Popular Electronics®

". . . the widest and flattest frequency response curve we have yet obtained from a speaker system."

In its 25 years in business, Acoustic Research has been a steadfast proponent of compact speaker systems. Even its nine-driver Model AR/LST of a few years ago was relatively compact for a speaker system of its capabilities. Now AR has made a turnabout with the introduction of its Model AR-9 floor-standing speaker system that is large by any standard.

The Model AR-9 is a tall, column-shaped four-way speaker system with five drivers. It's rated to handle up to 400 watts of continuous power, with each channel driven to clipping 10% of the time on normal music material. Since

large system handles up to 400 watts continuous power

the speaker system is rated for 87 dB SPL at 1 meter when driven by 1 watt, it can actually deliver an ear-splitting 113 dB SPL at 400 watts! The five-driver speaker system's only response specification is for its lower limit, which is −3 dB at 28 Hz. The impedance is rated at nominally 4 ohms, with a minimum of 3.2 ohms.

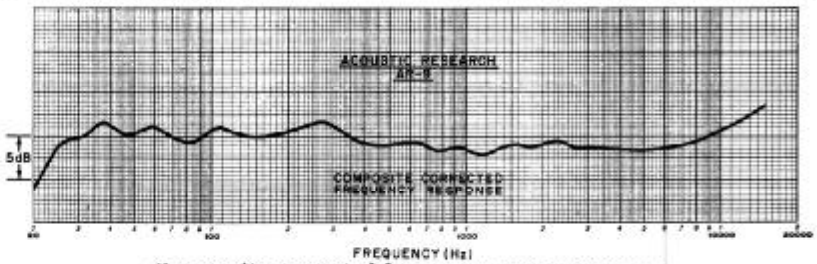
The speaker system measures 52 ¾"H x 15 3/16"D x 15"W (134 x 40.2 x 38.1 cm) and weighs 130 lb (59 kg). Suggested retail price is $750 each.

General Description. The bass frequencies from the speaker system, up to 200 Hz, are radiated by a pair of 12" (30.5-cm) acoustic-suspension woofers located at the bottom rear on the two sides of the enclosure. Radiation is to the sides. By keeping the bass radiators as close as possible to the rear wall and floor surfaces, this placement essentially eliminates cancellation of the upper bass by reflections from room surfaces through shifting the lowest cancellation frequency to a point beyond the driver's operating range.

The midrange, from 200 to 1200 Hz, is radiated by an 8" (20.3-cm) acoustic-suspension driver located in a separately sealed subenclosure that faces forward about halfway up the front sur-

two side-firing acoustic-suspension woofers per cabinet

face of the enclosure. The cancellation reflections from room boundaries that might affect the response of this driver fall below its operating range. The two remaining drivers are vertically aligned with the lower midrange driver.



Composite corrected frequency response curve.

Frequencies between 1200 and 7000 Hz are handled by a 1½" (38.1-mm) dome tweeter surrounded by a donut-shaped ring that AR refers to as a "semi-horn." (It's designed to improve driver radiating efficiency in the upper part of its frequency range.) Beyond 7000 Hz a smaller dome tweeter that measures ¾" (19.1-mm) takes over. The gaps in the voice coils of the two tweeters are filled with a high-temperature "ferrofluid" that helps conduct heat away from the voice coil and provides mechanical damping of the tweeters' resonances.

The front of the speaker surrounding its middle and high-frequency drivers is covered with a sheet of acoustic fiber that AR calls an "Acoustic Blanket." Its function is to absorb energy radiated in the plane of the speaker board. According to AR, the radiated energy would otherwise be reflected from the edges of the speaker cutouts and cabinet. So the "Blanket" is designed to reduce the possibility of interference with the smoothness of the system's frequency response and directional characteristics.

The small three-position switches on the front panel below the 8" cone driver are provided for adjusting the levels of the lower, upper midrange, and high-frequency drivers from their maximum (nominally flat) outputs to −3 and −6 dB.

The crossovers between the lower and upper midrange drivers have a gradual 6-dB/octave slope to smooth the blending of sound in this most vital part of a speaker system's operating range. The woofer crossover circuit has an equalizing section that flattens out the bass response in the vicinity of resonance and extends it downward somewhat in frequency. Moreover, the upper midrange driver portion of the crossover system has an impedance-equalizing function as well.

Laboratory Measurements. The measurements we made on the Model AR-9 under semireverberant conditions yielded the widest and flattest frequency response curve we have yet obtained from a speaker system. When it was combined with the close-proximity microphone bass response curve and corrected for the room's and microphone's characteristics, the composite response of the system was within ±2 dB from 25 to 12,000 Hz. It rose slightly to +4 dB at 15,000 Hz. This was the limit of our calibrated microphone's known accuracy. (A new calibrated microphone we now use, Bruel & Kjaer's Model 4133, will enable us to give more accurate and meaningful results at the highest audio frequencies in future reviews.)

The dispersion characteristics of the tweeter were good. There was only about 3 dB of difference in the high-

Product Focus

In designing the Model AR-9, Acoustic Research has made a special effort to achieve the best possible stereo imaging. One school of speaker system design holds that phase coherence, or uniform time delay across the system's operating frequency range, is important for the optimum stereo effect. AR made a study of the subject that led to the conclusion that the human ear is insensitive to phase shifts having a major effect on the shape of a complex waveform.

AR used a computer to analyze the qualities of music itself, as well as of a number of different speaker systems. In the former case, a specific musical tone from six different recordings of the same work, were analyzed and no consistent phase relationships between the components of that tone were found. The conclusion was that phase relationships are completely inconsistent over time periods longer than a few milliseconds, and that the resulting gross waveform changes are imperceptible to listeners.

The second experiment, involving a number of speaker systems, led to the conclusion that the "blurring" of a spatial image due to various frequency components arriving at slightly different times was mainly caused by reflections from the speaker structure itself, rather than from any "time alignment" error between the drivers. In fact, some of the stepped enclosure shapes used to obtain uniform time alignment of the drivers in a multiway system were noted to actually degrade the stereo performance of the system by causing unnecessary reflections from the edges of the enclosure.

In the Model AR-9, a high degree of accuracy in spatial imaging was obtained by positioning the midrange and high-frequency drivers on a single vertical axis and covering the front of the cabinet with a heavy fiber sheet that absorbed high-frequency energy before it could be reflected from the edges of the cabinet and speaker cutouts. This had the expected effect of smoothing out the frequency response of the system. (As our measurements confirmed, it is impressively smooth.) Furthermore, in listening tests with the blanket in place and removed, AR found that it improved the perceived stereo imaging and location of instrumental sounds and enabled the listener to judge the acoustic size of individual sound sources more accurately. It also reduced the audible coloration of the sound, as a result of the smoother frequency response.

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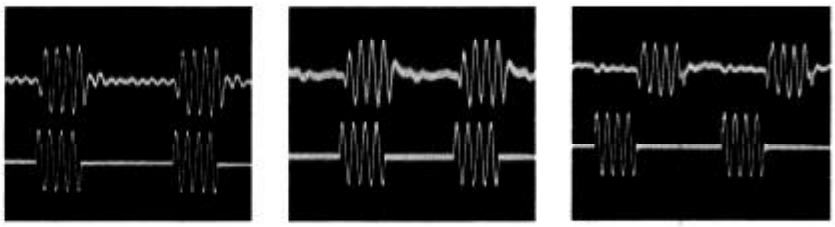
frequency response curves measured on-axis with the speaker and 30° off-axis. The level switches had their indicated effects, which were confined to the rated operating frequency ranges of the respective drivers. The tone-burst response of the system was excellent, yielding bursts that were as clean as any we have been able to make in a "live" acoustic environment. The system's sensitivity was as rated, so that driving it with 1 watt of random noise in the octave centered at 1000 Hz produced an 87-dB SPL 1 meter away.

driver positions give uncolored spatial imaging

Low bass distortion was one of the system's most striking qualities, though it was not too surprising in view of the use of two large acoustic-suspension woofers in a 4.25 cu. ft. (120-liter) cabinet. At a 1-watt input (based on 8 ohms, which is actually 2 watts into the speaker system's nominal impedance), the distortion was between 0.22% and 0.50% from 100 Hz down to 50 Hz. It rose very gradually to 1.3% at 25 Hz and to 2.5% at 20 Hz. A 10 dB increase in power to the very considerable level of 20 watts into the nominal 4-ohm impedance had only a slight effect on the distortion. It then measured between 0.32% and 0.63% down to 50 Hz and rose to 3% at 30 Hz and 6.7% at 20 Hz.



Tone-burst responses at (left to right) 60, 250 and 4000 Hz.

The impedance was relatively constant, measuring a minimum of about 3 ohms at 50 and 2500 Hz (also its approximate dc resistance) and reaching maxima of 8 ohms at 28 Hz and just shy of 10 ohms at 750 Hz. Since the impedance was between 3 and 5 ohms almost everywhere except at 28 and 750 Hz, the 4-ohm rating is well justified.

User Comment. Although the Model AR-9 should be installed as close as possible to the rear wall to obtain the full benefit of its woofer placement in smoothing the upper bass response, this is not critical. We were unable to get the speaker systems much closer than 18" (45.7 cm) from a wall, but they still sounded fine.

The system's sound betrays its kinship to earlier AR models in its smoothness and lack of coloration. Moreover, it has an exceptionally blended and homogeneous sound that never gives a hint that it is emanating from five drivers distributed over a large cabinet. The unified nature of the AR-9 sound remains apparent, even at rather close listening distances. Also, the high end is far better than that of some of the earlier AR speaker systems, which tended to have a "soft" quality. If the program has energy in the highest audible octave, it emerges from the Model AR-9 with crystalline clarity. By the same token, if the program has any distortion or a frequency-response aberration, the system will do nothing to conceal the flaw.

The bass quality is tops, too. Male voices are not artificially colored by the usual resonances in the upper-bass system. However, not only did the AR-9 deliver the usual excellent bass response expected of any good speaker, it also seemed to have a subliminal "floor" of deep bass that could be felt rather than heard on much of the material we played. In an A-B comparison against the AR/LST (which headed the AR line a few years ago, and can hardly be said to be shy of bass), the Model AR-9 appeared to have another octave of response at the low end. The feeling of "body" that this imparts to the sound is rarely, if ever, heard through speaker systems whose output extends only to 35 or 40 Hz. It is usually associated with a good "subwoofer" system, but in this case the subwoofer is part of the basic system (remember, there are two-woofers in each speaker system).

Although the Model AR-9 can deliver a most impressive sound level when driven by a powerful amplifier, we recommend staying within the AR guidelines for driving it. Husky as the drivers are, they can be blown out by an overenthusiastic application of several hundred watts of power. While tastes differ widely when it comes to speaker system selection, we feel that anyone who wants to listen to music reproduced as naturally as possible in the home—and who has the space and money to accommodate a pair of Model AR-9s—should certainly audition a pair before making a final buying decision (or even to compare them to one's present speaker system, just for curiosity's sake).

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