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Haas effect: The Haas Effect refers to the brain's ability to integrate *incident sound* and *early reflections* into a single sound. Those early arrivals which occur within the first 5-35ms that are not more than about 10dB louder than the direct sound will be combined and added to the first arrival and localized to its source. If the delayed sound is more than 10dB louder or the delay is greater than 35ms, the listener will perceive distinct echoes. This is a type of sensory inhibition which causes the response to the direct sound source to inhibit response to the reflections. Haas further noted the *Precedence Effect*: the position of a perceived sonic image created by two sound sources depends on both the arrival times and the relative levels. If two sound sources arrive at the same time and at the same level, human aural perception will image the sound toward the centerpoint between the two sounds. If two sounds are equally loud, the *image* will shift toward the earliest-arriving signal. Further, if one source is louder, the image can be moved back to the center between the two sources by adding delay, provided that the delay time is less than 25ms. Beyond 25-30ms, the ear begins to hear the delayed sound as a discrete echo and the image shift effect no longer works. This phenomenon is usually used to simulate a stereo image in a monophonic recording where the original signal is panned hard left and a copy is delayed (1-50ms delay) and panned hard right. The Precedence Effect may be mitigated by slightly attenuating the volume of the *dry* sound.

half-space loading: The placement of a loudspeaker against a wall or other hard, reflective surface. Such a placement typically improves the performance of a loudspeaker, enabling a wider dynamic range, as well as improving the amplitude response of the speaker. An alternative to placing the loudspeaker in a *free-field*.

half track: (1) A recording format in which two parallel tracks are recorded in a single pass on a $\frac{1}{4}$ " tape, each track using slightly less than half of the tape width. On some machines, a very narrow track with *SMPTE* or other synchronizing information is recorded and reproduced in the *guardband*. In this case, the data is *frequency-modulated* onto a very high-frequency tone in order to minimize *crossstalk* or *bleeding* into the audio. (2) A tape machine which records on half of the tape width only. This allows the tape to be inverted at the end of its play time, doubling the recording time for a given length of tape. See also *two-track*, *four-track*.

half-step: The musical interval of a minor second in a *diatonic* scale, equal to 100 cents. In *equal temperament*, there are twelve semitones in each octave, so in the equal tempered scale, the minor second has a frequency ratio of the $\sqrt[12]{2}$, or about 6%. In *just intonation*, the minor second has a frequency ratio of $\frac{15}{16}$. Also called a *semitone*. See *scale*.

half-time: See *alla breve*.

handles: Sound sections between works in a *production track* that enable the re-recording mixer to cross-fade smoothly between shots with different *backgrounds* and/or *room tones*.

handshaking: In data transmission, the process of checking that a receiving device is ready to receive, or that a transmitting device is ready to transmit. Also, the method whereby such checking takes place. In MIDI, handshaking occurs in System-Exclusive, where messages are sent between two devices to ensure that both are present and that both have received or transmitted blocks of data.

hang: In film, the act of playing back a given element during a mix for the purposes of adding the track(s) to the mix. "We won't premix the Foley cloth but will hang it at the final mix instead."

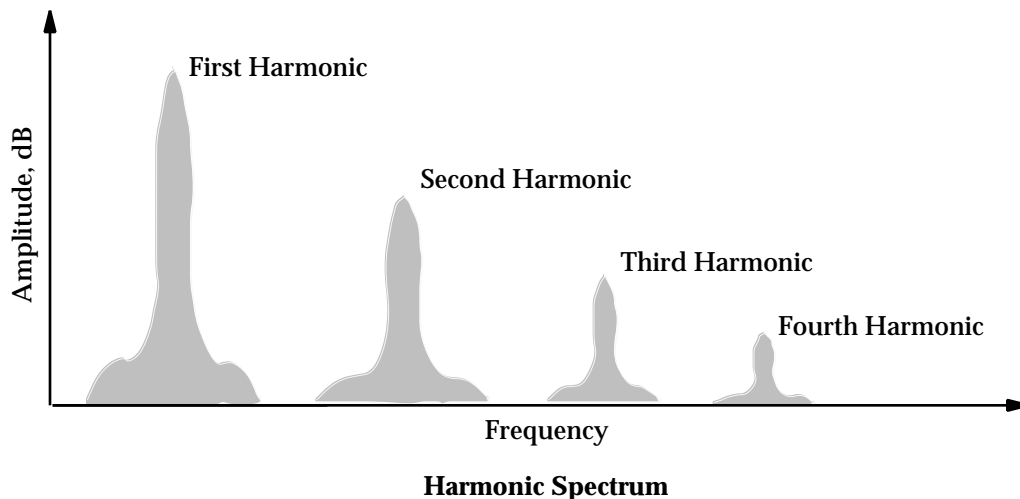
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hangover: The *resonance* which continues in a loudspeaker cone after the input signal has stopped. See also *damping factor*, *impulse response*, *ringing*.

hard disk recording: A computer-based form of tapeless recording in which incoming audio is converted into digital data and stored on a hard disk. Sort of the digital counterpart to *direct-to-disc* analog (vinyl) recording, but being digital, the recording can be edited.

hard knee compression: A characteristic of certain designs of a *compressor* wherein nothing happens to an input signal until the signal reaches the threshold limit, but as soon as it does, the full level of gain reduction is applied, as determined by the ratio control setting. A graph of the input gain against the output gain will show a sharp change in *slope* at the threshold level. Compare with *soft knee compression*.

harmonic: A frequency that is a whole-number multiple of the *fundamental frequency*. For example, if the fundamental frequency of the sound is 440Hz, then the first two harmonics are 880Hz and 1.32kHz. A harmonic is the same as a *partial* where the partials exhibit the property that the *overtones* are mathematical multiples of the fundamental frequency. See *harmonic series*, Appendix C.



harmonic distortion: The onset of harmonic distortion is the displacement of energy from a single frequency to its *harmonics*. The presence of harmonic frequencies added to an output signal by an electrical circuit or speaker, generally undesirable, caused by the system not being perfectly *linear*, such as when an amplifier is operated in a nonlinear portion of its *transfer curve*. It is expressed as a percentage of the original signal:

$$\text{THD} = \frac{(\text{Total Signal} - \text{Fundamental Signal})}{\text{Total Signal}}$$

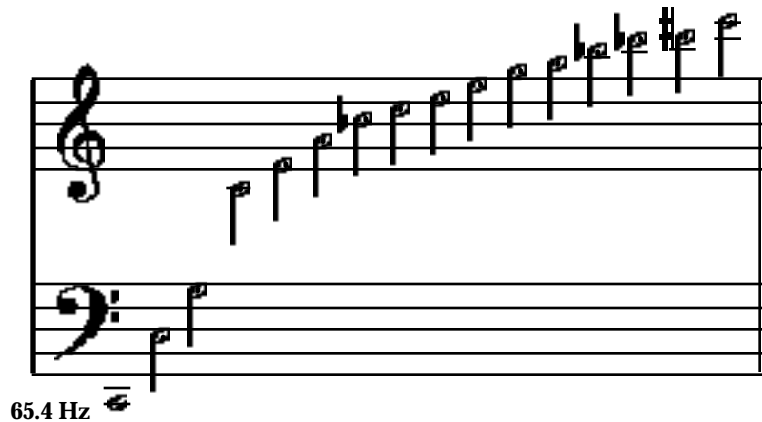
In a perfect audio device, such as an amplifier or tape recorder, the output signal would be a replica of the input signal with no changes except possibly the amplitude of the signal. See also *doubling*.

harmonic enhancement: A technique used by *aural enhancers*. See *harmonic synthesis*.

harmonic envelope: The natural *decay* in the *harmonics* of a natural instrument over time.

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harmonic series: A set of all of the frequencies which are an integral multiple of the frequency of the lowest tone, or *fundamental*. See *harmonic*, *partial*. Humans perceive a harmonic series as a single *pitch* whose tonal quality is determined by the exact mix of related harmonics present. Below are illustrated the first sixteen harmonics in the harmonic series for the fundamental, C=65.4Hz. The notes indicating the 7th, 13th, 14th and 15th harmonics occur slightly flat or sharp of the notated pitch.



The first sixteen harmonics for the fundamental C=65.4 Hz

harmonic series tuning: A tuning system which is based on the first sixty *harmonics* of the *tonic*, resulting in a tuning not based on the usual diatonic scale. There are more notes per octave as the tuning progresses up the harmonic series; the top 32 keys of a keyboard cover one octave in pitch.

harmonic structure: The sequence of *chords* used in a piece of music.

harmonic synthesis: A technique used by *aural enhancers* which creates new high-frequency harmonics not present in the original recording. Adding a small amount of carefully controlled distortion can make a sound quality appear cleaner and more detailed. This happens by sending some dry sound to a side-chain *highpass filter*. The output of the filter is processed dynamically to add *phase-shift* and create synthesized HF (only) harmonics related to the dry signal.

harmonizer: See *pitch-shifter*.

hat: See *top hat*.

haystack filter: See *bell filter*.

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HDCD: High Definition-Compatible CD. A trademark *dithering* process by Pacific Microsonics. The “HDCD process effectively cancels the additive distortions and simultaneously provides additional data to reduce the subtractive distortions” and is compatible with existing consumer digital playback equipment, claiming that there is a clear improvement in the fidelity of the conventional CD. The process works by converting an analog signal into a digital signal with a word length of “longer than 16 bits” and at a sampling frequency of “greater than 100kHz.” These data can then be encoded into the standard CD format, or used with 20- or 24-bit recording/editing hardware/software. When used with an HDCD decoder, the reconstructed signal is output at the appropriate > 16-bit, > 44.1kHz format.

HDTV: High Definition TeleVision. A term designating any television system using many more than the standard number of lines per *frame* specified in the NTSC, PAL, or SECAM systems. Experimental HDTV systems have been developed to provide high-resolution computer animation for motion pictures, flight simulators, etc., but are unlikely to be used for broadcast any time soon due to their inherent incompatibility with existing broadcast standards. The HDTV standard includes 5.1 audio, using AC-3 encoding.

head: (1) On a tape recorder, an electromagnetic *transducer* that (i) converts electrical energy in the signal into a magnetic field that induces magnetization in the tape, or (ii) produces an electrical signal in response to the varying *remanent* magnetism stored along a passing length of tape. See *erase head*, *playback head*, *record head*, *sync head*. (2) In general, the transducing mechanism used in recording or playing back signals on various media, e.g., the cutting head of a record mastering lathe, the optical head of a motion picture projector, etc.

head gap: See *gap*.

head losses: Limitations in the *frequency response* of the signal a tape head can transfer to or read from tape due to its inherent design or construction.

headphone box: See *cue box*.

headphone mix: See *cue mix*.

headroom: The amount of additional signal above the nominal *input level* that can be sent to a module before *clipping* distortion occurs. On a digital tape, input levels are set very low, -15VU to -12VU, to allow adequate headroom for occasional input peaks that might exceed -12VU. See *dynamic headroom*, *dynamic range*, *overs*.

head shield: A metal shield installed around as much of the *playback head* as is possible, in order to minimize distortion due to *EMI*.

heads-out: A tape recording which has been rewound and is ready to play. It is generally considered best for long-term storage to leave recordings *tails-out* for minimum *print-through*.

head stack: The assembly of tape heads in a magnetic recorder. The head stack normally consists of an erase head, a record head, and a playback head. Also called a *head block*.

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helical scan: A type of videotape, data, or audio recorder in which the tape is wrapped around a large rotating drum, on which the actual record and playback heads are mounted. Since the heads rotate quickly and write parallel tracks at a very small angle with respect to the tape path, the signal written on the tape is many times the actual length of the tape itself. Thus, helical scan recording offers very high resolution at low tape speeds. Almost all consumer and professional videotape formats employ the helical scan principle, largely replacing the *quadruplex recorder*.

Helmholz resonator: A structure used in *loudspeaker* systems which is designed to *resonate* at a particular frequency. Because of the particular design of the resonator, the sound at the tuned frequency is dampened, and two bands, one each of higher and lower frequency, are produced, extending the *bass* response of the loudspeaker.

Henry: (1) See *Jecklin disk*. (2) A measurement for *inductance*.

Hertz (Hz): The unit measurement of *frequency* which equals one cycle per second, named after German physicist H.R. Hertz. The frequency range of human hearing is from about 20Hz-20kHz.

heterodyne: To mix two frequencies together producing the sum and difference of the two input frequencies; any information contained on either original frequency is continued in the sum and difference frequencies. Heterodynes are used as the basic design for all AM, FM, amateur radio, CB, TV, radar, and satellite systems. See *amplitude modulation*.

HFS: Hierarchical File System. A Mac-specific logical file format for CDs. CDs written in HFS cannot be read on PCs. Compare with *ISO 9660*.

high-fidelity: Refers to the reproduction of sound with little or no *distortion*. At least 15kHz of audio *bandwidth* is required for stereo high-fidelity.

hi-fi video sound: The result of encoding the stereo soundtracks input to hi-fi type VHS or Beta format videotape recorders on an *frequency modulated* carrier wave. This information is recorded along with picture data via the video record heads. Reproduction of hi-fi sound approaches digital quality audio.

high band: A type of video system in which the picture information is encoded on a much higher carrier frequency than early color video systems; the broadcast standard currently in use.

high-frequency compression: See *HX/HX pro*.

high-output low-noise (HOLN): A type of *magnetic recording tape* with very high sensitivity to applied magnetic fields, and with a very high *S/N ratio*, commonly used in professional audio applications.

highpass filter: A filter that attenuates the frequencies below its *rolloff frequency*.

hiss: Audio noise that sounds like air escaping from a small aperture. See *Barkhausen effect*.

hit point: See *cue*.

hold time: An *envelope* parameter that specifies how long the *attack* segment of an envelope is to be held at full level.

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hole-in-the-middle: An undesirable effect due to an extreme angle used with a *coincident pair* where the stereo *image* is all left and right, with very little sound in the center. Or, a similar phenomenon created by a surround system where the loudspeakers are too far apart to deliver balanced sound adequately to all seats in a theater.

hook: In popular music, the short melodic idea designed to be instantly memorable. It is often used for the chorus of a song, as well as for a *fade*.

horn: A type of loudspeaker enclosure named for its characteristic shape, with the speaker itself mounted in the narrow end of its tapered interior surface. Because the sound waves emanating from the speaker itself are internally enlarged before they exit from the larger end of the tapered surface, horn enclosures are highly *efficient*. Also, any horn-shaped device placed in front of a speaker to disperse sound.

horn tweeter: A high-frequency loudspeaker which has a horn-shaped flare fixed to the front in order to increase acoustic efficiency and better control the *directivity*.

hose: Slang term for an audio cable, e.g., a microphone cable or a *snake*.

hot: In a *balanced line* system, the conductor which carries the in-phase component of a signal. For example, pin 2 of an *XLR* connector.

hot hole: In film, slang for the projector gate itself, where the picture start mark is threaded up at the beginning of a session.

house mix: An output on a *sound reinforcement* control console that is used to feed the power amplifiers for the loudspeakers in the venue, usually highly equalized to correct for *house modes*.

house mode: The unique acoustic profile of a particular performance or recording venue. It is necessary to know the *reverberation* patterns within the space so that microphones, speakers, acoustic *damping*, etc. can be appropriately placed to produce or simulate the spatial and *ambience* effects desired, or to correct for *room modes*.

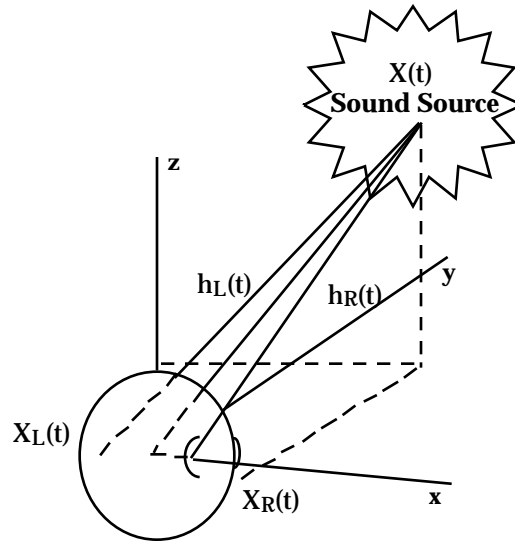
house sync: Also called *black-burst*.

HPF: See *highpass filter*.

HRIR: Head-Related Impulse Response. See *HRTF*.

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HRTF: Head-Related Transfer Function. A function used to find the sound pressure that an audio source produces at the ear-drum. This is described by the impulse response from the source to the ear drum, called the Head-Related Impulse Response (HRIR), and its *Fourier transform* is the HRTF. The HRTF captures all of the physical cues to the source localization; once the HRTF for the left and right ears is known, accurate *binaural* signals may be synthesized from a *monaural* source.



$$x_L(t) = \int h_L(t) x(t-\tau) \delta\tau$$

$$x_R(t) = \int h_R(t) x(t-\tau) \delta\tau$$

Head-Related Transfer Function

HSS: HyperSonic Sound.™ A *loudspeaker* technology developed by American Technology Corporation. This design produces audio by mixing an *ultrasonic* carrier with audio *sidebands*, in much the same manner of *heterodyning*. The mixing takes place in the air, relying on the nonlinearity of the atmosphere. The resultant sound is actually not generated at the *transducer*, but all along a projected column of ultrasonically vibrated air in front of the transducer as a conversion by-product of the interaction of the ultrasonic waves. Inaudible ultrasound energy is projected, which in turn emerges as *AF* sound from adjacent reflective surfaces. An acoustical sound wave is created in the air molecules by down-converting ultrasonic energy into the *AF*. This process supposedly is free of the problems of conventional speaker *voice coils*, *cones*, *crossover networks*, or *enclosures*. In addition, because sound is generated along the entire length of the projected column, there is minimal (1dB) amplitude loss as a function of distance from the transducer, across an average-sized room.

hub: The cylindrical plastic or metal center of a tape reel to which the tape is attached and around which it is wound.

hum: Audio noise that has a steady low-frequency pitch, typically caused by the effects of induction of nearby AC lines or leakage of AC line frequency into an amplifier's signal circuits, usually at 60Hz or 120Hz.

humanize: To introduce slight, random variations to the timing, velocity, duration and possibly other parameters of a track to make *quantized* tracks sound more natural. See *percentage quantization*.

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hum switch: A switch found on some audio equipment, such as amplifiers for musical instruments, which reverses the neutral and hot leads of the power cord in order to reduce *hum*. The ground lead is unaffected.

HX/HX Pro: Headroom eXtension. A special circuit developed by Dolby Labs to reduce the tendency in cassette recorders toward *self-erasure*. In magnetic tape recording, loud, high frequencies in the signal look like *bias* to the tape which will tend to erase the signal as it is being recorded. The effect is called *high frequency compression*. The HX Pro system senses the level of high frequencies and reduces the level of bias dynamically.

hybrid amplifier: An amplifier that uses a combination of transistors and tubes, supposedly combining the best characteristics of each.

hypercardioid microphone: The narrowest of the *unidirectional* patterns, the hypercardioid is a variation on the *cardioid* microphone pick-up pattern which is most sensitive at the front and sides, while rejecting sounds entering 110° - 250° to the rear, with a small lobe of sensitivity at 180° to the rear. The pick-up pattern of a hypercardioid is narrower than that of a *supercardioid* and is somewhat similar to that of a *figure-eight* mic, but the response is asymmetrical in that the hypercardioid has greater sensitivity to sound arriving at the front of the capsule than to sound arriving at the rear. See *acceptance angle*. Also called a *cottage loaf mic* in the UK, for reasons related to bread.

hyperinstrument: An instrument which has had its sound-producing capability enhanced electronically.

hysteresis: In magnetic tape recording, the hysteresis inherent in the process of magnetizing the tape represents a large nonlinearity, and this causes *harmonic distortion*. The use of *bias* in the recording process reduces the effect of the hysteresis, and hence, reduces the distortion. Compare with *Barkhausen effect*.

hysteresis loop: The graph of applied magnetic force vs. *remanent magnetism*. One measure of a specific recording tape's performance.

I

IDE: Integrated Disk Electronics. A standard interface *bus* in PCs, most commonly used for hard disks. EIDE is Enhanced IDE, somewhat faster than the original IDE specification. This later evolved into ATA (Advanced Technology (AT) Attachment) and UltraATA. This evolution is fairly parallel to the *SCSI* bus technology used by Macs.

IEC characteristic: The European *pre-emphasis* and *de-emphasis* equalization standard for magnetic tape recording.

IEM: In-Ear Monitor. Earphones used by musicians when recording to hear a special *cue mix*, *overdubbing*, or during a performance to better hear other musicians. Sometimes used instead of *stage monitors* to reduce problems of feedback or to provide each musician with a separate *monitor mix*. See *earwig*.

IFPI: **International Fédération Phonographique Industrie.** The European equivalent of the RIAA.

IIR: Infinite Impulse Response. See *FIR*.

IMA: Interactive Multimedia Association.

image: (1) The apparent relative placement of individual sound sources, as imagined by a listener of recorded audio, created during the recording and mixing processes, as well as by the final format of the media, e.g., *stereo*, *surround-sound*. See *imaging(1)*, *Haas effect*. (2) See *imaging(2)*.

image shift: In *multichannel* sound reproduction, a change in the apparent left-to-right position from which a particular sound seems to emanate.

imaging: (1) The ability to localize the individual instruments, voices, or other sound sources when listening to a *stereophonic* recording is called imaging. Accurate imaging with two channels is almost impossible, requiring both channels to have identical *gain* and *frequency response*, the two loudspeakers to be within 1dB of each other in frequency response and the *phase* must be identical. In addition, the listener must be precisely between the two speakers. The lack of accurate imaging with traditional, two-channel stereo has led to three-channel (LCR) and higher-channel audio recording and reproduction in an attempt to improve the listening experience. Contrast with *stereo spread*. (2) The resulting output of a *D/A converter* is a stair-step waveform which contains a great deal of high-frequency distortion called *images*. To reconstruct a smooth replica of the original signal, the stair-step is passed through a steep lowpass filter called an *anti-imaging*, or *reconstruction filter*. See *quantization error*.