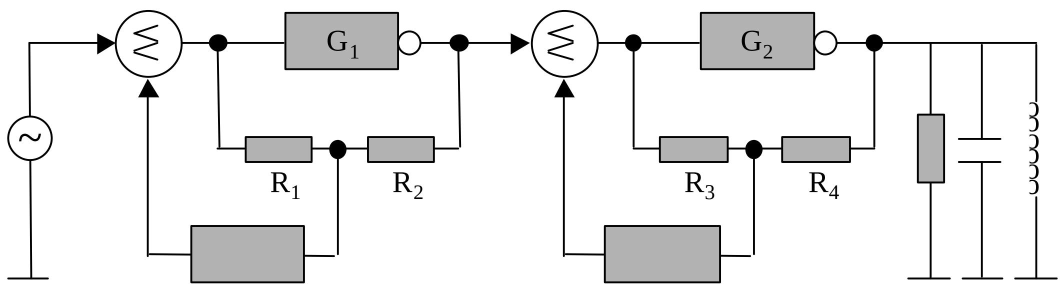
The HEGEL SoundEngine™ Technology (patent pending)

By using dynamic local error canceling for different gain stages in the amplifier a very low distortion and a large dynamic range can be achieved. The dynamic range, linearity and musicality can be significantly improved compared to existing audio technologies. The figure below shows the basic architecture of the Hegel amplifier technology.

By cascading several amplifier stages each using local error correction the drawbacks of the traditional amplifier technologies can be avoided. The local error correction is dynamically adjusted to cancel non-linearities and distortion in case the applied input signal will cause sufficient non-linearity for one or more of the cascaded gain stages. Hence no error correction is done when the amplifying stages do not contribute to non-linearity. The error correction is only applied when necessary. When no error correction is performed, the gain stages are working as cascaded local feedback gain stages with the specified voltage and current gain.



The Hegel error correction topology includes the strengths of both global feedback- and local feedback topologies, without introducing the drawbacks of these two topologies.

Because of the distributed local error correction topology, the signal delay through respective amplifying stages is kept low, and hence the error correction speed and error canceling is much higher than in a global feedback amplifier. This gives increased linearity end error correction capabilities for high frequency signals compared to the global feedback approach.

Overview of different Audio Amplifier Technologies

Traditional Analog Amplifier Technologies (Class-AB)

The amplifier technologies used in audio amplifiers on the market today are global feedback- and local feedback technologies. These two amplifier technologies have several shortcomings, and among the most severe drawbacks are the following problems:

The connected output loudspeaker cable feeding the connected speaker will act as an antenna, and will pick up radio frequency (RF) disturbances from mobile telephones, computers etc. These RF disturbances will reach the output of the amplifier, and will also reach the negative input terminal of the input stage of the amplifier through the feedback network. The RF-signal will be rectified by the transistors in the input stage and will shift the bias of the input stage. This will increase the distortion of the amplifier circuit.

When current is delivered to a loudspeaker from an amplifier, the inductive voice coil in the speaker will generate an opposing current kick-back signal sent back to the amplifier. This current kick-back signal will reach the output of the amplifier. The kick-back will also reach the input stage of the amplifier through the internal feedback network, and will disturb the operation of the amplifier input stage creating distortion and intermodulation.

The time delay of the amplifying stages will result in a delayed feedback signal to the negative feedback input terminal of the input stage. Because of the delayed corrective feedback signal the input stage will momentarily see a large input signal, that will cause the input stage to be overloaded. This overload condition will cause distortion called transient intermodulation. To avoid this problem the input signal to the amplifier must be bandwidth limited according to the forward path time delay properties of the amplifying stages.

In an amplifier driving reactive loudspeaker loads, the frequency compensation necessary to insure stable operation will give large delays and phase shifts through the amplifier, and hence the bandwidth limiting of the input signal must be increased. Because of this, the overall bandwidth of such a global feedback amplifier will be restricted. The internal frequency compensation of the global feedback amplifier will also reduce the open loop gain at high frequencies, and this reduced loop gain will give increased distortion and intermodulation at high frequencies. The reduction of distortion and intermodulation is more necessary at high frequencies due to higher nonlinearity of the amplifying semiconductor components at high frequencies.

The main disadvantage by using local feedback technology is that the non-linearities of the different amplifying stages will be too large to make a high dynamic range linear amplifier for amplifying both weak and strong signals. Often the linearity when amplifying weak signals can be sufficient, but the linearity will decrease when amplifying large signals, because of the voltage and current dependent non-linearities of the semiconductors used in the amplifying stages at high voltage swings and high output currents. The output impedance of the output stage will not be sufficiently low to make the frequency response flat when connected to a load with frequency dependent impedance, such as a loudspeaker. This will give frequency dependent amplitude deviations from flat frequency response, and hence a coloring of the amplifier's sonic signature dependent on the connected loudspeaker load.

Digital Class-D Amplifiers

Compared to linear power amplifier designs, digital class D or Pulse Modulation Amplifier (PWMA) have several well documented measurable technical shortcomings:

Power output in real loudspeaker load is significantly lower than power output in resistive loads under 'lab type' measurements.

Reliability problems in practical use are often experienced due to burned output MOS switching transistors. These switches are difficult to protect from complex speaker loads.

The complex switching power conversion stage is difficult to design and implement and will generate a significant amount of switching noise disturbing the feedback error correction system.

Switching of the main power supply will introduce large amounts of timing-jitter giving signal dependant distortion.

The low-pass reconstruction filter in series with the amplifier output will give a significant output impedance, giving frequency response deviations when driving real loudspeaker loads because of the speakers impedance variations with frequency. Feedback in the digital modulation based systems is not possible.

Significant EMI considerations are necessary in amplifier design and system implementation.