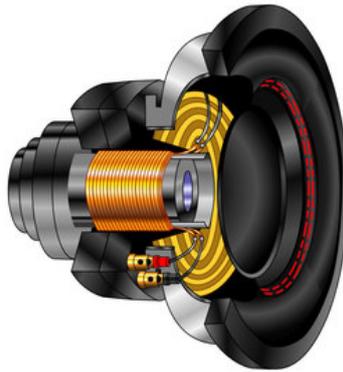


HiFi LOUDSPEAKER DESIGN

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Loudspeaker Glossary



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Acousta-Stuf™:

Acousta-Stuf™ is a sound absorption and dampening fiber typically used in sealed box enclosures.

Acousta-Stuf™ is a crimped polymer fiber that was designed to offer a similar performance to long hair wool. This non-volatile synthetic fiber is superior to other materials because it is safe to handle and will not decay with age.

Acoustic Suspension:

A type of loudspeaker enclosure that uses a sealed rear chamber to contain the back wave and provide damping of the cone motion. To qualify as an acoustic suspension system, the enclosure must literally be airtight.

Active Crossover:

An electronic high or low-pass filter that is placed between the pre-amplifier or source and the amplifier. The benefits of an active filter include removing components from within the speaker, removing the complexities of driver impedances from the equation, and greater flexibility with regard to crossover slopes and points.

Air, Airy, Airiness:

A subjective term often used to describe a speaker's ability to reproduce very high frequencies with detail and low distortion. Airiness helps provide an ambient soundfield and is very important to producing a "live" sound.

Amplifier:

An electronic device responsible for increasing signal levels. A power amplifier produces the high currents necessary for driving speakers. A pre-amplifier is responsible for increasing the low voltages associated with turntables, microphones, or other low-voltage devices.

Anechoic Chamber:

A room that is designed such that the walls absorb all incoming sound waves and reflect nothing back. An anechoic chamber is useful for measuring speakers without the negative influences of the typical listening room. Using an anechoic chamber can provide a superior picture of the theoretical output of a system, however real-world factors such as room gain and floor bounce cannot be measured.

Anechoic Response:

The frequency response of a driver or system measured in an anechoic environment. As above, this response does not include any room effects such as room gain, floor, or wall reflections.

Attenuate (attenuation):

The reduction in output of a signal. In speakers, a tweeter is oftentimes attenuated to match the level of a woofer. This attenuation can be achieved with series or parallel resistors, but often an L-pad is used to maintain a constant impedance load to the crossover.

Back plate:

A steel plate that is on the back of a loudspeaker driver's magnet structure that transmits the negative magnetic pole into the pole piece. A bumped back plate has a raised central portion that helps prevent the voice coil from hitting the plate on the down stroke.

Baffle:

The front panel of a speaker where the drivers are mounted. A baffle can either be the front wall of an enclosure, or a two-dimensional plane where a driver is mounted. A baffle is used to separate the radiated front and back waves of a driver.

Baffle Step:

An increase in the high frequency output of a loudspeaker as the radiation pattern changes from 4-pi space to 2-pi space. At wavelengths shorter than half the width of a baffle, the waves "bounce" off the front baffle and are reinforced due to reduced acoustic impedance. At wavelengths longer than half the baffle width, the waves no longer are reinforced off of the front baffle and radiate in all directions. The result is a 6dB increase (step) in the output above the baffle step frequency.

Baffle Step Compensation:

A circuit that is used in a speaker crossover to "compensate" for the increase in output at higher frequencies due to the baffle step. Typically the change in output across the baffle step is 6 dB. Baffle step compensation can be achieved by using a low-pass filter at or near the baffle step frequency to counter the natural rise. However, this will only be successful in speakers that have relatively low crossover points where excessive attenuation above the baffle step is not a problem. Baffle step compensation can also be achieved by using an inductor and resistor in parallel with a second resistor shunting to ground. Resistor values are generally on the order of the nominal impedance of the driver and the inductor is generally in the .5-1.0 mH range.

Bandpass:

A combination of high-pass and low-pass filters that yield a section of flat response with a roll-off on either end. In the acoustic realm, a bandpass can be achieved by using a single driver within a front and back enclosure tuned to different frequencies. In the electronic realm, a bandpass filter is usually used on the midrange of a three-or-more-way speaker to allow only a narrow band to be reproduced.

Bandpass gain:

A phenomenon that occurs in electrical and acoustic systems when the high-pass and low-pass sections of a bandpass filter interact with each other. As the passband region of the filter narrows, the amount of bandpass gain also increases.

Bass:

The lowest portion of the audio frequency spectrum, generally from 20 Hz to 160 Hz.

Bessel Filter:

A type of crossover filter that has a small peak in the response at the crossover frequency. The Q of the filter is slightly higher than average, and phase characteristics are average.

Bi-amp(ing):

The ability of a single speaker to be driven by two separate amplifiers. Generally this is accomplished by having two sets of inputs on the back of the speaker, one going to the tweeter high-pass filter and one going to the woofer low-pass filter. It is also possible in 3 or more-way systems by combining the tweeter and midrange into one section, etc. This method can be used to allow separately adjustable levels for the treble and bass, but is not guaranteed to produce positive results.

Bi-pole:

A speaker using two drivers facing opposite directions and operating in phase with each other. In home theater setups, bipolar speakers produce a somewhat diffuse sound field, but there is still some direct radiation at the listener.

Biscuit:

A small spline of wood that is used to help reinforce a joint. The biscuit is placed into a slot and glued, where it absorbs moisture and swells up. The swelling action along with the increased gluing surface area yields a very secure joint.

Bi-wiring:

Bi-wiring uses the same internal layout as bi-amping, but is accomplished by using one amplifier channel with two separate runs of wire to the speaker. There are many claims about the sonic improvements of this technique, but very little scientific evidence to back them up.

Binding Post:

The most widely used method of accepting speaker-level connections on mid to high-end speakers. A binding post consists of a metal shoulder with a protruding threaded rod on which a nut tightens down.

Bondo®:

An epoxy-based filler traditionally used in autobody repair. Makes an excellent wood filler for speaker building because of its great adhesion to MDF, fast curing time, and ease of sand-ability.

Bucking Magnet:

A charged ring-type magnet that can be used to help shield a driver. The bucking magnet is secured to the rear of the motor structure with the like magnetic poles together. This will reduce the stray magnetic field, but will also affect the T/S parameters of the driver.

Bumped Back Plate:

A back plate that has a protruding central portion that helps prevent the voice coil from hitting it on the down stroke.

Butt Joint or Lap Joint:

In woodworking, a type of joint that connects two pieces of wood by fastening the end-grain of one piece to the face of another. The weakest type of joint, due to the lack of lateral support and the limited gluing surface area.

Butterworth Filter:

A crossover filter slope that yields a maximally flat frequency response in the passband with minimal phase shift. Drawback is a shallower slope than other filter topologies.

Capacitance:

A measure of the ability of a device to store electric charge and resist changes in voltage. Capacitance is measured in Farads.

Capacitor:

An electronic component composed of two metallic plates separated by a dielectric. Stores electric charge and opposes changes in voltage. In speaker building and all AC circuits, a capacitor acts as a high pass filter. Typical values in crossover networks are in uF, or 1/1,000,000th of a Farad.

Center Channel:

The speaker used in a surround-sound setup that is responsible for reproducing vocals and other centrally located sounds. The speaker is generally magnetically shielded to prevent interference with CRT based screens. While many will argue that a center channel speaker is not necessary, in cases with a lot of off-axis movie watching, it greatly helps keep dialogue centered on the screen. Care should be taken to keep the center channel timbre matched to that of the front speakers, which is important to provide a smooth transition as sounds move from one speaker to the next.

Clipping:

A type of distortion that occurs when the tops of the sine wave are cut-off or "clipped". This generally occurs in amplifiers when they exceed output voltage, and can be very detrimental to a speaker due to the non-linear motion that is created.

Closed Box:

A completely sealed loudspeaker enclosure. See Sealed Box

Coaxial:

A type of loudspeaker transducer that has separate high-frequency and low-frequency drive units together in one driver. In most situations, a tweeter is suspended in front of the woofer cone, but it can also be located on top of the pole piece where a dustcap is normally found. Coaxial arrangements can create a "point-source" where the acoustic centers of both drivers are on the same axis.

Comb Filtering:

An artifact seen in multi-driver systems that is the result of constructive and destructive interference from multiple point sources. The addition or subtraction of multiple sources will vary with location relative to the speaker. Comb filtering becomes more of a concern at higher frequencies due to the shorter wavelengths involved. Most often used when talking about line arrays where spacing between tweeters can be problematic.

Compliance:

The overall stiffness of a speaker driver's suspension. Represented in the Thiel-Small parameters by the figure V_{as} , the equivalent air volume with the same springiness.

Compression (power):

A condition in loudspeaker transducers that is a result of high temperatures in the voice coil, causing an increase in resistance and overall impedance. Symptoms of compression include a decrease in sound output, unpredictable spectral changes, and other audible distortions. This term is most commonly used when referring to a speaker's ability to remove heat from the voice coil at high powers.

Compression (driver):

A type of driver that forces a larger radiating surface area through a small opening. This is then usually attached to a horn loading system that provides greater directivity and better acoustic coupling with the surrounding air mass. The advantage of compression drivers is their very high efficiency and ability to produce very high output.

Cone:

The portion of a driver that is attached to the voice coil and excites the air as the coil moves. The main function of a cone is to increase the radiating area of the voice coil while maintaining a rigid form. The traditional conical shape is most often used because it yields excellent strength to weight ratio when force is applied from the vertex.

Conjugate Network:

Another name for impedance compensation or Zobel networks. A circuit consisting of a capacitor and resistor in series, in turn paralleled to the driver. Is used to counter the rising impedance found in most drivers above their resonance point. This enables more ideal functioning of a crossover.

Copper Cap:

A copper ring that is placed on top of the pole piece in order to reduce eddy currents. Helps reduce distortion and improve high-frequency performance.

Counter- EMF:

A voltage generated in the opposite direction of the input signal as a result of the voice coil moving back through the magnetic gap. The harmful effects of counter-EMF can be reduced by having an amplifier with a high damping factor. Also called Back-EMF

Curvilinear Cone:

A type of cone that is flatter towards the surround and curves progressively steeper towards the voice coil. Benefits of a curvilinear cone can include better high-frequency performance and better off-axis response.

Crossover:

An electrical filter within a loudspeaker responsible for dividing up the frequency spectrum and sending

portions to the appropriate drivers.

Coil:

In crossover construction, a simplified name for an inductor. Used because most inductors look like a large coil of magnet wire.

Cutoff:

The frequency where useful output can no longer be produced. Usually this is the F3 of a speaker, the frequency where the response is 3 dB down.

Dado:

In woodworking, a groove that is machined into a piece of wood to accept another board for making T-shaped joints. A joint formed by using a dado is strong because of the increased gluing surface area, and the presence of some lateral stability.

D'Appolito Configuration:

An arrangement of two woofers and a tweeter such that the tweeter is placed vertically between the two woofers. A D'Appolito configuration yields a narrower high-frequency vertical dispersion that in turn reduces floor and ceiling reflections. A superior vertical symmetry is achieved compared to traditional two-way speakers. One thing to consider when building D'Appolito style systems is the increased distance between the acoustic centers of the woofers. This may cause comb filtering problems when crossed at high frequencies.

Damping (or Dampening):

The ability of a material to reduce vibrations. On a driver, a cone coating or surround material can minimize vibrations within the cone, yielding flatter frequency response. Overall movement of the cone can be damped electrically or mechanically through the voice coil and suspension. In speaker cabinets, damping materials can reduce wall vibrations when applied directly to the walls, or can absorb acoustic energy from within the enclosure itself.

Damping Factor:

A measurement of an amplifier's ability to control the motion of a speaker at the stop of transient impulses. Technically defined as the ratio of the load impedance to the amplifier's output impedance. The high output impedance of the amplifier enables it to absorb the back EMF generated by the voice coil. A damping factor greater than 10 is usually adequate, however amplifiers with damping factors up to several thousand are available. Note that damping factor varies with frequency as the load's impedance changes.

DC resistance:

A measure of the pure resistance of a driver's voice coil at rest. Is used to help calculate crossover networks and determine nominal impedances.

Delay Network

A ladder delay network or a lattice delay network is a compensation network that doesn't affect the amplitude response, but alters the phase and group delay response.

The main purpose of a ladder delay network is to align the acoustic centers of the drivers on the horizontal plane. Let's consider a 2 way setup. Even though the speakers are placed flush on the baffle, the tweeter is actually in front of the woofer, acoustically. Implementing a lattice delay network will delay the tweeter, and the two drivers will be phase coherent.

Decibel (dB):

A logarithmic scale used to measure relative acoustic output levels. Zero Decibels is defined as the quietest sound the average human is capable of hearing. Traditionally, a difference of 3 dB is considered the smallest change in loudness that the average human can detect. A doubling of perceived loudness is equivalent to a 10dB change in acoustic output. A 3dB increase in acoustic output requires double the amplifier power, while a 10dB increase in acoustic output requires a one-hundred-fold increase in amplifier power.

Detail:

A subjective term used to characterize a speaker's ability to reproduce and separate small variations in input. Usually used to describe a tweeter's ability to play intricate overtones and nuances.

Diffraction:

A series of constructive and destructive interferences that occur as waves change directions or go around obstacles. Typically, main diffraction concerns are at the edges of the front baffle and around the frames of drivers. A typical diffraction will look like a series of dips followed by peaks in the response.

Dipole:

A loudspeaker type that features one or two drivers that emanate sound in opposite directions out of phase with each other. A benefit of a dipole speaker is the cancellation of the sound at 90 degrees to the listening axis, which helps reduce side-wall room interactions. In home theater, dipoles are often used to create a "diffuse" soundfield where there is minimal sound radiated directly at the listener.

Directivity:

The tendency of a loudspeaker transducer to radiate sound in a particular direction. Typically used to describe the dispersion patterns in horn-loaded drivers. A very directive driver will project sound only to a small portion of three-dimensional space. This can be very helpful in sound reinforcement where coverage needs to be tightly controlled.

Dispersion:

The characteristic pattern of how a loudspeaker radiates sound in a three-dimensional space. Horizontal dispersion describes the amount of sound output at various angles side-to-side from the listening axis. Vertical dispersion describes sound output at various angles up and down from the listening axis. Many times controlled dispersion is used to reduce unwanted reflections from floors, ceilings or other obstructions in the sound field.

Distortion:

Any type of error in the reproduction of an audio signal. Distortions can be produced at any point in the music chain, and can be caused by analog, digital, or mechanical errors.

Dome:

A type of loudspeaker driver that uses a convex, dome-shaped diaphragm. Traditionally only used for mid-to-high-frequency drivers due to the limited structural integrity of this shape. It does have the advantage of generally improved dispersion with less diffraction compared to cone-shaped drivers.

Doping:

A thin layer of viscous material that is added to the surface of drivers to dampen resonances within the diaphragm.

Driver:

A term for a loudspeaker transducer in its raw state without an enclosure. Driver types are woofers, tweeters, midranges, compression drivers, domes, etc.

Dual Voice Coil:

A speaker driver, usually a woofer or subwoofer, that has two voice coil windings on one former. There are actually two sets of terminals on the woofer for hooking an amplifier to each coil. A dual voice coil woofer allows stereo signals to be summed and produced from one driver. Other benefits include additional wiring flexibility (series or parallel combinations) and the ability to use one coil to change the electrical damping characteristics of the woofer.

Dynamic Range or Dynamics:

A measure of a system's abilities to produce very quiet and very loud sounds. In digital devices, dynamic range measures the difference between the largest and smallest possible signals produced. In loudspeakers, dynamic range is a somewhat subjective term used to describe a speaker's ability to produce quiet sounds and very loud sounds with good intelligibility and low distortion.

Early reflections:

The first reverberated sounds to reach the listening position generated by direct reflections from floors,

ceilings, and walls. These are the most harmful to sound reproduction because they arrive very soon after the original signal and at fairly large magnitudes.

EBP:

Efficiency Bandwidth Product, equal to the F_s divided by Q_{es} . The EBP is used to help determine what type of enclosure a woofer is suitable for. The general rule of thumb is that EBP's less than 50 are better for sealed enclosures and EBP's >50 are better for vented enclosures. However, this is only a general rule of thumb, successful designs can be achieved that do not follow it.

Efficiency:

A rating of how much acoustic output a driver or system will produce with a given amount of input power.

Electrostatic Speaker:

A loudspeaker type that uses a thin dielectric film suspended between two electrically charged panels. The motion of the diaphragm is the result of electrostatic charges pulling or pushing on it. This arrangement is unique because there is no voice coil; the signal is applied by changing the voltage on the electric panels.

Enclosure:

A cabinet that entraps the rear wave from a loudspeaker transducer to keep the front and back waves separate. Also serves to enhance bass response due to the physical properties of the air enclosed.

Even Order:

Any of the crossover slopes that are of an even order, usually 2nd or 4th.

Excursion:

The distance a driver's diaphragm is capable of moving from the at-rest position. Maximum linear excursion (X_{max}) refers to how far a driver cone can move while still under control of the motor. Mechanical excursion is how far the cone can physically move including portions where the voice coil is out of the magnetic gap. Typically, excursion figures represent the amount of movement in one direction from the at-rest position. However, movement in both directions is sometimes given with a peak-to-peak rating.

F3 (6,8, etc.):

The point in an acoustic roll-off where the output is 3 Decibels down from the baseline level. The 3dB figure is used because this is the point where a decrease in output will be noticeable to the average human.

F10:

The point in an acoustic roll-off where the output is 10 Decibels down from the baseline level. The 10dB figure is important because this is where the average human will perceive a loudness of one-half of the baseline level.

Farad:

The unit of measure of capacitance. The ability to store one coulomb of energy at one volt is equivalent to 1 Farad. In most loudspeaker applications, the values commonly used are in the μF range, or 1/1,000,000th of a Farad.

Far-Field:

The far-field can be defined as any distance from a loudspeaker at which inter-driver integration is complete. Typically set at 1m. Far-field measurements are useful because they usually take baffle step and driver-to-driver spacing into account. In studio monitoring situations, near-field and far-field listening techniques are used to evaluate a mix.

Fc:

The resonant frequency of a box system.

Ferrofluid:

A fluid that has magnetic properties that allow it to be attracted to magnetic fields. Often used in

tweeter magnetic gaps to provide mechanical damping and to help conduct heat away from the voice coil.

Fiberglass:

Fiberglass is a material often used in speakers as a damping material. Fiberglass has excellent thermodynamic characteristics useful for speaker building, but is considered less safe than polymer based damping materials. Fiberglass can be used as general stuffing in sealed enclosures, or used to damp walls in vented cabinets.

Film and Foil Capacitor:

A type of capacitor that uses two separate layers of a solid metal and dielectric film. This type of capacitor generally has superior audio characteristics than other types of capacitors.

First-Order Crossover Network:

A crossover network that uses a single component as a filter, yielding a cutoff slope of 6 dB per octave.

Five-way Binding Post:

A type of connection usually found on speakers and amplifiers used for connecting speaker wire. The term five-way comes from its ability to connect to multiple wire termination methods: bare wire (compressed under the nut), bare wire (through-hole), speaker pin, spade plug, banana plug, and banana plug (through-hole). Used very often on high-end speakers for its flexibility and ease of use.

Floor Bounce:

Typically, the first of the early reflections to reach the listening position from a loudspeaker. The negative effects of this reflection are the greatest due to the close relative lengths of the original signal and reflected signal. The usual result of floor bounce is a large dip and hump in the frequency response between 100 Hz and 200 Hz.

Fourth Order Bandpass:

A type of bandpass enclosure that uses a sealed rear chamber and a vented front chamber.

Fourth Order Crossover Network:

A filter type that uses four components to produce a roughly 24 dB per octave rolloff.

Flush Mounting:

A process of recessing a driver in its baffle so that the faceplate of the driver is even with the surrounding baffle. Flush mounting will prevent diffraction effects that occur as the waves go around the edge of a mounting flange.

Frequency:

The number of cycles of a wave that pass a given point in a given time. Most often measured in Hz (cycles/second).

Frequency Response:

A measurement of a loudspeaker driver or system's output over a large range of frequencies. A typical frequency response curve plots loudness in dB vs. frequency. This information is useful because the overall tonal characteristics of a speaker can be determined from this plot. Also, the useful operating range of a speaker can be measured.

F_s:

The resonant frequency of a loudspeaker driver in free-air.

Full-range driver:

A driver that is designed to produce a wide range of frequencies. There are no set limits to what frequencies must be covered in order to qualify as a full-range driver. It is very difficult to produce a driver that is capable of producing both ends of the frequency spectrum simultaneously, in most cases either top-end or bottom-end response will be sacrificed to a certain extent.

Fundamental:

The lowest or primary tone produced in the spectrum of a given sound.

Golden Ratio:

A ratio often used in calculating the internal dimensions of a speaker enclosure. The ratio is 0.62 :1.0 : 1.62 and is used because it spreads the internal resonances of the cabinet over the broadest frequency range.

Grill:

A screen or mesh that covers the front of a speaker or driver to protect it from damage. Despite using acoustically transparent grill cloth, the grill frame may cause some negative effects because of diffraction problems.

Group Delay:

A measurement of the amount of phase delay induced by a filter at various frequencies. Ideally, a filter would pass or attenuate all signals without any changes in the phase of the input signal. In the real world this is not the case, and differing amounts of delay will be induced at varying frequencies. By examination of a group delay plot we can see how phase has been affected, and we can detect problems that may cause phase distortion or "smearing" of the signal.

Harmonic:

A multiple of the fundamental frequency that is found in many locations within the sound reproduction chain. Each higher harmonic is produced at a smaller output than the last. In speakers, harmonics are detrimental to the accurate reproduction of a signal and are one of the primary forms of distortion. Naturally occurring harmonics are responsible for the unique sound characteristics of varying instruments and voices.

Helmholtz Resonance:

Resonances that occur when air or other fluids are excited and form standing waves within a fixed volume. The traditional examples of Helmholtz resonance are organ pipes and "blowing over the top of a bottle." As can be imagined, Helmholtz resonance produces extremely detrimental frequency response problems. When designing ports for vented enclosure, Helmholtz resonance must be considered in situations where port length is much greater than port diameter. Helmholtz resonance can also be found in long, narrow enclosures of any shape.

High-Pass Filter:

A filter that allows high frequencies to pass, but cuts off lower frequencies. Used on tweeters and midranges to limit low frequency production, thus reducing excursion and distortion.

Impedance:

A complex calculation of the resistance of electron flow in alternating current circuits. Impedance is calculated from a combination of resistive, capacitive, and inductive elements in a circuit. Measured in ohms.

Impedance Curve:

A plot of the impedance of a loudspeaker across the entire frequency spectrum. An impedance plot is useful in determining many key parameters in loudspeaker design. Most driver T/S parameters can be derived from the impedance plot, as well as most in-box performance parameters.

Inductance:

A device's ability to resist changes in current, measured in Henries.

Inductor:

An electronic device that resists changes in current due to the production of a magnetic field around itself. In crossovers, an inductor is a coil of insulated magnet wire that acts as a low-pass filter. Inductors come in several types, air-core, iron-core, and ferrite core. Air-core inductors are considered the best for audio applications, followed by iron core, and then ferrite core. When large inductance values are needed, iron or air core inductors may be used. An inductor should have the lowest possible DC resistance to allow maximum power throughput and minimal negative effects on the crossover.

Values typically seen in crossover networks are in mH, or 1/1000th of a Henry.

Infinite Baffle:

A loudspeaker enclosure type that theoretically uses an infinitely large rear chamber to contain the back wave. Since an infinitely large volume is not possible in many situations, traditionally any volume roughly 5 times the Vas of the driver is considered infinite. Woofers to be used in infinite baffle situations must have a high Qts, giving them adequate damping in a free-air situation, and allowing them to operate effectively. Benefits of an infinite baffle enclosure are extremely clean and uncolored sound with very low bass output capabilities. In home construction, infinite baffle woofers are often installed in ceilings or floors, using an attic or basement to contain the back wave.

Isobaric:

A loudspeaker configuration in which two woofers are sealed together with a very small airspace in between. The two drivers can be facing each other in a "clamshell" arrangement, or placed very close together with the magnet of one woofer near the cone of the other. An isobaric configuration yields an overall Vas which is half that of a single woofer. When the two woofers are wired in parallel an increase in efficiency results, but the maximum SPL is not increased since it is still excursion-limited. In a clamshell arrangement, some distortion can be reduced due to the cancellation of odd-order non-linearities.

Jasper Circle Jig:

A jig that mounts to the base of a router to allow easy machining of circular holes and recesses. Pre-drilled with all of the holes and labels necessary to create any diameter circle.

Kevlar®:

A synthetic fiber produced by DuPont® that is sometimes used in loudspeaker driver cones because of its high strength to weight ratio.

L-Pad:

A means of attenuating the output of a tweeter or midrange using a combination of series and parallel resistors. An L-pad can provide variable levels of attenuation without changing the impedance that the crossover sees.

Labyrinth:

A type of loudspeaker enclosure that is similar to a transmission line. A labyrinth features a constant cross-sectional area that has damping material lining the walls only. The typical length is 1/4 wavelength.

Le:

Abbreviation for voice coil inductance.

Linkwitz-Riley Crossover:

A type of crossover popularized by Siegfried Linkwitz, of a second or fourth order classification. Both drivers are 6dB down at the crossover frequency and sum to zero to yield a flat frequency response on axis. L-R crossovers also produce a main lobe that is perpendicular to the drivers' central axis.

Listening Room:

A dedicated room designed specifically for listening to hi-fidelity sound reproduction. A listening room typically has dimensions conducive to good listening and is well damped to reduce room reflections.

Lobing:

The three-dimensional shape of how sound radiates from a multiple-point-source speaker. The sound will vary with different angles relative to the listening axis due to the separation of the acoustic centers. At some angles, there will be cancellations at certain frequencies. Lobing occurs vertically in vertically aligned speakers and horizontally in horizontally aligned speakers.

Low-pass:

A filter type that allows low frequencies to pass, while rolling off higher frequencies. A low-pass filter is used on woofers to reduce their output at frequencies where they experience cone breakup or poor off-axis response.

Magnetic Gap:

The round opening in the top of the motor between the pole piece and the top plate. The magnet's entire field is concentrated into this small gap where the voice coil sits. Having a narrow magnetic gap contributes to a high-efficiency speaker, but care must be taken to ensure that the voice coil will not rub on either side.

MDF:

Medium Density Fiberboard. A type of engineered wood product that is used extensively in the loudspeaker industry. It is used because of its relatively high mass and good damping characteristics. MDF is made from glued and pressed wood pulp fibers; the process is very similar to the paper making process. MDF can be either a very light brownish-yellow color or a darker brown, depending on what type of sawdust is used in its making. This mainly varies by what part of the country the MDF is coming from. MDF machines very well, it will hold sharp edges and complex forms very well. Care should be taken in securing MDF due its layered nature that tends to separate when inserting screws. Most glues will work with MDF, though the suggested types are standard "yellow" carpenters glue or polyurethane-based glue.

Metallized Film:

A method of constructing capacitors using a non-conductive dielectric with a thin layer of metal deposited on one side. The very thin layers of film are then rolled up to produce a large surface area of alternating layers of metal and dielectric. Most relatively inexpensive capacitors are constructed using this method.

Midrange:

The central portion of the audible frequency spectrum. The midrange is considered one of the most critical areas in speaker performance due to the location of human vocals and many instruments in this area. Midrange frequencies can range from as low as 200 Hz up to 4000 Hz, though the traditional range does not extend quite as high.

Miter Joint:

A joint type in which both pieces of wood are beveled and glued together. Miter joints exhibit improved strength compared to butt joints because of the greater gluing surface area and the securing of end-grain to end-grain. Miter joints are most often used in situations where odd angles are being joined, or the builder does not want any exposed end grain. In MDF, miter joints are far superior to butt joints, because they join end-grain to end-grain and will not de-laminate the material when stressed.

Motor:

The motor consists of the top plate, back plate, magnet, and pole piece. The motor contains the parts that are responsible for the motion of a loudspeaker diaphragm. The strength of the control over the voice coil and cone are determined by the motor design.

Mono-pole:

The traditional type of loudspeaker in which sound is radiated in one direction. As opposed to a di-pole or bi-pole type speaker that radiates sound in multiple directions.

Mylar Capacitor:

A capacitor type that uses mylar as a dielectric. Considered superior to electrolytic capacitors, but not as good as polypropylene or film-and-foil capacitor types.

Near-Field:

The near-field can be defined as any distance relative to a speaker at which driver integration is not fully complete. Typically the near-field of a speaker is distances less than 1 meter. Near-field measurements are useful because they can measure the response of a driver without the effects of the room. Near-field measurements are only good up to several hundred Hz however, since interactions with cabinet edges and across the driver itself are not taken into account. In studio monitoring situations, near-field and far-field listening techniques are used to evaluate a mix.

Non-Polar Electrolytic Capacitor:

A type of capacitor that uses a thin layer of oxidized metal as the dielectric between layers. Non-polar refers to its ability to be used in either direction in a circuit.

Notch Filter - Parallel:

A filter used in crossover construction that attenuates the signal only at a specific frequency. The "notch" can be adjusted to a specific frequency, depth and width. The most versatile type of notch filter is the "parallel notch filter" or "parallel trap circuit"; these are two different names for a combination of a resistor, inductor, and capacitor in parallel. By adjusting the values of these components, the location, width, and depth of the notch can be manipulated. These filters are very difficult to design, due to the complex interactions of the non-ideal portions of each component. A notch filter like this is usually designed using formulae to calculate approximate values and then trial-and-error to get the exact desired result. The advantages of a parallel notch filter are that they work independently from the impedance of the driver, and can be added to an existing crossover network.

Notch Filter - Series:

The series notch filter is used primarily on tweeters and dome midranges to reduce the magnitude of the impedance peak at the resonant frequency. The large impedance peak on non-ferrofluid enhanced domes can cause erratic performance of the crossover near the resonant frequency. An inductor, capacitor, and resistor are connected in series to each other, all of which are connected in across the terminals of the driver.

Octave:

An interval in the audio frequency spectrum equal to one-half or double of the starting value. One octave above 400 Hz is 800 Hz, one octave below 400 Hz is 200 Hz.

Odd-order:

Any of the crossover slopes that are of an odd order, usually 1st or 3rd order.

Padding:

A term used synonymously with attenuation, usually referring to reducing the output of a tweeter, i.e. padding down a tweeter.

Parallel:

A method of connecting electrical components such that the voltage drop across each component is the same. In speaker building, this is accomplished by connecting the terminals such that "positive is to positive" and "negative is to negative." In a speaker, using two drivers in parallel causes an arguable 6dB increase in output. This is due to the halving of the system impedance and a doubling of radiating area. Two drivers in parallel in the same enclosure require a doubling of cabinet space. It is important to note that the total system impedance of two speakers in parallel will be half that of one driver.

Passive Crossover:

An electrical filter within a loudspeaker responsible for dividing up the frequency spectrum and sending portions to the appropriate drivers. Most passive crossovers consist of a combination of resistors, capacitors, and inductors. They do not require any external power and are performed to the signal at the speaker-level.

Passive Radiator:

A moveable piston often constructed like a woofer without a motor structure, which is used to tune a box to a certain frequency. The frequency at which a passive radiator (of a fixed diameter and

compliance) is tuned is controlled by the moving mass of the diaphragm. Some benefits of a passive radiator enclosure are the elimination of extremely long ports, the non-existence of port noise, and higher frequencies will not leak out through the port.

Phase:

Phase is a relative measurement of the difference between "where" periodic waveforms are at a given time. Two waves are "out of phase" (180 degrees) when the crest and trough of both waves occur at the same time. This will cause a cancellation of the two waves. When two separate speakers are connected "out of phase" a de-localized sound field will be created with a dramatic reduction of bass output. In crossover design, phase is used to measure the relative output of multiple drivers at a certain frequency. Some crossovers exhibit excellent phase response, meaning that inter-driver destructive interference is kept to a minimum. Phase can vary anywhere from 0 to 360 degrees and varies with frequency as well.

Piezo Tweeter:

A type of tweeter that used a simple piezoelectric crystal as the diaphragm. These piezoelectric crystals mechanically vibrate as current passes through them. The advantage of this type of tweeter is that no crossover is needed due to their high internal impedance.

Planar Transducer:

A loudspeaker drive unit that uses a thin film suspended between two magnets as the diaphragm. The voice coil itself is etched onto the diaphragm, and as current flow through it, the diaphragm moves back and forth. In a planar transducer, the diaphragm is attached along the length of the driver. Most planar transducers are dipolar by nature, though a rear chamber may be used to contain the back wave. Due to the limited excursion capabilities of most planar transducers, it is difficult to produce low bass frequencies.

Pole Piece:

The portion of a loudspeaker transducer that provides the negative magnetic pole on the inside of a voice coil. In the most general sense, the pole piece is a cylinder of metal that is on the inside of the voice coil. A T-shaped pole piece has a smaller diameter towards the bottom, and is wider at the top, yielding a T-shaped profile. The widest portion of the T is directly across from the top plate of the magnet structure. A vented pole piece has a hole through it to allow air to enter the magnetic gap to increase cooling abilities.

Port:

A cutout or tube in a vented box that "tunes" the box to a certain frequency. The port provides an additional air mass that is excited at its own frequency, enabling extended bass response. A port can be anything from a hole in a cabinet to a 4" diameter by 20" long piece of PVC. In a given box, a longer port corresponds to a lower tuning frequency.

Port Noise:

An occurrence in vented box systems where erratic "wind noise" is created by the movement of air through the port. Port noise is generally described as a "chuffing" sound that will occur at maximum excursions of the driver. By increasing the diameter of a port, the speed at which air moves through the port will be reduced, in turn reducing port noise. Port noise can also be reduced by using flared ends on the port tubes, which provide a superior airflow across the transition from the port to the outside air.

Power Handling:

The amount of electrical power that can flow through a loudspeaker driver before functioning ceases. Most often, the thermal power handling is quoted. This is a measure of how much power a driver can take before the voice coil insulation melts or other joints come apart and the driver fails. In reality, most drivers will reach a point of maximum excursion before their thermal power-handling limit is reached.

Push-Pull:

A method of using two woofers in the same box. A push-pull enclosure uses two woofers on opposite sides of the box operating out of phase with each other. Overall performance will be roughly the same as in a traditional two-woofer format, except for a potential decrease in some forms of distortion. This occurs because some distortions may now be present out of phase thus canceling out.

PVC Pipe:

The typical plastic pipe that is used for plumbing in homes. It is very useful for making ports in loudspeakers due to its availability in a variety of lengths and diameters.

Quasi-Anechoic:

A method of making loudspeaker measurements that can produce results similar to those found in a full-blown anechoic chamber, but in a standard room. These measurements can be taken by "gating" out the reflections from the boundaries within the room. Quasi-anechoic responses will be very accurate above a certain frequency, but will have invalid results below that point.

Q:

The losses or relative damping (ratio of stored to dissipated energy or ratio of reactive to resistive energy) of a system. In an impedance plot, a driver Q can be determined by how high and narrow the resonance peak is. A high, narrow peak indicates a high Q, while a lower, wide peak indicates a low Q.

Qes:

The losses or relative damping (ratio of stored to dissipated energy or ratio of reactive to resistive energy) of a driver at F_s , considering only its electrical (non-mechanical) resistances.

QL:

The Q of a vented speaker cabinet resulting from all of the box losses (acoustic weaknesses).

Qmc:

The Q of a sealed loudspeaker cabinet at F_c , considering only its mechanical (non-electrical) resistances.

Qms:

The losses or relative damping (ratio of stored to dissipated energy or ratio of reactive to resistive energy) of a driver at F_s , considering only its mechanical (non-electrical) resistances.

Qtc:

The Q of a sealed loudspeaker considering both mechanical and electrical resistances.

Qts:

The losses or relative damping (ratio of stored to dissipated energy or ratio of reactive to resistive energy) of a driver, considering both mechanical and electrical resistances.

Rabbet:

In woodworking, a groove or recess that is placed along the edge of a board to improve joint quality. Using rabbets to make a joint provides increased strength because of the increased gluing surface area, and the bonding of both end-grain and side-grain fibers.

Re:

The DC resistance of a loudspeaker transducer, measured in ohms.

Resistance:

A material's ability to resist the flow of electrons, measured in ohms.

Resistor:

An electrical component that provides resistance to current flow. In crossovers, resistors are used in conjunction with other elements to produce various filters, and to attenuate output.

Resonant (Resonance) Frequency:

The frequency at which an object will naturally mechanically vibrate.

Ribbon Driver:

A type of loudspeaker transducer that uses a thin metallic film suspended between two magnets as the diaphragm. A true ribbon driver differs from a standard planar transducer in that the diaphragm is

attached only at the ends. Thus, a true ribbon driver is very delicate, but is able to move very quickly and can produce high frequencies very accurately.

Ringling:

A type of distortion found in loudspeakers that is usually caused by the natural resonances within a driver's cone material. It can also be used to refer to the poor transient performance of a driver or system.

Rms:

The mechanical resistance of a loudspeaker's suspension losses.

Satellite Speaker:

A typically small speaker designed to reproduce frequencies above a certain point. A satellite speaker is used in conjunction with a subwoofer to fill in the lower octaves. Advantages of satellites are the ability to use small enclosures that can be more discreet in a room. The disadvantage of them is the difficulty integrating the lower and higher frequencies.

Sd:

The radiating surface area of a loudspeaker driver.

Sealed Enclosure:

A type of loudspeaker enclosure in which the rear of the woofer fires into a tightly sealed chamber that is completely separate from the surrounding air space. Sealed boxes have a higher F3 than a vented box with the same woofer, but the low-end response rolls off at a shallower rate. Sealed boxes exhibit superior transient response and group delay characteristics than ported boxes.

Second Order Filter:

A filter that uses a combination of two components to yield an approximate 12 dB per octave roll-off.

Sensitivity:

A measure of the acoustic output of a loudspeaker resulting from the application of a fixed input power. Most often, sensitivity is measured in decibels at a distance of 1 meter from the source with 1 watt of input power (dB 1W/1m). It is also seen as dB at 2.83V/1m, which allows a better comparison of sensitivities regardless of load impedance. 2.83V is the amount of voltage necessary to deliver 1 watt of power into an 8-ohm load.

Series:

A method of connecting multiple electrical components such that there is the same current through each. In loudspeakers, connecting woofers in series is accomplished by connecting the woofers "positive to negative." Putting two woofers in series will double the system impedance and system radiating area. The net result of using two woofers in series is no gain in efficiency. However, the increase in surface area will reduce the amount of excursion required to produce a given SPL, and a higher overall SPL can be produced.

Series Notch Filter:

The series notch filter is used primarily on tweeters and dome midranges to reduce the magnitude of the impedance peak at the resonant frequency. The large impedance peak on non-ferrofluid enhanced domes can cause erratic performance of the crossover near the resonant frequency. An inductor, capacitor, and resistor are connected in series to each other, all of which are connected in parallel across the driver.

Shielded:

A loudspeaker driver or system that has a very small stray magnetic field making it acceptable for use near CRT-based screens. To shield a driver, a magnet of the opposite polarity is attached to the rear of the motor structure. This reduces the stray magnetic field considerably, but to further improve shielding a ferrous cup is placed over the entire magnet assembly. When done properly, the combination of the second magnet and the metal cup will reduce the stray field to almost nothing. Also, many drivers that use neodymium magnets are inherently shielded very well due to the smaller stray magnetic field.

Snake Oil:

A term used in the audio community to describe ideas or technologies that claim to give large improvements in performance, but there is little or no scientific evidence to back these claims.

Speaker:

A driver or combination of drivers that is used as a system to convert electrical signals into acoustic output.

Spider:

The corrugated cloth ring that attaches the voice coil to the frame of a speaker. The typical accordion spider is used because it allows forward and backward motion without allowing the voice coil to move side-to-side.

SPL:

The measured loudness of a sound. Often measured in decibels (dB) from one meter (1m) away from a speaker driver while it is playing a test tone that is being driven by one watt (1W) of power from the amplifier. Also measured from a speaker that is being driven with 2.83 volts @ 8 ohm of audio voltage. (Example: 90 dB 2.83V/1m)

Step Response:

A measurement of how a speaker responds to a theoretically infinitely fast transition from zero output to a finite output. An ideal step response will look like a triangle without any extra zigs in it.

Subwoofer:

A loudspeaker transducer specifically designed to produce extremely low frequencies. A subwoofer will generally only be capable of output up to several hundred Hz. In home theater, a separate track is recorded for the subwoofer. These are typically powered by their own amplifier, separate from the main speaker amplifiers.

Surface Mounting:

The installation of loudspeaker drivers such that the frame of them mounts on top of the baffle. This should generally be avoided to reduce diffraction around the driver frame, and is more important at higher frequencies.

Thiele-Small parameters:

Thiele-Small parameters are a set of data characterizing the electrical and mechanical properties of a loudspeaker transducer. This data can be used to help design enclosures and predict the driver performance within them.

Third Order Crossover Network:

A filter that uses three components to produce a roughly 18 dB per octave rolloff.

Three-Way Speaker:

A speaker system that uses three separate drivers to cover the entire audio spectrum. Usually a large woofer, a smaller midrange and a tweeter are used together.

Toe(in):

A slight angle placed on a pair of speakers so that the drivers are facing at an angle other than perpendicular to the wall. This is helpful to make sure that the listening seat is at the proper axis relative to the speakers.

Top Plate:

A steel plate that is on top of the magnet that transmits the positive magnetic pole to the outside of the voice coil. The frame is also attached to the motor structure through the top plate.

TQWT or TQWVP:

Tapered Quarter Wave Tube or Voight Pipe. A type of transmission line enclosure where the driver is placed at the 1/3 point of the length of the line. The tapering of the line produces a slight horn-loading effect on the bass frequencies, which can help boost bass response.

Transient Response:

A transient is a sudden change in signal amplitude, experienced in fast transitions from quiet to loud. In a speaker system, the transient response describes a speaker's ability to tightly control its cone motion. The cone will start and stop quickly to match the input signal with a minimal amount of distortion and time smearing.

Transmission Line:

A type of loudspeaker enclosure that routs the back-wave of a speaker through a long tunnel that eventually exits via the front of the speaker. The theory of the transmission line is to make a line length equal to $1/4$ or $3/4$ of a wavelength, therefore the front and rear waves will add to each other upon exiting the front of the line. Because of the long, narrow rear enclosure, Helmholtz resonances tend to be a problem and produce significant ripples in the low frequency response. Line stuffing is generally used to increase the apparent length of the tube and distribute the Helmholtz resonance frequencies. However, getting exact line lengths tends to be difficult, and will often result in poor performance. There have been several very successful transmission line designs, however they are much more difficult to perfect than the traditional sealed and ported enclosures.

Treble:

The highest frequencies in the audio spectrum. Generally from 4 kHz up to beyond audibility.

Tweeter:

A type of loudspeaker transducer that is responsible for producing the top of the frequency range. There are several traditional styles of tweeters: ribbons, domes, and cones. The key feature of a tweeter is its low moving mass, enabling it to produce the fast vibrations necessary for high frequency reproduction. Another advantage of a tweeter is its ability to produce high frequencies well off-axis.

Two-Way Speaker:

A speaker system that uses two drivers to cover the entire audio range. In most standard speakers, the crossover occurs in the 2 kHz to 4 kHz range.

Vas:

The Thiele-Small parameter that measures the overall compliance of a loudspeaker transducer. The Vas is defined as the volume of air that has the same compliance as the driver.

Vented Enclosure:

A type of loudspeaker enclosure where the woofer is mounted in an enclosed box except for one vent or port connecting to the outside air space. Vented enclosures feature a lower F_3 point than a sealed box for the same woofer. The lower F_3 comes at the expense of a steeper low-frequency roll-off. In a vented enclosure, the driver excursion is at a minimum at the box tuning frequency, and increases dramatically below this. Care must be taken to prevent over-excursion (unloading) of the woofer at frequencies below the tuning frequency.

Voice Coil:

The coil of magnetic wire that moves within the magnetic gap of a loudspeaker transducer. The voice coil is the portion of a driver that directly transforms electrical energy into mechanical energy.

Voice Coil Former:

A cylindrical tube of paper, aluminum, or Kapton® that the voice coil is wound on. A former must be very strong and have excellent thermal properties to prevent deformation of the voice coil at high power levels. A vented voice coil former has holes in it, through which hot air can escape to help cool the motor structure.

Woofer:

A loudspeaker transducer that is responsible for producing sound in the 40 Hz to 200 Hz range. To produce a given SPL at lower frequencies, increased radiating area and increased excursion capabilities are needed. These increases are necessary for low frequency production, however they inhibit the driver's ability to produce high frequencies.

Xmax:

The measurement of how far a diaphragm can move while still maintaining linear behavior. Traditionally it was defined as the voice coil length minus the air gap height. With the current high-strength motors, significant control over the cone is still possible even without the entire voice coil in the gap.

Z:

Abbreviation for impedance. In T/S parameters, Z represents the nominal impedance of a speaker.

Zobel Network:

Another name for a conjugate network, which is used to flatten the impedance rise found in woofers at increasing frequencies.
