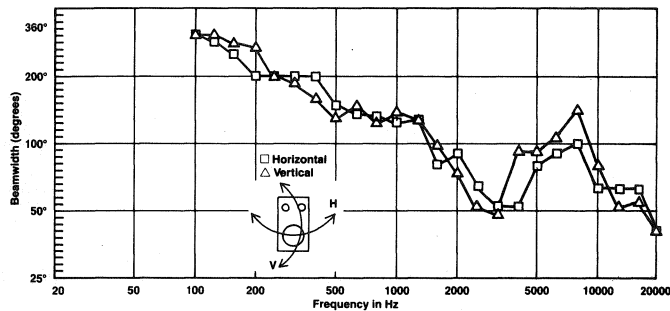


Figure 20 shows the beamwidth characteristics of the 4412, while Figure 21 shows that of the 4312A. Note that the horizontal pattern control of the 4412 is smoother than that of the 4312A, indicating better control of power response.

**Figure 20: Beamwidth (-6 dB) vs. Frequency, 4412**



**Figure 21: Beamwidth (-6 dB) vs. Frequency, 4312A**



**References:**

1. J. B. Lansing, "The Duplex Loudspeaker," J. Society of Motion Picture Engineers, Volume 43, Number 3 (Sept. 1944).
2. D. Smith, D. Keele, and J. Eargle, "Improvements in Monitor Loudspeakers," J. Audio Engineering Society, Volume 31, Number 6 (June 1983).
3. D. Fink, "Time Offset in Crossover Design," J. Audio Engineering Society, Volume 28, Number 9 (Sept. 1980).
4. J. Eargle, "Time Domain Response in Monitor Loudspeakers," Recording Engineer/Producer, October 1981.

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