Goldmund White Paper

TELOS AMPLIFIERS
GOLDMUND ACOUSTICAL GROUNDING TECHNOLOGY

The circuit designs, electrical concepts, and construction techniques used in Goldmund amplifiers.

It may come as a surprise that many of the most important technical advances made by Goldmund have come in the field of audio amplification, an area in which many circuit designs have changed so little in many decades.

In order to eliminate time distortion—an unnatural delay of higher audio frequencies relative to lower ones—Goldmund amplifiers have a bandwidth of approximately 3 MHz, roughly 100 times that of a typical audio amplifier. Through a Goldmund amplifier, a 20 kHz tone is delayed only 100 ps relative to a 20 Hz tone. This is a performance no other audio amplifiers can match.

Goldmund engineers have devised special protection circuits that enable the company's amplifiers to deliver their extremely high power safely and to preserve both the amplifiers themselves and the speakers to which they are connected. Goldmund's unique Mechanical Grounding technology practically eliminates sound-smearing vibrations inside the amplifier. Finally, as part of its Proteus project, Goldmund is now using digital audio processing inside its amplifiers to compensate for the driver characteristics and positioning of its speakers.

Bandwidth

All audio amplifiers are capable of reproducing the full range of audible sound from 20 Hz to 20 kHz. However, these amplifiers do not allow audio signals to pass without alteration. In order to prevent a damaging phenomenon known as oscillation, almost all amplifiers incorporate filters that block frequencies above the audio range. Although these filters may not affect the linearity of the amplifier within the audio band, they have a significant and measurable effect on the phase of sounds within the audio band.

As a result, the treble frequencies are shifted in phase—in other words, delayed—relative to the midrange and bass frequencies. Such phase and timing errors do not exist in nature; whether you are listening to the sound of a voice, a violin, or a jet engine, all frequencies emerge from the source simultaneously and arrive at your ear simultaneously. Thus, the brain is particularly sensitive to timing and phase errors.

Goldmund engineers have found out that audio amplifiers must have a bare minimum of 10 times the bandwidth of audible sound in order to avoid plainly audible phase errors. In order to prevent any possibility of phase error, we have increased the bandwidth of our amplifiers to approximately 3 MHz, more than 100 times the audible bandwidth of sound. Thus, phase errors in the audible range cannot be measured or heard.

Delivering such extended bandwidth from a high-powered amplifier is a difficult engineering exercise. It starts in the amplifiers' power supplies, which in Goldmund amplifiers must deliver the full output potential within a mere 400 ns.
To achieve this goal, the power supply uses multiple smaller transformers in the place of a single large one. Smaller transformers charge and discharge more quickly than larger transformers, and produce tighter, better-contained magnetic fields that are less likely to interfere with other amplifier components. Instead of using one or two large, slow-acting capacitors for power storage and filtering, Goldmund uses dozens of faster, smaller capacitors.

Because Goldmund amplifiers have a bandwidth normally associated with high-frequency radio broadcast equipment, even the spaces between the components and the circuit-board traces are critical. Errors in these design parameters would result in filtering of high frequencies and, therefore, phase errors; they could even introduce the possibility of amplifier malfunction. Thanks to their years of experience and experimentation, Goldmund's engineers are among the few capable of designing these high-power, high-bandwidth circuits.

Acoustical Grounding

An amplifier's ability to move a speaker cone forward or backward is important, but so is its ability to stop a speaker cone from moving.

Speaker cones are, in effect, spring-loaded; thanks to the compliance of the surround and spider that attach the cone to its basket, a cone can bounce back and forth, an effect that smears audio transients. Fortunately, an amplifier can act as a brake on a moving cone. This is what we call "driver control" or, even more appropriately "Acoustical Grounding".
After the electrical force from the amplifier moves the speaker cone, the spring action of the cone's suspension pulls it back to its original position. As a result, the driver's voice coil moves in conjunction with the driver's magnet, generating electricity that flows back into the amplifier.

Ideally, an amplifier's output would appear as a perfect short circuit to any electrical energy flowing back into it. It would thus block the generation of electricity and act as a brake on the moving cone. Without such damping, the cone would "ring", or oscillate back and forth until the energy built up in the cone's suspension is dissipated. The measure of an amplifier's ability to prevent such oscillation is referred to as damping factor; thanks to the acoustical grounding technology developed by our acoustic laboratory, the damping factor of a Goldmund amplifier is greater than that of any typical audio amplifier.

Protection circuitry

In the audio field, Goldmund amplifiers are unique in their ability to deliver extremely high power—up to 5,000 W in the case of the Telos 5000—at the extremely high speed necessary to achieve a 3 MHz bandwidth. In order to prevent dangerous malfunctions inside the amplifier, and to prevent damage to the speakers connected to the amplifier, Goldmund has developed the most advanced protection circuits found in any audio amplifier.

Amplifier protection circuits must work quickly, detecting and rectifying problems before they can be heard, and before they can damage a speaker. In a conventional amplifier, these circuits must react at a fraction of the 0.05 ms it takes for a 20 KHz signal to rise to its peak power. In a Goldmund amplifier, with a rise time of 400 ns (or 400 billionths of a second), the protection circuit does its work within a mere 40 ns.
The protection circuits temporarily shut down the amplifier if any of four conditions are present: an output overload (power above the amplifier's maximum rating appearing at the output terminals), a thermal overload (temperatures hot enough to damage the amplifier's output transistors), or the presence of excessive high- or low-frequency energy at the amplifier's input or within its circuitry. None of these circuits is connected directly to the audio circuitry, so none can affect the sound of the amplifier.

Thermal grounding

Heat is the principal enemy of performance and reliability in an amplifier. It is well known that heat can destroy electronic and electrical components. What is not so well known is that it changes the value of resistors and the gain of transistors, thus forcing the circuit to deviate from the ideal performance its designers intended.
Goldmund amplifiers minimize heat buildup by mounting the MOSFET output transistors on a large, gold-plated copper heat transmitter that carries heat away from the transistors more quickly than a traditional aluminum heat sink can. The transistors are mounted using specially treated Kapton isolators, which provide a higher thermal transfer rate than typical mica isolators.

We also use proprietary technology in our resistors to maintain consistent performance through a wide range of temperatures.

Goldmund Media Room Application

The Telos circuit appears in all the Media Room amplifiers called the U-Telos. Each of these revolutionary amplifiers includes:

- 1 D/A Convertor board using the Alize 7 Goldmund D/A technology,
- 1 DSP board giving each channel its own frequency and time response parameters (so it includes the crossover of the attached speaker),
- 1 Telos amplifier board, of the latest technical evolution.

The advantage of the U-Telos for the Media Room is that each speaker is treated individually, keeping a possible multiplication of the channels up to one channel per speaker.

In addition, the DSP circuit is used to monitor the playback level of each individual driver in order to protect it against overload and maintain its long term integrity.
All of the U-Telos installed in a media room are linked by an Ethernet connection to the central room controller which can detect any anomaly and advise the service center without interrupting the room functioning.

Latest Development of the Telos Technology

In 2010, the latest Telos amplifiers, the Telos 350 and Telos 3500, include an optional pluggable DSP board, just like the U-Telos amplifiers of the Goldmund Media Room. Connectable to a laptop by an USB connector, the future DSP board will allow Amplitude, Phase and Delay to be adjusted to set the Telos 350 and Telos 3500 in any configuration, including a complete Media Room environment.