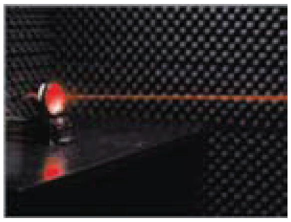
Three Stages in Engineering JBL® Loudspeakers

JBL® speakers are thoroughly tested and qualified at each stage to ensure that the finished product performs flawlessly. Every speaker design starts with physical dimensions that facilitate installation in factory locations, along with a complete set of performance targets. Performance targets include maximum SPL, or how loud the speaker must play at its limits. From the maximum SPL target, we determine the amount of power required to drive the speaker to its output limit and set a power-handling target. Sensitivity, another important performance target, indicates how efficiently the speaker converts electrical input into acoustic output. A frequency-response target is also included. This target describes not only the shape of the speaker's response, but also the maximum allowable magnitude of narrow peaks and dips in its response. Finally, target Thiele/Small parameters are defined to describe the speaker's behavior at low-frequency cut-off in its intended application, whether that application is a custom-built enclosure or the interior of a car's door. A careful analysis of all these targets determines the excursion and heat dissipation required for the speaker to produce the necessary frequency response at maximum SPL and maximum input power. With that information, engineers design the motor, choosing voice-coil and magnet dimensions.



COMPUTER-AIDED DESIGN AND MODELING

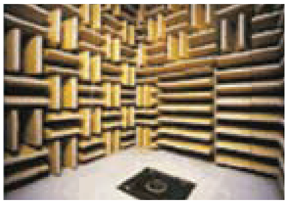
During this phase of development, the engineers draw intricate diagrams of the proposed speaker's construction. Once the computerized drawing is complete, it is imported into an analysis program. JBL engineers use extensive Finite Element Analysis (FEA) to model the performance of the speaker's motor and moving parts. FEA divides the device being modeled into thousands of small parts or elements, and predicts performance based on the shape of the design and the materials that will be used in construction. The motor is analyzed using magnetic and thermal FEA. This analysis helps to ensure magnetic-field symmetry for low distortion, the proper motor force required to drive the speaker's moving assembly, and the heat dissipation needed for high power handling. The moving assembly composed of the cone, voice coil and former, spider and surround – is analyzed using structural FEA, which enables the engineers to observe the movement of the assembly to guarantee symmetry for low distortion. This analysis also permits the engineers to determine the proper elasticity of the spider and surround to provide the appropriate restoring force and perfect performance at the speaker's excursion limits.

PROTOTYPING

Once the computer-modeling phase is complete. Technician's hand-build prototypes, machining metal parts and attaching them to prototype frames, which are built using a stereo-lithography machine. The stereo-lithography, or SLA, machine uses a computer-guided laser to form a speaker basket out of a bath of plastic resin. Once the basket fit and finish are perfected, off-tool parts are built, and then fully working, production-grade samples are assembled.

TESTING

We spare no expense in testing loudspeakers. Prototype and production samples are first tested for frequency-response range and uniformity in one of our anechoic chambers using MLS (maximum-length sequence) and swept sine-wave analyzers. Sine-wave analysis measures harmonic distortion, which is a critical element in determining the sonic accuracy of the speaker. MLS analysis compares the noise output from the analyzer to the output of the speaker in order to determine the speaker's impulse response, a measure of transient response accuracy. The speaker's impulse-response measurement is then converted into a high-resolution frequency-response measurement using a mathematical operation called Fast Fourier Transform, or FFT. Real-Time Laser Vibrometry is used to measure the structural behavior of the moving assembly. The Klippel analyzer measures magnetic-field symmetry during the speaker's operation.



Careful analysis of all these measurements determines the location and causes of unwanted resonance and distortion in the speaker's output, enabling the engineers to refine the speaker's design to eliminate them. Once the design is perfected, power handling is verified for production-grade samples by subjecting them to filtered octaves of pink noise at rated power for 100 hours. That's right, 100 hours. Finally, samples are tested for longevity in our environmental test lab, according to the rigorous standards set by the automotive industry. The last phase in our extensive testing involves the most critical instruments in our possession – our ears. We listen…and listen…and listen.

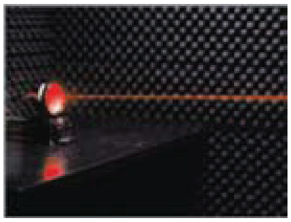
HARMAN

HARMAN Consumer. Inc
8500 Balboa Boulevard Northridge, CA 91329 USA

JBL by HARMAN

Three Stages in Engineering Infinity® Loudspeakers

Infinity® speakers are thoroughly tested and qualified at each stage to ensure that the finished product performs flawlessly. Every speaker design starts with physical dimensions that facilitate installation in factory locations, along with a complete set of performance targets. Performance targets include maximum SPL, or how loud the speaker must play at its limits. From the maximum SPL target, we determine the amount of power required to drive the speaker to its output limit and set a power-handling target. Sensitivity, another important performance target, indicates how efficiently the speaker converts electrical input into acoustic output. A frequency-response target is also included. This target describes not only the shape of the speaker's response, but also the maximum allowable magnitude of narrow peaks and dips in its response. Finally, target Thiele/Small parameters are defined to describe the speaker's behavior at low-frequency cut-off in its intended application, whether that application is a custom-built enclosure or the interior of a car's door. A careful analysis of all these targets determines the excursion and heat dissipation required for the speaker to produce the necessary frequency response at maximum SPL and maximum input power. With that information, engineers design the motor, choosing voice-coil and magnet dimensions.



COMPUTER-AIDED DESIGN AND MODELING

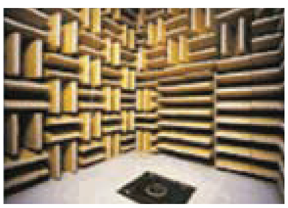
During this phase of development, the engineers draw intricate diagrams of the proposed speaker's construction. Once the computerized drawing is complete, it is imported into an analysis program. Infinity engineers use extensive Finite Element Analysis (FEA) to model the performance of the speaker's motor and moving parts. FEA divides the device being modeled into thousands of small parts or elements, and predicts performance based on the shape of the design and the materials that will be used in construction. The motor is analyzed using magnetic and thermal FEA. This analysis helps to ensure magnetic-field symmetry for low distortion, the proper motor force required to drive the speaker's moving assembly, and the heat dissipation needed for high power handling. The moving assembly composed of the cone, voice coil and former, spider and surround – is analyzed using structural FEA, which enables the engineers to observe the movement of the assembly to guarantee symmetry for low distortion. This analysis also permits the engineers to determine the proper elasticity of the spider and surround to provide the appropriate restoring force and perfect performance at the speaker's excursion limits.

PROTOTYPING

Once the computer-modeling phase is complete. Technician's hand-build prototypes, machining metal parts and attaching them to prototype frames, which are built using a stereo-lithography machine. The stereo-lithography, or SLA, machine uses a computer-guided laser to form a speaker basket out of a bath of plastic resin. Once the basket fit and finish are perfected, off-tool parts are built, and then fully working, production-grade samples are assembled.

TESTING

We spare no expense in testing loudspeakers. Prototype and production samples are first tested for frequency-response range and uniformity in one of our anechoic chambers using MLS (maximum-length sequence) and swept sine-wave analyzers. Sine-wave analysis measures harmonic distortion, which is a critical element in determining the sonic accuracy of the speaker. MLS analysis compares the noise output from the analyzer to the output of the speaker in order to determine the speaker's impulse response, a measure of transient response accuracy. The speaker's impulse-response measurement is then converted into a high-resolution frequency-response measurement using a mathematical operation called Fast Fourier Transform, or FFT. Real-Time Laser Vibrometry is used to measure the structural behavior of the moving assembly. The Klippel analyzer measures magnetic-field symmetry during the speaker's operation.



Careful analysis of all these measurements determines the location and causes of unwanted resonance and distortion in the speaker's output, enabling the engineers to refine the speaker's design to eliminate them. Once the design is perfected, power handling is verified for production-grade samples by subjecting them to filtered octaves of pink noise at rated power for 100 hours. That's right, 100 hours. Finally, samples are tested for longevity in our environmental test lab, according to the rigorous standards set by the automotive industry. The last phase in our extensive testing involves the most critical instruments in our possession – our ears. We listen…and listen…and listen.

HARMAN

HARMAN Consumer. Inc
8500 Balboa Boulevard Northridge, CA 91329 USA

Infinity® by HARMAN